The COVID-19 pandemic, problematic internet use, post-traumatic stress and mental health

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The COVID-19 pandemic, problematic internet use, post-traumatic stress and mental health

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Editorial: The COVID-19 pandemic, problematic internet use, post-traumatic stress and mental health

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KEYWORDS

COVID-19, pandemic, internet use, post-traumatic stress, mental health

Editorial on the Research Topic
The COVID-19 pandemic, problematic internet use, post-traumatic stress and mental health

The COVID-19 pandemic has caused significant loss of life and disruptions to daily activities worldwide, which can be traumatic and have short-term and long-term effects on mental health. Although public health measures such as social distancing, quarantine, and lockdowns can facilitate disease control, they may exacerbate feelings of fear, worry, stress, and social isolation, leading to mental health issues. While the internet has become increasingly important in coping with pandemic-related stress, excessive reliance on it may lead to problematic internet use and associated health risks. This Research Topic curated a collection of papers that are representative of current trends and advances in discussing and investigating the complex relationships among internet use, COVID-19 related stress and mental health issues.

The Research Topic has shown that COVID-19 has had a significant impact on mental health in different populations worldwide. For example, in Italy, 20–30% of ICU patients infected with COVID-19 exhibited depression or anxiety and perceived stress at 1 month and 6 months after discharge from hospital. At 6 months, 7% of patients showed post-traumatic stress symptoms (Carola et al.). In China, adults experiencing self-infection or close contact reported the highest levels of distress compared to those who experienced neighborhood infection or family member infection (Xiong et al.). COVID-19 survivors also reported stress related to stigma and discrimination in intimate social relationships, workplaces, and children's schools, with sexual minorities who were involved in mass disease transmission experiencing a higher level of stigmatization (Kang et al.). The impact of COVID-19 on mental health was not limited to those who were infected, but also extended to the general public and medical professionals. Over 20% of college students reported depressive symptoms during the pandemic (Luo et al.). In addition, Liu et al. investigated the sleep quality, fatigue, and mental workload and their contributing factors among clinical first-line nurses working in three tertiary hospitals. It was reported that 49% of nurses' mental workload was severely affected by COVID-19, and 68.9% of nurses' sleep quality was slightly

affected (Liu et al.). Addressing these COVID-19 related mental health and stigma issues is crucial as such knowledge will help to prevent related issues in future emerging pandemics.

Furthermore, internet use during the pandemic has played a mixed role in mental health. On one hand, internet use caused a series of mental health issues and behavior problems. For example, Zhang et al. found that attachment anxiety affected smartphone addiction among university students during the COVID-19 confinement, with teacher-student relationships and school connectedness mediating the relationship. Among school teachers, problematic gaming had stronger negative influence than problematic social media use on their psychological distress during online teaching due to COVID-19 (Chen et al.). On the other hand, several studies reported a protective effect of internet use during the COVID-19 pandemic. Teng found mobile internet use significantly alleviated mental distress in Chinese adults through trust and happiness. Huang et al. reported that the online risk information ground factors significantly affect online users' perceptions of health risks, and trust in official media was linked to reduced depressive symptoms. They highlighted the importance of fostering public trust in official media through rapid dissemination and transparency of information in mitigating the negative impact of COVID-19 (Huang et al.).

Future research directions on this topic should focus on several key areas. First, more intervention studies are needed to identify effective strategies to cope with mental health, behavioral health, and stigma issues during and after pandemics. The COVID-19 pandemic has highlighted the need for innovative and effective interventions (e.g., digital health techniques, transdiagnostic interventions) to support mental health in the unusual circumstances such as quarantine and lockdowns, which have challenged the applicability of conventional interventions. Research in this area can help identify strategies that are most effective in the context of pandemics. Second, more longitudinal studies are needed to establish the causal relationship between internet use and mental health outcomes given the mixed findings from existing cross-sectional studies. Third, social and health minority groups deserve particular attention as the pandemic

may have added extra burdens to their life (e.g., intersectional stigma, health equity). Last but not least, there is a need to better understand the underlying mechanisms that link internet use and mental health outcomes and the reason for its mixed role. This may involve exploring factors such as the purpose of internet use, the source and the reliability of online information. Since internet use has become an indispensable part of everyday life, research in this area is important to delineate the relationship between internet use on mental health outcomes and the potential mechanisms in order to inform best practices on education and training, health promotion and early identification of internet users of at-risk mental health.

Author contributions

XY: Writing—review and editing. QL: Writing—original draft. KC: Writing—review and editing. AMSW: Writing—review and editing. MR: Writing—review and editing. XW: Writing—review and editing. GZ: Writing—review and editing.

Conflict of interest

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

Publisher's note

Attachment anxiety and smartphone addiction among university students during confinement: Teacher–student relationships, student–student relationships and school connectedness as mediators

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Learning at home during the COVID-19 confinement might affect students' relationships with their peers, teachers, and schools and increase the possibility of smartphone addiction. We hypothesized that attachment anxiety directly and indirectly affects smartphone addiction, with teacher–student relationships, student–student relationships, and school connectedness as mediators. The participants were 999 university students from different regions of China. The results showed that six of the paths were significant except the one between student–student relationships and smartphone addiction. Also, the association between attachment anxiety and smartphone addiction was mediated by teacher–student relationships and school connectedness not but student–student relationships. The current study highlights the mediating effect of school connectedness and teacher–student relationships in the multiple mediation model, and suggests that universities can alleviate the risk of smartphone addiction in distance teaching by cultivating good teacher–student relationships and strengthening students' sense of belonging to their schools.

KEYWORDS

COVID-19, attachment anxiety, smartphone addiction, student-student relationships, teacher-student relationships, school connectedness

Introduction

On December 31, 2019, Chinese health officials initially notified the World Health Organization's (WHO) Beijing office that a cluster of pneumonia cases of unclear origin had appeared in Wuhan, the capital of Central China's Hubei Province (1). On February 11, 2020, WHO formally designated the virus COVID-19, short for "coronavirus disease 2019" (2). COVID-19 caused a large-scale outbreak of new pneumonia, which shut down

Wuhan for 76 days. Since early 2020, COVID-19 has emerged and spread rapidly on a global scale, with serious impacts on public health and social life in various countries (3). Until 5 July 2022, it has killed 6 million people and infected 500 million more around the world (4). Many universities around the world have stopped traditional in-person teaching and have implemented online teaching models (5). As the pandemic continues to spread, the landscape of education is experiencing rapid changes with an undefined time course (6), and learning at home may remain normalized for some time to come. People are spending much more time on smartphone than they did pre-outbreak, with nearly 30% online for more than 5 h a day (7). But it is unclear whether the risk of smartphone addiction might increase when students were learning at home during confinement.

Smartphone addiction is a phenomenon where individuals indulged in smartphone-based activities and had strong desire and dependency on their smartphones (8). Several studies have introduced other terms such as problematic smartphone use (9), mobile phone addiction (10), addictive smartphone behavior (11). In the current study, we decided to use the term "smartphone addiction" to describe the condition.

As a common source of behavioral addiction, smartphone addiction can cause severe damage to both physical and mental health. University students nowadays are digital natives who have grown up surrounded by smartphones (12). However, the key changes in their psychological and brain development have not yet been completed, making them more vulnerable to the impact of smartphone addiction (9). Extensive use of smartphones may lead to sleep disorders (13) and may also affect emotions and cognition. A high level of smartphone addiction is associated with anxiety, depression, impulsivity, and other types of mental distress among university students (14).

Therefore, numerous studies have focused on the causes of smartphone addiction. Depression, low self-esteem, loneliness, and shyness may contribute to smartphone addiction (15, 16). As a personality trait, attachment style is also an important predictor of smartphone addiction. An anxious attachment style has been shown to be positively related to smartphone addiction (17). Many studies have reported the indirect effects of attachment style on smartphone addiction, with typical mediators including emotions (18, 19), psychological distress (20–22), and relationships (10, 23).

Different from western university students, Chinese university students are accommodated uniformly by their schools, with four to eight students sharing the same dormitory and often hanging out together. In addition, students often participate in school activities as a unit of class, with a strong collective. As adolescents grow into independent adults, physical proximity to parental attachment figures becomes less important (24). Thus, compared with primary and middle school students, the role of university students' relationships at school exceeds that of family relationship. The quarantine policies and home-based learning brought

by COVID-19 have led to social distancing and damage to human relationships (25), maybe with greater influence on ones with anxious attachment style. The level of attachment anxiety in Chinese university students has been on the rise in recent years (26), and individuals with high attachment anxiety tend to have more conflicts in their relationships (27). Primary human relationships include interpersonal relationships and organizational relationships (28). The need to quarantine at home during the pandemic has led to students spending long periods far away from the university campus, during which time they mainly communicate with their teachers and schoolmates online, which might influence their relationships with peers, teachers, and schools. Then, the damage of relationships might drive them to depend alternatively on smartphones for possible consolation (10). However, no study has explored how these "relationships" mediate the association between attachment anxiety and smartphone addiction during confinement. We focused on Flores' (29) theory, which states that the higher the level of attachment anxiety, the more difficult it is to satisfy the relationships with others, leading to various types of addiction. We anticipated that attachment anxiety would influence smartphone addiction via relationship factors such as interpersonal and organizational relationships. Therefore, in current study, we explored how teacher–student relationships, student–student relationships, and school connectedness mediate the relationship between attachment anxiety and smartphone addiction among university students. We sought to build a conceptual framework based on the attachment theory: Chinese university students accustomed to collective life with attachment anxiety tend to have poor relationships with their peers, teachers and schools during the confinement period, and therefore lead to smartphone addiction. Based on the results, we aimed to develop a better understanding of the possible causes of university students' smartphone addiction during the confinement, to provide tangible solutions to alleviate the problem, and also to establish a foundation from which we and other researchers could make further investigation of the impact of attachment anxiety on smartphone addiction.

Anxious attachment style and smartphone addiction

Addiction is a manifestation of attachment disorder, and there is an inverse relationship between addiction and healthy interpersonal attachment (29). Attachment styles have frequently been referred to in studies of addictive behavior, and a growing number of studies (30) have examined the influence of attachment styles on technology addiction (20).

Attachment theory was proposed by the psychologist John Bowlby in the 1960s (31). The theory conceptualizes the tendency of humans to establish strong emotional ties with

intimate people. According to the theory, individuals who experience unwilling separation and loss are at risk of various forms of emotional distress and personality disorder, including anxiety, anger, depression, and emotional detachment (32). Attachment styles can be divided into secure attachment and insecure attachment, and the latter can be divided into anxious attachment and avoidant attachment (33). People with an anxious attachment style have a hyperactive attachment system and tend to seek constant support and comfort. People with an avoidant attachment style, in contrast, have a deactivated attachment system that leads to the inhibition of psychological and social relationship needs, which means that they deliberately maintain a clear distance from others (34). Unlike attachment avoidance, people with an anxious attachment style are more impacted during the confinement, because they are more invested in the relationship out of fear of being abandoned and alone (33).

Attachment anxiety has been reported to cause intensive and dysfunctional Internet and social media use, and is closely related to smartphone addiction (17, 35). People with attachment anxiety are afraid of being abandoned and are likely to engage in intimacy-seeking, relationship-related disclosure behaviors (36). If their relationships with family members and peers (30) do not satisfy their relationship needs, anxiety about being abandoned or rejected by others may drive them to use smartphones for comfort (10), which eventually increases the risk of addiction (19). Therefore, we theorized that students who are unable to return to campus or meet their teachers and peers at school during home quarantine find it hard to satisfy their attachment needs, which increases the probability of smartphone addiction. More specifically, we hypothesized that attachment anxiety directly affects smartphone addiction during the confinement, leading to our first hypothesis.

> **H1:** During the confinement period, attachment anxiety is positively related to smartphone addiction among university students.

Teacher–student relationships and student-student relationships as mediators of smartphone addiction

Numerous studies have examined how interpersonal relationships may contribute to smartphone addiction (37, 38). Individuals with high attachment anxiety are reported to get less social support and be less satisfied with the interpersonal relationships they build. They frequently worry that their friends will abandon them, so they try to be as emotionally close to others as possible. They could turn to smartphones for safety as a result of unhappy relationships (39). For example, individuals with high attachment anxiety frequently use their cell phones

to contact others in order to maintain stable relationships (40). They are more likely to be on social media and to be concerned about how others perceive them (41). Student-student and teacher–student relationships are important types of interpersonal relationships among university students (42). When emerging adults leave home for university, there is a gradual shift from parental attachment to peer attachment (43), which means that students are more likely to turn to their peers and teachers to satisfy their attachment needs (27). Although teachers' work is mainly focused on education, providing care and emotional support is also an important part of their role (44). Therefore, although a teacher–student relationship is not a complete attachment bond, it can create a certain sense of security for the student (45). In terms of student–student relationships, an insecure attachment style is negatively related to perceived peer support (46). Attachment anxiety can predict the quality of university students' peer relationships, which is manifested through friendship quality and the level of loneliness (27).

Meanwhile, the quality of interpersonal relationships is closely related to smartphone addiction. Studies have demonstrated both direct (47) and indirect (48) effects of teacher–student relationships on smartphone addiction. Specifically, perceived support from teachers can reduce problematic smartphone use by promoting students' self-esteem (47). Deviant peer affiliation, representing poor student–student relationships, is positively related to Internet game addiction (49). For the same reason, healthy student–student relationships are negatively associated with smartphone addiction (50). Based on our review of the relevant literature, we hypothesized that attachment anxiety would negatively predict a good interpersonal relationship and a tendency toward smartphone addiction:

> **H2a:** During the confinement period, attachment anxiety is negatively related to good teacher–student relationships, which in turn is negatively related to smartphone addiction. In other words, teacher-student relationships mediate the association between attachment anxiety and smartphone addiction.
>
> **H2b:** During the confinement period, attachment anxiety is negatively related to good student–student relationships, which in turn is negatively related to smartphone addiction. In other words, student-student relationships mediate the association between attachment anxiety and smartphone addiction.

School connectedness as a mediator of smartphone addiction

School connectedness is a composite variable describing students' psychological sense of safety and membership to

their school environment (51). The importance of school connectedness has been suggested because students need meaningful and supportive relationships outside of their family, and such bonds usually occur in the school environment (52). Attachment anxiety directly affects students' connectedness and life satisfaction, and individuals with insecure attachment styles are likely to experience difficulties in fulfilling their need to belong (53). Students with positive school connectedness enjoy their school life and have better sense of belonging in school (54). School connectedness has been shown to be a salient predictor of students' psychological wellbeing and prosocial behavior (55).

Also, students' feelings about school act as prominent predictors of smartphone addiction. For example, problematic Internet use is lower among students who show appreciation for their school than among those who do not (56); lower school connectedness is related to increased Internet game addiction (57); and maladjustment in school is associated with smartphone addiction (58). Given that school connectedness is likely to be weaker when students are far away from campus, we propose the following hypotheses in the context of the confinement. We hypothesized that school connectedness acts as a mediator in the relationship between anxiety attachment and smartphone addiction. This is based on the significant relationship between anxiety attachment and school connectedness, school connectedness and smartphone addiction, and anxiety attachment and smartphone addiction.

H2c: During the confinement period, attachment anxiety is negatively related to school connectedness, which in turn is negatively related to smartphone addiction. In other words,

student-student relationships mediate the association between attachment anxiety and smartphone addiction.

The hypothetical model is shown in Figure 1.

Materials and methods

Participants

In the worst year of the epidemic in China, most universities took quarantine measures. Due to the confinement policy, a two-stage sampling survey method was used, combining probability and non-probability sampling. Based on geographic position and socioeconomic development, China is divided into four major regions: Northeastern region, Eastern region, Central region, and Western region. Then, five typical administrative cities were selected from each region. The participants were recruited online *via* messages sent to undergraduate students through WeChat in 2020. To ensure the validity of the research, screening was performed to ensure the participants (1) were Chinese university students, (2) were studying at a university that conducted confinement policy requiring home study, and (3) possessed a smartphone. After screening, 1,052 eligible participants remained, but data from 53 of them were excluded because their response times were too short or their responses to different items were too similar, according to the standard practice for questionnaire-based research. Eventually, 999 participants (384 male and 615 female, $M_{age} = 20.05$, $SD_{age} = 1.175$, age range 17–29) provided valid data. We obtained
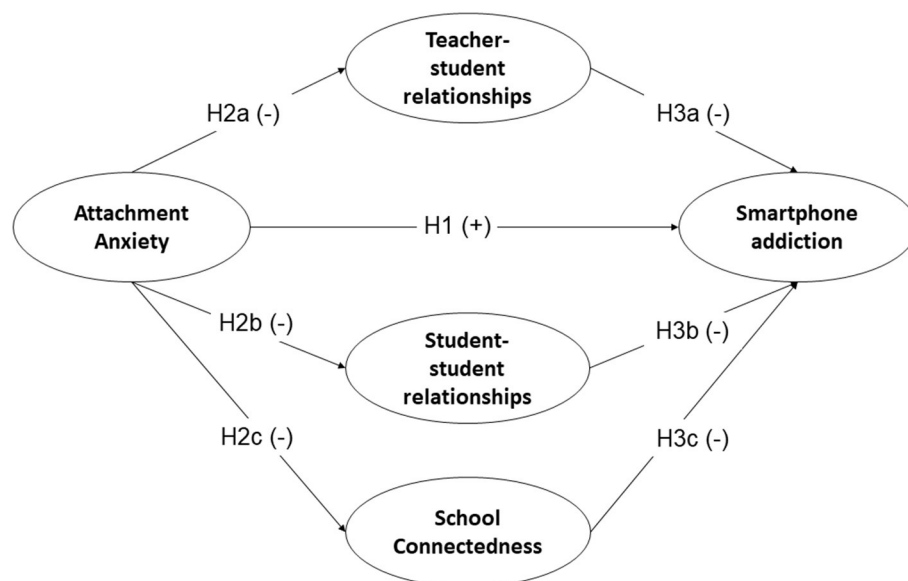
FIGURE 1
Hypothetical model. (+) Means a hypothesized positive association, and (−) means a hypothesized negative association.

Demographics		Frequency	Percentage
Gender	Male	384	38.4
	Female	615	61.6
Grade	Freshman	99	9.9
	Sophomore	262	26.2
	Junior	526	52.7
	Senior	112	11.2
School location	Northeastern region	302	30.2
	Eastern region	326	32.6
	Central region	161	16.1
	Western region	210	21.0
Home learning duration	<2 months	96	9.6
	2–3 months	158	15.8
	4 months or more	745	74.6

informed consent forms from all the participants and one from a 17-year-old participant's parents. This study was approved by the Research Ethics Committee of the corresponding's author's university.

The participants completed a questionnaire designed to collect information on demographic variables, attachment anxiety, teacher–student relationships, student–student relationships, school connectedness, and smartphone addiction. After completing the questionnaire, the participants received modest monetary compensation in return for their contribution to the study. 52.7% of the participants were junior and 26.2% were sophomore. More than half of the participants studied in Northeastern region and Eastern region. 74.6% of the participants experienced home learning exceeding 4 months. The detailed demographic information is shown in Table 1.

Measures

Covariates

The information about participants' gender, age, online course duration, and whether to use smartphone to access online courses were collected as covariates.

Attachment anxiety

Based on previous research on attachment styles (10), attachment anxiety was measured by four items selected from the Adult Attachment Scale (AAS). AAS was developed by Collins and Read (59) based on a scale created by Hazan and Schaeffer and updated in 1996 (e.g., "I often worry about being abandoned by my friends.") In China, this scale has been proven to be reliable (60). The participants indicated their agreement with each item on a 7-point Likert scale from 1 (not at all true)

to 7 (always true). A higher score means more severe attachment anxiety. In the current study, Cronbach's alpha for this scale was 0.925, indicating good reliability.

Teacher–student relationships during the confinement

Teacher–student relationships were measured by three items adapted from Pianta's (61) Student–Teacher Relationship Scale (STRS) and the Inventory of Parent and Peer Attachment (IPPA) developed by Armsden and Greenberg (62), which include items such as "During the confinement period, I could tell my problems and troubles to at least one teacher at school." Initially designed to evaluate peer and parent relationships, the IPPA has also been adapted to assess students' relationships with their teachers (22). The participants indicated their agreement with each item on a 7-point Likert scale from 1 (not at all true) to 7 (always true). A higher score means better teacher–student relationships. In the current study, Cronbach's alpha for this scale was 0.844.

Student–student relationships during the confinement

Student–student relationships were measured by three items adapted from the Inventory of Parent and Peer Attachment (62) (e.g., "Although we couldn't meet during the confinement period, my friends at school could tell when I was upset about something."). This scale was revised in 2011 and has been proven to be reliable in China (63). Responses were given on a 7-point Likert scale from 1 (not at all true) to 7 (always true) based on the participants' cognition of student–student relationships during the confinement. A higher score means better student–student relationships. In the current study, Cronbach's alpha for this scale was 0.885.

School connectedness during the confinement

School connectedness was measured using three items adapted from Resnick et al's. (64) School Connectedness Scale and the Program for International Student Assessment (PISA) student survey (Chinese version) (65). The items measure students' engagement at school and whether or not they feel part of their schools (e.g., "The lack of school atmosphere during the confinement period made me feel awkward and out of place."). The PISA questionnaire was used and demonstrated to be reliable in a previous study of students' connectedness to school (66). Responses were given on a 7-point Likert scale from 1 (not at all true) to 7 (always true) based on the participants' sense of belonging to school during the confinement. All three items were reverse coded, and a higher score means greater school connectedness. In the current study, Cronbach's alpha for this scale was 0.682.

Smartphone addiction during the confinement

Smartphone addiction was measured using five items adapted from Leung's (67) Mobile Phone Addiction Index (MPAI) and Young's (68) screening questionnaire (e.g., "During the confinement period, I used my smartphone to make myself feel better when I was feeling down."). Items were answered on a 7-point Likert scale from 1 (not at all true) to 7 (always true). A higher score means more severe smartphone addiction. In the current study, Cronbach's alpha was 0.890.

Data analysis

We conducted descriptive statistical analysis using SPSS version 19 to examine the characteristics of the participants and the measured constructs. Structural equation modeling (SEM) was performed with Mplus version 7 to test the relationships among the latent constructs.

Following a two-stage procedure (69), we first performed confirmatory factor analysis (CFA) to evaluate the measurement model, which verified the associations between the latent constructs and the observable variables by assessing the reliability and validity of the measurement tools.

Second, the structural equation model tested the relationships among the constructs by examining the standardized path coefficients. We performed a bootstrap procedure to test the mediation effects of our hypothetical model, as this has been shown to be a valid and powerful method of verifying mediation effects (70).

We also evaluated the fitness of the model using the chi-square test, degree of freedom (df), standardized root mean square residual (SRMR), Tucker–Lewis index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). TLI and CFI values > 0.90 and RMSEA values < 0.08 indicate an acceptable model fit (71).

Results

Examination of the measurement model

To evaluate the measurement model, we used Cronbach's alpha and composite reliability (CR) values to examine the reliability of the constructs. According to Fornell and Larcker (72), CR values above 0.700 represent good composite reliability. In the current study, Cronbach's alpha ranged from 0.682 to 0.925, and the CR values ranged from 0.784 to 0.927, suggesting that the reliability of the latent constructs was good or acceptable (see Table 2).

To test the validity of the measurement model, convergent and discriminant validity were evaluated. Convergent validity was evaluated by the average variance extracted (AVE) of each construct. The AVE values ranged from 0.548 to 0.762 (see Table 2), and all were above the recommended value of 0.500 (72), thus indicating good convergent validity. To evaluate discriminant validity, we compared the square root of the AVE with the absolute values of the correlation coefficients between each construct and the other constructs. According to Table 3, the square roots of the AVE of each construct were larger than the absolute values of the correlation coefficients between constructs. Therefore, discriminant validity was also acceptable.

Examination of the structural model

The structural model was analyzed to test the relationships between the constructs. The hypothetical model and path coefficients (standard errors) are shown in Figure 2. According to the path coefficients, attachment anxiety was positively related to smartphone addiction ($\beta = 0.29$, $p < 0.001$), thus confirming **H1**. The paths between attachment anxiety and teacher–student relationships (**H2a**, $\beta = -0.10$, $p = 0.014$), attachment anxiety and student–student relationships (**H2b**, $\beta = -0.23$, $p < 0.001$), and attachment anxiety and school connectedness (**H2c**, $\beta = -0.38$, $p < 0.001$) were all statistically significant, thus supporting **H2a**, **H2b,** and **H2c**. Teacher–student relationships (**H3a**, $\beta = -0.13$, $p = 0.001$) and school connectedness (**H3c**, $\beta = -0.41$, $p < 0.001$) were both negatively associated with smartphone addiction, thus confirming **H3a** and **H3c**. However, the path between student–student relationships and smartphone addiction (**H3b**, $\beta = 0.04$, $p = 0.370$) was not significant, thus **H3b** was not confirmed. Only one of the seven paths in the model was not significant. The hypothetical model provided a good fit to the data ($\chi^2 = 1011.215$; df = 196; SRMR = 0.081; TLI = 0.914; CFI = 0.925; RMSEA = 0.065).

Verification of the mediation effects

The bootstrap method was used to test the indirect effects of attachment anxiety on smartphone addiction. The indirect effects of the three mediators (teacher–student relationships, student–student relationships, and school connectedness) in the hypothetical model were estimated with 10,000 randomly assigned samples from the original data (Table 4). The mediation effects of teacher–student relationships and school connectedness were both significant because the 95% confidence intervals did not include zero, thus confirming **H4a** and **H4c**. However, the mediation effect of student–student relationships was not significant as the 95% confidence interval included zero ($p = 0.383$); thus, **H4b** was not confirmed. Comparison of the mediation effects among the three constructs showed that the contrast between the mediation effects of teacher–student relationships and school connectedness was significant ($p < 0.001$), implying the existence of different mediation effects on the relationship between attachment anxiety and

TABLE 2 Descriptive statistics, reliability, and validity of constructs.

	Mean	SD	Cronbach's α	CR	AVE
Attachment anxiety	2.736	1.543	0.925	0.927	0.762
Teacher–student relationships	3.891	1.536	0.844	0.880	0.710
Student–student relationships	4.511	1.484	0.885	0.904	0.759
School connectedness	4.435	1.476	0.682	0.784	0.548
Smartphone addiction	3.608	1.478	0.890	0.896	0.637

CR, composite reliability; and AVE, average variance extracted.

TABLE 3 Construct correlations and discriminant validity.

	1	2	3	4	5
1. Attachment anxiety	**0.873**				
2. Teacher–student relationships	−0.077*	**0.842**			
3. Student–student relationships	−0.212**	0.435**	**0.871**		
4. School connectedness	−0.312**	0.254**	0.191**	**0.740**	
5. Smartphone addiction	0.428**	−0.188**	−0.135**	−0.432**	**0.798**

**p < 0.01, *p < 0.05, and the square roots of the AVE were shown in bold.

FIGURE 2
Multiple mediation model. Path values are the standardized path coefficients (standard errors); ***$p < 0.001$, *$p < 0.05$. Gender, age, online course duration, and whether to use smartphone to access online courses were controlled.
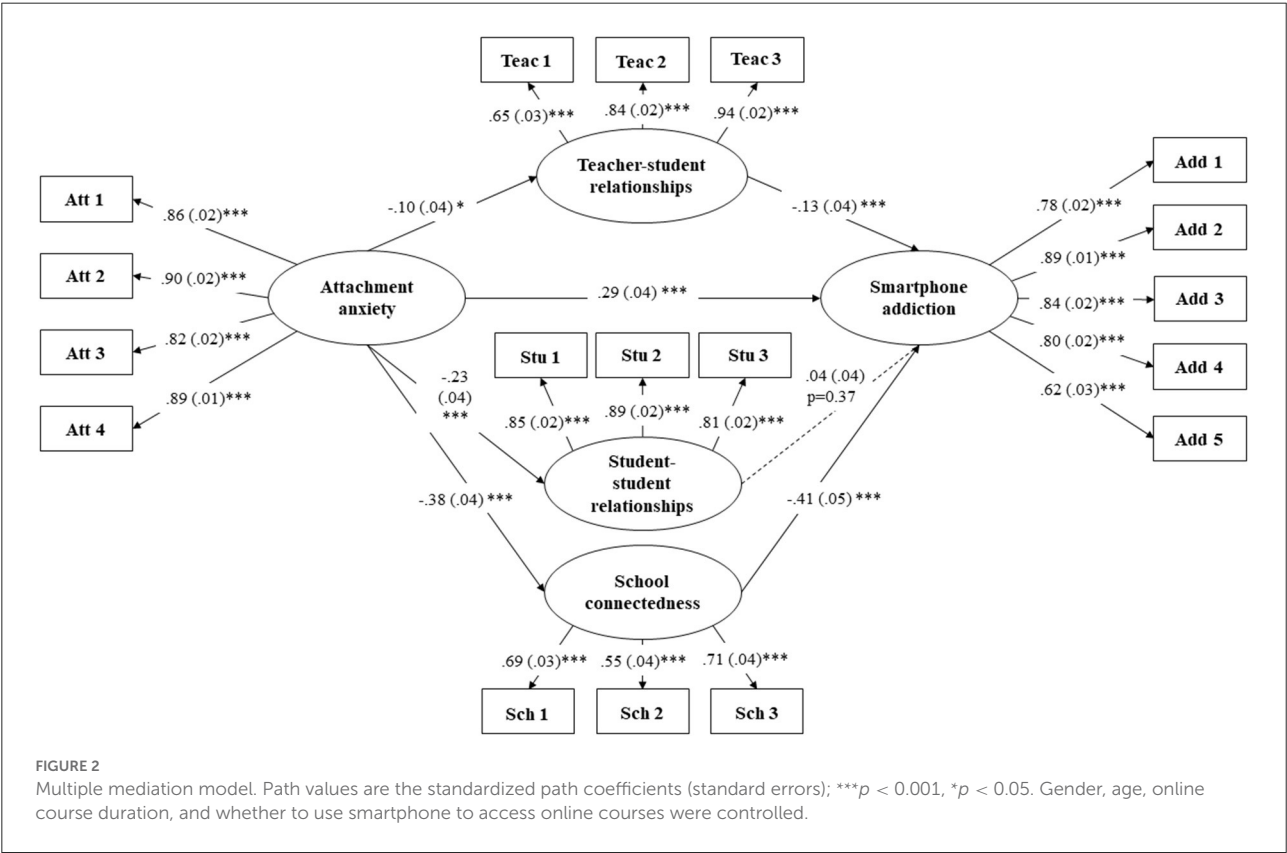
TABLE 4 Specific indirect effects.

| | Point estimate | Product of coefficients | | | Bootstrap (10,000 samples) | | | |
| | | | | | BC 95% CI | | Percentile 95% CI | |
		S.E.	Est./S.E.	P	Lower	Upper	Lower	Upper
Indirect effects								
Teac	0.012	0.006	1.880	*	0.003	0.028	0.002	0.026
Stu	−0.008	0.009	−0.872	0.383	−0.027	0.009	−0.027	0.009
Sch	0.144	0.026	5.556	***	0.100	0.202	0.098	0.199
Total	0.148	0.028	5.381	***	0.100	0.208	0.098	0.206
Contrasts								
Teac vs. Stu	−0.020	0.012	−1.605	0.108	−0.048	0.001	−0.046	0.002
Teac vs. Sch	−0.133	0.026	−5.022	***	−0.190	−0.087	−0.188	−0.085
Stu vs. Sch	−0.152	0.028	−5.446	***	−0.213	−0.104	−0.210	−0.101

Teac, teacher–student relationships; Stu, student–student relationships; Sch, school connectedness; BC, bias corrected. *** $p < 0.001$, * $p < 0.05$.

TABLE 5 Hypotheses and conclusions.

Hypotheses	Conclusion
H1: Attachment anxiety → Smartphone addiction	Confirmed
H2a: Attachment anxiety → Teacher–student relationships	Confirmed
H2b: Attachment anxiety → Student–student relationships	Confirmed
H2c: Attachment anxiety → School connectedness	Confirmed
H3a: Teacher–student relationships → Smartphone addiction	Confirmed
H3b: Student–student relationships → Smartphone addiction	Not confirmed
H3c: School connectedness → Smartphone addiction	Confirmed
H4a: Attachment anxiety → Teacher–student relationships → Smartphone addiction	Confirmed
H4b: Attachment anxiety → Student–student relationships → Smartphone addiction	Not confirmed
H4c: Attachment anxiety → School connectedness → Smartphone addiction	Confirmed

smartphone addiction. Table 5 shows that most of our hypotheses were verified.

Discussion

The COVID-19 pandemic may have normalized home quarantine. For Chinese university students who are accustomed to collective life, especially those with high attachment anxiety, the confinement policy would affect their relationships with peers, teachers and schools. Then, smartphone addiction might be used to make up for the lack of these relationships. However, there has been no research on whether learning during the confinement period, which affects both interpersonal and organizational relationships, is associated with the severity of problematic smartphone use. Based on attachment theory and previous studies, the current study established a multiple mediation model between attachment anxiety and smartphone addiction among university students during the COVID-19 pandemic.

Our results showed that attachment anxiety was positively associated with smartphone addiction, demonstrating that students with higher attachment anxiety are more likely to develop smartphone addiction. This finding is in line with that of Han et al. (17), who also found that attachment anxiety was positively related to mobile phone addiction. Attachment anxiety was also associated with smartphone addiction through multiple mediators. We believe that university students' excessive smartphone use serves as a kind of emotional compensation for their failed interpersonal and organizational relationships during home quarantine. According to previous research, emotional compensation occurs when people seek to adjust their emotions to balance what they perceive to be an inappropriate response from others (73). This finding can help to shed light on the present study: when students were unable to gain attachment satisfaction in their relationships with peers, teachers, and schools, they were highly likely to turn to their smartphones for emotional compensation.

The mediating effect of teacher–student relationships during the COVID-19 confinement

We found that attachment anxiety was negatively associated with good teacher–student relationships. Meanwhile, teacher–student relationships had a negative influence on smartphone addiction, which is in line with the study by Peng et al. (47), which found that teachers' support for students' autonomy reduced students' problematic smartphone use. Teacher–student relationships were a significant mediator in our study.

These results suggest that during the COVID-19 pandemic, university students with high attachment anxiety tend to have poor relationships with their teachers, which increases the potential for problematic smartphone use.

The mediation effect of teacher–student relationships implies that unlike face-to-face regular periods, students with a high level of attachment anxiety tend to lack interactions and bidirectional emotional exchanges with their teachers during home quarantine. They try to compensate for their sense of emptiness and insecurity through the use of smartphones, and excessive use can easily lead to smartphone addiction. The mediating effect demonstrates that teacher–student relationships have an important role in preventing smartphone addiction. The findings also imply that if teachers provide care and support to enhance their relationships with students, students will be less likely to develop smartphone addiction during the confinement.

The mediating effect of student–student relationships during the COVID-19 confinement

As expected, attachment anxiety was negatively associated with student–student relationships. This suggests that in the confinement students with high attachment anxiety are likely to have poor relationships with their school peers. Previous studies (74) have found that student–student relationships are negatively correlated with addictive behavior, whereas healthy student–student relationships can alleviate addiction. However, similar to Ihm's (75) study, we found no significant association between student–student relationships and smartphone addiction; therefore, the mediating effect was also non-significant. This suggests that even though university students with attachment anxiety tend to have problematic student–student relationships, they are unlikely to compensate for the lack of companionship by excessively using their smartphones.

We believe that student–student relationships failed to mediate the relationship between attachment anxiety and smartphone addiction because the policy of home quarantine served as an external attribution source. In the absence of face-to-face communication, students with attachment anxiety have a reasonable explanation for the lack of concern and understanding from their peers, and the sense of loss caused by online alienation from school peers seems more acceptable than feeling isolated offline. In addition, without face-to-face communication, individuals can still perceive the presence of their school peers through multiple channels, such as "liking" and commenting on their social media posts. In contrast, during the confinement, online courses are almost the only way for students to perceive the existence of their teachers and

schools, and to maintain their relationships through interaction with them.

Individuals with attachment anxiety are prone to show aggressive behavior after being treated unfairly (76). They also hold contradictory attitudes toward their attachment figures, exhibiting dependent and rejecting behaviors simultaneously (30). Therefore, if the need for security is unsatisfied, individuals with attachment anxiety tend to behave in extreme ways and try to impose their psychological pain on their attachment objects. Students who perceive neglect and threat from their school peers during home quarantine may respond in this way, which is actually facilitated by distance and online communication. However, when individuals believe that they have been unfairly treated by their schools and teachers, it is difficult for them to retaliate and they may turn to their smartphones to vent their emotions. Furthermore, this study only focused on student–student relationships in the school context. During the confinement, students can compensate for the loss of companionship at school by strengthening their relationships with their neighborhood peers. Hence, it is understandable that no significant relationship was found between student–student relationships and smartphone addiction.

The mediating effect of school connectedness during the COVID-19 confinement

Similar to teacher–student relationships, school connectedness was negatively correlated with attachment anxiety and smartphone addiction. School connectedness also significantly mediated the relationship between attachment anxiety and smartphone addiction. These findings indicate that students with high attachment anxiety tend to lack school connectedness during the confinement, which could lead to smartphone addiction. In contrast, university students with strong school connectedness are less likely to develop smartphone addiction in the confinement period.

When away from school during quarantine, students have little direct contact with their schools. The lack of interaction and participation in school life can lead to university students feeling detached from their schools. Students in Chinese universities are provided with uniform housing, and they typically socialize in dorms of four to eight people. Students who board on campus can focus more on their studies, form better relationships with others, and feel more connected to the school (77). The lack of parental love and care may also be partially made up for by the campus community. The safety and health of students with high attachment anxiety, as well as the development of wholesome living and studying practices, are also ensured by school policies, peer supervision,

and teachers' guidance (78). It is critical to cultivate a student-first campus culture and a diversified boarding life, where students can express emotions, learn to collaborate, and deal with peer relationships through numerous school activities (79). Generally speaking, Chinese universities have complete, student-oriented facilities with varied activities and caring living arrangements to provide emotional support for students. However, the quarantine policies and home-based learning brought by COVID-19 forced students to leave school suddenly. If universities are not able to provide good services, varied activities, and more supervision during the confinement via the internet, there is a greater chance that students will become addicted to their smartphones. If schools could introduce more measures to increase the sense of belonging during the confinement period, smartphone addiction could be alleviated to a great extent.

Contrasting mediation effects

A multiple mediation model was established in this study. Examination of the mediation effects revealed significant differences between teacher–student relationships and school connectedness, and student–student relationships and school connectedness. The contrasting mediation effects indicate that these two mediators relieve smartphone addiction rather differently.

The literature review suggested that teacher–student relationships often appear to be part of the school relationship. Relationships with teachers and school peers have been used to measure students' relational maladjustment in school (58). In the current study, we examined school connectedness in the same dimension as interpersonal relationships with teachers and school peers. The significant difference in mediation effects between school connectedness and teacher–student relationships confirms our expectation that teacher–student relationships can operate as an independent mediator. Teachers and schools alleviate smartphone addiction differently. Positive relationships with teachers can provide students with warmth and security, which may satisfy their psychological needs and in turn relieve their Internet addiction (48). Likewise, encouraging school appreciation (56) and strengthening school connectedness can offer students a sense of participation and security that could help to prevent smartphone addiction.

Although student–student relationships did not have a significant mediation effect, there was a significant difference in mediation effects between student–student relationships and school connectedness. This highlights the importance of the mediating effect of school connectedness in the multiple mediation model, and suggests that a strong sense of school connectedness is more helpful than student–student relationships in alleviating students' mobile phone addiction.

Conclusion

In the context of the COVID-19 pandemic, we explored the multiple paths between attachment anxiety and smartphone addiction using the framework of attachment theory. A multi-mediation model was established, and we found that attachment anxiety both directly and indirectly affected smartphone addiction among university students. Teacher–student relationships and school connectedness served as significant mediators of smartphone addiction. However, student–student relationships was not associated with smartphone addiction during the confinement period.

The literature on attachment styles and addiction focuses mainly on interpersonal, especially parental and peer, relationships (80). Although school connectedness has also been widely mentioned (54, 81), most studies have merely emphasized the interaction between the sense of connectedness and interpersonal relationships (82, 83). As far as we are aware, few studies have taken school connectedness as an organizational relationship and examined it in the same dimension as interpersonal relationships. Our findings show that attachment anxiety is not only related to interpersonal relationships but can also influence organizational relationships.

Students with high attachment anxiety use smartphones to compensate for feelings of emptiness and loss. If individuals with attachment anxiety find it difficult to perceive personal relationships or school connectedness in reality, they may become addicted to smartphones, specifically activities centered on relationships (e.g., online games or SNS).

Psychologists specializing in the prevention and treatment of smartphone addiction are likely to focus on the obsession with smartphones, unaware that students may be suffering from high attachment anxiety, perceiving poor personal relationships, and lacking school connectedness during their confinement on COVID-19. Excessive smartphone use can be attributed to maladaptive coping strategies or relational factors; therefore, prevention and treatment should concentrate on relational factors such as interventions to improve teacher-student relationships and school connectedness, and adaptive coping strategies. Recognizing and managing those relational factors, in the future, may help to alleviate the problem of smartphone addiction among university students when they are unable to attend school. On the one hand, students should be aware that smartphone addiction is more likely to occur in distance learning or e-learning and consciously avoid the threat. On the other hand, universities should pay attention to the efficiency and practicability of distance teaching, focus on cultivating good relationships between teachers and students, and enhance students' sense of belonging to their schools. Creating a sense of security and participation for students, so that they may fully perceive the existence of their teachers and schools even when they are away from campus, should help to reduce the possibility of smartphone addiction to a great extent.

Despite our innovations and contributions, a few limitations of this study should be taken into account. First, the use of an online self-report survey led to some limitations, although an offline study was not possible because of the pandemic. For instance, the participants were not selected through probability sampling only; rather, the questionnaires were collected online and the results were screened. In addition, self-report bias is always a possibility with self-report questionnaires. Second, this was a cross-sectional study based on a retrospective design and was thus subject to the inherent limitations associated with retrospective analyses. Compared with prospective studies, the cause–effect relationships are uncertain in a retrospective design. The variables cannot be manipulated and observed systematically, which may lead to inaccurate conclusions. Third, the data were collected from a single country and are only representative of Chinese university students; thus the study lacks a multicultural perspective in the context of the global pandemic. Whether the research results can be applied to other cultural contexts remains unknown. Fourth, we did not examine relationships other than teacher–student relationships, student–student relationships, and school connectedness in the present study. For example, parental relationships and the presence of other cohabitants may also have an effect on the conclusion during home study, which could be incorporated in future studies. Also, assessing the severity of smartphone addiction using only five items is another limitation of the present study.

Data availability statement

The datasets generated and analysed during the current study are not publicly available due to the consideration of participants' privacy, but are available from the corresponding author on reasonable request.

Ethics statement

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

Author contributions

FZ and WZ analyzed data and wrote the main manuscript text. QZ and ZL were responsible for investigation and data curation. All authors reviewed 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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Appendix

TABLE A1 Measurement items and factor loading.

Construct	Item	Loading
Attachment anxiety	Att 1. I often worry about being abandoned by my friends.	0.872
	Att 2. I often worry that my friends don't really care about me.	0.898
	Att 3. I find others are reluctant to get as close as I would like.	0.824
	Att 4. I often worry that my friends will not want to stay with me.	0.895
Teacher–student relationships during the confinement	Teac 1. During the confinement period, I could tell my problems and troubles to at least one teacher at school.	0.797
	Teac 2. During the confinement period, most teachers made me feel that they were concerned about my studies.	0.849
	Teac 3. During the confinement period, most teachers made me feel that they were concerned about my daily life.	0.879
Student–student relationships during the confinement	Peer 1. Although I couldn't meet my schoolmates during the confinement period, they still cared about how I was feeling.	0.863
	Peer 2. During the confinement period, I could count on my friends at school when I needed to get something off my chest.	0.903
	Peer 3. Although we couldn't meet during the confinement period, my friends at school could tell when I was upset about something.	0.847
School connectedness during the confinement	Sch 1. During the confinement period, I didn't feel like I belonged at school. (Reverse scored)	0.776
	Sch 2. I wish I had studied at another school during the confinement period. (Reverse scored).	0.697
	Sch 3. The lack of school atmosphere during the confinement period made me feel awkward and out of place. (Reverse scored)	0.746
Smartphone addiction during the confinement	Add 1. During the confinement period, I used my smartphone for increased amounts of time to achieve satisfaction.	0.821
	Add 2. During the confinement period, I used my smartphone to make myself feel better when I was feeling down.	0.863
	Add 3. During the confinement period, I attempted to spend less time on my smartphone but was unable to.	0.861
	Add 4. During the confinement period, I felt anxious and lost when I hadn't turned on my smartphone for some time.	0.804
	Add 5. During the confinement period, my family and friends complained about my use of the smartphone.	0.614

Psychological health in COVID-19 patients after discharge from an intensive care unit

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Along with physical changes, psychological changes are detectable in patients with COVID-19. In these patients, the stressful experience of intensive care unit (ICU) hospitalization may aggravate psychological conditions. Our study examines the short- and long-term psychological consequences of COVID-19 in ICU patients. COVID-19 patients completed the self-rating questionnaires *Kessler 10 Psychological Distress Scale* (K10), *Perceived Stress Scale-10* (PSS), *Impact of Event Scale Revised (*IES-R), and *Post-traumatic Growth Inventory (*PTGI) and were clinically interviewed 1 and 6 months after discharge. Altered behavioral-psychological symptoms and patients' strategies (adaptive vs. maladaptive) for *coping* with stress during and after hospitalization were coded during clinical interviews. Between 20 and 30% of patients showed moderate symptoms of depression or anxiety and perceived stress 1 and 6 months after discharge. Sleep problems, difficulty concentrating, confusion in placing events, and fear of reinfection were observed in many (6–17%) patients. At 6 months, only 7% of patients showed PTSD symptoms, and 50% showed post-traumatic growth in the "appreciation of life" sub-scale. Finally, 32% of subjects were classified as "maladaptive coping patients," and 68% as "adaptive coping patients." Patients who adopted "adaptive" coping strategies showed significantly lower levels of anxious-depressive symptoms and perceived stress when compared to subjects with "maladaptive" strategies at both time points. Coping strategy had no effect on PTSD symptoms or post-traumatic growth at 6 months. These findings clarify the short- and long-term psychological effects of intensive care due to COVID-19 infection and demonstrate that patient characteristics, particularly strategies for coping with stress, seem to play a critical role in psychological outcomes.

KEYWORDS

SARS-CoV 2, COVID-19, clinical psychology, K10, perceived stress, state anxiety, intensive care unit

Introduction

The novel coronavirus 2019 (COVID-19) pandemic has generated worldwide alarm. COVID-19 infection causes respiratory disease ranging from mild—or pauci-symptomatic—to fatal (1). Since its outbreak, COVID-19 has infected more than 300 million people and resulted in over 5 million deaths (2). Italy was one of the first countries to be severely impacted by COVID-19; more than 8 million confirmed cases and more than 130 thousand deaths were recorded in Italy as of December 2021 (2, 3).

COVID-19 affects both physical and psychological health. The post-acute phase of disease is often characterized by physical and psychological sequelae ranging from respiratory difficulty, cardiovascular abnormality, and prolonged infirmity to neurological and psychological (including cognitive and behavioral) complications (1). Psychological stressors, such as fear of illness, uncertainty about the future, traumatic memories of severe illness, and social isolation, may foster psychopathological outcomes, which, in turn, may worsen a patient's general medical condition (3, 4). Furthermore, studies suggest that coronaviruses can indirectly induce psychopathological sequelae *via* an immune response as well as by direct viral infection of the central nervous system. COVID-19 can cross the blood-brain barrier and infect the central nervous system (CNS), resulting in both short- and long-term neurological and neuropsychological sequelae (5–11). There is increasing evidence that while people with mild or moderate COVID-19 infection generally develop only respiratory symptoms, some patients with severe infection also develop neurological conditions like confusion, stroke, and even infectious toxic encephalopathy and viral encephalitis (12).

COVID-19 has a significant emotional impact on patients due to both the characteristics of the virus itself and its psycho-physical-social consequences. COVID-19 survivors often develop psychiatric distress such as insomnia, along with anxious, depressive, and even post-traumatic psychological reactions (11, 13, 14). Younger age, chronic disease, or a history of psychiatric illness may contribute to the development of depressive and anxious symptoms during the pandemic, while more social support, including physical and psychological assistance, is correlated with lower stress levels (13, 15–20).

In 5–11% of cases, COVID-19 infection causes medical complications, chiefly acute respiratory failure, that necessitate hospitalization in an intensive care unit (ICU) (21); treatment of ARF (22) often involves mechanical ventilation. ICU care can have a major impact on the psychological wellbeing of patients (23). The ICU environment can be stressful, with the noise of medical devices, constant lighting, ongoing alarms, and staff working under pressure. Some studies suggest that sounds alone can contribute to sleep and mood disturbances (24, 25). ICU patients have limited freedom of movement, and especially patients in need of ventilation support may have difficulties communicating. During invasive and prolonged medical interventions, patients under sedation often have impaired perception, and they may experience altered mental states including delirium. Such experiences in an ICU may themselves become a specific risk factor for the development of psychopathology and for a reduction in psychological wellbeing and quality of life. Studies suggest that patients are at a heightened risk for experiencing psychological symptoms during and following an ICU stay (26, 27). During the first year of recovery after an ICU stay, approximately one third of survivors experience symptoms of anxiety and depression, and about a fifth experience clinically important symptoms of PTSD (26, 28–33). In a systematic review (28), the median point prevalence of questionnaire-assessed substantial PTSD symptoms was 22%, and the median point prevalence of clinician-diagnosed PTSD was 19% assessed from ≈6 weeks to 7 years, though most studies had PTSD assessments within the first year post-ICU. Pre-ICU psychopathology, greater in-ICU benzodiazepine administration, and post-ICU memories of frightening and/or psychotic experiences in the ICU might predict the onset of post-traumatic syndrome after discharge (28, 34). While it is well known that ICU admission can result in PTSD, literature on the short- and long-term consequences of ICU admission specifically for COVID-19 is lacking.

Traumatic experiences like ICU hospitalization can also lead to positive developments. This phenomenon is known as post-traumatic growth (PTG), defined as the subjective experience of a significantly positive change for an individual following a major life crisis. PTG can follow many different types of traumatic event, such as bereavement (35), combat (36), or cancer (37).

Patients' coping strategies during adaptation to trauma may have a dramatic impact on their general recovery. Adaptive coping strategies, i.e., problem-centered strategies that help the individual openly face and internalize the traumatic event, correlate with better outcomes (38–40). On the other hand, maladaptive coping strategies, aimed at the reduction of tension *via* the activation of specific defensive mechanisms, are likely to worsen the patient's current conditions and prognosis (40–43).

Literature on the psychopathological sequelae of COVID-19 patients after ICU hospitalization is still largely lacking. Longitudinal data at 3 months after discharge are rare (44–46), and, to our knowledge, longer-term data are non-existent.

We found little evidence of published studies related to PTG in COVID-19 patients (47–49) particularly with samples of COVID-19 patients after discharge from the ICU (49).

Similarly, we found no studies on the use of adaptive vs. maladaptive coping strategies in COVID-19 patients after ICU hospitalization.

We hypothesize, first, that the experience of COVID-19 infection may be a risk factor for the development of anxious, depressive, and PTSD symptoms; second, that post-traumatic growth may occur following recovery from COVID-19; and third, that psychopathological outcomes may be moderated by coping strategies adopted by the patients.

Materials and methods

Participants

All patients ($N = 71$) who were infected with COVID-19 and admitted to the ICU of the Sant'Andrea University Hospital in Rome (73.5% men, 26.5% women), between November 2020 and May 2021, were included in this study. Patients completed self-assessment questionnaires and were clinically interviewed 3 months (Timepoint 1, T2) and 5–6 months (Timepoint 2, T2) after discharge. Psychological interviews were included in a general medical screening after discharge. The subjects' mean age was 60 years, and the age range was 34–85 years.

Prior to enrolment, all participants were given a complete description of the study and provided written informed consent. The patients were interviewed and screened for psychological symptoms using questionnaires. The study was approved by the Ethical Committee of the Department of Dynamic and Clinical Psychology, Sapienza, University of Rome (Prot. n. 0000144).

Psychometric tools

Questionnaires were administered online or, for patients who had difficulty with digital tools, face-to-face before the interviews. At the first time point, 1–3 months after discharge, patients completed the Kessler 10 Psychological Distress Scale (K10) and Perceived Stress Scale (PSS) questionnaires. At the second time point, 5–6 months after discharge, the same patients completed the K10 and PSS questionnaires again and, in addition, the Post-Traumatic Growth Inventory (PTGI) and Impact of Event Scale Revised (IES-R) questionnaires. At the second time point, 10% of patients in the first sample were excluded from the second interview because they had begun psychotherapy.

Kessler 10 psychological distress scale

K10 (50), a 10-item questionnaire, provides a global measure of distress experienced in the previous 4 weeks. We used the validated Italian translation (51). Each item is scored on a 5-point Likert scale: 1 ("never"), 2 ("rarely"), 3 ("some of the time"), 4 ("most of the time"), or 5 ("all of the time"). To be consistent with previous validation studies (50, 52), patients who scored between 20 and 24 were considered mildly distressed, and patients who scored between 27 and 40 were considered highly distressed.

Perceived stress scale-10

PSS (53), a 10-item questionnaire, measures the degree to which one perceives aspects of one's life as uncontrollable, unpredictable, and overwhelming. Participants are asked to respond to each question on a 5-point Likert scale ranging from 0 (never) to 4 (very often), indicating how often they have felt or thought a certain way within the past month. Scores range from 0 to 40, with higher composite scores indicative of greater perceived stress. Patients were considered to have intermediate perceived stress if they scored between 18 and 26, whereas they were considered to have high perceived stress if they scored between 27 and 40. The PSS possesses adequate internal reliability (53).

Post-traumatic growth inventory

PTGI (54) is a 21-item inventory that assesses the positive psychological change that may occur after a traumatic experience. We used the validated Italian translation (55). Participants are asked to respond to each statement on a 6-point Likert scale ranging from 0 ("I did not experience this change as a result of my crisis") to 5 ("I experienced this change to a very great degree as a result of my crisis"), with intermediate scores of 1 ("a very small degree"), 2 ("a small degree"), 3 ("a moderate degree"), and 4 ("a great degree"). The PTGI assesses patient growth on five sub-scales: relating to others, new possibilities, personal strength, spiritual change, and appreciation of life. Patients' scores were compared to scores obtained by an Italian normative sample (55). Mean of the normative reference sample was for "appreciation of life" 7.66 ± 4.37, for "personal strength" 9.48 ± 5.64, for "relating to others" 14.12 ± 9.13, for "new possibilities" 10.38 ± 7.07, and for "spiritual change," 3.33 ± 3.36. The test-retest reliability (alpha) of the PTGI is 0.71 and its internal consistency is 0.90 (55).

Impact of event scale revised

IES-R (56), a 22-item questionnaire, assesses the magnitude of symptomatic response in the past 7 days to a specific traumatic life event. This version of the IES comprises three dimensions: avoidance, intrusion, and hyperarousal. We used the Italian validation (57). Participants are asked to report their degree of distress during the past 7 days on a 5-point Likert scale: 0 (not at all), 1 (a little bit), 2 (moderately), 3 (quite a bit), or 4 (extremely). Given the timing of PTSD onset assessable 1 month after the traumatic event (58), we assessed the presence of post-traumatic symptoms only at the second time point.

Clinical assessment

Clinical interviews were conducted within a medical screening process prepared by the ICU and investigated the following areas:

- general anamnestic information
- sleep quality before, during, and after hospitalization
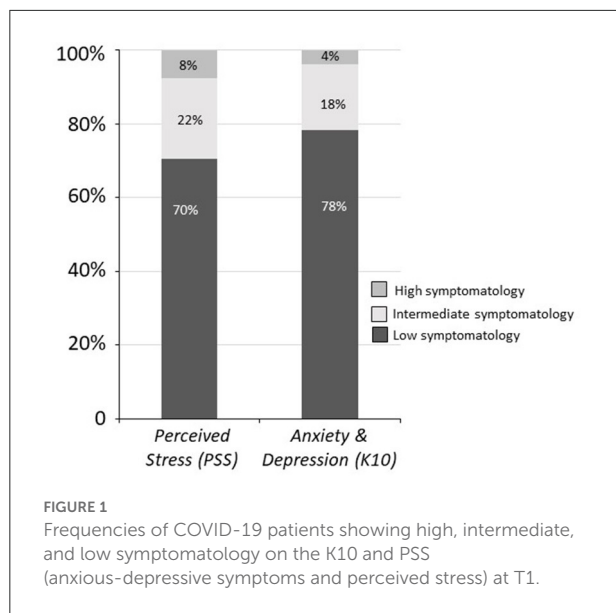
- post-traumatic symptomatology
- spiritual faith and its possible supporting role for the patient
- memories and experiences of hospitalization
- current psychological state.

Frequency tables of reported behavioral-psychological symptoms were developed from the content of the interviews.

Adaptive and maladaptive coping strategies employed by the patient during and after hospitalization were investigated during the clinical interviews. Coping strategies are behaviors implemented by individuals to deal with stressful or traumatic situations. In accordance with the literature (38, 59), we define adaptive coping strategies as problem-centered strategies (such as active coping, planning, and social support). Maladaptive coping strategies are strategies aimed at reducing tension (such as avoidance, denial, and emotional release). Assessment of coping strategies from the content of the interviews was performed independently by four different certified psychologists. Indicators of post-traumatic growth were also assessed from the interviews.

Statistics

Count data were expressed as frequency and percentage. Measurements were described by the mean and standard deviation. Repeated-measures analyses of variance (RM-ANOVA) were performed to assess the long-term effects of ICU admission due to COVID-19 on anxious-depressive symptoms (from the K10) and stress-related variables (from the PSS). One-way analyses of variance (ANOVAs) were performed to

evaluate the impact of coping strategy on anxious-depressive and PTSD symptoms (from the K10 and IES-R), perceived stress levels (from the PSS), and post-traumatic growth (from the PTGI). Significant RM-ANOVAs and ANOVAs ($P < 0.05$) were followed by *post-hoc* comparisons using Duncan's test. Statistical analyses were carried out using Statistica, version 12.0 (StatSoft, Tulsa, OK, USA).

Results

Anxious-depressive symptoms, perceived stress levels, and behavioral symptoms

To assess the levels of anxious-depressive symptoms and perceived stress in COVID-19 patients at the first time point, the frequencies of scores on the K10 and PSS were evaluated. Twenty-two percent of patients exhibited medium to high levels of anxious-depressive symptoms (sample mean ± SD: 16.85 ± 6.25; Figure 1). A larger percentage (30%) of patients showed medium to high levels of perceived stress (11.48 ± 9.32; Figure 1). Based on questionnaire results and each patient's psychological condition according to the clinical interview, 10% of patients were referred for psychotherapy and excluded from the assessment of psychological symptoms at the second time point.

To evaluate whether levels of anxiety-depression and of perceived stress had changed between the first and second time points, two repeated-measure ANOVAs were performed on the scores from the K10 and the PSS. No significant change in the level of anxious-depressive symptoms was detected between time points (Figure 2). Time had a statistically significant effect on PSS scores; levels of perceived stress were lower at time point 2 than at time point 1 (Figure 2).

The frequency of other behavioral symptoms was also recorded during the clinical interviews at the first time point. Specifically, 17% of patients reported sleep problems, 9% reported active inhibition of ICU memories, 7% reported confusion in temporally placing events, 7% reported short-term memory problems, 14% reported concentration problems, and 6% reported fear of being infected again (Table 1).

Long-term PTSD symptoms and post-traumatic growth

In order to detect PTSD symptoms at the second time point, the frequencies of scores on the IES-R questionnaire were recorded. Only 7% of patients showed a score above the clinical cutoff of 33; the majority of the sample showed no symptoms or moderate symptoms (total IES-R = 12.09 + 12.33; Table 2, Figure 2).

FIGURE 2
A reduction of the perceived stress levels **(A)**, but no change in anxious-depressive symptoms **(B)**, measured respectively by PSS and K10, was observed in COVID-19 patients between Time point 1 and Time point 2. 70% of patients obtained a score between 0 and 15, 23% obtained a score between 16 and 32, and only 7% of patients scored above the clinical cut-off for PTSD symptoms measured by IES-R at Timepoint 2 **(C)**. *$P < 0.05$.

TABLE 1 Frequency of behavioral symptoms recorded during the clinical interviews at time point 1.

Symphoms post ICU	% Patients
Sleep problems	17
Active inhibition of ICU memories	9
Confusion in temporally placing events	7
Memory problems (short-term)	7
Concentration problems	14
Fear of being infected by Covid again	6

TABLE 2 Descriptive statistics of the IES-R and PTGI sub-scales (mean + st.dev.).

Measure	M	SD
PTGI- Relating to others	11.61	9.81
PTGI-New possibilities	7.02	7.31
PTGI-Personal Strength	6.82	6.13
PTGI-Spiritual Change	2.59	3.39
PTGI-Appreciation of Life	6.75	4.69
IES- Avoidance	0.48	0.57
IES-Intrusiveness	0.66	0.68
IES-Iperarousal	0.50	0.57

The presence of PTG on each of the PTGI sub-scales was evaluated at the second time point (Table 2, Figure 3). The fraction of patients who scored at or below the normative reference sample on each sub-scale was 48% % for "appreciation of life," 68% for "personal strength," 66% for "relating to others," 73% for "new possibilities," 66% for "spiritual change."

Impact of active vs. passive coping strategies on PSS, K10, IES-R, PTGI scores

Qualitative analysis of clinical interviews at the first time point classified 32% of patients as "maladaptive coping patients" (8M and 3F; age 63.20 ± 11.29) and 68% as "adaptive coping patients" (22M and 5F; age 60.92 ± 10.66). Four ANOVAs were performed to assess whether the coping strategy was associated with anxious-depressive symptoms and levels of perceived stress at each of the two time points. Coping strategy had a statistically significant effect on both scores at both time points; "adaptive coping patients" showed significantly lower levels of anxious-depressive symptoms and perceived stress than "maladaptive coping patients" at both time points (perceived stress, time point 1: $F_{(1,65)} = 11.91$, $p < 0.001$; perceived stress, time point 2: $F_{(1,37)} = 7.85$, $p = 0.008$; anxiety-depression, time point 1: $F_{(1,65)} = 21.51$, $p < 0.001$; anxiety-depression, time point 2: $F_{(1,37)} = 8.90$, $p = 0.005$; Figure 4).

ANOVAs were performed to assess whether coping strategy was associated with PTSD symptoms and PTG levels at the second time point. Coping strategy showed no significant effect on PTSD or any of the PTG sub-scales.

Qualitative analysis of clinical interviews

The perception of post-traumatic growth, along the six dimensions of the PTGI, was investigated through qualitative analysis of the clinical interviews. The subjects' accounts provided an overview of the type of post-traumatic growth present in the sample and its characteristics.
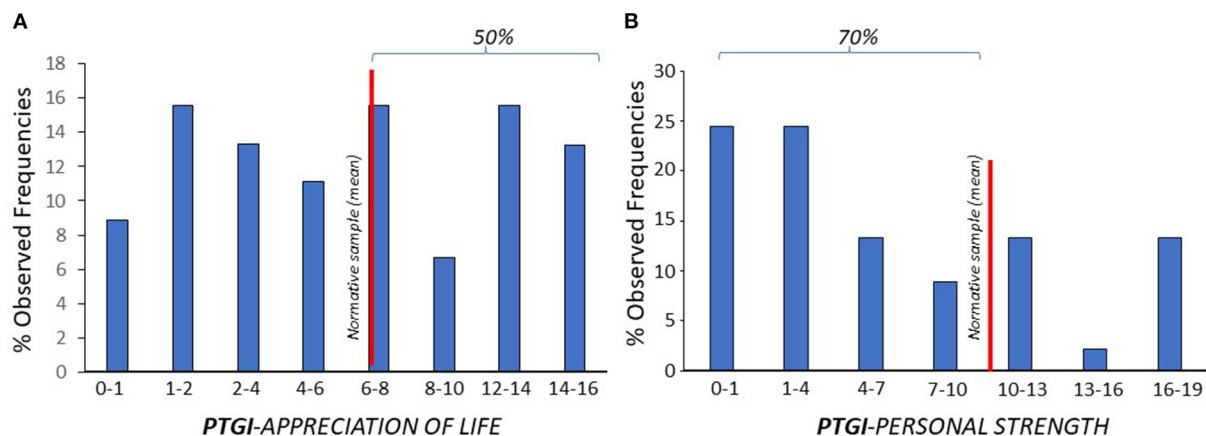
FIGURE 3
The fraction of patients who scored (% observed frequencies) at or below the normative reference sample (red line) was 48% for "appreciation of life" (**A**), and 68% for "personal strength" (**B**) subscales.
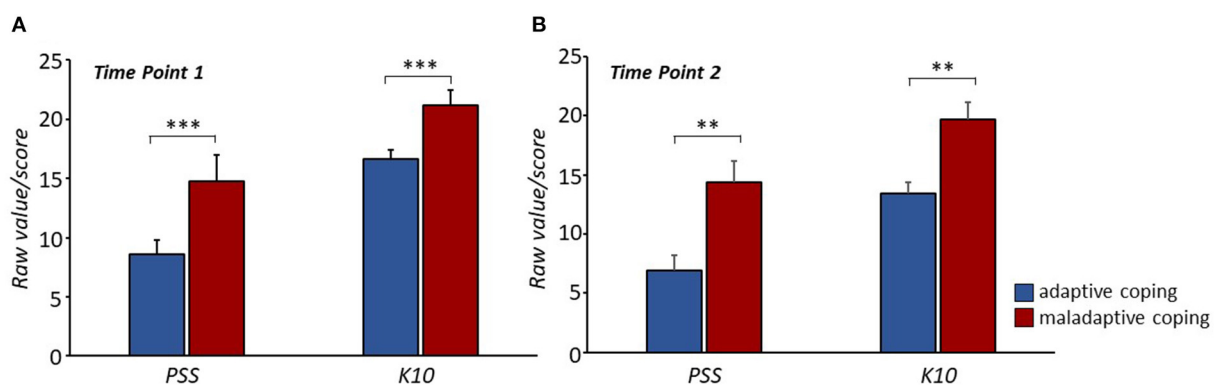
FIGURE 4
Significant lower perceived stress levels and anxious-depressive symptoms were observed in "adaptive coping patients" compared to "maladaptive coping patients" at both time points (**A, B**). **$P < 0.01$, ***$P < 0.001$.

Relating to others

Growth in "relating to others" was one of the clearest trends that emerged in clinical interviews. "Relating to others" refers to the propensity of survivors of a traumatic event to talk to family, friends, or fellow survivors, with whom survivors might feel a sense of closeness and connection. Growth along this dimension underscores the subject's greater sensitivity to interpersonal relationships and thus greater perception of appreciating and valuing them. For example, one of the interviews reported,

> (…) He acknowledges a high level of apprehension toward his wife and son after hospitalization and acknowledges that at times this is exacerbated by the lived experience (…) Reports that after discharge he is reconsidering priorities in his life, giving more space to his marital relationship and with his son (…).

Appreciation of life

"Appreciation of life" relates to how trauma clarifies what is truly important in the survivor's life. Having experienced a traumatic event can lead the survivor to reconsider the value of life, as well as the precarious balance between life and death. For example, one interview reported,

> (…) He can't wait to get back to work and wants to devote himself body and soul to patients, especially those in intensive care. He says he knows what it feels like in those conditions and how important even a caress or an extra word is in those places, so he wants to commit himself to this field. He feels that this has been an important life experience that has changed him for the better (…)

New possibilities

"New possibilities" was a prominent theme in the clinical interviews. "New possibilities" refers to the readiness of the survivor to experience new life scenarios following the traumatic event. The traumatic event and the experience of survival become the engine that pushes the survivor to live new realities, seek new experiences, and pursue new interests. For example,

> (...) If she had to go back, she would seriously think about being a nurse. She ended up being so motivated that we even talked about the possibility for her to volunteer in hospitals in the future (...). She feels it is her mission to tell everyone about what she went through there and the humanity she found, so that everyone can appreciate what the doctors and nurses at ICU do for us.

Personal strength

"Personal strength" was the area of post-traumatic growth most evident in the clinical interviews. "Personal strength" refers to the development of greater self-efficacy and capacity. The survivor of the traumatic event may feel greater confidence in their own actions and wisdom and therefore may feel more able of dealing with future events. In the interviews, participants reflected on their increased perception that they could cope with future challenges.

> (...) He feels that the ICU experience may have improved him because now when he faces a problem, he realizes that he is calmer because he knows that a solution can always be found (...)

Spiritual change

"Spiritual change" was not a prominent aspect of the post-traumatic growth experienced by participants. This dimension concerns an individual's connection to nature, to others, and to the world and the individual's understanding and acceptance of him/herself and others.

Discussion

Despite growing interest in the effects of the COVID-19 pandemic and of infection on mental health (60–62), many unknows remain. This study investigated the short- and long-term psychological effects of COVID-19 infection on patients who experienced acute illness and ICU admission. Among our patients, 22% exhibited moderate anxious and depressive symptoms, and 30% exhibited medium to high levels of perceived stress ≈1 month after discharge from the ICU. Levels of anxious and depressive symptomatology remained stable, while perceived stress levels in this sample decreased by ≈6 months after discharge. These findings are in line with many

studies that suggest that anxious and depressive symptoms result from hospitalization due to COVID-19 (13, 43, 63–65). A meta-analysis by Saidi et al. (66) found prevalence levels for symptoms of depression and anxiety at 45 and 47%, respectively, in hospitalized COVID-19 patients. Other studies have reported rates ranging from 18 to 30% within the first 3 months after discharge (44–46). Deng et al. (67) and Moayed et al. (68) found a prevalence of 46.6% for elevated perceived stress in patients infected with COVID-19. SARS and MERS patients admitted to the ICU experienced similar psychological distress that persisted even 6 months after discharge (15).

Our interviews revealed other relevant behavioral symptoms, including sleep disturbances, concentration problems, active inhibition of ICU memories, confusion in the temporal placement of events, short-term memory problems, and fear of re-infection. The presence of sleep-related disorders seems to be in line with data from previous studies (66) in which the prevalence of sleep disorders was 34% among COVID-19 patients. Consistent with our study, Poyraz et al. (45) found that a notable percentage of COVID-19 patients also reported behavioral symptoms after recovery, such as sleep disturbance and difficulty concentrating in 38.8 and 15% of the sample, respectively. A qualitative study (68) of patients admitted to the ICU for other medical causes found an absence of ICU-related memories at 3 months post-discharge, likely because the patients had been sedated. In our study a substantial percentage of COVID-19 patients complained of active memory inhibition in the ICU, even though they had been awake and conscious during hospitalization.

The experience of being hospitalized for COVID-19 has characteristics that make it a risk factor for the development of PTSD (28, 33). However, ICU admission for COVID-19 appears to be associated with relatively low prevalence rates of PTSD. In our sample, only 7% of patients reported PTSD symptoms. In a meta-analysis, Nagarajan et al. (69) found a 16% prevalence of PTSD among patients with COVID-19 infection that led to acute illness. By contrast, for coronaviruses SARS and MERS, the prevalence of post-admission PTSD was 39% (15). For other medical causes, the prevalence of PTSD after ICU admission is 19–22%, higher than but comparable to that for COVID-19 (28).

The potential for psychological growth after trauma is less well studied than the more physiological consequences of trauma (70, 71) and may add an important perspective to current thinking about trauma. PTG can be transformative; in the face of emotionally overwhelming and stressful events, individuals can commit their resources and skills toward overcoming adversity and emerge with a perception of an improvement in themselves (72–74). This process in survivors of intensive care for COVID-19 has been studied little. Our results agree with previous work (47–49) that PTG can be significant in patients who have experienced intensive care for COVID-19, even if it is accompanied by moderate psychological distress. We found significantly higher "appreciation of life" but lower "personal strength" among our sample relative to the Italian normative

sample. Less PTG in "personal strength" may make sense given the history of our sample. The feeling of helplessness and the lack of autonomy that ICU patients experienced during wakefulness may have contributed to lower self-efficacy, especially for managing future adverse events after hospitalization. The lower values of "personal strength" may also have been a consequence of "long COVID," defined as the persistence of fatigue and residual respiratory symptoms after recovery (75, 76). Previous studies have shown positive associations between COVID-19-related concerns and PTG in samples of U.S. civilians and veterans (70, 77). Others have reported high rates of PTG, especially in "appreciation of life" and "relating to others," in a sample of parents in Portugal during the pandemic (78). An assessment of PTG in hospitalized patients undergoing bone marrow and/or stem cell transplantation and palliative care (79, 80), found, as did our study, that "appreciation of life" was among the areas of most significant growth; the assessment also found no change in "personal strength." Finally, a study conducted by Holtmaat et al. (81) on cancer patients showed that the most impacted domain was "relating to others."

To investigate patient response to the experience of hospitalization in the ICU, we further assessed the coping strategies patients used during hospitalization and upon recovery. In our sample, 32% of subjects were classified as "maladaptive coping patients" while 68% were classified as "adaptive coping patients." Patients who adopted "adaptive coping strategies" showed significantly lower levels of anxious-depressive symptoms and PSS, compared to subjects with "maladaptive strategies." But coping strategy had no effect on PTSD symptoms or PTG levels. An association between adaptive coping style and lower risk of psychological distress has also been described in students during the COVID-19 pandemic (82). A lack of association between coping strategy and PTSD symptoms has been previously observed, as well (83). Although the relationship between coping strategies and PTG in COVID-19-infected populations is still not well established, our data appear to be at odds with recent research showing that coping strategies can influence PTSD and PTG in other contexts (49, 74, 84–87). Adaptive coping strategies, such as problem solving, were positively associated with high levels of PTG and negatively correlated with PTSD symptoms in military and civilian samples. Together, our findings and the wider literature suggest a complex relationship between coping strategy, PTG, and PTSD symptoms that should be further investigated.

Limitations

Our sample was small and not representative; the characteristics of the sample itself and of the pandemic more generally did not allow for the selection of an ideal experimental sample. Because of sample size, we did not perform statistical analyses controlling for demographic factors such as age groups, gender, and level of education.

Second, in our study we did not perform an evaluation of risk factors for the development of anxiety, depressive or stress symptoms following COVID-19 infection and ICU hospitalization. In fact, longer-term hospitalization (88), female gender (14, 89–91), perception of low social support (14, 88), previous psychiatric problems (89) and low oxygen saturation (92) are associated with increased psychological distress at discharge.

Third, coping strategy was assessed on a clinical basis by four independent expert clinical evaluators and psychologists, rather than *via* a standardized questionnaire.

Fourth, the study was limited by specific characteristics of the sample and the absence of a control group. Because our sample included only patients who had been admitted to the ICU for COVID-19, it was not possible to compare them either to patients who had experienced only COVID-19 infection or to patients who had experienced an ICU admission independently of COVID-19.

Finally, the patients in our original sample who were most psychologically compromised at the first time point were referred, for ethical reasons, to psychotherapy services and thus were excluded from the second phase of assessment in which PTSD and PTG were investigated.

Future perspectives

Future research should investigate whether the psychological effects of ICU hospitalization for COVID-19 resolve or persist over a longer timescale, especially in patients who used maladaptive coping strategies. Longitudinal studies should be performed at least 1 year after discharge from the ICU. In addition, comparisons should be made between patient groups like ours and (1) COVID-19 patients for whom ICU hospitalization was not necessary and (2) patients admitted to the ICU for other organic causes/pathologies. These controls would help clarify the independent effects of COVID-19 and ICU hospitalization.

Conclusions

This study provided an in-depth look at the short- and long-term psychological effects of the experience of intensive care for severe COVID-19. Results indicated that patient characteristics and patient coping strategies may play a decisive role in psychological outcomes. Moreover, this study showed that survival of COVID-19 together with ICU hospitalization may foster positive psychological growth, as well.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Ethical Committee of the Department of Dynamic and Clinical Psychology, Sapienza, University of Rome (Prot. n. 0000144). The patients/participants provided their written informed consent to participate in this study.

Author contributions

VC, CV, MR, MP and GN design the study and collected the data. VC, CV, and CM analyzed the data and designed the figures/tables. All authors wrote 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

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The adaption of the Chinese version of the COVID Stress Scales as a screening instrument of stress: Psychometric properties during the COVID-19 pandemic

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The COVID Stress Scales (CSS) was used to access related distress concerning Corona Virus Disease 2019 (COVID-19). Based on China's epidemic prevention and control policies during the COVID-19 pandemic, the adaption of the Chinese version of the CSS was developed. Our study evaluated the reliability and validity of the Chinese adapted version of the CSS during the COVID-19 pandemic. An online survey was employed to construct a national sample of 2,116 participants in Chinese mainland. We examined the factor structure, internal consistency, convergent validity, discriminant validity, and concurrent validity. The results demonstrated that the six-factor solution for the Chinese adaptation of the CSS proved a good fit with the data after comparing the factor structure with the five-factor model. The six-factor model had good reliability and supported good convergent, discriminant, and concurrent validity of the CSS Chinese adaption. Overall, our findings supported the Chinese adapted version of the CSS as a psychometrically sound measure of stress during the COVID-19 pandemic in China.

Introduction

The coronavirus disease 2019 (COVID-19) outbreak became a worldwide health emergency. In December 2019, the first cases of pneumonia of unknown origin were identified in Wuhan, China. The WHO confirmed a new coronavirus was the cause of pneumonia in Wuhan (1). The complexity and uncertainty of the pandemic threatened human physical health and mental health (2). Plenty of studies reported negative psychological effects such as posttraumatic stress symptoms, fear, and confusion (3). The stress caused by the virus increased during a lock-down period at home (4, 5). Besides, the resurgence of COVID-19 could exacerbate the psychological impacts

of the pandemic (6). Due to the social and economic uncertainty associated with the COVID-19 pandemic, certain groups such as young people and women had a risk of suicide during the height of the pandemic (7). Another study reported that people might experience mild to severe depression and anxiety symptoms while the outbreak continued (8). Their positive emotion progressively decreased over time (9).

In response to the unprecedented psychological impact of the current pandemic, Taylor suggested that developing a measure of COVID-19-related stress and anxiety was an urgent need during the pandemic (10). After examining the relevant literature and consulting experts, they developed the COVID Stress Scales (CSS) to measure COVID-19-related stress (10). The CSS contained six domains: (1) the worries about the dangerousness of COVID-19, (2) fears about COVID socio-economic consequences (e.g., fears of disruption in the supply chain), (3) COVID-19-xenophobia (e.g., fears that foreigners are sources of COVID-19), (4) the worries about being infected by COVID-19-related contamination (i.e., objects, surfaces), (5) traumatic stress symptoms (e.g., nightmares relating to COVID-19), and (6) COVID-19-related checking (e.g., checking news media). The initial psychometric evaluation of the CSS demonstrated good reliability, convergent and discriminant validity (10). The CSS total and subscale scores had shown high internal consistency and test-retest reliability, and the internal consistency of the total score had been reported as 0.95 (10). There were controversial about the factor structure. The initial development was constructed by examining relevant literature and consulting experts, which contained six domains. However, the results from the exploratory factor analysis (EFA) indicated a five-factor solution, COVID-related danger scale and contamination scale loaded on the same factor (10). The five-factor solution was also confirmed in other studies (11, 12). Although Taylor proposed a five-factor model of CSS that was based on a large collection of research evidence, plenty of studies applying confirmatory factor analysis (CFA) had shown a good fit for the six-factor model with the studied population (13–16). Besides, we found that the CSS-Arabic version supported the five-factor solution in the Egyptian and Saudi contexts (11). While it also supported a six-factor solution in a Palestinian context after excluding five items (14). Nevertheless, the CSS Spanish translation proved that the six-factor model was better than the five-factor model and the six-factor model fitted the data well (16). Above all the current studies which were proved to be valid and reliable were conducted in other cultural contexts, which hadn't been adapted and validated in the Chinese population during the COVID-19 pandemic. Standards for Educational and Psychological Testing recommended that evidence of validity should be clarified for each intended use of the test score among the targeted population and for specific procedures (17). It was necessary to confirm the factor structure in the Chinese context.

To reduce the rapid spread of COVID-19 across the world, China decided to suspend the entry into China by foreign nationals holding visas or residence permits temporarily on 26 March 2020 (18). Then a portion of foreign nationals was allowed to enter China after 23 September 2020 according to the announcement, but other measures in the Announcement issued on March 26 continued to be implemented (19). Regarding the epidemic prevention and control policies in China, the foreigners in the CSS xenophobia domain were defined as COVID-19-related personnel, including personnel living in high-risk areas or passing through them, the frontline medical staff, epidemic prevention workers, and other relevant personnel.

Briefly, the main goal of our study was to adapt the CSS to Chinese and to determine the psychometric properties of the Chinese population during the COVID-19 epidemic. Firstly, we explored the factor structure and compared the different factor structures of the adaptation of the Chinese version of the CSS. Additionally, internal consistency values were calculated for the reliability of the Chinese adapted version of the CSS. Psychometric studies of the Persian and Arabic versions of the CSS were based on the Classical Theory of Tests (CTT), which emphasized the evaluation of internal consistency and construct validity of an instrument in a general way (20). In our study, we used the CTT to evaluate the internal consistency and construct validity of the CSS Chinese adaptation (21). Average Variance Extracted (AVE), Composite Reliability (CR), and the square root of the AVE were used to assess convergent validity and discriminant validity. Finally, we calculated the correlations between the CSS and other scales including the Coronavirus Anxiety Scale (CAS), the Fear of COVID-19 Scale (FCV-19S), and depression anxiety stress scales (DASS-21) to examine its concurrent validity.

Methods

Participants and procedure

Over 1 week period in August 2021, a cross-sectional online survey was conducted in Chinese mainland through the WeChat public platform following the electronic research methodology guideline (22) to prevent the spread of COVID-19 through contact. All participants using WeChat might see this survey, and answer the questionnaire by scanning the two-dimensional barcodes of the questionnaire address or clicking the relevant link. Electronic informed consent was obtained from each participant before starting the investigation. All participants were provided with anonymity and confidentiality of their data, and they were informed about the nature, purpose, and procedure of the study. Participants could withdraw from the survey at any moment without providing any justification. This web-based questionnaire was completely voluntary and

non-commercial. Participants agreed to the online informed consent statement and completed the questionnaires. After completing the scales, every participant would receive a reward, which contained an individual report and reward (1-3 CNY randomly). The research was approved by the ethics committee of the Second Xiangya Hospital of Central South University.

To ensure the data quality, questionnaires were valid if they met the following criteria. The inclusion criteria included: (1) time for each item completion more than 2 seconds; (2) the participants aged 18 and above, and (3) the item responses were not consecutive identical. Finally, 2,116 questionnaires were included in the final analysis.

Measures

The COVID Stress Scales (CSS)

The CSS was a 36-item self-report instrument designed to assess COVID-19-related stress and anxiety symptoms over the past week. Items were scored on a 5-point Likert scale from 0 (not at all) to 4 (extremely). Higher scores indicated a higher level of stress. The transcultural and lingual adaption from English to Chinese was performed using Beaton and colleagues' methods (23). The translation process was composed of several steps based on the Brislin translation model (24).

We used a forward-backward translation. The translation procedures were as follows. Firstly, the CSS was translated from English into Chinese by two native Chinese-speaking researchers with high English proficiency from the research team independently. Subsequently, two psychology experts reviewed the translated version concerning its content accuracy, semantic equivalence, and sentence structure. Modifications were made after the group reached a consensus. Some minor revisions were made during the translation process. Lastly, the Chinese-adapted version of the CSS was back-translated into the English language again. The back-translated and original versions were compared to ensure accuracy. Our research team reviewed and checked the translation. Finally, the adaption of the Chinese version of the CSS was confirmed.

Considering epidemic prevention and control policies in China, the foreigners in the CSS xenophobia domain were changed to COVID-19-related personnel which included personnel living in or passing through high-risk areas, the frontline medical staff, epidemic prevention workers, and other relevant personnel. Six items of the xenophobia domain were adapted. The amended items were (a) " *I am worried that COVID-19-related personnel is spreading the virus*", (b) "*If I met COVID-19-related personnel, I'd be worried that they might have the virus*", (c) "*I am worried about contacting COVID-19-related personnel because they might carry the virus*", (d) "*If the COVID-19-related personnel doesn't take care of their hygiene, I'm worried they'll spread the virus*", (e) "*If I went to a restaurant where COVID-19-related personnel has been, I'd be worried about*

catching the virus", and (f) "*If I was in an elevator with COVID-19-related personnel, I'd be worried that they're infected with the virus*".

The Coronavirus Anxiety Scale (CAS)

The CAS was a 5-item self-report instrument designed to assess the levels of COVID-19 anxiety (25). The CAS had good reliability and validity (2, 26, 27). It was a brief mental health screener to measure current anxiety over the last 2 weeks. Items were rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (nearly every day over the last 2 weeks). In our study, Cronbach's alpha internal consistency coefficient was 0.95.

The Fear of COVID-19 Scale (FCV-19S)

The FCV-19S was a 7-item instrument to measure an individual's fear of COVID-19 (28). Items were scored on a 5-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). The higher score indicated a higher level of fear. The Chinese version of the FCV-19S had good internal consistency reliability (Cronbach's alpha = 0.92) and validity (29). In our study, Cronbach's alpha internal consistency coefficient was 0.95.

Depression Anxiety Stress Scales (DASS-21)

DASS-21 was a 21-item instrument to measure the experiences of depression, anxiety, and stress over the past week (30). It consisted of three subscales: depression, anxiety, and stress. Each subscale included seven items. Items were rated on a 4-point Likert scale ranging from 0 (not at all) to 3 (strongly agree). The scale had been validated in China (31). In our study, Cronbach's alpha internal consistency coefficient was 0.98.

Statistical analysis

Data were analyzed with the SPSS 26.0 and Amos 26.0. We assessed internal consistency reliability using Cronbach's alpha(α), McDonald's omega(ω), and the Spearman-Brown formula(accepted value $\geq$0.70) using the CTT (21). Values equal to or greater than $\alpha = 0.70$ $\omega = 0.70$ were considered satisfactory (32, 33). CFA was to test the hypothesized factor structures obtained from the Canadian and American samples (10) and the Arabic sample (14) separately. Model fit was assessed using comparative fit index (CFI), Tucker-Lewis index (TLI), normed fit index (NFI), incremental fit index (IFI), root-mean-square-error of approximation (RMSEA), and standardized root-mean residual (SRMR). The CFI, NFI, IFI, and TLI values $\geq$0.90 suggested the good fit model (34). Additionally, the RMSEA value between 0.06 and 0.08 and the SRMR value $\leq$0.08 suggested a better-fitted model (35). The smallest Akaike information criterion (AIC), Bayesian information criterion

(BIC), and expected cross-validation Index (ECVI) indicated the model with the best fit (36).

Besides, an instrument's convergent validity could be determined by examining two variables, the AVE of the latent variable and the measure's CR. Convergent validity could be considered adequate when the AVE value was ≥0.50, the CR value was ≥0.70 (37, 38). The discriminant validity was measured by the square root of the AVE. The square root of the AVE in each factor was better than the correlation coefficient value of the factor with other factors indicating it had good discriminant validity (39).

Finally, criterion validity was made up of two subcategories: predictive and concurrent. Concurrent validity was demonstrated when two assessments agreed or a new measure was compared with one already considered valid (40). Previous studies had revealed that pandemic-related anxiety was distinct from anxiety-related traits (41, 42), but few studies measured pandemic-related anxiety as concurrent validity. Therefore, concurrent validity was a necessary content in criterion validity. Thus, concurrent validity was measured by calculating the Pearson product-moment correlation coefficient between the CSS and other correlated scales (CAS, FCV-19S, DASS-21).

Results

Demographic variable

We summarized the participants' characteristics in Table 1. A total of 2,116 participants were included in the study. Respondents aged from 18 to 68 (M = 31.21, SD = 9.51) and the females accounted for 59.0% of the total sample. Most of the participants got vaccinated (67.6%). Among the sample, the monthly income of the majority of subjects was 5,000–9,999 CNY (42.9%).

Construct validity

We tested the models mentioned in the literature to verify the structural validity of the CSS Chinese adapted version. One was the six-factor model, which included danger (D), socio-economic consequences (SE), xenophobia (X), contamination (C), traumatic stress (T), and compulsive checking (CH). The other was the five-factor model, which combined danger (D) and contamination (C) into one factor. When modeling ordered categorical data, the research seemed to indicate that if there were a large number of ordered categories the data could be treated as continuous. Finney and DiStefano recommended treating the data as continuous and employing maximum likelihood estimation if the variables had five categories or more, the data were approximately normally distributed (43). Thus, we used the maximum likelihood to estimate each model in our study. The CFA was conducted to

TABLE 1 Sample characteristics (*n* = 2,116).

Characteristic	Variable	M	SD
Age		31.21	9.51
		Count	*Percent*
Gender	Male	868	41.0
	Female	1,248	59.0
Education level	Junior school and below	288	13.6
	Senior school	738	34.9
	Bachelor	982	46.4
	Master and above	108	5.1
Marital status	Single	866	40.9
	Married	1,204	56.9
	Divorced	37	1.8
	Widowed	9	0.4
Monthly income level (CNY)	2,000 or less	398	18.8
	2,000–4,999	623	29.4
	5,000–9,999	908	42.9
	10,000 or more	187	8.9
Occupation	Healthcare workers[a]	507	24.0
	Enterprise or institution workers[b]	600	28.3
	Teachers or students[c]	514	24.3
	Others[d]	495	23.4
Vaccination	Not Vaccinated	686	32.4
	Vaccinated	1,430	67.6

[a]Included doctors, nurses, disease control staff, medical departmental managers, and psychological counselors. [b]Included government personnel, community staff, volunteers, social workers, and policies. [c]Included teachers or students from universities, middle schools, or elementary schools. [d]Included freelancers, retirees, and other relevant staff. M, mean; SD, standard deviation.

determine the goodness-of-fit of the six-factor model with 36 items (Figure 1).

As was shown in Table 2, all resulting incremental indices in the six-factor model were greater than those in the five-factor model and exceeded the 0.90 level, indicating a better model fit in the six-factor model. The RMSEA value was 0.067 (90 % confidence interval:0.065–0.068) in the six-factor model; in the five-factor model, the RMSEA value was 0.085 (90 % confidence interval:0.083–0.086). The SRMR value in the six-factor model was 0.038, while in the five-factor solution was 0.047. The AIC, BIC and ECVI in the six-factor model [AIC = 6,213.648, BIC = 6,705.832, and ECVI = 2.938 (90 % confidence interval: 2.821–3.057)] smaller than those [AIC = 9,610.543, BIC = 10,074.440, and ECVI = 4.544 (90 % confidence interval:4.397–4.694)] in five-factor model indicated the six-factor model with the best fit.

Internal consistency reliability

Cronbach's alpha (α), McDonald's omega (ω), and Spearman-Brown coefficient were calculated for the internal
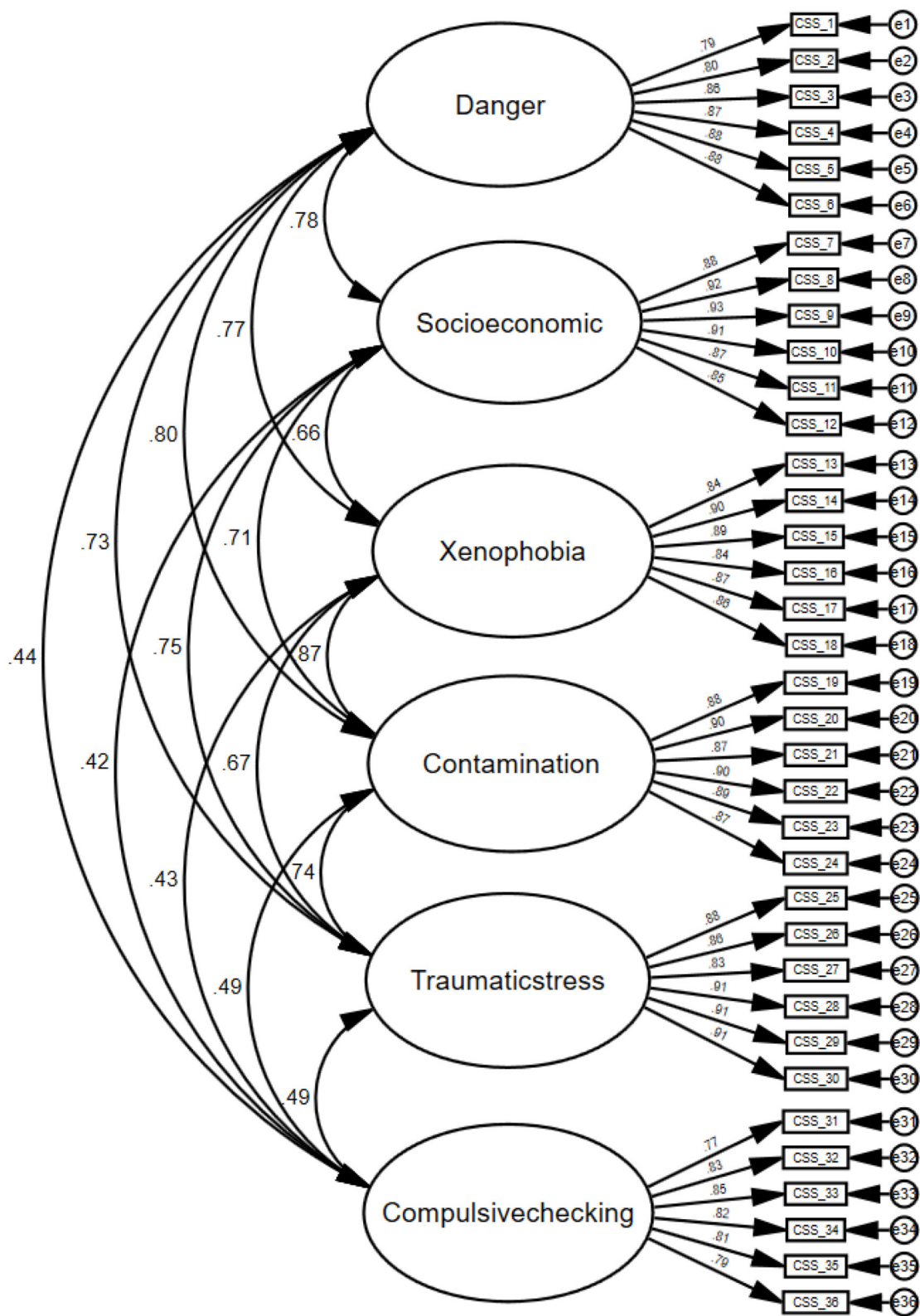
TABLE 2 Fit indices of various structural models for confirmatory factor analysis ($n = 2,116$).

Model	χ2	df	RMESA [90%CI]	CFI	TLI	NFI	IFI	SRMR	AIC	BIC	ECVI [90%CI]
Six-factor model	6,039.648	579	0.067 [0.065-0.068]	0.935	0.929	0.929	0.935	0.038	6,213.648	6,705.832	2.938 [2.821-3.057]
Five-factor model	9,446.543	584	0.085 [0.083-0.086]	0.895	0.886	0.889	0.895	0.047	9,610.543	10,074.440	4.544 [4.397-4.694]

df, degrees of freedom; RMSEA, root-mean-square-error of approximation; CI, confidence interval; CFI, comparative fit index; TLI, Tucker-Lewis index; NFI, normed fit index; IFI, incremental fit index; SRMR, standardized root-mean residual; AIC, Akaike information criterion; BIC, Bayesian information criterion; ECVI, expected cross-validation Index.

TABLE 3 Normative data and reliability indices for the COVID Stress Scales and its subscales ($n = 2,116$).

Scales	M	SD	Alpha	Omega
COVID Stress Scales	29.58	26.71	0.97	0.97
COVID danger	4.56	5.38	0.94	0.94
COVID socio-economic consequences	3.12	5.25	0.96	0.96
COVID xenophobia	5.63	5.74	0.95	0.95
COVID contamination	4.88	5.45	0.96	0.96
COVID traumatic stress	2.73	4.57	0.95	0.96
COVID compulsive checking	8.67	6.04	0.92	0.92

Alpha, Cronbach's alpha coefficient; Omega, McDonald's omega coefficient. M, mean; SD, standard deviation.

consistency of the CSS Chinese adaptation. Cronbach's alpha was 0.97, McDonald's omega was 0.97, and split-half reliability through the Spearman-Brown formula was 0.90, indicating the high reliability of the CSS Chinese adapted version. The Cronbach's coefficients of subscale scores and McDonald's Omega subscale value in terms of the six-factor model were summarized in Table 3. The dimensions of Danger ($α = 0.94$; $ω = 0.94$), Socioeconomic consequences ($α = 0.96$; $ω = 0.96$), Xenophobia ($α = 0.95$; $ω = 0.95$), Contamination ($α = 0.96$; $ω = 0.96$), Traumatic stress ($α = 0.95$; $ω = 0.96$), and Compulsive checking ($α = 0.92$; $ω = 0.92$) had adequate reliability indices.

Convergent validity and discriminant validity

As shown in Table 4, the factor loading of each item on all corresponding subscales was better than 0.70 in the six-factor model. AVE was better than 0.50, and CR was better than 0.80. These results supported a good convergent validity of the Chinese adapted version of the CSS.

As shown in Table 5, the square root of the AVE in each factor (D, SE, X, C, T, CH) was better than the correlation coefficient value of the factor with the other factor. According to Zait and Bertea, the results showed that it had a good discriminant validity (39).

Concurrent validity

As shown in Table 6, there were strong positive correlations between the FCV-19S, the CAS, the DASS-21, and the CSS.

The CSS total score was positively correlated with the FCV-19S ($r = 0.73$), the CAS ($r = 0.66$), the DASS-21 ($r = 0.63$), the DASS_D ($r = 0.58$), the DASS_A ($r = 0.63$) and the DASS_S ($r = 0.62$). The results provided an evidence of criterion validity.

Discussion

During the COVID-19 pandemic, the scales which assessed general mental health might be underestimated or overestimated because they didn't assess specific symptoms associated with COVID-19 (44). In response to the current pandemic, Taylor suggested that developing a measure of COVID-19-related stress and anxiety was an urgent need during the pandemic (10). The current study aimed to examine the psychometric properties of the adaption of the Chinese version of the CSS. The study showed that the Chinese adapted version of the CSS had good internal consistency, convergent validity, discriminant validity, and concurrent validity. Besides, we tested the factor structure and found the Chinese adapted version fit the six-factor model. Overall, the results indicated that the Chinese adapted version of the CSS showed good psychometric properties.

In our study, the six-factor structure was supported by CFA in the Chinese adapted versions of the CSS. The findings echoed the previous researchers (14, 16) and the original authors' six scales construction (10) though inconsistent with the five-factor model reported by the original research (10) and other researchers (12, 45). The six-factor model presented adequate adjustment indices in our sample of participants (RMSEA = 0.067, SRMR = 0.038; CFI = 0.935; and TLI = 0.929). In contrast, five-factor model had worse adjustment indices (RMSEA = 0.085; SRMR = 0.047; CFI = 0.895; and TLI = 0.886). Besides CFI, TLI, RMSEA, and SRMR, we also compared other resulting incremental indices such as AIC, BIC, and ECVI in the study. The six-factor model (AIC = 6,213.648, BIC = 6,705.832; ECVI = 2.938) were smaller than those in the five-factor model (AIC = 9,610.543; BIC = 10,074.440; ECVI = 4.544), indicating the better model fit in the six-factor model. In our study, factor loadings ranged from 0.7–0.93, which was a higher range than reported. It was worth noting that factor loadings were even high, above what was recommended (46). The difference in the factor structure across different surveys might result from the difference in the population. The original validation study, utilizing parallel analyses, demonstrated that the five-factor solution was sufficiently stable for the Canadian and US

TABLE 4 Convergent validity (n = 2,116).

Items		Factor	Estimate	CR	AVE
CSS_1	<–	D	0.787	0.939	0.719
CSS_2	<–	D	0.802		
CSS_3	<–	D	0.855		
CSS_4	<–	D	0.875		
CSS_5	<–	D	0.884		
CSS_6	<–	D	0.880		
CSS_7	<–	SE	0.879	0.960	0.799
CSS_8	<–	SE	0.917		
CSS_9	<–	SE	0.927		
CSS_10	<–	SE	0.915		
CSS_11	<–	SE	0.871		
CSS_12	<–	SE	0.852		
CSS_13	<–	X	0.836	0.948	0.752
CSS_14	<–	X	0.895		
CSS_15	<–	X	0.894		
CSS_16	<–	X	0.844		
CSS_17	<–	X	0.872		
CSS_18	<–	X	0.859		
CSS_19	<–	C	0.876	0.955	0.781
CSS_20	<–	C	0.899		
CSS_21	<–	C	0.870		
CSS_22	<–	C	0.897		
CSS_23	<–	C	0.887		
CSS_24	<–	C	0.873		
CSS_25	<–	T	0.876	0.956	0.783
CSS_26	<–	T	0.861		
CSS_27	<–	T	0.831		
CSS_28	<–	T	0.911		
CSS_29	<–	T	0.915		
CSS_30	<–	T	0.911		
CSS_31	<–	CH	0.773	0.921	0.660
CSS_32	<–	CH	0.827		
CSS_33	<–	CH	0.848		
CSS_34	<–	CH	0.822		
CSS_35	<–	CH	0.814		
CSS_36	<–	CH	0.789		

AVE, Average Variance Extracted; CR, Composite Reliability; CSS, COVID Stress Scales; D, danger; SE, socio-economic consequences; X, xenophobia; C, contamination; T, traumatic stress; CH, compulsive checking.

TABLE 5 Discriminant validity (n = 2116).

	D	SE	X	C	T	CH
D	(0.848)					
SE	0.749**	(0.894)				
X	0.726**	0.638**	(0.867)			
C	0.766**	0.688**	0.837**	(0.884)		
T	0.704**	0.721**	0.637**	0.710**	(0.885)	
CH	0.417**	0.396**	0.408**	0.460**	0.461**	(0.813)

** $p < 0.01$.
The numbers on the diagonal were the square root of the average variance extraction (AVE).
D, danger; SE, socio-economic consequences; X, xenophobia; C, contamination; T, traumatic stress; CH, compulsive checking.

TABLE 6 Pearson's correlations between the FCV-19S, the CAS, the DASS-21, and the CSS.

	1	2	3	4	5	6	7
1.DASS-21	1						
2.DASS_D	0.97**	1					
3.DASS_A	0.97**	0.91**	1				
4.DASS_S	0.97**	0.92**	0.92**	1			
5.FCV-19S	0.58**	0.53**	0.58**	0.57**	1		
6.CAS	0.55**	0.51**	0.56**	0.53**	0.52**	1	
7.CSS	0.63**	0.58**	0.63**	0.62**	0.73**	0.66**	1

**Correlation is significant at the 0.01 level (2-tailed).
DASS-21, depression anxiety stress scales; DASS_D, DASS-21 depression subscale; DASS_A, DASS-21 anxiety subscale; DASS_S, DASS-21 stress subscale; FCV-19S, The Fear of COVID-19 Scale; CAS, Coronavirus Anxiety Scale; CSS, COVID Stress Scales.

community-based samples (10). This solution was replicated in Iran among persons with anxiety and obsessive-compulsive disorders (12). While our study was conducted in the Chinese population, similar to the results in the Peruvian context (16). The most confusing was that the CSS Arabic version supported the five-factor solution in the Egyptian and Saudi contexts (11). Meanwhile, it also supported the six-factor solution in a Palestinian context after excluding five items (14). We deduced that the danger and contamination factors were the separated factors in different populations. Danger and contamination subscales were merged and observed as a single construct in the five-factor model. Differences in the factor structure of the CSS might reflect a specific context or purpose of the CSS. Our findings suggested that in the Chinese population, a distinction between perceptions of the pandemic as dangerous and disrupting everyday functioning on the one hand, and getting exposure to virus in the immediate environment on the other hand, should be made. Besides, it was related to what Taylor suggested that people use various psychological factors when facing the threat of a pandemic, presenting adaptive behaviors, emotions, and defensive reactions linked to their psychological vulnerability (47).

The Chinese adapted version of the CSS and its subscales showed good internal consistency. The internal consistency was also been reported using the McDonald's omega coefficient,

which was a more appropriate estimation measure that was based on factor loadings and was not influenced by sample size or the number of items on the scale (48). The internal consistency of the total ($\alpha = 0.97$, $\omega = 0.97$, Spearman-Brown coefficient = 0.90) and subscale scores ($\alpha = 0.92$–0.96; $\omega = 0.92$–0.96) were similar to those reported in previous psychometric studies of the CSS (11).

The convergent validity and discriminant validity of the Chinese adaption of the CSS were established in the study. The significant correlations between the subscales in the present study were close to the association reported by the original authors (10). In Taylor and his colleagues' (10) study, the convergent validity was evaluated through the correlations of the scales of the CSS with the pre-COVID trait measures such as anxiety and obsessive-compulsive (OC) symptoms. The discriminant validity was evaluated by the correlations of the general and pre-COVID traits. In our study, the convergent validity was assessed through AVE and CR, the factor loading of each item on all corresponding subscales was better than 0.70. AVE was better than 0.50, and CR was better than 0.80. The square root of the AVE in each factor was to access the discriminant validity. The results demonstrated that the square root of the AVE in each factor was greater than the correlation coefficient value of the factor with other factors. The results supported good convergent validity of the Chinese adapted version of the CSS through diverse statistical methods.

According to previous studies (49, 50), mental health was associated with stress measures. In our study, all correlations were significant between the FCV-19S, the CAS, the DASS-21, and the CSS. The findings supported the concurrent validity of the CSS. The correlation coefficients were significant as expected ($r = 0.58$–0.73). The correlations between the FCV-19S, the CAS, and the CSS were in line with other studies examining COVID-19-related scales (12, 41). Similar results might indicate that COVID-19-related health anxiety was distinct from anxiety traits (41, 42). The correlation with DASS-21 was in line with the previous study (14). The results suggested that more stress perceived by individuals under the COVID-19 pandemic might be associated with higher depression and anxiety symptoms (51).

Our study also had several limitations. Firstly, we conducted the online survey with self-report measurements due to the COVID-19 epidemic. Secondly, this study did not investigate other aspects of reliability and validity such as test-retest reliability and predictive validity. Evidence of test-retest reliability would be a benefit for longitudinal research in the future. Thirdly, future researchers could develop more objective stress measures, such as physiological stress indicators or known-groups validity (10) to investigate the criterion validity of the CSS.

Conclusion

Regardless of all the above limitations, this study provided data supporting the psychometric properties of the adaption of the Chinese version of the CSS. The results supported the six-factor structure proposed in prior research. In conclusion, the Chinese adapted version of the CSS was a reliable and valid tool for assessing the stress of COVID-19 in China. The spread of coronavirus in China could amplify the risk of maladaptive and stressful symptoms in an already compromised living environment. Understanding stress-related and COVID-19-associated outcomes might be an urgent priority in China.

Data availability statement

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

Ethics statement

All procedures performed in this study involving human participants were following the ethical standards of the Committee of the Second Xiangya Hospital of Central South University, the American Psychological Association (APA, 2010), and the 2013 Helsinki Declaration. The patients/participants provided their written informed consent to participate in this study.

Author contributions

DW conceived and designed the study. LX and QL performed the analysis. LX, QL, HY, and DW prepared and modified the manuscript. All authors were involved in the study conduction and contributed substantially to its revision and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.962304/full#supplementary-material

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Prevalence and risk factors of depressive symptoms among 140,259 college students during the COVID-19 epidemic normalization in China: A cross-sectional survey

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Objective: College students are one of the most vulnerable populations to the COVID-19 pandemic's mental health effects. During the coronavirus disease 2019 (COVID-19) outbreak, we wanted to see how common depressive symptoms were among college students and what factors contributed to that.

Methods: Between 21 and 27 May 2021, 140,259 college students from three cities in Henan Province, China, were involved. The Patient Health Questionnaire-9 was used to determine depressive symptoms (PHQ-9). Multiple logistic regression analysis was used to calculate odds ratios (ORs) and 95% CIs for potential depressive symptom factors.

Results: Mild depressive symptoms and above are present in 21.12% of college students. Women had a higher prevalence of mild depressive symptoms than men (61.38 vs. 59.75%), and depressive symptoms were most prevalent among rural students and least prevalent among city students (21.44 vs. 20.29%). Participants with depressive symptoms are also more likely to have a poor-behavioral status. From none-to-severe depressive symptoms, 78.88, 15.78, 2.80, 1.67, and 0.88% had them. Gender, residential location, and behavioral status were found to be associated with depressive symptoms after adjusting for potential confounders.

Conclusion: This cross-sectional study identified the factors that influence the prevalence of depression in college students. It found that the government should pay more attention to mental health issues affecting college students in combating the COVID-19 epidemic normalization.

KEYWORDS

depressive symptoms, COVID-19, college students, factors, China

Introduction

A new-type coronavirus, which has been identified in December 2019 (1), has caused global health concerns due to its devastating impact (2, 3). The imported cases from abroad have been controlled in China at this stage. The epidemic situation in China is sporadic on the whole, and there are occasional small-scale epidemic situations in some parts. In response to the outbreak of the virus, the Chinese government has implemented various measures to prevent the spread of the disease. These include the suspension of public transportation and the closure of non-essential leisure and entertainment establishments (4). A longitudinal population-based study shows that symptoms of anxiety and depression are significant during COVID-19 and increase during lockdown (5, 6). At the same time, some studies have shown that being isolated from others can lead to depressive symptoms. The link between isolation and anxiety has been linked to a variety of mental health issues (7, 8). It has been known that students who are forced to stay at home and are socially isolated are more prone to experiencing higher levels of depression (9, 10).

The depressive symptom is a common mental health disorder that affects the mental health of the general population. It has a worldwide prevalence of 17.3% when using self-reporting instruments to assess depression and is considered to be a mental health disorder (11). In comparison to their counterparts throughout the world, college students have greater rates of mental disorders such as depressive symptoms (12), which can cause horrible feelings such as fear, inadequacy, and wrath, and also psychological and physical morbidities (13–15). Loneliness and illness management measures increase the risk of depression in previously healthy children and adolescents, according to a comprehensive systematic evaluation of data from over 50,000 children and adolescents in 63 research (16, 17). It is clear that the COVID-19 pandemic's direct and indirect psychological and social consequences are pervasive (18–21).

Most of the current literature on the psychological impact of COVID-19 has focused on health workers, patients, and children the general population (22–26). Studies have shown that COVID-19 exposure can lead to high levels of anxiety and depressive symptoms among healthcare workers (27), which raises widespread concern. Of note, college students are at the age of high risk for the onset of mental illness (28, 29). Despite growing evidence of mental health complications from COVID-19 among middle- and high-school students in China (30), there is sparse evidence of psychological or mental health effects of the COVID-19 pandemic on college students, and large sample survey evidence for this group of college students is still very limited. In the face of COVID-19 outbreak, expansion in China and other parts of the world, this study assessed the prevalence of depressive symptoms among college students and identified potential risk and protective factors contributing to depressive symptoms to assist government agencies and healthcare professionals in safeguarding the school's psychological wellbeing.

Methods

Study participants

The cross-sectional study is to investigate the impact of the COVID-19 pandemic on the college student depressive symptoms by using an online questionnaire through an online survey platform ("SurveyStar," Changsha Ranxing Science and Technology, Shanghai, China) during 21–27 May 2021. In the three cities in Henan Province, China, college students were selected and invited to participate in the survey using a cluster sampling method. In total, 148,999 participants were recruited. For quality control, we excluded the data of participants aged <18 years or aged >25 years or those who took ≤100 s to fully respond to the questions ($n = 8,740$). After this exclusions process, a total of 140,259 participants, aged 18–25 years, were included in this analysis.

The study protocol was approved by the Ethics Committee of Zhengzhou University (ZZUIRB2021-118).

Data collection

To collect sociodemographic data, a standard questionnaire was devised (age, gender, grade, and residential location). The behavioral status about COVID-19 includes "Has the number of handwashing increased significantly after the outbreak," "The situation of wearing masks when going out after the outbreak," as well as mental state (worry and fear levels) and depressive symptoms. City, rural, and county-level cities were used to classify residential locations. The worry and fear levels were divided into five levels (extremely, very, somewhat, not so, and not at all) based on 5-point Likert scale (31). To examine depressive symptoms, the Patient Health Questionnaire-9 (PHQ-9) was employed (32). The PHQ-9 is based on the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition's diagnostic criteria for depressed symptoms (DSM-IV). The PHQ-9's psychometric qualities have already been established in the Chinese populations and developing-country medical settings (32–34). On a 27-point scale, participants were asked how often nine symptoms had emerged in their lives in the previous two weeks: 0 = "not at all," 1 = "several days," 2 = "more than half the days," 3 = "nearly every day." The severity of depressive symptoms was scored as follows: 0–4 for no depression symptoms, 5–9 for mild, 10–14 for moderate, 15–19 for moderately severe, and 20–27 for severe

TABLE 1 Characteristics of the study participants by depression status.

Characteristics	All participants	No-depression	Depression	P value
	n = 140,259	n = 133,885	n = 6,374	
Age (years)	20.43 ± 4.57	20.43 ± 4.57	20.47 ± 4.53	<0.001
Gender (%)				<0.001
Male	70,123 (50.00)	66,717 (49.83)	3,406 (53.44)	
Female	70,136 (50.00)	67,168 (50.17)	2,968 (46.56)	
Residential location (%)				<0.001
City	29,962 (21.36)	28,581 (21.35)	1,381 (21.67)	
Rural	78,604 (56.04)	75,078 (56.08)	3,526 (55.32)	
Country-level city	31,693 (22.60)	30,226 (22.58)	1,467 (23.02)	
Worried level (%)				<0.001
High	69,154 (49.31)	65,356 (48.82)	3,798 (59.58)	
Moderate	43,235 (30.83)	41,701 (31.15)	1,534 (24.07)	
Low/none	27,870 (19.87)	26,828 (20.04)	1,042 (16.35)	
Fear level (%)				<0.001
High	38,599 (27.52)	35,862 (26.78)	2,737 (42.94)	
Moderate	62,507 (44.57)	60,229 (44.99)	2,278 (35.74)	
Low/none	39,153 (27.92)	37,794 (28.23)	1,359 (21.32)	
Has the number of handwashing increased significantly after the outbreak (%)				<0.001
Yes	133,858 (95.44)	12,8197 (95.75)	5,668 (88.78)	
No	6,401 (4.56)	5,688 (4.25)	716 (11.22)	
The situation of wearing masks when going out after the outbreak (%)				<0.001
Always wear a mask when you go out	100,010 (71.30)	96,961 (71.67)	4,061 (63.61)	
Wear masks when going to crowded places or taking public transport	38,537 (27.48)	36,512 (27.27)	2,029 (31.78)	
Wear masks occasionally	1,469 (1.05)	1,250 (0.93)	223 (3.49)	
Do not wear masks	243 (0.17)	172 (0.13)	71 (1.11)	

Data were presented as mean (SD) normal distribution continuous variables and numbers (percentages) for categorical variables; P values were calculated using student's t-test and chi-square. Compared with no-depression, P < 0.05.

depressed symptoms (35). A cutoff of 10 or more is reported as diagnostic (35).

Statistical analysis

Continuous data were presented as mean ± standard deviation (SD) and compared using the t-test, while categorical variables were presented as frequencies (%) and the significance of categorical variable differences was determined using the chi-squared test. The odds ratios (ORs) and 95% CIs of depressed symptoms were calculated using a logistic regression model. Multivariable adjustment modeling was performed: Model 1 was the crude model. Model 2 was adjusted for gender, residential location, worried level, and fear level. Statistical Package for the Social Sciences (SPSS) (version 26) was used for all statistical analyses, with P values of < 0.05 indicating statistical significance. Imputation or other substitution procedures were not employed, and only respondents who provided complete data were included in the analysis.

Result

Basic characteristics of participants

In total, 140,259 participants (aged 18–25 years), which include 70,123 men and 70,136 women, were invited in to participate in the survey from 27 May to 27 May. The characteristics of the participants were listed in Table 1 along with their relationships with depressed symptom status. The study population contained 6,384 cases of depressive symptoms (4.54%). Participants with depressive symptoms had different proportions of age, gender, residence location, and behavioral status than those without depressive symptoms (all P values of <0.05).

Prevalence of depressive symptoms

The overall depressive symptoms prevalence was 4.54% among college students during the COVID-19 pandemic in
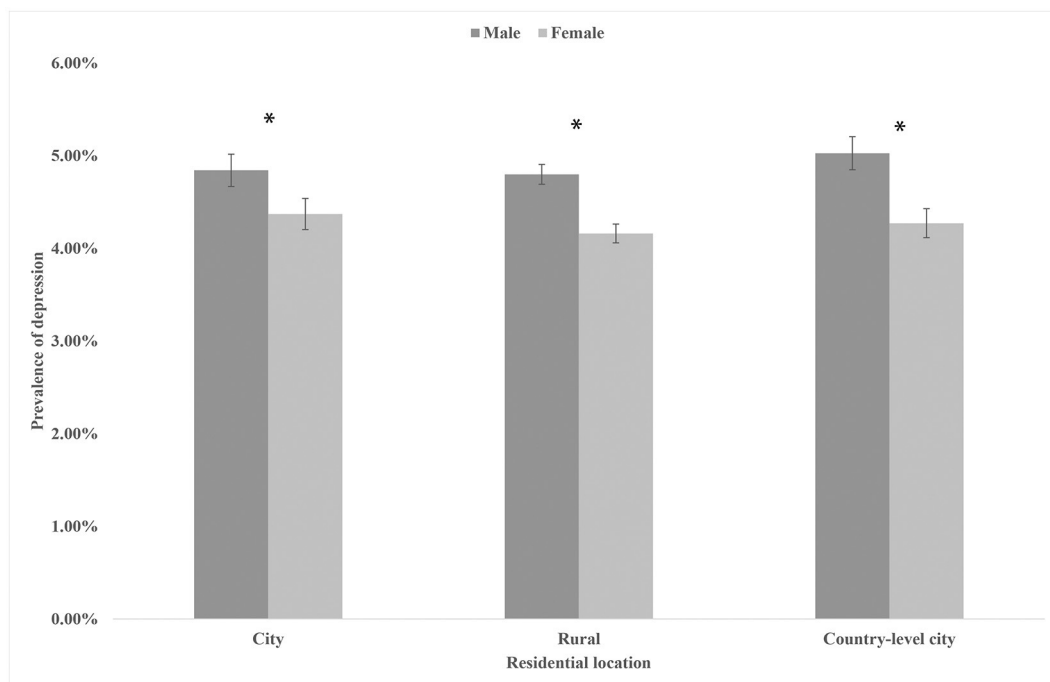
The prevalence of depression symptoms in participants by residential location and gender. * $P < 0.05$.
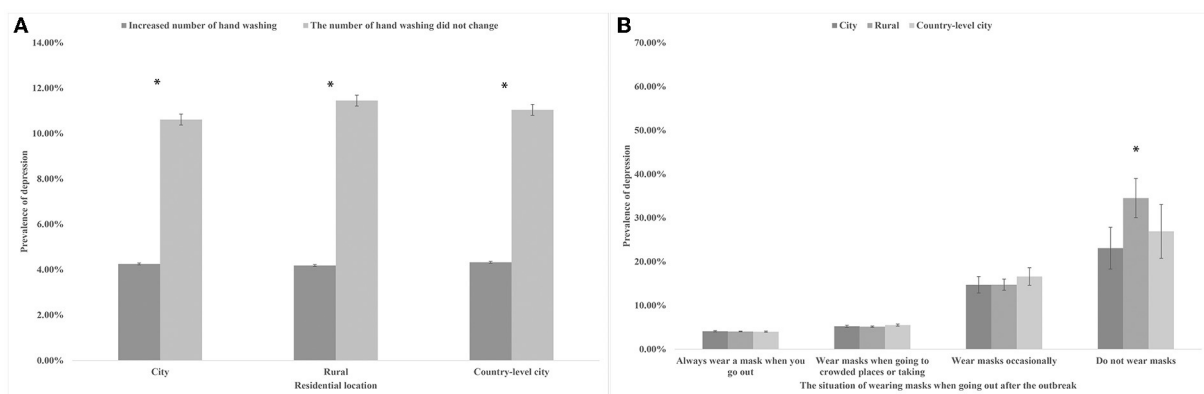
(A) The prevalence of depression symptoms in participants by degree of handwashing and residential location. * $P < 0.05$. (B) The prevalence of depression symptoms in participants by degree of wearing masks and residential location. * $P < 0.05$.

China. The prevalence of depressive symptoms in participants was shown in Figure 1 by gender and home region. Male participants living in country-level cities had the highest prevalence of depressive symptoms at 5.03%. Women who resided in rural areas had the lowest prevalence of depressed symptoms, at 4.16%. Overall, the prevalence of depressive symptoms was higher among men than among women, whether in cities, rural, or county-level cities. Figure 2A

showed that whether in cities, rural, or country-level cities, the prevalence of depressive symptoms among students who did not change the number of handwashing was higher than those who increased the number of handwashing. Figure 2B showed that the prevalence of participants who lived in rural who do not wear masks was higher than participants who lived in the country-level city who do not wear masks (34.51 vs. 26.92%), but the opposite was

true in participants who wear masks occasionally, where participants who lived in the country-level city was higher than the participants who lived in the rural areas (16.62 vs. 14.75%).

Depressive symptoms

Table 2 shows the percentage of pupils with varying levels of depressive symptoms. The proportion of depressive symptoms from none to severe were 78.88, 15.78, 2.79, 1.67, and 0.88%, respectively. Mild depressive symptoms were most common. Compared to men, there were more women who had depressive symptoms (61.38%). But men were more likely to be moderately severe and severe. Obviously, the largest proportion of depressive symptoms occurred in rural (21.44%). The proportion of severe depressive symptoms was the highest (1.07%), although the city proportion of depressive symptoms was the lowest (20.29%). In participants with depressive symptoms, there was a variation in response rates across the nine PHQ symptoms, as shown in Figure 3. Obviously, feeling tired or inactive (78%) and difficulty falling asleep, uneasy sleep, or excessive sleep (75%) were the most common symptoms.

The positive or risk factors of depressive symptoms

Using multivariable logistic regression analysis, Table 3 showed the relationship between participant characteristics and depressive symptoms. Compared with men, women had 17% [OR 0.83 (95%CI: 0.79–0.88)] reduced odds of depressive symptoms. Meanwhile, after adjusted, students from rural had 8% reduced odds of anxiety [OR 0.92 (95%CI: 0.86–0.98)] compared to the cities. Compared with students with correct behavioral status about epidemic characteristics, students with incorrect behavioral status had higher odds of depressive symptoms. For example, students who make the number of hand-washing unchanged after the outbreak had 232% [OR 3.32 (95%CI: 3.05–3.61)] increased odds of depressive symptoms, compared with students who has the number of handwashing increased significantly after the outbreak. Similarly, compared with students who always wear a mask when they go out, students who wear masks when going to crowded places or taking public transport had 49% [OR 1.49 (95%CI: 1.41–1.57)] increased odds of depressive symptoms. Meanwhile, students who wear masks occasionally [OR 4.67 (95%CI: 4.02–5.42)] and students who do not wear masks [OR 11.26 (95%CI: 8.48–14.96)] had higher odds of depressive symptoms.

Discussion

This is a large-scale cross-sectional epidemiological investigation that took place in Henan Province. We investigated the prevalence of depressive symptoms among 140,259 college students during an outbreak of COVID-19. Our study showed that the prevalence of mild depressive symptoms and above among college students is 21.12%, which was lower than previous studies (37%) (36). Gender, residential location, and behavioral status were found to be associated with depressive symptoms among college students.

The overall prevalence of depressive symptoms in the present study was higher than in previous studies, which may be due to the introduction of epidemic prevention and control measures during the COVID-19 period (30). Some studies have found that female students have higher levels of depressive symptoms than male students (23, 37, 38). However, in contrast to previous findings (39), in our study, male students had more depressing symptoms than female students. Previous research has found similar differences in depressive symptoms between male and female students (40, 41). This could be due to the fact that in China, conventional gender roles and divisions still exist (42). During China's COVID-19, Chinese men as family pillars must bear more psychological pressure to ensure adequate supply and family safety, such as taking high-risk family matters. This differs from studies in other countries (43). At the same time, in the case of COVID-19, the lack of coping strategies will exacerbate male mental health problems (44).

Meanwhile, participants in our study who lived in rural areas had the highest proportion of depressed symptoms (Table 2). Differences in education, family income, medical insurance, and other social-culture factors could explain the disparity between city and rural residents (45). Students from rural areas are more likely to have come from poor families and are regarded as having a lower social status, resulting in disadvantages (46). Lower economic development levels in rural have reduced the ability to solve the problems brought by COVID-19.

Correct behavioral status was identified as a protective factor for our study. Even if only 0.17% of participants stated that they did not wear a mask during the outbreak, they were 1,026% more likely to exhibit depressive symptoms. Depressive symptoms were substantially more common among pupils who had an inappropriate behavioral status. This research emphasizes the need for educational intervention and the dissemination of accurate information. Our research found that knowing the correct type of mask was linked to a lower likelihood of depressive symptoms among college students. Wearing masks has been proven in patients with subclinical or mild COVID-19 to minimize the production of salivary and respiratory droplets (47). Wearing a mask, which is likely the most effective psychological sign for the general public,

TABLE 2 The rate of different severities of depressive symptoms.

Variables	None		Mild		Moderate		Moderately severe		Severe	
	n	%	n	%	n	%	n	%	n	%
Total	110,630	78.88	22,129	15.78	3,923	2.80	2,341	1.67	1,236	0.88
Gender										
Male	56,456	40.25	9,752	6.95	1,807	1.29	1,322	0.94	786	0.56
Female	54,174	38.62	12,377	8.82	2,116	1.51	1,019	0.73	450	0.32
Residential location										
City	23,883	79.71	4,463	14.90	802	2.68	494	1.65	320	1.07
Rural	61,750	78.56	12,698	16.15	2,218	2.82	1,298	1.65	640	0.81
Country-level city	24,997	78.87	4,968	15.68	903	2.85	549	1.73	276	0.87

Data were presented as mean (SD) normal distribution continuous variables and numbers (percentages) for categorical variables.

FIGURE 3
The proportion of nine PHQ symptoms in depression participants.
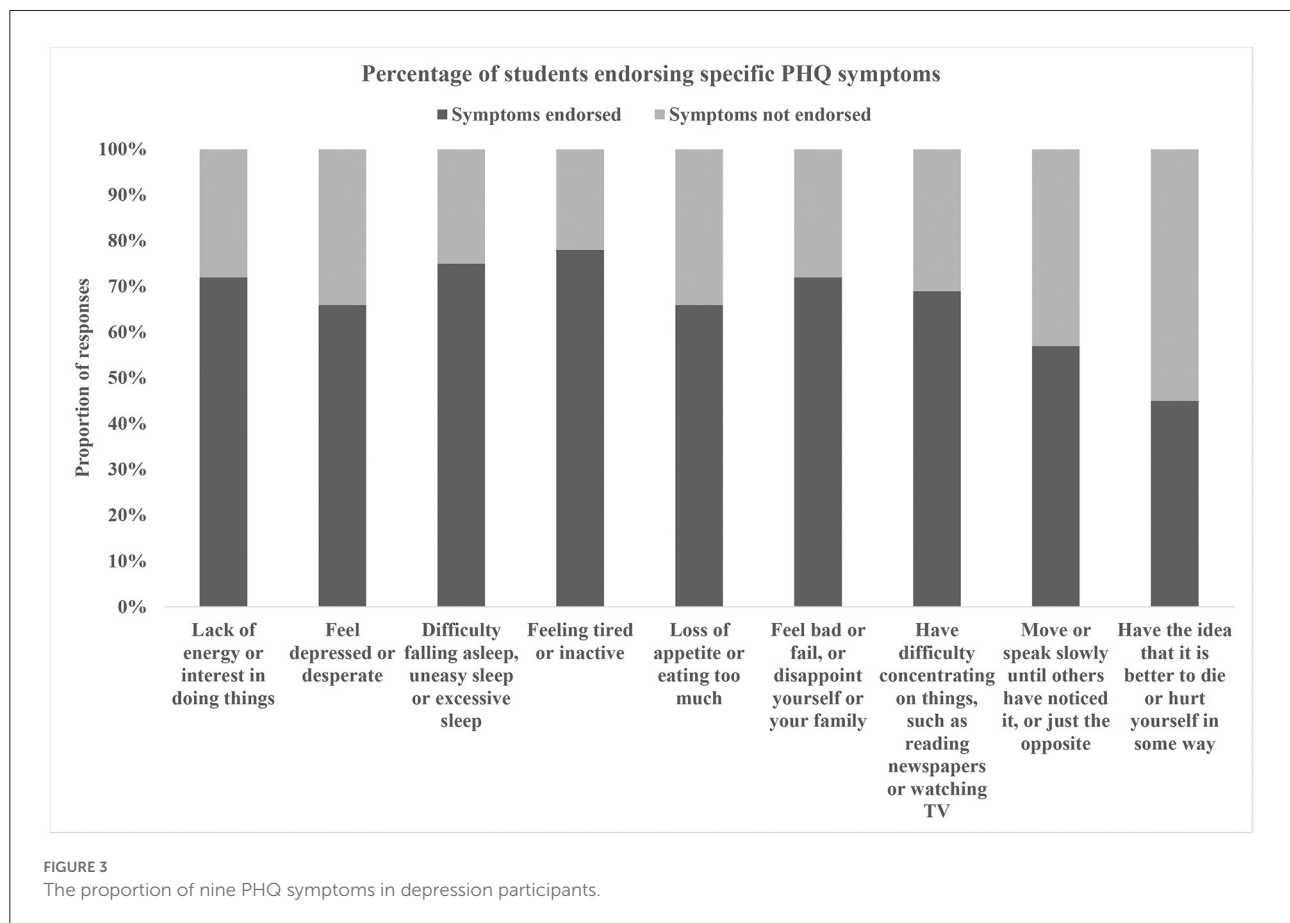
is necessary as a vital piece of personal protection equipment (48). Furthermore, our findings on COVID-19 health beliefs and face mask use point to some critical health literacy challenges. Because effective communicable disease prevention necessitates individuals to avoid activities that pose a high risk of infection and comprehending the rationale behind suggestions calling for societal responsibility to combat the pandemic, high levels of health literacy are critical (49). Europeans, on the other hand, have mixed feelings about face masks for cultural reasons. The need to utilize them is typically difficult for Europeans to accept (50). It also recommends that we should boost COVID-19 knowledge promotion, particularly in the behavioral status (51). Students can have a better understanding of COVID-19 through public awareness and education, allowing them to protect

TABLE 3 Independent association of characteristics of study participants and depression during the COVID-19 epidemic in Henan province.

Characteristics	Model 1		Model 2	
	OR (95%CI)	*P* value	OR (95%CI)	*P* value
Gender				
Male	1.00 (ref)		1.00 (ref)	
Female	0.87 (0.82–0.91)	<0.05	0.83 (0.79–0.88)	<0.05
Residential location				
City	1.00 (ref)		1.00 (ref)	
Rural	0.97 (0.91–1.04)	0.38	0.92 (0.86–0.98)	<0.05
Country-level city	1.00 (0.93–1.08)	0.91	0.98 (0.91–1.06)	0.67
Has the number of handwashing increased significantly after the outbreak				
Yes	1.00 (ref)		1.00 (ref)	
No	2.84 (2.61–3.08)	<0.05	3.32 (3.05–3.61)	<0.05
The situation of wearing masks when going out after the outbreak				
Always wear a mask when you go out	1.00 (ref)		1.00 (ref)	
Wear masks when going to crowded places or taking public transport	1.31 (1.24–1.39)	<0.05	1.49 (1.41–1.57)	<0.05
Wear masks occasionally	4.14 (3.58–4.80)	<0.05	4.67 (4.02–5.42)	<0.05
Do not wear masks	9.76 (7.39–12.89)	<0.05	11.26 (8.48–14.96)	<0.05

OR, odds ratio; CI, confidence interval.
Model 1: no adjustment.
Model 2: adjusted for gender, residential location, worried level, and fear level.

themselves from COVID-19-related depressed symptoms by practicing good hygiene, wearing a mask, exercising, and eating well (30).

Furthermore, we differentiated the severity of depression symptoms. The findings revealed that the majority of college students had mild depressive symptoms, with only a minority having moderate-to-severe depressive symptoms. It is worth noting that among the students who have depressive symptoms, feeling tired or inactive (78%) and difficulty falling asleep, uneasy sleep, or excessive sleep (75%) are the most common symptoms. As a result, we proposed that the health department establish an online psychological intervention platform where students can seek online psychological assistance if they are experiencing the two symptoms listed earlier (30).

To our knowledge, this is a large sample study of the prevalence of depressive symptoms among college students. Second, to diagnose depression symptoms, we employed the PHQ-9 standardized questionnaire. Finally, to make our results more realistic, we removed participants who did not match the study's conditions. However, some limitations should be recognized when discussing our findings. First, although we corrected several covariates, some potential confounding effects cannot be excluded. Second, because the study is cross-sectional, it is unable to draw inferences regarding the cause-and-effect linkages between the variables. Third, the behavioral status represents the participants' awareness of the COVID-19 pandemic characteristics, although its effectiveness cannot be guaranteed. Finally, because the participants in this study were college students, our findings may not apply to students in other grades.

Conclusion

In conclusion, the prevalence of depressive symptoms among college students was not optimal during the COVID-19 pandemic normalization, particularly among students residing in the rural areas. Furthermore, in the follow-up work, factors such as gender, home location, and behavioral status should be evaluated as part of the overall management of depressive symptoms. These findings imply that in order to prevent COVID-19, governments should pay attention to college' student's mental health, and we should increase the COVID-19 knowledge promotion, particularly in behavioral status.

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 Zhengzhou

University (ZZUIRB2021-118). The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

Conceptualization: XLu and QX. Data curation, visualization, and writing—original draft: XLu. Investigation: KF, JW, DW, XW, XLo, and HL. Writing—review and editing: QX, KF, CWa, CWu, and ZM. 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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Factoring and correlation in sleep, fatigue and mental workload of clinical first-line nurses in the post-pandemic era of COVID-19: A multi-center cross-sectional study

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Background: A better understanding of the factors and their correlation with clinical first-line nurses' sleep, fatigue and mental workload is of great significance to personnel scheduling strategies and rapid responses to anti-pandemic tasks in the post-COVID-19 pandemic era.

Objective: This multicenter and cross-sectional study aimed to investigate the nurses' sleep, fatigue and mental workload and contributing factors to each, and to determine the correlation among them.

Methods: A total of 1,004 eligible nurses (46 males, 958 females) from three tertiary hospitals participated in this cluster sampling survey. The Questionnaire Star online tool was used to collect the sociodemographic and study target data: Sleep quality, fatigue, and mental workload. Multi-statistical methods were used for data analysis using SPSS 25.0 and Amos 21.0.

Results: The average sleep quality score was 10.545 ± 3.399 (insomnia prevalence: 80.2%); the average fatigue score was 55.81 ± 10.405 (fatigue prevalence: 100%); and the weighted mental workload score was 56.772 ± 17.26. Poor sleep was associated with mental workload ($r = 0.303$, $P < 0.05$) and fatigue ($r = 0.727$, $P < 0.01$). Fatigue was associated with mental workload ($r = 0.321$, $P < 0.05$). COVID-19 has caused both fatigue and mental workload. As 49% of nurses claimed their mental workload has been severely affected by COVID-19, while it has done slight harm to 68.9% of nurses' sleep quality.

Conclusion: In the post-COVID-19 pandemic era, the high prevalence of sleep disorders and fatigue emphasizes the importance of paying enough attention to the mental health of nurses in first-class tertiary hospitals. Efficient

nursing strategies should focus on the interaction of sleep, fatigue and mental workload in clinical nurses. In that case, further research on solutions to the phenomenon stated above proves to be of great significance and necessity.

Introduction

During the COVID-19 pandemic, nurses often spend the greatest amount of time and have the most frequent direct contact with patients, who may have a fever and/or an infectious disease, and often shoulder almost the entire burden of nucleic acid testing (NAT) and sampling. In the case of long COVID-19 or post-sequelae infection and repeated outbreaks, which place a demand on the breadth of healthcare systems (1), nurses must manage and control the continuous development of the pandemic while caring for non-COVID-19 patients and protecting themselves from infection.

Based on a hospital's ability to provide medical care, medical education and conduct health research, hospitals in China are designated as primary, secondary or tertiary institutions (2). Furthermore, based on the level of service provision, size, medical technology, medical equipment, and management and medical quality, these three grades are further subdivided into three subsidiary levels, resulting in a total of nine levels. A first-class tertiary hospital is more specialized than any other level (3). In particular, the clinical first-line nurses of first-class tertiary hospitals in China need to be ready to support health institutions in areas where outbreaks occur. This is bound to pose new challenges for nurses who are already in a high-risk and high-burden position for prevention and control during the normalization period of the pandemic.

China is among the first to enter the post pandemic ear of anti-COVID-19 (4), while the sleep quality, fatigue and mental workload of clinical nurses keep unknown. In the wake of the COVID-19 outbreak, the occupational pressure on medical staff has soared, and their sleep quality, fatigue status and mental health have also received extensive attention. A range of evidence has reported poor sleep quality and fatigue among medical workers during the COVID-19 pandemic. The incidence of insomnia ranges from 34.0 to 36.1% (5). The prevalence of fatigue among nurses was 35.06% (6), and the average mental workload score of nurses was 65.9 ± 12.71 (7). To provide new suggestions to managers to build more reasonable strategies to fight post COVID-19 stressors among

healthcare professionals, the data on nurses' sleep, fatigue and mental workload status and contributing factors need to be updated. Therefore, we took these three stressors as the main outcomes and tried to describe the current situation of nurses and determine the factors contributing to these stressors.

Previous research has demonstrated a correlation between sleep and fatigue, or sleep and mental workload, or fatigue and mental workload. Many evidence-based studies have shown that fatigue or insufficient sleep causes exhaustion, decreases concentration, and increases mortality (8). For nurses, disturbed sleep and fatigue lead to a higher risk of nursing errors (9). Similarly, a high mental workload has a negative impact on a person's health and work safety, and causes issues such as mental health problems, mental distress and low job satisfaction (10).

However, little is known about the quantitative relationship among sleep, fatigue and mental workload. And there is a lack of studies evaluating all three simultaneously in clinical nurses. We believe that quantifying the inter-relationship among them may help optimize the health maintenance strategies of nursing staff and efficiently coordinate anti-epidemic human resources.

Therefore, in this study, we regard sleep quality, fatigue and mental workload as the main outcomes and explore their relationships. The main aims of this survey were as follows: (1) to describe the sleep quality, fatigue, and mental workload and the associated factors; (2) to assume there will be interaction among them; and (3) to clarify the impact of COVID-19 on nursing staff in first-class tertiary hospitals.

Materials and methods

Study design

A cluster sampling, multi-center, cross-sectional observational study was carried out from November 20th, 2021 to November 27th, 2021 in 3 first-class tertiary hospitals affiliated with the Army Military Medical University in

Chongqing, China. The recommended minimum sample size was 315, based on the formula:

$$N = Z_\alpha^2 \times P(1-P) \div \delta^2 \qquad (1)$$

where Z_α = 1.96 at a 95% CI with a 5% margin of error. The proportion (P) of the sample with insomnia was 71.8% ([11]) and the δ value in this study was 0.05 ([12]). Considering a 20% invalid survey response rate, the expected sample was at least 378. Finally, 1005 participants responded to the survey, and 1,004 of the 1,005 provided valid responses (response rate 99.9%).

We completed our investigation through Internet. Chinese Questionnaire Star[1] was chosen to be the platform to deliver our questionnaire, meanwhile necessary Informed Consent Form would also be demonstrated. After that, we will acquire a QR code without Additional expenditure. Nurses logged on to *Questionnaire Star* via scanning the QR code with a smartphone or computer. There, they were able to read the 2-page informed consent form. After reading the consent form, the nurses could decide whether to take part in this survey. The subjects who agreed to participate in the study were required to electronically sign the consent form and then complete the questionnaires; otherwise, the *Questionnaire Star* tool would end the interview directly. Each participant was only allowed to submit once in order to avoid double submission. Volunteers who help to fill out our survey mentioned above will get rewards from Questionnaire Star. The reward amount would range from $ 5 to $ 10 at random.

Study population

A notice for volunteers through the Nursing Management Offices of the three hospitals. The notice indicated the purpose of the survey, the precautions that need to be cooperated, and the inclusion and exclusion criteria.

Inclusion criteria included the following: (1) registered nurses who had worked in their current hospitals since the outbreak of COVID-19 in China; (2) nurses with the ability to use basic information technology such as a computer and the WeChat App; (3) nurses who volunteered to participate and signed an informed consent form.

Exclusion criteria included the following: (1) nurses who had not worked fulltime for the past month for any reason and (2) nurses with physical or mental illnesses (e.g., depression or epilepsy).

Collection of the demographic data

A total of 1,005 questionnaires, including 1 unqualified data, were collected (efficient rate of 99.9%). There were 29

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1 https://www.wjx.cn/

sociodemographic variables evaluated in this study, the details of which are provided in **Supplementary material**.

Measurement of sleep quality, fatigue, and mental workload

Sleep quality assessment

The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate the sleep quality of the eligible nurses. The PSQI is a mature scale that is widely used to assess the sleep quality of people with no special restrictions. Its reliability and validity have been evaluated by many studies ([13]). The scale has 7 items: sleep latency, sleep duration, sleep quality, habitual efficiency, sleep disturbance, daytime dysfunction and the use of sleeping medications. Total PSQI scores can range from 0 to 21: 8 points or more indicate a sleep disorder, 8-10 points indicate a minor sleep disorder, 11-15 points indicate a serious sleep disorder, and 16 points or more indicate a severe sleep disorder ([14]).

Fatigue assessment

The Modified Fatigue Impact Scale (MFI-20) was used to assess the participants' fatigue in the past 4 weeks. This 20-item scale can be categorized into 5 dimensions: Comprehensive fatigue, physical fatigue, activity reduction, physical decline and mental fatigue. Total fatigue scores can range from 0 to 100 and are interpreted as no fatigue (0-20), minor fatigue (21-39), serious fatigue (40-59), severe fatigue (60-79) and extremely severe fatigue (80-100) ([15]). This scale was used to measure fatigue in Chinese population with a good validity and reliability ([16]).

Mental workload assessment

The NASA task load index (NASA TLX) ([17]) is a tool for measuring and conducting a subjective mental workload (MWL) assessment. It rates performance across six dimensions to determine an overall workload rating. The six dimensions are as follows: mental demand, physical demand, temporal demand, frustration level and effort and performance. The total MWL score ranges from 0 to 100 points. The higher the score is, the higher the mental workload is. This scale has been *validated* by Chinese scholars and can be used to test the mental workload of Chinese nurses ([18]). In this study, we used the weighted workload score.

Statistical analyses

First, all answer sheets were exported from *Questionnaire Star* to SPSS 25.0 and error-checked by the study team. Then, all data were divided into measurement data and classification data, and the QQ chart and Bonferroni test were used to check the normality and homogeneity of the variance.

Second, for the descriptive analysis of the participants' sociodemographic data, the average standard deviation was evaluated for measurement data such as age, height, and weight, and the frequency was assessed for classification data such as sex, length of service, and education. Multi-correspondence analysis was conducted for one multichoice question, "Which time periods may be the most fatiguing when a nurse is on night shift duty?"

Third, for the distribution of the three scales (the MFI-20, PSQI, and NASA-TLX), the mean and standard deviation were calculated to determine whether the scores conformed to a normal distribution. However, the mean (max, min) was used to analyze the score distributions that did not conform to a normal distribution, such as the score for frustration level (a NASA-TLX component) and that of sleep duration and the use of sleeping medication (PSQI components). The frequency was used to analyze the severity of fatigue and insomnia.

Fourth, path analysis was conducted by IBM Amos 21.0 to check the correlations among sleep, fatigue and mental workload. A result was considered significant when two-tailed P values were < 0.05. The standardized regression weights (β values) present the correlation. Factor weights between 0.5 and 0.95 indicate that the measured variable contributes well to the latent variable. According to Jackson's recommendation [19] and Rappaport's suggestion [20], seven model fit indices were reported as followed: Chi-square (X^2), degrees of freedom (df), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), Comparative fit index (CFI), Root-mean-square error of approximation (RMSEA) and Bayesian information criteria (BIC) values. When GFI, AGFI and CFI were more than 0.9, the result could be described as good fit. Besides, a model is considered acceptable when those indices mentioned above were above 0.8 RMSEA being lower than 0.05 indicated a good model fit, while lower than 0.08 is considered acceptable. A result of good model fit could also be identified when BIC value was lower than both saturated and independence model.

Finally, to determine the factors affecting the target outcomes and control the influence of confounding factors, stepwise linear regression analysis was conducted. When the VIF value was < 10.0, the factor was considered to present a low level of interference. The standardized coefficient beta indicated the degree of impact the factors had on the dependent variables: The higher the value was, the greater the degree of influence.

Ethical considerations

Guided by the 2000 Declaration of Helsinki for ethical standards, the protocol has been approved by the Ethics Committee of the First Affiliated Hospital of Army Medical University, PLA (Ref: KY2021062).

Results

Descriptive statistics of nurse characteristics

In total, 1,005 clinical first-line nurses of three tertiary hospitals responded to the survey without any missing data and their demographic characteristics were detailed in Figure 1. Figure 1A shows the mean and standard deviation of data that were the numerical variables. Figure 1B shows the percentage of nurses with sociodemographic data, which were categorical variables.

Distribution of total scores of three scales and their component scores

The Cronbach's alpha coefficient was 0.829 for NASA-TLX, 0.556 for PSQI, and 0.771 for MFI-20. Cronbach's alpha coefficients indicated that the NASA-TLX, PSQI, and MFI-20 had a satisfactory internal consistency.

The average total PSQI score was 10.545 ± 3.399, in which the average sleep quality score was 1.617 ± 0.814, sleep latency score was 1.761 ± 0.953, habitual efficiency score was 2.224 ± 0.913, sleep disturbance score was 1.412 ± 0.677, and daytime dysfunction score was 1.994 ± 0.821. The mean (max, min) sleep duration score and the use of sleeping medication score, which are components of the PSQI, were 1.36 (0, 3) and 0.171 (0, 3), respectively. The insomnia incidence of the nurses was 80.8% ($n = 811$). In the past month, 80.4% of the nurses had a PSQI score higher than 8, and only 19.2% of the nurses had PSQI scores lower than 7 with normal sleep. The percentages of nurses with degrees of insomnia were as follows: Serious insomnia (41.2%, $n = 414$), minor insomnia (31.7%, $n = 318$) and severe insomnia (7.9%, $n = 79$).

The average fatigue score was 55.81 ± 10.405, of which the average comprehensive fatigue score was 13.218 ± 3.149, physical fatigue score was 11.843 ± 3.039, activity reduction score was 9.754 ± 2.551, physical decline score was 10.607 ± 2.679 and mental fatigue score was 10.388 ± 2.941. The fatigue rate of the nurses in this survey was 100%, mainly including serious fatigue (53.4%, $n = 536$) and severe fatigue (37.6%, $n = 378$).

The weighted score of mental workloads was 56.772 ± 17.26, in which the mental demand score was 7.908 ± 7.157, physical demand score was 12.603 ± 9.716, temporal demand score was 10.511 ± 7.688, effort score was 9.466 ± 6.815 and frustration level score [mean, (max, min)] was 6.582 (0, 33.33).

The abovementioned results are detailed in Figures 2A-C.

A

B
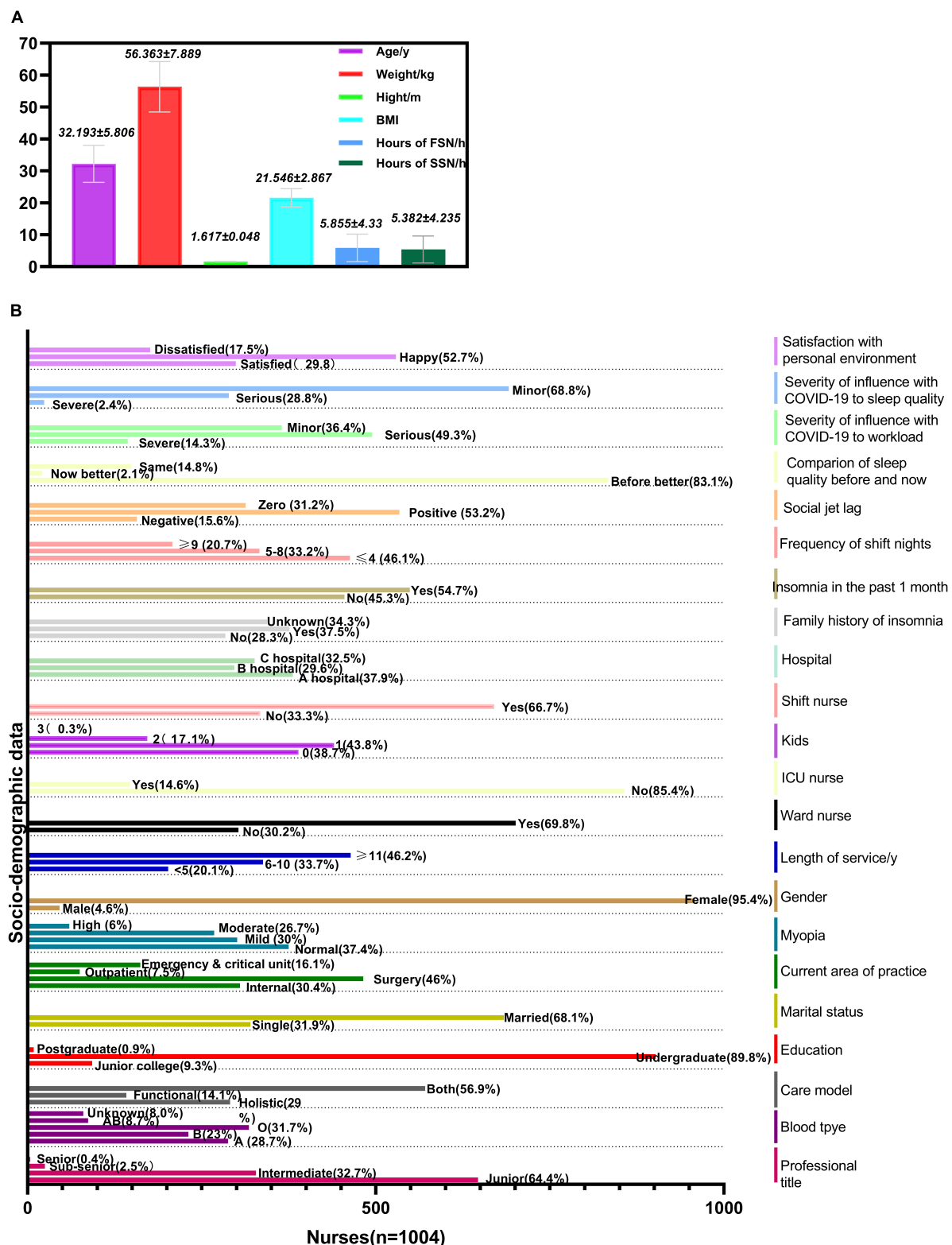
FIGURE 1

Descriptive analysis of sociodemographic data (*n* = 1004). FSN, first shift night; SSN, second shift night. **(A)** The mean and standard deviation of demographic data of nurses. **(B)** The percentage of nurses on socio-demographic data.
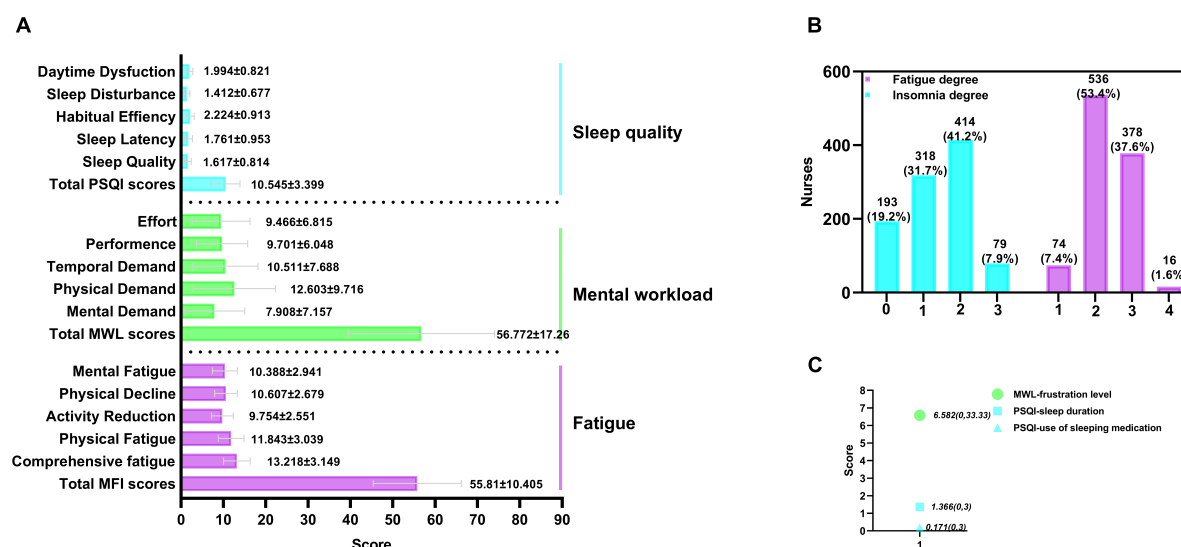
Distribution of total scores of three scales and their component scores (*n* = 1004). MFI, multiple fatigue impact scale; PSQI, the Pittsburg Sleep Quality Index; MWL, the NASA task load index; 0, normal; 1, minor; 2, serious; 3, severe; 4, extremely severe. **(A)** Distribution of total scores of MFI, MWL, and PSQI, and their component scores. **(B)** Percentage of the degree of insomnia and fatigue. **(C)** Analysis of the component score of MWL and PSQI [(mean, (max, min)], which did not conform to the normal distribution.

Interrelationships among sleep, fatigue and mental workload with path analysis

To test the hypotheses that there will be interaction among sleep, fatigue and mental workload, Path Analysis was conducted through IBM Amos 21.0. Sleep, fatigue and mental workload were the three latent variables. The dimensions of the PSQI, including sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, hypnotic drugs and daytime dysfunction, were regarded as the observed variables for *sleep*. The dimensions of the MFI-20, including comprehensive fatigue, physical fatigue, activity reduction, physical decline and mental fatigue, were regarded as the observed variables for *fatigue*. The dimensions of the NASA-TLX, including mental demand, physical demand, temporal demand, performance, effort and frustration level, were regarded as the observed variables for *mental workload*. The final structural model was presented in **Figure 3**.

The values pertaining to the model were that X^2 was 855.409, df was 132, GFI was 0.908 (> 0.9), AGFI was 0.880 (> 0.8), CFI was 0.805 (> 0.8), RMSEA was 0.074 (< 0.08) and BIC value was 1,124.967 (saturated model: BIC = 1181.909; independence model: BIC = 3996.345). All indices indicated acceptable model fit.

Based on the analysis detailed in **Table 1**, the covariances of sleep, fatigue and mental workload were significantly different (*P* < 0.05). There was a positive correlation among them. The correlation coefficient between sleep and mental workload

was 0.303, that between sleep and fatigue was 0.727, and that between mental workload and fatigue was 0.321.

The significance of all unstandardized regression coefficients except sleep efficiency was found (**Table 2**). The observed variables that contributed significantly to *sleep* included sleep quality (β = 0.809), sleep latency (β = 0.679), sleep disturbance (β = 0.582), and daytime dysfunction (β = 0.605). The observed variable that contributed significantly to *mental workload* was physical demand (β = 0.948). The observed variables that contributed significantly to *fatigue* included comprehensive fatigue (β = 0.785), physical fatigue (β = 0.802), physical decline (β = 0.561), and mental fatigue (β = 0.627).

Stepwise linear regression of the factors associated with the target outcomes

Figure 4A shows the influencing factors of the fatigue. Among all the independent variables, nine variables were successfully included in the model (R^2 = 0.339, 95% *CI*: 40.065 to 48.889). Based on the analysis, the regression equation, which is between the dependent variable (the MFI score) and the independent variables (influencing factors), was as follows:

$$a = 44.477 + 0.81 * b + 0.123 * c + 2.239 * d - 2.791 * e$$
$$- 1.376 * f - 1.72 * g - 1.452 * h - 1.444 * i - 1.638 * j$$

Figure 4B shows the influencing factors of the sleep. Among all the independent variables, twelve variables were successfully
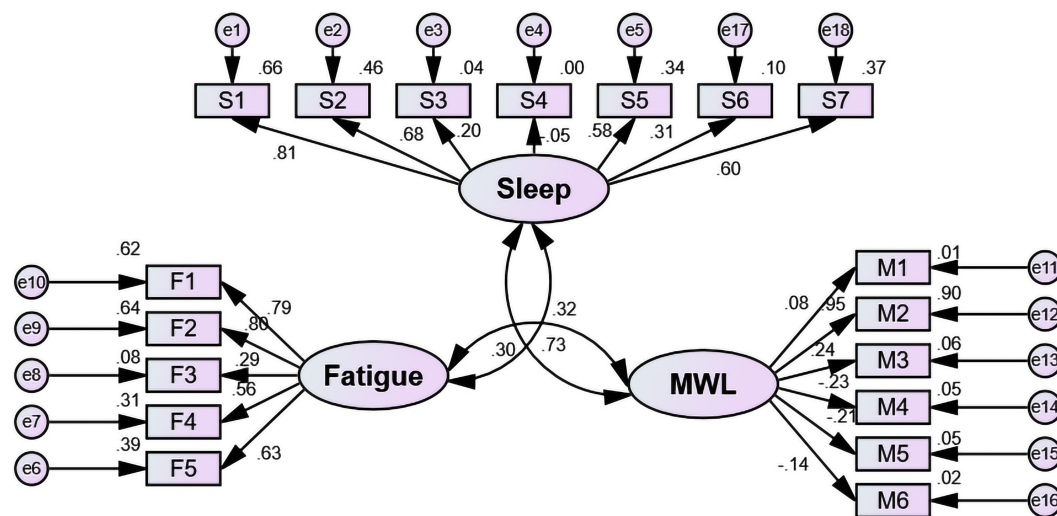
FIGURE 3
Model of the correlation among sleep, fatigue and mental workload in frontline nurses (n = 1004). MWL, mental workload; S1, sleep quality; S2, sleep latency; S3, sleep duration; S4, sleep efficiency; S5, sleep disturbance; S6, hypnotic drug; S7, daytime dysfunction; M1, mental demand; M2, physical demand; M3, temporal demand; M4, performance; M5, effort; M6, frustration level; F1, comprehensive fatigue; F2, physical fatigue; F3, activity reduction; F4, motivation decline; F5, mental fatigue.

TABLE 1   Correlation coefficient, covariance and covariance significance among sleep, fatigue and mental workload (n = 1004).

	Correlations estimate	Covariances			
		Estimate	S.E.	C.R.	P
Sleep ↔ Mental Workload	0.303	0.112	0.053	2.125	0.034
Sleep ↔ Fatigue	0.727	0.883	0.068	12.954	***
Mental Workload ↔ Fatigue	0.321	0.333	0.156	2.129	0.033

***P < 0.001; SE, Standard error; CR, Critical ratio.

included in the model (R^2 = 0.428, 95% CI: 2.982 to 6.528, P < 0.001). Based on the analysis, the regression equation, which is between the PSQI score and influencing factors, was as follows:

$$a = 4.62 - 2.311 * b + 0.076 * c + 0.032 * d - 1.007 * e$$
$$+ 0.588 * f + 1.186 * g - 1.337 * h + 0.386 * i$$
$$- 0.601 * j + 0.275 * k + 0.363 * l - 0.416 * m$$

Figure 4C shows the influencing factors of the mental workload score. Among all the independent variables, there were 8 variables finally included in the model (R^2 = 0.223, 95% CI: 0.757 to 19.875, P < 0.001). Based on the analysis, the regression equation, which is between the mental workload score and influencing factors, was as follows:

$$a = 10.316 + 0.393 * b + 1.111 * c + 3.656 * d - 2.103 * e$$
$$+ 1.242 * f + 3.763 * g + 2.331 * h + 2.308 * i$$

Figure 4D shows the common influencing factors of the fatigue, sleep and mental workload. The study found that three factors, including personal environment satisfaction, insomnia in the past month and current area of practice, were common influencing factors of the three. The joint influencing factor of the mental workload and sleep was education, that for the mental workload and fatigue was COVID-19, and that for the fatigue and sleep was the comparison of nurses' sleep quality before the pandemic and at the time of this study. There was a mutual relationship among the fatigue, sleep and mental workload.

Discussion

This multicenter cross-sectional study aimed to update the information about sleep, fatigue and mental workload in hospital nurses in China during the normalized pandemic era of COVID-19, to quantify the interrelation among the three and to explore the related

TABLE 2 Path coefficients, unstandardized regression coefficients and their significance (n = 1004).

	Standardized estimate	Unstandardized			
		Estimate	S.E.	C.R.	P
S1 ← Sleep	0.809	1			
S2 ← Sleep	0.679	0.981	0.049	20.109	***
S3 ← Sleep	0.199	0.447	0.078	5.75	***
S4 ← Sleep	−0.046	−0.064	0.048	−1.323	0.186
S5 ← Sleep	0.582	0.597	0.035	17.218	***
S6 ← Sleep	0.309	0.26	0.029	8.989	***
S7 ← Sleep	0.605	0.753	0.042	17.927	***
M1 ← Mental Workload	0.078	1			
M2 ← Mental Workload	0.948	16.397	7.449	2.201	0.028
M3 ← Mental Workload	0.243	3.329	1.474	2.258	0.024
M4 ← Mental Workload	−0.229	−2.471	1.101	−2.245	0.025
M5 ← Mental Workload	−0.215	−2.604	1.169	−2.228	0.026
M6 ← Mental Workload	−0.144	−1.687	0.811	−2.081	0.037
F5 ← Fatigue	0.627	1			
F4 ← Fatigue	0.561	0.815	0.055	14.793	***
F3 ← Fatigue	0.290	0.401	0.049	8.21	***
F2 ← Fatigue	0.802	1.322	0.069	19.097	***
F1 ← Fatigue	0.785	1.341	0.071	18.896	***

***P < 0.001; SE, Standard error; CR, Critical ratio; S1, Sleep quality; S2, Sleep latency; S3, Sleep duration; S4, Sleep efficiency; S5, Sleep disturbance; S6, Hypnotic drugs; S7, Daytime dysfunction; M1, Mental demand; M2, Physical demand; M3, Temporal demand; M4, Performance; M5, Effort; M6, Frustration level; F1, Comprehensive fatigue; F2, Physical fatigue; F3, Activity reduction; F4, Motivation decline; F5, Mental fatigue.

factors of them. Thus, we came across these findings as below.

Fatigue and associated factors

We found that front-line clinical nurses suffered from varying degrees of fatigue, and the positive detection rate of fatigue was 100%.This was much higher than both before and during the pandemic of COVID-19 (6, 21). Different from other occupations, the fatigue of nurses is mainly comprehensive fatigue and physical fatigue. This may contribute to the high physical workload (22).

High fatigue prevalence and the reasons behind it are thought provoking. We found these factors may cause different level of fatigue: poor sleep, lower satisfaction of personnel environment, professional title, current department of practice, blood type, and COVID-19.

Poor sleep may lead to fatigue, which manifested daytime dysfunction (23). Likewise, the more tired the body is, the less sleep it may be. It is because excessive fatigue can easily cause autonomic dysfunction that the nerves are in a state of excitement, so as to insomnia (24).

Personnel environment is one component of job satisfaction (25). Lower satisfaction of personnel environment might decrease motivation to work and increase physical and mental

fatigue. Nursing managers should pay attention to the personnel environment, try to create a happy personnel culture for their nurse staff.

Professional title and current department of practice were also factors of fatigue. The lower the job title was, the more fatigue would be. Because nurses' job title had a positive correlation with their length of experience (r = 0.630, P < 0.001). The nurses with a low job title would be in younger experience of nursing, they might lack clinical experience so that spend more time and energy dealing with clinical problem. Likewise, nurses in surgery department were more fatigue than those in internal department. This might be due to differences in work content and work intensity. The hospitals we investigated were all first-class tertiary hospitals in China, which often undertake the diagnosis and treatment of many patients who need major surgeries. Surgery nurses in these hospitals usually require more physical effort to care for preoperative and postoperative patients and more mental effort to prevent and manage postoperative complications.

Sleep and associated factors

Using PSQI to assess sleep quality of nurses, we found a higher incidence (80.2%) of insomnia both before COVID-19 and during the epidemic (26–28). In addition, 54.7% of nurses

A

Independent variables	Unstandardized Coefficients		Standardized Coefficients	T	P	95.0% CI		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	44.477	2.248		19.782	0.000	40.065	48.889		
b. PSQI	0.810	0.099	0.264	8.164	0.000	0.615	1.004	0.633	1.579
c. MWL	0.123	0.017	0.205	7.250	0.000	0.090	0.157	0.834	1.199
d. Satisfaction with personal environment	2.239	0.431	0.146	5.200	0.000	1.394	3.084	0.846	1.182
e. Insomnia in the past 1 month (no)	-2.791	0.635	-0.134	-4.395	0.000	-4.037	-1.545	0.719	1.391
Insomnia in the past 1 month (yes)	0								
f. Professional title	-1.376	0.488	-0.074	-2.822	0.005	-2.333	-0.419	0.971	1.030
g. Current area of practice (surgery)	-1.720	0.543	-0.082	-3.169	0.002	-2.785	-0.655	0.982	1.018
Current area of practice (internal)	0								
h. Severity of the influence with COVID-19 to sleep quality	-1.452	0.524	-0.073	-2.771	0.006	-2.480	-0.424	0.967	1.035
i. Blood type (B)	-1.444	0.640	-0.058	-2.256	0.024	-2.700	-0.188	0.991	1.010
Blood type(A)	0								
j. Comparison of sleep quality before and now (same)	-1.638	0.801	-0.056	-2.044	0.041	-3.211	-0.066	0.886	1.129
Comparison of sleep quality before and now (before better)	0								
R^2=0.339, P<0.05									
a. Dependent Variable: MFI									

B

Independent variables	Unstandardized Coefficients		Standardized Coefficients	T	P	95% CI		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	4.620	0.835		5.533	0.000	2.982	6.258		
b. Insomnia in the past 1 month (no)	-2.311	0.182	-0.339	-12.685	0.000	-2.668	-1.953	0.811	1.234
Insomnia in the past 1 month (yes)	0								
c. MFI	0.076	0.009	0.234	8.237	0.000	0.058	0.095	0.718	1.393
d. MWL	0.032	0.005	0.160	6.019	0.000	0.021	0.042	0.814	1.228
e. Comparison of sleep quality before and now (same)	-1.007	0.245	-0.105	-4.119	0.000	-1.487	-0.527	0.882	1.134
Comparison of sleep quality before and now (before better)	0								
f. Hours of the second half of the night	0.058	0.020	0.072	2.896	0.004	0.019	0.097	0.929	1.076
g. Gender (female)	1.186	0.395	0.073	3.002	0.003	0.411	1.962	0.976	1.024
Gender (male)	0								
h. Comparison of sleep quality before and now (now better)	-1.337	0.581	-0.056	-2.303	0.021	-2.476	-0.198	0.966	1.036
Comparison of sleep quality before and now (before better)	0								
i. Current area of practice(surgery)	0.386	0.167	0.057	2.311	0.021	0.058	0.714	0.962	1.040
Current area practice (internal)	0								
j. Education	-0.601	0.267	-0.054	-2.248	0.025	-1.126	-0.076	0.985	1.015
k. Satisfaction with the personal environment	0.275	0.133	0.055	2.077	0.038	0.015	0.535	0.829	1.207
l. Night fatigue period (6am-8am)	0.363	0.167	0.053	2.173	0.030	0.035	0.691	0.973	1.028
Night fatigue period (22pm-0am)	0								
m. Night fatigue period(23pm-1am)	-0.416	0.196	-0.051	-2.120	0.034	-0.802	-0.031	0.981	1.019
Night fatigue period (22pm-0am)	0								
R^2=0.428, P<0.05									
a. Dependent Variable: PSQI									

C

Independent variables	Unstandardized Coefficients		Standardized Coefficients	T	P	95% CI		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	10.316	4.871		2.118	0.034	0.757	19.875		
b. MFI	0.393	0.055	0.237	7.151	0.000	0.285	0.501	0.710	1.408
c. PSQI	1.111	0.179	0.219	6.196	0.000	0.759	1.463	0.626	1.597
d. Satisfaction with the personal environment	3.656	0.770	0.143	4.748	0.000	2.145	5.168	0.856	1.169
e. Severity of the influence with COVID-19 to workload	-2.103	0.722	-0.083	-2.911	0.004	-3.520	-0.685	0.972	1.029
f. Myopia	1.242	0.515	0.068	2.411	0.016	0.231	2.253	0.996	1.004
g. Education	3.763	1.574	0.067	2.390	0.017	0.674	6.852	0.992	1.008
h. Current area of practice (surgery)	2.331	0.977	0.067	2.385	0.017	0.413	4.249	0.980	1.020
Current area of practice (internal)	0								
i. Insomnia in the past 1 month (no)	2.308	1.143	0.067	2.019	0.044	0.064	4.552	0.718	1.394
Insomnia in the past 1 month (yes)	0								
R^2=0.223, P<0.05									
a. Dependent Variable: MWL									

D

FIGURE 4

Stepwise linear regression of the factors associated with the target outcomes (*n* = 1004). MFI, multiple fatigue impact scale; PSQI, the Pittsburg Sleep Quality Index; MWL, the NASA task load index; PES, personal environment satisfaction; CAP, current area of practice; IPOM, insomnia in the past one month. **(A)** Factors associated with MFI. **(B)** Factors associated with PSQI. **(C)** Factors associated with MWL. **(D)** Common influencing factors of MFI, PSQI and MWL.

self-reported sleep complaints in past one month. The sleep problems of clinical front-line nurses mainly manifest as low sleep efficiency, daytime dysfunction and difficulty falling asleep.

Sleep quality is due to multisystem factors (8, 29), including the neural system, lifestyle, job environment, and physical and psychological factors. We found that these factors may cause sleep disorders: nursing occupation, gender, current department of practice, education, lower satisfaction of personal environment and shift nights.

Occupation of nursing itself may cause sleep disorders. We found in this study 83.1% of nurses reported their sleep quality before they became a nurse were better than after that. Because nursing is a such profession that they have to take more frequent shift work. Li found the prevalence of shift work sleep disorder in the sampled shift nurses was 48.5% (30). We also found that nurses suffered most fatigue at 23 pm to 0 mn and 6 am to 8 am when they were on night shift duty. This indicated shift nights may exacerbate sleep disorders (31).

Women's sleep quality is significantly worse than men's. Rani (32) reported that higher odds of sleep problems among women in China. Same to resent studies (33, 34), we found women's worse sleep mainly manifested as worse subjective sleep quality, long time sleep latency and short sleep duration. The reason for this difference may be related to the development of the brain during childhood (35).

Education level affects sleep quality, and lower level may contribute more to sleep problem. Resent study (36) pointed that educational attainment has positive effects on cognitive function. The person with higher education level may have the ability to learn more skills to improve their sleep quality. They may also have a better cognition to develop good sleep hygiene habits. Thereby, nursing managers should encourage their nurses to improve their education attainment.

Nurses practicing in surgery department are pond to worse sleep than those in internal department (37). As the saying goes: three points of treatment, seven points of care, especially for clinical surgery nurses. Comparison with the internal nurses, they would provide service to postoperative patients who may occur complications at any time. Clinical surgery nurses are always more carefully to care their patients so that they always burden a severe mental pressure although they are out of duty.

Lower satisfaction of personal environment may contribute more to insomnia. Number of studies pointed a positive correlation between job satisfaction and sleep (25, 38–40). A health personnel environment can reduce job stress, improve sleep quality. We believe that nursing leaders should focus on the strategies for developing a health personnel culture.

Also, poor sleep may cause some negative outcomes, including more fatigue (41), higher mental workload (42). And we found that insomnia may increase subjective sleep complaints. It is important for leaders to listen to and encourage nurses to self-report sleep problems to reduce nursing safety risks associated with sleep disorders.

Mental workload and its associated factors

We found weighted mental workload score (56.772 ± 17.26) was lower than that previously reported during the outbreak of COVID-19(65.9 ± 12.71) (7) and before the pandemic (80.48 ± 11.76) (43). This change may be ascribed to the decline in hospitalized COVID-19 patients. Most nurses regarded physical demand as the most important component of their mental workload, followed by temporal demand or performance, which was different from a recent study that found the time demand to be the most important component, followed by mental demand and physical demand (44).

The reasons, this study found, which may cause high level of mental workload, including lower satisfaction of personal environment, COVID-19, myopia, current department of practice and poor sleep. Contrary to Boultinghouse' report of physician (45), we found there was a positive correlation between nurses' mental workload and personnel environment. This discrepancy may indicate a more complex personnel environment for nurses. Working in such a complex personnel environment, nurses may need to spend so much energy dealing with personal relationships, that they will struggle to complete clinical nursing tasks. In addition, clinical surgery nurses reported a higher mental workload score than medical nurses. This may be due to the different work content and work intensity before mentioned. Similar to a previous study, we also found that COVID-19 itself contributed to mental workload (46).

The correlation among sleep, fatigue, and mental workload

Most previous studies have only demonstrated the relationship between sleep and fatigue (47, 48), or fatigue and mental workload (42, 49), or sleep and mental workload (31, 50). A recent study (51) investigated the fatigue, sleep and mental workload of shift night workers. But it still just addressed the relationship between fatigue and mental workload instead of all the three. It was possible that the authors assessed sleep with the participants' self-report instead of scales or wearable devices. However, we quantified the inter-relationship of sleep, fatigue and mental workload. The positive correlation of the three indicated they could improve each other. This finding might provide a new perspective to managers and supervisors. That is, when assessing nurses' mental health, sleep quality, fatigue and mental workload should be taken into account together rather than solely.

In addition, with path analysis, we found that the dimensions of the PSQI, including sleep quality ($\beta = 0.81$), sleep latency ($\beta = 0.68$), sleep disturbance ($\beta = 0.58$) and daytime dysfunction ($\beta = 0.60$), contributed significantly to the sleep index; the dimensions of the MFI-20, including comprehensive fatigue ($\beta = 0.79$), physical fatigue ($\beta = 0.80$), physical decline ($\beta = 0.56$) and mental fatigue ($\beta = 0.63$), contributed greatly to fatigue; and the physical demand ($\beta = 0.95$) dimension of the NASA-TLX contributed most to mental workload. This meant that sleep quality, sleep latency, sleep disturbance and daytime dysfunction in sleep, comprehensive fatigue, physical fatigue, physical decline and mental fatigue in fatigue and physical demand in mental workload had a positive and direct correlation. Therefore, given the interplay of different manifestations of sleep, fatigue, and mental workload, targeted interventions are recommended for more effective management of the associated risks.

Predictors among sleep, fatigue, and mental workload

Figure 4D, a general diagram, presents the factors associated with the main outcomes in this study and the relationships among them.

The common risk factor for mental workload and sleep was education, and for mental workload and fatigue, it was COVID-19. In this study, education was positively correlated with mental workload but negatively correlated with sleep. This meant that the higher the education level was, the greater the mental workload and the worse sleep was.

In addition, the comparison of sleep quality before and after the COVID-19 pandemic—better before, better now, or the same—was influenced by the joint factor of sleep and fatigue. Regardless of whether the nurses had the same or better sleep quality, compared to better sleep before, it was negatively correlated with both fatigue and poor sleep. This indicates that the nursing profession itself has an impact on sleep and fatigue.

Furthermore, we also found that personnel environmental satisfaction, insomnia in past one month and current area of practice were correlated with sleep, fatigue and mental workload. Personnel environmental satisfaction, which was detailed as satisfied, happy, and dissatisfied, in that order,

had a positive correlation with poor sleep, fatigue and mental workload. This meant that the more dissatisfied the nurses were with their personal environment, the worse their sleep and the greater their fatigue and mental workload. This was similar to a previous study, except that the study reported job satisfaction rather than personnel environmental satisfaction (10). Thereby, when intervening on sleep, fatigue, and mental workload, the focus should be on the comprehensive assessment and effective coping of personnel environment, self-reported insomnia and practicing department.

The impact of COVID-19 on clinical frontline nurses

COVID-19 was a predictor of both mental workload and fatigue. The COVID-19 pandemic has certainly had multifaceted and vigorous psychological and mental impacts on nurses, such as anxiety, depression, and stress (52). Our study also found that the influence of COVID-19 on sleep or workload had a profound impact on the fatigue and mental workload of the nurses; that is, the greater the impact of COVID-19 was, the higher the level of fatigue and mental workload. A prior study reported that COVID-19 and workload are variables that significantly predict psychological discomfort (44), but did not mention the relationship between COVID-19 and fatigue.

As of November 20, 2021, according to a report from the National Health Commission of the People's Republic of China, there had been 1,051 confirmed cases, including 395 imported cases; a total of 92,818 cases were cured and discharged, and 98,505 cases were confirmed (53). Although the Chinese government has managed the pandemic well, due to the complexity of the virus itself and the severity of the international pandemic, COVID-19 still has a profound impact on the fatigue and mental workload of nurses, especially clinical frontline nursing staff. This may serve as a warning that we still cannot take the impact of COVID-19 lightly, even though the anti-epidemic war has now entered a normalization stage of prevention and control.

Limitations of the study

This survey has several limitations. First, the data collection was only in one city. Some external factors, such as work culture, social capital, health service, and climate in different regions of China, may also affect the studied health outcomes (54–57). Future studies may include these factors and recruit samples from more regions to generalize the findings. Second, the measurement of sleep, fatigue, and mental workload relied almost entirely on self-reported scales, which are prone to be subjective and may cause a nonobjective result. Hence, to ensure the objectivity and authenticity of the results,

some objective measurements (e.g., fatigue testing based on electroencephalogram signs, actigraphy, and Polysomnography) will be considered in future research. Third, because of the cross-sectional study design, this study could not determine causal relationships between influential factors, including personnel environmental satisfaction, fatigue, sleep quality, mental workload, current area of practice and insomnia in past one month. Thus, a more rigorous study design (e.g., cohort study) (58) should be conducted to check the factors related to the sleep, fatigue and mental workload of nurses. In addition, this study only collected data on sleep, fatigue and mental workload for the previous month, which represented a snapshot of the short-term status of the nurses. Therefore, future research should focus on longer periods of time and dynamic data collection to obtain a more comprehensive assessment.

Conclusion

In summary, clinical first-line nurses demonstrated worse sleep, higher levels of fatigue and lower levels of mental workload during post-epidemic of anti-COVID-19 era. Poor sleep, fatigue and mental workload had a positive and direct relationship with each other. The predictors influencing sleep, fatigue and mental workload were also identified. Moreover, COVID-19 has a greater impact on sleep, fatigue and mental workload among clinical front-line nurses than before and during the pandemic. Nursing managers, policy makers and employers should take sleep, fatigue and mental workload into consideration together rather than solely when assessing nurses' mental health. Also, some target interventions, such as solving the long sleep latency, improving sleep efficiency, reducing fatigue degree and physical demand, are recommended for more effective management of the sleep, fatigue or mental workload associated risks.

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/s.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the First Affiliated Hospital of Army Medical University, PLA (Ref: KY2021062). The patients/participants provided their written informed consent to participate in this study.

Author contributions

Funding

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.2022.963419/full#supplementary-material

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COVID-19 related information seeking: The impact of media on parental concerns

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The expansion of information sources and their use has accelerated since the beginning of the COVID-19 pandemic, sometimes provoking significant concern in the daily lives of parents. The objective of this study was to investigate the association between COVID-19 related information sources and the level of concern about COVID-19 among parents of school-aged children. Using factor analysis and hierarchical ascending classification, we constructed groups according to the information sources they used. We performed ANOVA analysis and then binomial logistic regression to compare concern levels among the groups created. Overall, the 3,459 participants were mainly women (79.2%) and 59.5% reported being between 35 and 44 years old. The mean concern score in our sample was 9.5/15 (s.d. = 3.87). The whole sample fell into three groups: (1) Traditional Media ($n = 1,610$), who mainly used newspapers; (2) Online Social Networks and Entourage ($n = 776$), who mostly consulted online social media as well as friends and family; and (3) the Unplugged ($n = 1,073$), who consulted few or no information sources. Compared to the Unplugged, individuals in the other two groups had a higher risk of being concerned (Traditional Media, OR = 2.2; $p < 0.001$; Social Networks and Entourage, OR = 3.1; $p < 0.001$). Communication about pandemic risk should be conveyed based on reliable information and at moderate intervals to safeguard the mental health of individuals.

KEYWORDS

COVID-19, parental concern, information sources, media use, cluster analysis

Introduction

As of June 2, 2022, a cumulative total of approximately 540 million cases of COVID-19 and 6.3 million deaths had been reported worldwide (1). Within this profound health and social crisis, information sources play an important role in the dissemination of information. In times of crisis, populations receive official communications on how to prepare in advance for the impact of the event, and subsequently, information pertaining to ongoing daily activities is relayed to communities (2). To better understand the epidemic situation, and to protect their health, people have an intense need to seek information from various sources and maintain contact with their community (3, 4).

In the context of COVID-19, the high level of fear is probably one of the explanatory factors affecting people's behaviors and perceptions in information seeking (5, 6). Concerns about being infected or transmitting the virus to others were notably visible on social media, where panic seemed to spread faster than the COVID-19 itself (7) On the one hand, information overload phenomenon has led to a lack of confidence in media, especially in social media where a huge amount of untrustworthy content is available (8). On the other hand, inadequate information has sometimes provoked worst consequences in mental health, such as depression, stress and anxiety (9).

Today, this search for information has been facilitated by an explosion of (more or less reliable) information available primarily *via* traditional media (radio/television), new media (web and other digital media), and informal or personal sources of information (blogs, social media, opinion pieces). Nevertheless, this constantly changing and contradictory plethora of news has the potential to affect people's mental health and well-being (10). For example, recent studies have shown that the use of online social networks, *via* negative comments and shares (11), as well as time and frequency of use (12), is associated with significant anxiety. As a result, online social network use often leads to depression, insomnia and consequent emotional problems in individuals (13, 14). Furthermore, Sasaki et al. (15) showed that the use of television to learn about COVID-19 is also a significant factor in consumer anxiety. Other studies have also examined the links between stress, depression, and different information sources in the COVID-19 context (16–20). These have shown that exposure, time spent, and type of information source used are among the factors that trigger negative affect in individuals during COVID-19, generating significant mental health problems.

According to Roy et al. (21), the mental health of individuals, and especially of parents, must be a research priority during the COVID-19 pandemic. As the pandemic continues to ravage the world and protective measures to mitigate its impact are put in place, parents must necessarily expand their use of information sources to learn about COVID-19, as has been empirically demonstrated (22). At the same time, parents are experiencing many disruptions in their daily lives that inevitably augment their anxieties and psychological distress (23, 24), and these may be exacerbated by information sources.

At the same time, the pandemic have also impacted the lives of school-aged children due to restrictions in social interactions with peers and outdoor physical activities during school suspension (25, 26). This vulnerable population may be impacted by deterioration in parent-child relations (27), psychological well-being (28) or violence and maltreatment (29). Moreover, concerns have been raised about the use of digital technologies. School closure during the COVID-19 outbreak has resulted in children spending more time using the Internet (30) which led to many repercussions. For instance, problematic smartphone use contributed to prospective psychological distress among schoolchildren (31, 32) and problematic social media use were associated to depression, anxiety, and stress (33).

In this study, we aimed to understand how COVID-19 related information sources affect parents' concerns of school aged-children in the context of pandemic. This study focused specifically on the concerns of parents of school-aged children, a population that has been relatively understudied to date. We examined existing correlations between information sources (newspapers, online social networks, radio, online forums, friends and family, medical sources), frequency of use (always, often, sometimes, rarely, never), and concerns among parents of school-aged children.

Materials and methods

Study design

This study was a secondary analysis of a survey entitled "*Retour des enfants à l'école: intentions des parents d'enfants de Laval en contexte de pandémie (COVID-19).*" (34). That survey targeted parents of children attending schools within the Centre de services scolaires de Laval (Québec). We obtained the necessary approvals from the ethics committee of CHU Sainte-Justine Hospital in Montreal to conduct this study.

Participants

The survey was conducted using an online questionnaire from August 17 to September 2, 2020. 3,459 parents of school-aged children (4 to 18 years old) from the Centre de services scolaires de Laval have participated in the study. No other clinical inclusion and exclusion criteria was applied to enrollment. The questionnaire was available in French and English.

Dependent variable

Our dependent variable was a COVID-19 parental concern score, drawn from the iCARE study (available at: https://mbmc-cmcm.ca/covid19/). It was constructed with five questions using a 5-point Likert scale (*very worried, somewhat worried, not very worried, not at all worried, don't know/prefer not to answer*). More specifically, this score aggregates concerns about being infected, about the consequences of an infection, about infecting others and its consequences, and about a new wave of infections in the future. In the end, we obtained a score where the lowest value [0] corresponded to a very low level of concern and the highest value [15] to a high level of concern. By visually inspecting the graphic representations, we dichotomized the

concern score into two categories. A split was also applied to this measure in others studies (34, 35).

Moreover, this dependent variable was chosen in two ways. First, it captures both clinical concerns (concerns about being infected and about the consequences of an infection) and psychological concerns (concerns about infecting others and its consequences, and about a new wave of infections in the future thus providing a purposefully broad assessment of concerns experienced by the parents surveyed. Second, previous work on the relationship between concerns has shown that these clinical and psychological concerns has been correlated depending on the type of information source used (16–20). We therefore investigate this point.

Independent variables

We used questions about how often people consulted several information sources to learn about COVID-19. The proposed information media were radio, online social networks, friends and family, medical sources, online forums, and television. The online social networks suggested to participants were Facebook, Instagram and LinkedIn, while the example of medical sources were physicians or health care professionals. A 5-point Likert scale assessed the frequency with which these media were used to learn about COVID-19 (*never, rarely, sometimes, often, always*). Then, we merged the original five items into two groups (*never/rarely/sometimes*; *often/always*) for ease of analysis. The first group items corresponded to punctual consumers of these media, and the second group items were consistent with regular consumers. We assessed validity of the resulting solution by visually examining the individual composition of clusters (14). We used as control variables the sociodemographic characteristics of individuals, namely age, sex, education level, employment status and immigration status, as they are mostly used to control statistically the outcomes on this subject field (17) and their association with concerns and anxiety (36, 37).

Data analysis

The different information sources (radio, online social networks, friends and family, medical sources, online forums, television) were the active variables, and the sociodemographic variables (age, sex, education level, employment status, immigration status) were the illustrative variables. The data analysis was conducted in two stages. The first stage consisted of constructing a taxonomy of respondents according to the sources of information consulted, based on a multiple correspondence analysis (MCA) combined with a hierarchical ascending classification (38, 39). MCA is a factor analysis method suited to the analysis of categorical variables. The MCA revealed the most significant data structures (factorial

axes). The number of axes retained from the MCA was determined using the elbow criterion. In keeping with the general philosophy of multiple factor analysis, we did not use axis rotation, since the MCA is only an intermediate step toward developing a taxonomy (40). Using the axes retained from the MCA, we performed a hierarchical ascending classification using Ward's algorithm (41). This proven technique for creating homogeneous groups was used to avoid the creation of chain effects that could prevent us from obtaining clear distinctions between groups. The objective was to group individuals according to their characteristics by minimizing intra-class variance and maximizing extra-class variance to form homogeneous groups. We chose the optimal number of classes by examining the Euclidean distances (L2 dissimilarity measure) of the dendrogram (Figure 1).

The second stage consisted of an analysis to examine the association between the taxonomy profiles and parental concern. We performed an ANOVA analysis with a Bonferroni correction to compare statistically the concern means of the information groups, and we used a binomial logistic regression to explain individuals' concern levels. The groups from the hierarchical ascending classification were included as the explanatory variable of interest in the logistic model, and the sociodemographic variables were the control variables.

Results

Table 1 presents the numbers (*n*) and percentages (%) of parents who participated in the study according to certain sociodemographic characteristics.

Multiple correspondence analysis and hierarchical ascending classification

In the first stage of the analysis we performed an MCA. After observing the eigenvalues and appropriate modalities for the axes, we chose to retain two dimensions using the elbow criterion, thereby synthesizing 94.22% of the main inertia. Adding an incremental axis did not increase this explained inertia. In the second stage, we used the two axes to perform a hierarchical ascending classification. Euclidean distance analysis of the dendrogram (Figure 1) suggested partitioning our sample into three groups. These groups minimized intra-class variance and maximized inter-class variance.

The first group (*n* = 1,610), which we called Traditional Media, consisted of individuals who reported often or always seeking information about COVID-19 *via* traditional sources of information such as newspapers, television, or radio. The second group (*n* = 776), called Online Social Networks and Entourage, consisted of individuals who reported often or always seeking information about COVID-19 *via* online social
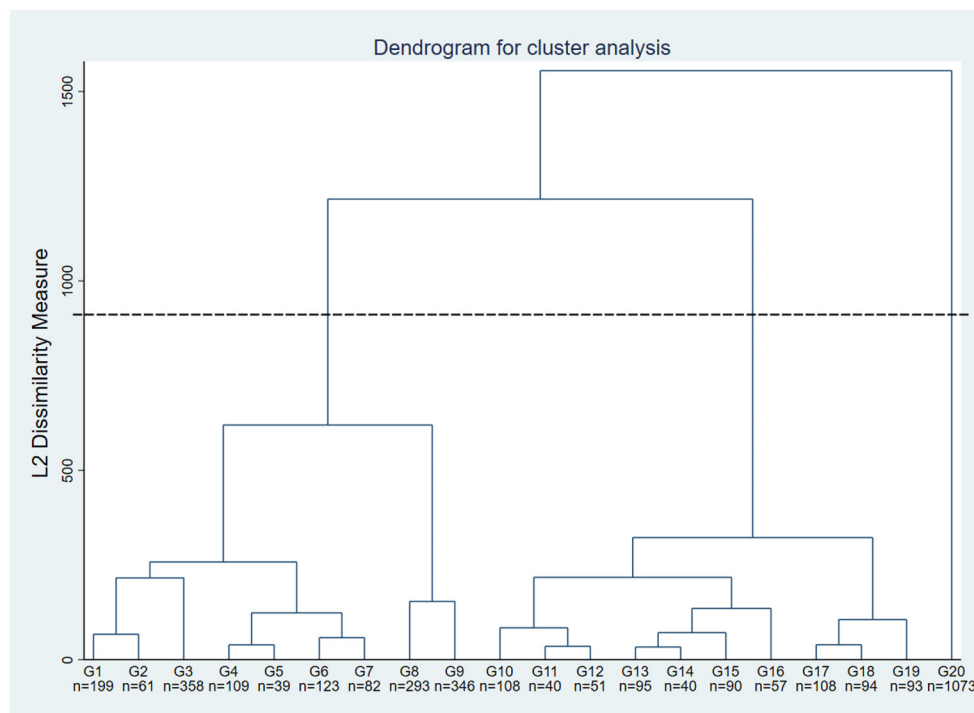
FIGURE 1

Dendrogram. The sample was initially divided into 20 groups (a partitioning commonly used in the literature) using Stata version 15 software. For illustration purposes, G1 corresponds to Group 1 and $n = 199$ indicates the number of individuals in Group 1, i.e., 199. The black dotted line corresponds to the cutoff point used to determine our three groups minimizing intra-class variance and maximizing inter-class variance.

TABLE 1 Sociodemographic statistics.

		n	%	CI (95%)
Sex	Male	718	20.8	[19.4; 22.1]
	Female	2,741	79.2	[77.9; 80.6]
Age	Under 35 years	282	8.2	[7.3; 9.1]
	35–44 years	2,059	59.5	[57.9; 61.1]
	45 years +	1,118	32.3	[30.8; 33.9]
Education level	High school diploma or less	522	15.0	[13.9; 16.3]
	College diploma	668	19.3	[18.0; 20.7]
	University degree	2,269	65.6	[64.0; 67.1]
Employment status	Employed	515	85.1	[83.9; 86.3]
	Unemployed	2,944	14.9	[14.9; 16.1]
Immigration status	Born in Canada	2,138	61.8	[60.2; 63.4]
	Immigration > 10 years	970	28.0	[26.6; 29.6]
	Immigration between 5 and 9 years	206	6.0	[5.2; 6.8]
	Immigration < 5 years	145	4.2	[3.6; 4.9]
	Total	3,459	100	

networks, online forums, or friends and family. The third group, called Unplugged ($n = 1,073$), was composed of individuals who never or rarely consulted any of the information sources

put forward in the questionnaire to learn about COVID-19. All descriptive statistics are presented in Table 2.

Sociodemographic statistics

From a sociodemographic standpoint (Table 2), we note that nearly 50% of individuals aged 35 years and over belonged to the Traditional Media group. Among those under 35 years, 40% belonged to the Unplugged group. As well, 51.3% of university graduates were in the Traditional Media group, whereas this percentage dropped to 21% for the Online Social Networks and Entourage group. Finally, among Canadian-born individuals, 51.2% were in the Traditional Media group, while only 13.9% were in the Online Social Networks and Entourage group. More specifically, we note that this last group was composed largely of individuals who had immigrated to Canada within the past 10 years. All the sociodemographic statistics are presented in Table 2.

Statistics of the dependent variable

The mean concern score in our sample was 9.5/15 (s.d. = 3.87). We calculated a mean for each profile in the

TABLE 2 Distribution of information sources by groups and sociodemographic characteristics.

	Initial sample (N = 3,459)	Traditional media (n = 1,610)	Online social networks and entourage (n = 776)	Unplugged (n = 1,073)
	N	n (%)	n (%)	n (%)
Information sources				
Television				
Never/Rarely/Sometimes	2,200	780 (35.4)	347 (15.8)	1,073 (48.8)
Often/Always	1,259	830 (65.9)	429 (34.1)	0 (0.0)
Newspapers				
Never/Rarely/Sometimes	1,938	445 (23.0)	420 (21.6)	1,073 (55.4)
Often–Always	1,521	1,165 (76.6)	356 (23.4)	0 (0.0)
Online social networks				
Never/Rarely/Sometimes	2,729	1,453 (53.2)	203 (7.5)	1,073 (39.3)
Often–Always	730	157 (21.5)	573 (78.5)	0 (0.0)
Radio				
Never/Rarely/Sometimes	2,769	1,185 (42.8)	511 (18.5)	1,073 (38.8)
Often–Always	690	425 (61.6)	265 (38.4)	0 (0.0)
Online forums				
Never/Rarely/Sometimes	3,247	1,610 (49.6)	564 (17.4)	1,073 (33.0)
Often–Always	212	0 (0)	212 (100.0)	0 (0.0)
Friends and family				
Never/Rarely/Sometimes	2,790	1,496 (53.6)	221 (7.9)	1,073 (38.5)
Often–Always	669	114 (17.0)	555 (83.0)	0 (0.0)
Medical sources				
Never/Rarely/Sometimes	2,484	941 (37.9)	470 (18.9)	1,073 (43.2)
Often–Always	975	669 (68.6)	306 (31.4)	0 (0.0)
Sociodemographics				
Sex				
Male	718	343 (47.8)	154 (21.4)	221 (30.8)
Female	2,741	1,267 (46.2)	622 (22.7)	852 (31.1)
Age				
Under 35 years	282	93 (33.0)	76 (27.0)	113 (40.0)
35–44 years	2,059	965 (46.9)	444 (21.6)	650 (31.5)
45 years +	1,118	552 (49.4)	256 (22.9)	310 (27.7)
Education				
High school or less	522	183 (35.0)	156 (30.0)	183 (35.0)
College	668	264 (39.5)	144 (21.6)	260 (38.9)
University	2,269	1,163 (51.2)	476 (21.0)	630 (27.8)
Employment				
Unemployed	515	193 (37.5)	186 (36.0)	136 (26.5)
Employed	2,944	1,417 (48.2)	590 (20.0)	937 (31.8)
Immigration				
Born in Canada	2,138	1,095 (51.2)	297 (13.9)	746 (34.9)
Immigration 10 years or more	970	406 (41.8)	310 (32.0)	254 (26.2)
Immigration 5–9 years	206	66 (32.0)	88 (42.7)	52 (25.3)
Immigration < 5 years	145	43 (29.7)	81 (55.9)	21 (14.5)
Concern score				
Mildly concerned (0–9)	1,579	694 (44.0)	227 (14.4)	658 (41.6)
Strongly concerned (10–15)	1,880	916 (48.7)	549 (29.2)	415 (22.1)

taxonomy. The Online Social Networks and Entourage group had a mean score of 11.0, making it the most concerned group. The last group, the Unplugged, had the lowest mean, at 8.0 (Table 3). The score for the middle group, Traditional Media, was 9.8. Analysis of variance with the Bonferroni correction showed the differences in means between each pair of groups to be significant at the 1% level (Table 3).

Binomial logistic regression

We used binomial logistic regression (Table 4) to analyze the association between groups and parents' level of concern. As described in the Materials and methods section, the concern score was separated into two categories to obtain our dependent variable. The distribution of level of COVID-19 concern is available in Figure 2. Individuals with a score of 0 to 9 inclusive were considered to have a lower level of concern (n = 1,579, 45.6%), and those with a score of 10 to 15 inclusive were considered more concerned (n = 1,880, 54.4%).In the Traditional Media group, the probability of being among the most concerned (scoring 10 to 15) was multiplied by a factor of 2.2 compared to the Unplugged group (OR = 2.2; $p <$ 0.001). In the Online Social Networks and Entourage group, the probability of being among the most concerned is multiplied by a factor of 3.1 compared to the Unplugged group (OR = 3.1; p < 0.001).

Among the control variables, employed individuals were 1.5 times less likely than unemployed individuals to be among the most concerned (OR = 0.69, or 1/0.69 = 1.45; p < 0.001). Regarding immigration, we note that individuals born outside of

Canada were more likely to be among the concerned than those born in Canada. For example, individuals who had immigrated to Canada in the past 5 years were 1.7 times more likely to be among the concerned persons than those born in Canada.

Discussion

The objective of this study was to analyze whether information sources and their frequency of use were associated with levels of concern among parents of school-aged children seeking information about COVID-19. Our study showed that, in our sample, parents who frequently used online social networks, online forums, and friends and family to obtain information about COVID-19 had a higher level of concern than those who never sought information about the pandemic.

Online social networks and strong concerns

In the literature, exposure to online social networks is widely associated with significant concern (10, 19, 42), which is consistent with the results of our study. The causes of this association between concern and online social networks have been the subject of several studies. One hypothesis is that online social networks are the source of numerous publications of all kinds that are not always scientifically sound. If the content has frightening information or graphics (in image or video format), this may exacerbate individuals' distress levels (43). As Cinelli et al. (44) showed empirically, these

TABLE 3 Mean level of concern and analysis of variance (Bonferroni correction).

	Initial sample (N = 3,459)	Traditional media (n = 1,610)	Online social networks and entourage (n = 776)		Unplugged (n = 1,073)
Mean concern score (s.d)	9.51 (3.87)	9.79 (3.63)	11.01 (3.72)		8.01 (3.81)
	Sum of squares	Degrees of freedom	Means of squares	Fisher stat	Prob > F
Between	4,284.64	2	2,142.32	155.85	< 0.001
Within	47,506.91	3,456	13.75		
Total	51,791.55	3,458	14.97		

Bartlett's test for equality of variances: chi^2 =2.96; Prob>chi^2 = 0.228

Bonferroni multiple comparison test

	Traditional media	Online social networks and entourage
Online Social Networks and Entourage	1.21	
P-value	<0.001	
Unplugged	−1.78	−2.9
P-value	<0.001	<0.001

TABLE 4 Binomial logistic regression.

			N	3,459
			Pseudo R²	0.0664

Dependent variable: Concern score

			OR	*p*	CI (95%)
Variable of interest	**Group** (ref: Unplugged)	Traditional media	2.21	<0.001	[1.88; 2.60]
		Online social networks and entourage	3.18	<0.001	[2.59; 3.92]
Sociodemographic variables	**Sex of parents** (ref: Male)	Female	1.31	0.002	[1.10; 1.57]
	Age (ref: Under 35 years)	35–44 years	1.12	0.412	[0.85; 1.47]
		45 years +	1.09	0.530	[0.82; 1.46]
	Employment status (ref: Unemployed)	Employed	0.69	<0.001	[0.53; 0.83]
	Education (ref: High school diploma or less)	College	0.87	0.286	[0.68; 1.11]
		University	0.69	0.001	[0.56; 0.85]
	Immigration status (ref: Born in Canada)	Immigration 10 years+	2.01	<0.001	[1.71; 2.39]
		Immigration 5–9 years	1.63	0.002	[1.20; 2.23]
		Immigration < 5 years	1.65	0.010	[1.13; 2.43]
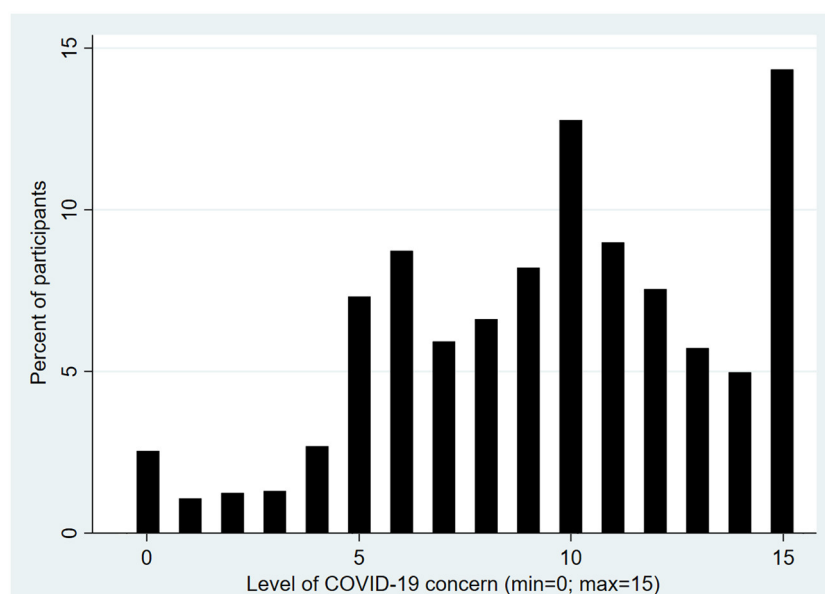
FIGURE 2
Distribution of level of COVID-19 concern.

platforms are also often prone to slander, false rumors, and dubious information, especially in the context of COVID-19. This onslaught of information, sometimes spreading faster than the virus itself, creates uncertainty and concern (45, 46) and generates a certain distrust among online social network consumers, who then comply only partially with health restrictions (47). For example, users of some online social networks have been found to have lower levels of compliance with social distancing compared to users of traditional media (48).

With respect to frequency of use, the study by Shensa et al. (14) also used a cluster analysis. From a nationally representative sample of 1,730 US adults, they identified five clusters based on online social network usage, which they labeled

Wired, Connected, Diffuse Dabblers, Concentrated Dabblers, and Unplugged. The authors showed that membership in the Wired and Connected clusters increased the likelihood of elevated symptoms of depression and anxiety. The main reason was that, in a crisis context, online social networks have significant informational and social potential and are more often used by parents with higher levels of anxiety in crisis situations (22, 49). Thus, the analyses conducted in our sample were not due to chance and appear to corroborate the findings of the existing literature on the subject.

Traditional media and concern

In our sample, the Traditional Media group using primarily television also exhibited a high level of concern, but to a lesser extent. This result is consistent with the work of Sasaki et al. (15) showing that the use of television to learn about COVID-19 was positively associated with concern, but on a lesser scale than for online social networks. When television channels regularly report news about hospitals and overwhelmed health professionals during peak epidemic periods, people's fears and concerns about COVID-19 are amplified (16). However, the engagement of vulnerable people in coronavirus-related preventive behaviors is significantly associated with impediments, benefits, self-efficacy, and trust in television for information about COVID-19 (50).

Thus, there exists a certain ambiguity between the concern mediated by images on television and that medium's reliable informational power, such that it continues to be one of the most consulted sources of information when it comes to learning about an epidemic context such as COVID-19.

The unplugged and attenuated concerns

An important finding in our analysis concerned the Unplugged information group. In our sample, 1,073 of 3,459 adults responded *never*, *rarely*, or *sometimes* with regard to learning about COVID-19 through the media put forward in the questionnaire. The results from the analyses of variances (Bonferroni correction in Table 3 and binomial logistic regression in Table 4) indicated that these adults were statistically less concerned than the other groups. However, few studies have shown that moderation in media consumption may not be associated with mental health risks for adults (51). In the study mentioned earlier, Shensa et al. (14) showed that membership in the Wired and Connected clusters increased the likelihood of elevated symptoms of depression and anxiety. The other three clusters were not statistically associated with depression and anxiety.

Limitations

Our results should, however, be interpreted while keeping in mind certain limitations. From a methodological point of view, the study could not establish a causal relationship between media exposure and concern, due to the cross-sectional design. As the epidemic continues, it is possible that media use may escalate subsequent negative psychological outcomes, which in turn would encourage increased media use (10). Second, our study focused only on investigating the effects of certain media on parental concern without addressing other components of mental health. For example, other studies have shown that high exposure to social media during a natural crisis such as COVID-19 also has an impact on depression, emotions, and posttraumatic stress disorder (16–18, 52). Third, because media use was self-reported, the measures may suffer from social desirability and/or recall bias. Fourth, since our sample was limited to 3,459 parents of school-aged children in Laval, Quebec, it is not certain that the results can be generalized to samples from other countries. Plus, more female (79.2%) than male (20.8%) participated in this study. Fifth, the binomial regression model has a predictive rate of approximately 63%, accurately classifying 2,166 individuals out of the 3,459 total observations. The area under the receiver operating characteristic curve (AUROC) is equal to 0.67. Our model has a correct discrimination power but could be improved by integrating other mental health variables (stress, depression, anxiety, etc.).

From a theoretical point of view, the information seeking variable failed to distinguish whether parents were more likely to consume valuable health-related information or misinformation. Although this was not the objective of this study, this information is important because misinformation has been found to worsen mental health consequences (9).

Conclusion

The results are consistent with previous studies demonstrating the association between the use and frequency of information sources consulted and mental health. This study sheds new light by focusing specifically on the concerns of parents of school-aged children, a population that has been relatively understudied to date. In our sample, adults who often or always used online social networks, friends and family, and television to learn about COVID-19 had higher levels of concern compared to parents who never, rarely, or sometimes used information sources.

Our findings suggest time spent using online social networks during the initial phase of an outbreak should be limited to reduce exposure to stressful and possible unreliable content. Public health authorities should promote information messages on all communication channels in order to reach a wide coverage

of the population, while notifying moderately the population with reliable and verified information. This could directly reduce negative psychological consequences for parents and indirectly for children. Particular attention should then be focused on online social networks and television, as these are widely used by the population. Further research, covering the different phases over the course of the pandemic, could provide a better assessment of parental concern by linking it with the sources of the information they consume over the long term.

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 Ethics Committee of the CHU Sainte-Justine in Montreal approved the study (#2021-3032). The patients/participants provided their written informed consent to participate in this study.

Author contributions

YA, OD, and RBDS contributed to the conception and design of the study and revised the article critically. YA and RBDS contributed to the analysis and interpretation of data. YA and OD drafted the article. All authors read and approved the final manuscript.

Conflict of interest

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

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The impact of mobile Internet use on mental distress among Chinese adults during the COVID-19 pandemic

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With the rapid development of digital technology, mobile Internet use is increasing in popularity in China. Previous studies have shown that mobile Internet use has a positive or negative effect on mental distress. Using CFPS2020 data, this paper finds that mobile Internet use significantly alleviates mental distress in Chinese adults. Heterogeneity analysis indicates that mobile Internet use can significantly alleviate mental distress among adults between the ages of 30 and 70, without a bachelor's degree or residing outside the province of Hubei. Furthermore, mobile Internet use significantly reduces mental distress through two mediators: trust and happiness. It also shows that watching short videos or learning online is associated with reduced mental distress, as opposed to online shopping, chatting, or playing games. However, the mental distress of new mobile Internet users in 2020 has not been alleviated. This paper enriches the relevant theoretical research and provides a practical reference for using the mobile Internet to ease mental distress during epidemics.

KEYWORDS

mobile Internet use, mental distress, COVID-19 pandemic, regression, mechanism analysis

Introduction

Anxiety or depression is a common mental disorder worldwide. According to the World Health Organization, about 3.8% of the global population is affected, including 5% of adults. The 2012–2015 China Mental Health Survey showed the lifetime prevalence of depression among Chinese adults reached 6.8% and its adequate treatment rate was only 0.5% (1). As the Chinese digital economy develops, mobile phone penetration and Internet penetration are increasing (2, 3). Online chatting, shopping, learning, and playing games are becoming integral parts of people's daily lives (4, 5).

In previous studies, there has been no consistent conclusion regarding the impact of Internet use on mental health. Studies have found that excessive Internet use may result in Internet addiction and depression (6, 7). As a result, young people become unmotivated in studying or even engaged in fraud (8–10). Other studies have indicated that Internet use can reduce anxiety and depression. Cotten et al. studied old adults in

assisted and independent living communities in Alabama and found that internet use increased older adults' communication with others, which alleviated their loneliness (11). Zhang et al. conducted an analysis of CFPS data in 2016 and 2018 using the DID method and found that the use of the Internet significantly reduced depression levels (12). Adama and Alhassan found that mobile phone penetration can significantly improve the quality of life of individuals in 114 countries (13).

The COVID-19 pandemic not only poses a serious threat to people's physical health but also to their mental health (14, 15). Li et al. conducted an online survey of Chinese adults using the Generalized Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9) to assess anxiety and depression severity. They found that COVID-19 was associated with a significant increase in anxiety and depression among Chinese adults (16). The rapid spread of COVID-19 can also cause vicarious traumatization to the public and medical personnel (17). Many governments have taken various public health emergency interventions to prevent the spread of COVID-19 (18). This may have resulted in a reduction in face-to-face communication between people, thus worsening loneliness, particularly among elderly people (19). As a result, how to effectively relieve people's mental distress under COVID-19 becomes of concern.

The previous literature mainly focuses on the relationship between Internet use and mental health, or the relationship between COVID-19 and mental health. Few studies have examined the relationship between Internet use and mental health during the COVID-19 pandemic. Duan et al. distributed questionnaires on Questionnaire Star to Chinese students in Hubei province, finding that students were suffering from smartphone addiction, Internet addiction, and worsening depression (20). Similarly, this study and Duan's study focus on the impact of Chinese Internet usage on mental health under COVID-19. However, they differ significantly in three respects. First, Li just focuses only on the Hubei Province in China. This study examines respondents from 32 provinces in China. Second, Li's research focuses on Internet addiction and overuse, while this study mainly examines the normal use of mobile Internet. Third, this paper takes into account the intermediary mechanism of trust and happiness.

This paper attempts to answer a new question: "Can mobile Internet use alleviate people's anxiety or depression during COVID-19?" We test the results of the basic regression using 2 Stage Least Square (2SLS) and Generalized Method of Moments (GMM); analyze heterogeneity among individuals of different ages, education levels, and regions; select two mediating variables for mechanism analysis; and conduct further research on Internet use patterns. This study contributes to the study of mental distress during COVID-19 and makes some useful recommendations, which have both theoretical and practical implications.

Hypotheses

Since the outbreak of COVID-19, many countries have implemented lockdown measures in order to prevent the spread of the virus (21, 22). These measures have resulted in a reduction in interpersonal communication, thus contributing to loneliness or depression (23). The COVID-19 epidemic can aggravate mental distress all over the world (24, 25).

Previous literature found that Internet use can relieve anxiety. Wang et al. examined the 2016 CFPS data using propensity score matching and logistic regression models and found that older adults who were online had relatively lower levels of depression (26). Based on data from the US Health and Retirement Study (HRS) of older adults, Heo et al. found that Internet use could enhance life satisfaction (27). Internet access can facilitate communication with the outside world (28). Mobile Internet use can moderately relieve anxiety or depression if it is not overused. Meanwhile, the spread of COVID-19 can exacerbate people's anxiety or depression. Thus, we propose Hypothesis 1 (H1):

H1: Mobile Internet use can alleviate people's anxiety or depression during the COVID-19 epidemic.

With the rapid development of internet technology and instant messaging, people are increasingly interacting online. Before COVID-19, people's interpersonal relationships and trust were relatively fragile online (29). After COVID-19, people rely more on mobile phone internet for establishing connections and exchanging information (30). During the pandemic, people may increase their trust in each other through online communication, thereby alleviating depression.

People's fear of COVID-19 can lead to a reduction in happiness and an increase in mental pressure (31). Gong et al. found that through E-chat, adults were able to increase their flexibility and happiness during the epidemic (32). Matthes et al. found that Austrians used their smartphones to disclose themselves online, increase the amount of communication with others, and thus increase their happiness during the epidemic (33).

Thus, we propose Hypothesis 2 and Hypothesis 3 (H2 and H3) as follows:

H2: Mobile Internet use can alleviate mental distress by increasing people's trust.
H3: Mobile Internet use can alleviate mental distress by improving people's happiness.

Data and methods

Data collection

The data used in this paper were from the China Family Panel Studies (CFPS) database in 2020 (http://www.isss.pku.edu.

cn/cfps/). It is a major project funded by Peking University and the National Natural Science Foundation of China (NSFC), which is being implemented by the China Social Science Survey (ISSS) of Peking University (34). This survey has been conducted every two years since 2010, in order to reflect changes in China's social, economic, educational, and health conditions. Since Coronavirus is widespread and lockdown policies are enforced, the 2020 CFPS survey was conducted mostly *via* telephone. There were 88.6% of telephone surveys conducted in 2020, compared to 21.1% in 2018.

The purpose of this study was to examine the impact of mobile Internet use on mental distress among Chinese adults. After data cleaning, we obtained a sample of 16,004 observations based on the CFPS 2020 survey data.

Variables measurement

Dependent variable: Mental distress

Generally, mental distress is measured by the CES-D8 or the PHQ-4 (35), which indicates feelings of anxiety or depression. The ISSS used a condensed version of the CES-D8 to measure mental distress in the CFPS2020 survey. In order to compare depression scores between 2012, 2014, and 2016, the survey organization used equipercentile equating the scores from the CES-D8 and CES-D20 sets to generate the CES-D20 for 2020. Consequently, this study adopted the ISSS's recommendation to use CES-D8 for measuring individual depression levels, and use CES-D20 as an alternative dependent variable for robustness. CES-D8 scores range from 8 to 32 on the CFPS2020 questionnaire. Those with a score of 16 or greater were considered to be depressed.

Independent variable: Mobile Internet use

This variable is derived from question number U201 of the CFPS 2020 questionnaire, which asks, "Do you use a mobile device, such as a mobile phone or tablet PC, to access the Internet?" If the answer is yes, then the variable is 1, otherwise, it is 0.

Instrumental variables: Mobile penetration and county average

We selected two instrumental variables to mitigate the potential endogenous problems. The variable Mobile Penetration is the mobile phone penetration rate in each individual's city, which is derived from the cell phone penetration rate in the China City Statistical Yearbook. The variable County average is the average time (minutes) spent on the Mobile Internet in an individual's county. It is calculated based on the CFPS survey question, "How long do you spend on the Internet on your mobile device (in minutes)."

Mediating variables: Trust and happiness

The mediating variables are Trust and Happiness. The variable Trust is assessed by asking the question, "In general, do you believe that most people are trustworthy, or should you take greater precautions when dealing with others?" (Question No. N1001). When the answer is that most people are trustworthy, the variable is set to 1, otherwise, it is set to 0. The variable Happiness is from the question "How happy do you think you are" (Question No.M2016). Individuals can rate their level of happiness on a scale of 0–10, with 10 representing the highest level of happiness and 0 representing the lowest level of happiness.

Control variables

According to previous related studies (36), this study selected variables related to individual characteristics as control variables. They are age (18–95 years old), gender (1 = male, 0 = female), marital status (1 = Married or having a spouse, 0 = others), employment (1 = Employmented, 0 = others), education (0 = Illiterate/Semi-literate, 3 = Primary school, 4 = Junior high school, 5 = Senior high school, 6 = 3-year college, 7 = Bachelor's program, 8 = Master's program, 9 = Doctoral program), insurance (1 = have any of the following medical insurances, e.g., Public medical insurance, Urban Employment Basic Medical Insurance, Urban Resident Basic Medical Insurance, Supplementary medical insurance, New Rural Cooperative Medical Insurance, 0 = others). And we also controlled the provincial dummy variable.

Table 1 shows the descriptive statistics of the main variables of this paper. The range of CES-D8 scores in the observations is 8–32, while the range of CES-D20 scores is 22–72. The higher the score, the greater the individual's level of depression or anxiety.

TABLE 1 Descriptive statistics.

Variables	N	Mean	SD	Min	Max
CES-D8	16,004	13.55	4.112	8	32
CES-D20	16,004	33.18	8.162	22	72
Mobile Internet use	16,004	0.628	0.483	0	1
Gender	16,004	0.495	0.500	0	1
Education	16,004	3.701	2.035	0	10
Age	16,004	47.53	16.01	18	95
Marital status	16,004	0.819	0.385	0	1
Employment	16,004	0.721	0.449	0	1
Insurance	16,004	0.892	0.310	0	1
Mobile Penetration	16,004	0.0117	0.00331	0.00735	0.0241
County average hours	16,004	98.91	37.48	19.23	258.9
Trust	15,936	0.595	0.491	0	1
Happiness	15,996	7.492	2.084	0	1

The mean VIF of the main variables is only 1.32, which is far below the threshold of 10, indicating that there is no significant multicollinearity.

Model design and data analysis

The effect of mobile Internet use on mental mistress

First, we used OLS to estimate the impact of mobile Internet use on mental distress during COVID-19. The basic regression model in this paper is:

$$\text{Mental}_i = \alpha_0 + \alpha_1 \text{Mobile}_i + \alpha_2 Z_i + \alpha_3 province + \varepsilon \quad (1)$$

Where Mental_i represents the mental distress of individual i, which is the level of depression measured by CES-D8, Mobile_i represents whether individual i uses the mobile device to use the Internet, Z_i represents a series of control variables, province represents the province dummy variable, and ε represents the random disturbance term.

Second, We used Instrumental Variable (IV)-2SLS and GMM methods for estimation due to possible endogeneity issues, taking into account issues such as heteroskedasticity.

The influence mechanism of mobile Internet use on mental distress

We selected two mediating variables (trust and happiness) to test the influence mechanism. We discuss three forms of the dependent variable mental distress. First, mental distress is represented by continuous values of CES-D8. Second, distress is a 0–1 dummy variable. The variable is set to 1 if CES-D8 exceeds 16 and zero otherwise. Third, health is another 0–1 dummy variable. The variable is set to 1 if CES-D8 is lower than 16 and zero otherwise.

We used bootstrapping methods to test the mediation effect. The bootstrapping test examines whether the 95% confidence interval of $\beta_1 \times \lambda_2$ includes the number 0.

Further research

In further studies, we examined the different purposes of mobile Internet usage. The questionnaire on the Internet part of CFPS in 2020 included whether to play online games (U91), whether to shop online (U92), whether to watch short videos (U93), whether to study online (U94) and whether to use WeChat (U11). Therefore, we set model (2) to further consider the impact of mobile Internet use for these five different purposes on mental distress.

$$\text{Mental}_i = \alpha_0 + \alpha_1 \text{Mobile}_i * Purpose_i + \alpha_2 Z_i + \alpha_3 province + \varepsilon \quad (2)$$

Where $Purpose_i$ represents the mobile Internet use based on five different purposes (game, shop, video, study, and chat) of individual i.

Moreover, we matched the CFPS data from 2018 with the CFPS data from 2020, setting model (3) and model (4), using probit and logit regression methods.

$$\text{Alleviate}_i = \alpha_0 + \alpha_1 \text{Mobile}_i + \alpha_2 Z_i + \alpha_3 province + \varepsilon \quad (3)$$

Where Alleviate_i is a 0–1 variable, 1 represents a reduction in mental distress in 2020 relative to 2018, and 0 for others.

$$\text{Alleviate}_i = \alpha_0 + \alpha_1 \text{Added}_i + \alpha_2 Z_i + \alpha_3 province + \varepsilon \quad (4)$$

Where Added_i is a 0–1 variable, 1 indicates that an individual is not using mobile online in 2018 but is using mobile online in 2020, and 0 indicates the other situation.

All the above data collation and estimation were done using STATA 16.0.

Results

OLS regression

Table 2 shows the results of the estimation using OLS.

Mobile Internet use relieved 0.773 units of personal anxiety if the control variables and the province dummy variable were not controlled. Mobile Internet use relieved 0.459 units of personal anxiety after controlling for the control variables and the province dummy variable. Both of these results are significant at the 1% level. We used CES-D20 as an alternative variable for regression testing, and the results were still robust. H1 is verified.

IV method

In order to resolve the potential endogeneity problem associated with traditional OLS, we used an instrumental variable approach to estimate the model (1). We selected two instrumental variables, Mobile Penetration and County average. The two variables are both theoretically macroscopic and are not correlated with other disturbances, such as the personality of an individual.

Table 3 shows the results of the estimation using OLS, 2SLS, and GMM, respectively. It indicates that mobile Internet use can significantly alleviate the mental distress of Chinese adults during COVID-19. However, the impact coefficients differ. 2SLS and GMM have regression coefficients close to 3.014 and 3.034, respectively. Both are greater than the OLS regression coefficients of 0.459.

We conducted a series of tests to verify whether the instrument variables were selected reasonably. The result of the under-identification test showed the p-value of the

TABLE 2 Result of basic OLS regression.

Variables	Mental distress CES-D8	Mental distress CES-D8	Mental distress CES-D20	Mental distress CES-D20
Mobile Internet use	−0.773***	−0.459***	−1.549***	−0.914***
	(0.069)	(0.088)	(0.138)	(0.175)
Age	–	−0.004	–	−0.007
		(0.003)		(0.006)
Gender	–	−0.766***	–	−1.524***
		(0.066)		(0.130)
Marital status	–	−0.531***	–	−1.045***
		(0.096)		(0.191)
Employment	–	0.422***	–	0.834***
		(0.078)		(0.155)
Education	–	−0.221***	–	−0.439***
		(0.021)		(0.042)
Insurance	–	−0.414***	–	−0.822***
		(0.109)		(0.217)
Constant	12.847***	14.871***	31.799***	35.777***
	(0.431)	(0.482)	(0.848)	(0.953)
Province	Yes	Yes	Yes	Yes
Observations	16,004	16,004	16,004	16,004
R-squared	0.030	0.051	0.030	0.051

Robust standard errors in parentheses. ***$p < 0.01$.

TABLE 3 Result of instrument variable regressions.

Variables	OLS	2SLS	GMM
Mobile Internet use	−0.459***	−3.014***	−3.034***
	(0.088)	(0.600)	(0.600)
Age	−0.004	−0.042***	−0.042***
	(0.003)	(0.009)	(0.009)
Gender	−0.766***	−0.713***	−0.713***
	(0.066)	(0.068)	(0.068)
Marital status	−0.531***	−0.342***	−0.341***
	(0.096)	(0.107)	(0.107)
Employment	0.422***	0.382***	0.381***
	(0.078)	(0.080)	(0.080)
Education	−0.221***	−0.069	−0.068
	(0.021)	(0.042)	(0.042)
Insurance	−0.414***	−0.277**	−0.274**
	(0.109)	(0.117)	(0.117)
Constant	14.871***	17.896***	17.918***
	(0.482)	(0.858)	(0.858)
Province	Yes	Yes	Yes
Observations	16,004	16,004	16,004
R-squared	0.051	–	–

Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$.

Kleibergen-Paap rk LM statistic < 0.01, indicating there is no unidentifiable instrumental variable. Wald F statistics in the weak identification test is $>10\%$ maximal IV size, which means there is no existence of weak instrumental variables. The p-value of the Hansen J statistic for the over-identification test is 0.234, indicating both instrumental variables selected are exogenous. We also performed the White test, Breusch-Pagan (BP) test, and Weighted Least Square (WLS) to test heteroscedasticity. The results showed that heteroscedasticity existed in the model. Therefore, although the regression coefficients of 2SLS and GMM in Table 4 are similar, the results of GMM are more effective in the presence of heteroscedasticity.

Heterogeneity analysis

Mobile Internet habits and mental distress levels may differ among different groups. The sample is divided into different groups based on their age, educational level, and whether they live in Hubei provinces.

The sample in this study consisted of individuals aged 18–95. Table 4 indicates that mobile Internet can reduce anxiety and depression in individuals. However, the effect of mobile Internet use on mental distress was not significant among individuals in the age groups 18–30 and 80–95.

As shown in Table 5, mobile Internet use by individuals without a bachelor's degree can significantly relieve mental distress. The Hubei Province was the first to discover COVID-19 in China. And it was also the most severe epidemic area in the country in 2020 [20]. Table 6 shows mobile Internet use has increased the mental distress of people in the region.

Mediation analysis

According to Table 7, mobile Internet use can significantly alleviate Chinese adults' mental distress by enhancing their trust or happiness. H2 and H3 are verified.

If the dependent variable mental distress is a continuous value of CES-D8, the mediating effect of the variable trust accounted for 8.9% (0.037/0.416) of the direct effect, and the variable happiness accounted for 18.18% (0.07/0.385) of the direct effect. If the dependent variable is the dummy variable distress, the mediating effect of the trust variable accounted for 9% of the direct effect, and the happiness variable accounted for 23.33% of the direct effect. If the dependent variable is the dummy variable health, the mediating effect of trust and happiness is the same as the value of the distress coefficient, but the sign is just the opposite.

TABLE 4 Regression results by age group.

Variables	Age, ≥80	Age, 70–80	Age, 60–70	Age, 50–60	Age, 40–50	Age, 30–40	Age, 18–30
Mobile Internet use	−1.482	−0.575*	−0.662***	−0.443***	−0.517***	−0.748***	−0.531
	(1.051)	(0.317)	(0.207)	(0.157)	(0.188)	(0.268)	(0.366)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	201	1,271	2,509	3,666	2,834	3,034	2,489
R-squared	0.161	0.117	0.104	0.081	0.070	0.036	0.057

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

TABLE 5 Regression by education grouping.

Variables	Bachelor's degree or above	Others
Mobile Internet use	−3.504	−3.062***
	(4.514)	(0.656)
Controls	Yes	Yes
Province	Yes	Yes
Observations	1,128	14,876

Robust standard errors in parentheses. ***$p < 0.01$.

TABLE 6 Regression by province grouping.

Variables	Hubei	Others
Mobile Internet use	5.300***	−3.055***
	(1.842)	(0.603)
Controls	Yes	Yes
Observations	135	15,869

Robust standard errors in parentheses. ***$p < 0.01$.

Further research

Consider the different purposes of mobile Internet use

Table 8 shows that online games, online short videos, online learning, and online chat can significantly alleviate individual anxiety or depression. The impact coefficient of online chat is the highest, which is −0.461***. Contrary to expectations, online shopping cannot significantly alleviate mental distress.

Consider the impact of the previous data—Use the 2018 and 2020 CFPS data

Table 9 shows that the left two regression coefficients were significantly positive ($p < 0.05$), and the right two regression coefficients were significantly negative ($p < 0.01$). It indicates that mobile Internet use can significantly alleviate individuals' anxiety or depression in general. However, newly enrolled individuals with mobile Internet access experienced increased anxiety. Perhaps new Internet users during the epidemic were anxious to understand the epidemic-related information, and some false information was disseminated on the Internet which led them to become more anxious.

Discussion

This paper focuses on the effect of mobile Internet use on mental distress among Chinese adults during COVID-19. It shows that mobile Internet use significantly reduces mental distress in 2020. The regression coefficients remained significant after 2SLS and GMM tests using the instrumental variables Mobile Penetration and County average. However, the impact of mobile Internet use on different adults differed. It has a greater effect on Chinese adults aged 30–70, without a bachelor's degree, or living outside Hubei province. According to the mechanism analysis, people can reduce their anxiety or depression by increasing their trust or enhancing their happiness. These conclusions are consistent with those reached by investigations conducted in the United States [37], England [38], or other countries. However, Cotten et al. found that Internet use has a greater impact on the mental health of retired Americans over the age of 50 [39], while we find that the greater impact is on Chinese adults aged 30–70. In addition, Internet addiction is generally defined as spending excess time online, that is, more than 20 h per week [40]. Based on CFPS2020 data, only ~0.4% of respondents use mobile Internet for more than 20 h a week. The number of Internet addicts is also predicted by American researchers to be ~ 0.3–0.7% of the total number [41]. Thus, Internet addiction is not taken into account in this study.

We also came to other interesting conclusions. The effects of chatting online, playing games, watching short videos, and studying online can alleviate anxiety and depression, with chatting online having the greatest impact coefficient. In contrast to expectations, shopping online does not reduce anxiety or depression among people. It is possible due to regional logistical

TABLE 7 Result of media effect.

	Observed coefficient	Bootstrap std. err.	95% conf. interval	
			Lower	Upper
Mobile → trust→ mental distress	−0.037***	0.013	−0.062	−0.012
Mobile → mental	−0.416***	0.091	−0.595	−0.238
Mobile → happiness→ mental distress	−0.070**	0.032	−0.132	−0.009
Mobile → mental	−0.385***	0.084	−0.549	−0.221
Mobile → trust→ distress	−0.003***	0.001	−0.006	−0.001
Mobile → distress	−0.033***	0.010	−0.052	−0.013
Mobile → happiness→ distress	−0.007**	0.003	−0.013	−0.001
Mobile → distress	−0.030***	0.009	−0.047	−0.013
Mobile → trust→ health	0.003***	0.001	0.001	0.006
Mobile → health	0.033***	0.010	0.014	0.052
Mobile → happiness→ health	0.007**	0.003	0.001	0.012
Mobile → health	0.030***	0.009	0.013	0.047

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

TABLE 8 Result of regressions based on the different purposes of mobile Internet use.

Variables	(1) Mental distress	(2) Mental distress	(3) Mental distress	(4) Mental distress	(5) Mental distress
Game	−0.154* (0.093)	–	–	–	–
Shop	–	0.018 (0.075)	–	–	–
Video	–	–	−0.233*** (0.074)	–	–
Learn	–	–	–	−0.211** (0.091)	–
Chat	–	–	–	–	−0.461*** (0.088)
Age	0.002 (0.003)	0.003 (0.003)	−0.001 (0.003)	0.002 (0.003)	−0.004 (0.003)
Gender	−0.759*** (0.067)	−0.774*** (0.066)	−0.771*** (0.066)	−0.777*** (0.066)	−0.767*** (0.066)
Marital status	−0.585*** (0.096)	−0.566*** (0.095)	−0.549*** (0.096)	−0.584*** (0.096)	−0.532*** (0.096)
Employment	0.420*** (0.078)	0.429*** (0.078)	0.430*** (0.078)	0.434*** (0.078)	0.424*** (0.078)
Education	−0.248*** (0.020)	−0.250*** (0.021)	−0.241*** (0.020)	−0.240*** (0.021)	−0.221*** (0.021)
Insurance	−0.439*** (0.109)	−0.440*** (0.109)	−0.424*** (0.109)	−0.434*** (0.109)	−0.414*** (0.109)
Constant	14.429*** (0.475)	14.311*** (0.477)	14.590*** (0.478)	14.371*** (0.471)	14.871*** (0.481)
Province	Yes	Yes	Yes	Yes	Yes
Observations	16,004	16,004	16,004	16,004	16,004
R-squared	0.050	0.050	0.050	0.050	0.051

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

delays experienced during the epidemic (42). After adding CFPS2018 data to the model for analysis, mobile Internet use still significantly alleviates people's anxiety or depression. However, there was an increase in mental distress among individuals who had recently joined the mobile network in 2020. It is possible that the individuals who joined the mobile network in 2020 primarily went online to find epidemic-related information (43). Searching for this news on the Internet is likely to reinforce negative emotions such as fear (44), which may exacerbate anxiety or depression.

Therefore, this study proposes the following recommendations: Individuals may chat, study, work, and play with mobile internet in order to increase psychological resilience and stress coping ability (31), and reduce their anxiety or depression. Medical institutions may study and implement ways to reduce people's mental distress through the Internet and other means. When preventing and controlling epidemics, governments should take measures to consider the mental distress of specific groups (such as elderly people with less Internet access, people

TABLE 9 Result of regressions based on the different purposes of
mobile Internet use.

Variables	Alleviate Probit	Alleviate Logit	Alleviate Probit	Alleviate Logit
Mobile Internet use	0.070**	0.112**	–	–
	(0.027)	(0.044)		
Mobile Internet use added	–	–	−0.331***	−0.534***
			(0.025)	(0.041)
Age	0.006***	0.009***	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Gender	−0.041*	−0.067*	−0.032	−0.053
	(0.021)	(0.034)	(0.021)	(0.034)
Marital status	−0.128***	−0.206***	−0.115***	−0.187***
	(0.029)	(0.047)	(0.029)	(0.046)
Employment	0.049**	0.079**	0.039	0.062
	(0.024)	(0.040)	(0.024)	(0.040)
Education	−0.015**	−0.024**	0.009	0.014
	(0.006)	(0.010)	(0.006)	(0.010)
Insurance	0.112***	0.185***	0.127***	0.207***
	(0.034)	(0.056)	(0.034)	(0.056)
Constant	−0.592***	−0.955***	−0.103	−0.163
	(0.182)	(0.295)	(0.183)	(0.297)
Province	Yes	Yes	Yes	Yes
Observations	16,004	16,004	16,004	16,004
Pseudo R-squared	0.00894	0.00895	0.0165	0.0165

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

with bachelor's or higher degrees, and areas with more serious epidemics).

This study is of great importance. First, this paper fully discusses the impact of mobile Internet use on people's mental distress during the COVID-19 epidemic, enriching relevant theoretical research. Second, this paper can provide more specific suggestions for using the network to alleviate people's mental distress during the epidemic, which can be used as a reference in the practice. Third, although COVID-19 has been spreading for 2 years, the newest Omicron variant is likely to be more infectious than ever (45). As a result, the study has a theoretical value not only for the short term but also for the long term.

This paper also has some limitations. First, the research should be further refined according to different groups, so that medical institutions and governments can take more targeted measures. Second, this paper uses the CFPS data because of its extensiveness, continuity, and accuracy. The data included some indicators related to the epidemic and Internet use in 2020, but the indicators are not sufficiently refined. In future studies, combining CFPS with special surveys can enhance the accuracy

of the research results. Third, we may study the threshold at which mobile networks are capable of alleviating mental distress in the future.

Conclusions

Mobile Internet use significantly reduced mental distress among adults during COVID-19 in 2020. This conclusion has been strengthened after 2SLS and GMM tests. The extent of the impact of mobile Internet use among different adults showed significant heterogeneity. Adults aged 30–70, without a bachelor's degree or living outside Hubei Province were significantly reduced in mental distress by mobile Internet use, while other groups were less affected. By enhancing trust and happiness, mobile Internet use significantly reduces people's mental distress. Chatting online also reduces mental distress by bringing people closer together. However, there was an increase in mental distress among individuals who had recently joined the mobile network in 2020. Future research can be further refined and deepened based on this study.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: http://www.isss.pku.edu.cn/cfps/.

Author contributions

MT contributed to the conception and design of the study, performed the statistical analysis, and wrote the submitted manuscript.

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Conflict of interest

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

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Evaluating a cross-lagged panel model between problematic internet use and psychological distress and cross-level mediation of school administrator support on problematic internet use: The serial mediating role of psychological needs thwarting of online teaching and psychological distress

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Background: To reduce the transmission of COVID-19, many teachers across the globe, including teachers in China, were required to teach online. This shift to online teaching can easily result in psychological need thwarting (PNT) of teachers' psychological basic needs (autonomy, competence, and relatedness), leaving them vulnerable to negative psychological outcomes. Resulting negative emotional state may lead to problematic internet use (PIU), which can lead to further psychological distress, forming a vicious cycle.

Methods: The present study was conducted using a cross-lagged panel model (with longitudinal data) and hierarchical linear modeling (HLM)

(with cross-sectional data). The aims were to investigate (i) the reciprocal relationships between two specific forms of PIU [problematic social media use (PSMU) and problematic gaming (PG)] and psychological distress among schoolteachers, and (ii) the influence of administrators' support on schoolteachers' PIU through a cross-level serial mediation model (PNT of online teaching was the first mediator and psychological distress was the second mediator affected by PNT of online teaching). Primary and secondary schoolteachers ($N = 980$; mean age = 34.76; 82.90% females) participated in two surveys (Time 1: mid-November 2021; Time 2: early-January 2022).

Results: Results indicated that (i) high psychological distress at Time 1 was associated with increased levels of PSMU and PG at Time 2. Inversely, PG at Time 1 was associated with increased psychological distress at Time 2, although PSMU at Time 1 did not have a significant influence on psychological distress at Time 2; (ii) during Time 1, increased administrative support contributed to alleviating teachers' psychological needs thwarting of online teaching, thereby lowering their psychological distress which, in turn, resulted in a decrease in PG.

Conclusion: PG had a stronger negative influence on teachers' psychological distress than PSMU. To relieve teachers' PG**,** administrative support can alleviate teachers' psychological needs thwarting of online teaching and psychological distress. Based on this finding, school managers must consider effective ways to support teachers during mandatory online teaching.

Introduction

Background

The COVID-19 pandemic has led to unprecedented changes in people's lives, with many different measures implemented to inhibit the spread of the disease. One widespread measure adopted worldwide was school closure which led to a shift from face-to-face teaching to online teaching (1, 2). Facing new job challenges during this period, the issue of schoolteachers' wellbeing was of great concern to both researchers and practitioners (1, 3–6). Not only did long periods of quarantine lead to an increase in negative psychological outcomes among many individuals (7, 8), but mandatory online teaching also contributed to additional work burden, stress, and mental health issues, particularly for schoolteachers with little experience with online teaching (9–12). Two systematic reviews carried out during the global COVID-19 outbreak between 2020 and 2021 further confirmed that a relatively high proportion of teachers suffered from mental health issues, with prevalence rates among teachers from Jordan, Brazil, USA, India, China, and Spain of (i) 15.9–28.9% for depression, (ii) 10–49.4% for anxiety, and (iii) 12.6–50.6% for stress (13, 14).

In addition to an increased work load due to the need to prepare online learning tasks (15–17), other sources of harm related to schoolteachers' mental health may have stemmed from other possible risk factors during this emergency period. One of these factors is problematic internet use (PIU), which has been shown to have a reciprocal relationship with negative psychological outcomes (i.e., each variable increases the vulnerability of experiencing the other) based on both cross-sectional and longitudinal studies (18, 19). A few studies have also found clear associations between PIU and teachers' negative psychological outcomes (9, 20, 21), including significant correlations with problematic social media use (PSMU) ($r = 0.31$) (9), significant differences between quartiles for emotional exhaustion, depersonalization, and decline of personal accomplishment (one-way ANOVA; $p < 0.001$) with higher internet addiction scores associated with higher levels of teacher burnout (21), and significantly higher frequency of depression among internet addicts vs. non addicts (t-tests; $p < 0.001$) (21). The worry concerning schoolteachers' PIU is reasonable in the context of COVID-19 because PIU often develops from excessive internet use (22, 23). In addressing the psychological pressure caused by the pandemic, consensus guidance by experts has noted that it is common for people to

overuse information and communications technology (ICT) as a coping strategy and that some groups of individuals are at higher risk of developing problematic use patterns (24, 25). Given that it is difficult for teachers to avoid excessive use of ICT due to being restricted from turning off or muting ICT notifications due to work requirements (15–17), it is reasonable to assume that some schoolteachers might have developed PIU during the pandemic.

Moreover, the period during which schoolteachers encountered high levels of thwarting of competence, autonomy, and relatedness due to online teaching requirements may have also contributed to and/or caused mental health issues among schoolteachers. As a result of their unfamiliarity with technology for online teaching, teachers have commonly expressed frustration with their own competence (i.e., competence thwarting) (11, 12, 26). In fact, schoolteachers had to conduct online teaching following the rules enforced by governments, which may have negatively impacted teachers' sense of autonomy (i.e., autonomy thwarting) (27, 28). Additionally, in a study conducted by Weißenfels et al. (6), the emotional burden caused by online teaching, not the amount of work overload, was found to have a significant and negative influence on teachers' mental health during the COVID-19 pandemic. Their study showed that it was unfamiliarity with the mandatory tasks teachers faced rather than the amount of work that negatively impacted their mental health, suggesting teachers specifically require additional emotional support during online teaching. However, due to home confinement, teachers who lacked social interaction received limited verbal and non-verbal feedback from colleagues and administrators (28). This made it challenging for teachers to fulfill their increased emotional relatedness needs, resulting in relatedness thwarting when implementing online teaching. The thwarting of competence, autonomy, and relatedness together constitutes the construct of psychological needs thwarting (PNT) (29, 30). Based on scores using the Psychological Need Thwarting Scale of Online Teaching (PNTSOT), research has demonstrated high levels of schoolteachers' psychological need thwarting due to enforced online teaching (9). Such thwarting of basic psychological needs serves as a proxy for psychological ill-being (29–31), as opposed to wellbeing, potentially leading to mental health problems for teachers.

As noted above, teachers' competence, autonomy, and relatedness have been thwarted by the implementation of online teaching that has been lacking in the requisite material, emotional, and training support. This, notably, is the responsibility of administrators and, as such raises the issue of administrative support as an important variable for consideration in the context of online teaching. In order to tackle thwarting of teachers' competence, responses from American high school teachers have highlighted necessary administrative support in several areas, such as providing tools and related professional development, counseling, support, tips, and resources, including those which can improve the

interactions among teachers, students and parents (32). In terms of autonomy, several studies have reported the impact of lack of administrative support on reduced work autonomy among teachers (33) while advocating for specific administrative actions to enhance autonomy, including clear curriculum guidelines for online teaching, provision of appropriate online platforms, scheduling of "self-care" time during the day, surveying of teachers to assess their needs, and expressing interest in teachers' input. In terms of relatedness, administrative support is a protective factor in terms of burnout, with emotional support, monitoring, provision of mental health to promote self-care, support for parent-teacher communication, and top-down guidance critical to the prevention of relatedness thwarting (34). Given the importance of administrative support, this variable will be evaluated in terms of reducing teachers PNT of online teaching which, in turn, can reduce psychological distress and related PIU behaviors. The purpose of this study will be clarified in the following sub-section.

Purpose of the research

At present, in the context of the ongoing COVID-19 pandemic, studies have already confirmed the relationship between PIU and three aspects of PNT (i.e., autonomy, competence, and relatedness thwarting) of online teaching, and their contribution to negative psychological outcomes among teachers (9, 35). However, as far as we are aware, none of these studies have extended the scope of inquiry to examine the lasting effects of PIU, particularly during the onset of the pandemic, on teachers' subsequent mental health and potential bidirectional relationships (i.e., between psychological distress and PIU). Additionally, previous research has not examined how school administration influences teachers' psychological distress, PNT, and PIU. As such, the mechanisms relating to these variables remain largely unclear.

To bridge this gap, the present study conducted a two-wave survey (i.e., with the first wave of data collected during campus closure when online teaching was required and the second wave of data collected after campuses reopened and face-to-face classroom teaching resumed). There were two primary aims of this study. The first aim was to investigate the reciprocal relationship between PIU [including two specific forms: PSMU and problematic gaming (PG)] and psychological distress among schoolteachers using a cross-lagged panel model. The selection of PSMU and PG as PIU variables was based on the fact that these are relatively common types of PIU (36, 37) and there are already well-developed psychometric instruments to assess these behaviors (38). The second aim was to examine the associations between school administrators' support, schoolteachers' PNT of online teaching, psychological distress, and PIU using Hierarchical Linear Modeling (HLM). Here, administrators' support was at the

FIGURE 1
Framework for the reciprocal relationship between PIU and psychological distress; variables include psychological distress and two forms of problematic internet use (PIU): problematic social media use and problematic gaming.
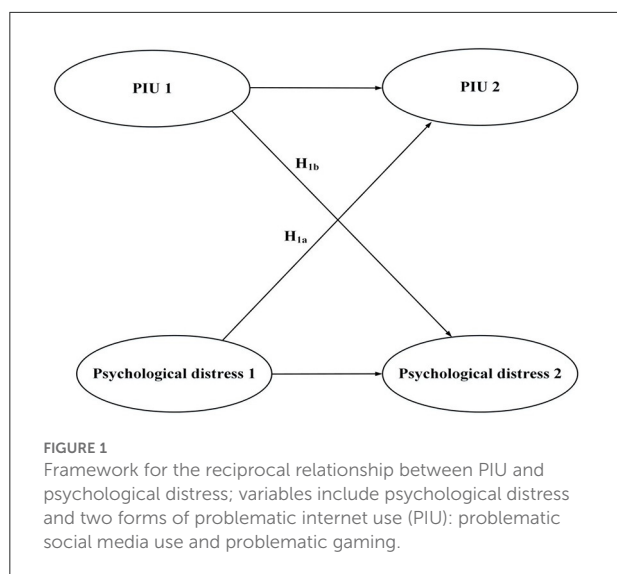
school level, and schoolteachers' mental health (including PNT of online teaching and psychological distress) and PIU were at the individual (teacher) level. The conceptual framework and research hypotheses are described in the following section.

Conceptual framework

Our research framework includes two conceptual models (see Figures 1, 2). The first model involves the reciprocal relationship between PIU and psychological distress. In this model, longitudinal data was used to verify our research hypotheses. The second model involves cross-level mediation (including the variables of administrators' support, PNT of online teaching, psychological distress, and PIU) and was tested using cross-sectional data.

The reciprocal relationship between PIU and psychological distress

In regard to the reciprocal relationship between PIU and psychological distress, the Interaction of Person-Affect-Cognition-Execution (I-PACE) model proposed by Brand et al. (39, 40) was used to explain the mechanism in which the psychological distress of teachers in stressful environments leads to the development of PIU. Subsequently, a bidirectional lens (18) was selected to interpret the potential reciprocal relationship between PIU and psychological distress, wherein PIU leads to psychological distress.

The I-PACE model is a framework to explain how PIU activities develop (39, 40) and has received empirical support (41, 42). More specifically, the I-PACE model

proposes the impact of major influencing variables on PIU, including predisposing background variables [i.e., underlying individual differences, such as personality, specific motives for using the excessive behaviors (e.g., use of the internet or smartphones for stress relief)], affective and cognitive responses, and executive functioning impairment. According to the I-PACE model, under stressful environments, some individuals will experience an emotional response, such as psychological distress. Consequently, these emotional responses can lead to addictive behaviors in some individuals, such as PSMU and PG (explained in the I-PACE model as behaviors caused by a reduction of executive functioning and loss of self-control). In the I-PACE model, increased psychological distress reduces some individuals' ability to inhibit their cravings for (and addiction to) social media use and online gaming. Finally, given diminished inhibitory control, some individuals increase their time spent on social media use and online gaming, which can become problematic in nature.

In the context of school closure, many schoolteachers were motivated to using Wi-Fi-enabled digital devices to help cope with stressors resulting from the pandemic (9, 41, 43). Moreover, with increased work hours (resulting from mandatory online teaching tasks with increased burdens and challenges) and other issues (e.g., fear of COVID-19, home restrictions, lack of support for conducting online teaching, or the thwarting of psychological needs due to online teaching), mandatory online teaching tasks created a stressful environment (9–13, 44) which resulted in psychological distress among many teachers, as a type of emotional response. According to the I-PACE model, increased psychological distress is likely to reduce teachers' inhibitory control over problematic online behaviors.

Moreover, in addition to the influence of psychological distress on individuals' PIU, PIU might also inversely increase psychological distress. This bi-directional association has been confirmed in recent studies (19, 45). As addictive behaviors develop, PIU may inversely enhance an individual's negative emotions as a result of their inability to adapt to their surroundings. This can lead to persistent negative effects on their mental health (46, 47). This is especially true for schoolteachers as recent findings showed that teachers' workloads were still heavy in the initial period after school campuses reopened (4, 6, 48). Addictive behaviors, potentially a response to negative emotions during school closure periods, may inhibit teachers' adaptation when facing normal offline teaching duties and may lead to increased psychological distress. Based on this literature, we hypothesized that there would be a reciprocal relationship between PIU and psychological distress. More specifically, the hypotheses (H_s) were: (i) teachers' initial psychological distress would demonstrate a positive association with subsequent PIU (H_{1a}), and (ii) teachers' initial PIU would demonstrate a positive association with subsequent psychological distress (H_{1b}).

FIGURE 2
Framework of the cross-level serial mediation model; all variables were assessed at Time 1, including administrator support, psychological need thwarting of online teaching (PNT_Online Teaching), psychological distress, and two forms of problematic internet use (PIU): problematic social media use and problematic gaming.
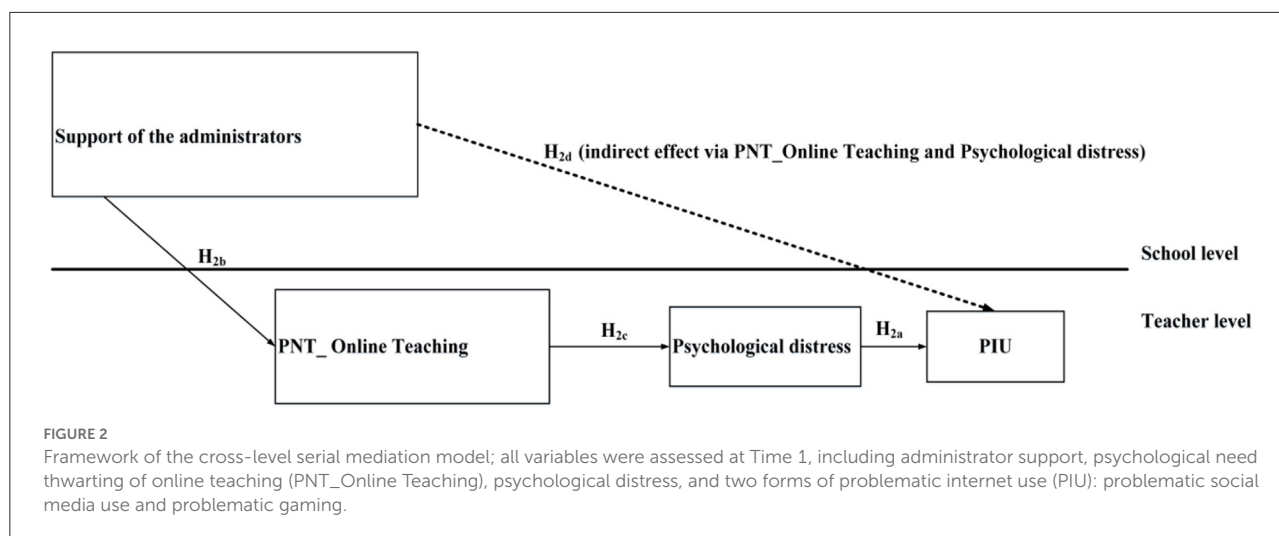
The cross-level mediation model

In relation to the second aim (i.e., to examine the associations between school administrators' support, schoolteachers' PNT of online teaching, psychological distress, and PIU), cross-level serial mediation was hypothesized, such that school administrators' support served as the independent variable with schoolteachers' PNT of online teaching and psychological distress as mediators (PNT of online teaching was the first mediator and psychological distress was the second mediator, affected by PNT of online teaching) with the two forms of schoolteachers' PIU as dependent variables. The model is illustrated as Figure 2. Among the paths in the model, according to I-PACE model explained above, a positive association between psychological distress and teachers' PIU was hypothesized (H_{2a}). The following paragraphs provide an overview of the other paths in this serial mediation model.

Before introducing the paths included in the cross-level serial mediation model, a brief justification is required as to why PNT was hypothesized as resulting from online teaching during school closure. In numerous surveys, teachers have expressed frustration of their psychological needs as a result of mandatory online teaching, although these studies did not exclusively use the term "PNT". For example, Yi et al. (9) and Collie (35), who used the theory of PNT as their framework, and some qualitative findings (i.e., interviews with teachers) have demonstrated high levels of frustration related to the competence of using technology for online teaching (11, 16). Moreover, teachers were seldom included in the decision-making process on how to conduct online teaching (27). In essence, such findings relate to PNT. Furthermore, in a recent study, Kulikowski et al. (28) used the title "E-learning? Never again!" to describe the context in which teachers were forced to teach online and the possibility of unintended consequences arising from this situation. In that study, core elements of PNT,

such as decreased perceived competence, limited autonomy, and restricted social interaction (relatedness) were all reported as reasons for low work motivation among teachers. Consequently, based on the aforementioned literature, in the present study we presumed that PNT was a substantial during online teaching.

Regarding the paths included in the cross-level serial mediation model, given that the thwarting of psychological needs is affected by the surrounding environment (29, 48), it is natural to consider that the support of school administrators may help alleviate teachers' PNT during online teaching. In the literature, when employees feel that their organizations treat them simply as tools, this organizational dehumanization contributes to employees' PNT and, indirectly, increases in psychological strain (49). Pressure from school administrators (including time constraints and performance evaluation) can result in the thwarting of teachers' psychological needs (50). Based on the aforementioned literature, we hypothesized that greater support from administrators would be associated with lower levels of teachers' PNT related to online teaching (H_{2b}).

Regarding the influence of PNT from online teaching on teachers' psychological distress, according to Self-Determination Theory, PNT is a risk factor for poor psychological wellbeing (29–31), with several empirical studies reporting adverse effects on teachers' mental health as a result of PNT. For example, PNT was significantly associated with burnout among Spanish schoolteachers (30). Moreover, in the context of the COVID-19 pandemic, Yi et al. (9) found that Chinese teachers' PNT from online teaching was positively associated with psychological distress. In a study conducted with Australian teachers, leadership types that frustrated teachers' autonomy (i.e., autonomy-thwarting leadership) increased teachers' emotional exhaustion (35). Consequently, we hypothesized that higher levels of PNT from online teaching would result in an increase in teachers' psychological distress (H_{2c}).

Finally, considering the aforementioned research hypotheses (H_{2a}, H_{2b}, and H_{2c}), we expected that increased administrative support would first alleviate teachers' psychological needs thwarting of online teaching which would then lower psychological distress. Through serial mediation, higher levels of administrative support would decrease teachers' PIU. Consequently, we hypothesized that administrative support would have a negative indirect effect on teachers' PIU through the serial mediators (i.e., PNT of online teaching and psychological distress) (H_{2d}).

Methods

Participants

The present study was conducted in a city in the Jiangxi Province of China and was approved by the Jiangxi Psychological Consultant Association (IRB ref: JXSXL-2020-J013). Contrary to the relatively lax restrictions concerning COVID-19 in many other countries, as of the time of writing, the Chinese government is still adopting a zero-COVID-19 policy to prevent the spread of COVID-19 infections. For example, if a COVID-19 infected individual is identified in a city, the local government tends to take a strict approach and closes public places and schools. At the end of October 2021, several COVID-19 infections were identified in the aforementioned city in Jiangxi Province and the city government decided to fully implement online teaching in primary and secondary schools across the whole city, and not allow any face-to-face physical courses (starting November 3, 2021). In this sudden move to online teaching, primary and secondary schools were required to offer all courses on specified online learning platforms. The implementation of online courses in primary and secondary schools differed. Online courses in secondary schools were conducted through live classes. In primary schools, based on the characteristics of different subjects, online courses were offered through various teaching methods. For example, in Chinese language classes, students were asked to watch pre-recorded videos explaining the content of their textbook. In physical education classes, children were asked to record teacher-specified actions and upload these video files to an online learning platform. Some courses (such as mathematics) were offered in the form of a combination of live lectures by teachers and asynchronous student exercises. In co-operation with the city's education authority, two weeks after the full implementation of online teaching, an online survey adopting purposive sampling was administered to assess schoolteachers' mental health status during this quarantine period (Time 1: mid-November, 2021). Subsequently, after a month of rigid restrictions, the pandemic outbreak was brought under control in the city and campuses reopened in mid-December, with teachers returning to in-person teaching. A follow-up online survey was conducted in early-January, 2022 (Time 2), ~2 weeks after the campuses reopened.

The data for the online survey were collected via a hyperlink which was sent to primary and secondary schoolteachers with the assistance of local education authorities. The survey was voluntary and asked participants to leave their email address if they would like to participate in the follow-up survey. Electronic informed consent was obtained on the first page of the online survey. A total of 1,642 school teachers provided their email addresses and participated in the longitudinal study. Given that HLM analysis required a grouping variable (ID) for evaluating and linking nested data (i.e., teachers' affiliation with a specific school), we removed responses from the participants who did not clearly disclose their school's name (e.g., the school's name was not written, was not legible, or was misspelled). The final sample for statistical analysis comprised 980 primary and secondary schoolteachers from 115 schools. Apart from the question asking for the school's name, participants were required to complete all other questions on each page of the survey in order to move on to the next page. As such, there were no missing data. Furthermore, we also confirmed that sample attrition was not systematic and would not have an obvious effect on the results (a detailed examination is provided in Supplementary Table S1 with note).

Measures

In the present study, demographic variables [i.e., age, sex, and school type (primary or secondary school)] were collected as the control variables for the cross-lagged panel model and HLM analysis. Regarding other measures, administrators' support and PNT of online teaching, participants were asked to answer questions in relation to ongoing mandatory online teaching at that time. For psychological distress and the two specific forms of PIU, participants were asked to answer questions considering their condition over the past month. Among these measures, except for administrators' support and PNT of online teaching (which were assessed at Time 1), other variables were assessed at both Time 1 and Time 2. The instruments used are described in the following subsections.

Administrators' support

Because there is no instrument that exclusively evaluates support from school administrators in a mandatory online teaching setting, we referred to the Scale of Technology Users' Beliefs (STUB) developed by Nistor et al. (51) to develop a new instrument for this study. More specifically, the STUB assessed how important individuals (e.g., line managers, colleagues, and friends) would expect them to use technology (e.g., *"People who are important to me think that I should use the computer as a learning tool"; "The senior management has been helpful*

in the use of the computer as a learning tool"). In terms of the principles of item development for the present study, the wording of the original STUB was retained for items assessing positive attitudes of important individuals toward technology use and the provision of help and resources for people using technology. In addition, the context of the items was revised to reflect the online teaching environment during the pandemic. Four items were then developed for the present study and were rated on a five-point Likert-type scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The four items were: "*Administrators want teachers to be able to teach online smoothly during the outbreak*", "*School administrators provided most of the necessary resources to help teachers be able to teach online during the outbreak*", "*Administrators always support and encourage teachers to use online teaching during the pandemic*", and "*Administrators understand the benefits of using online teaching during the pandemic*". The internal reliability was very good in this present study (Cronbach's α = 0.85, McDonald's ω = 0.85). The uni-dimensional structure of the adapted Administrators' Support Scale was validated using confirmatory factor analysis (CFA) with the estimation of diagonally weighted least squares (DWLS) since DWLS has less bias and more accurate performance than maximum likelihood (ML) and Robust ML in CFA when the observed indicators are ordinal (e.g., the Likert-type scale used in the present study) (52). The results of CFA showed that factor loadings that were all higher than 0.56 and the overall model had a good fit with the data [i.e., Comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were 0.99, 0.98, 0.05, and 0.04 respectively]. Furthermore, because the aggregated value of schoolteachers' perceived support from the administrators was used to represent this construct at school-level, the within-group agreement (r_{wg}) was justified and acceptable agreement was obtained in terms of the score on the four items ($r_{wg} = 0.88$). Consequently, it was deemed reasonable to aggregate the values from teacher-level responses to reflect a school-level factor.

Psychological need thwarting of online teaching

The Psychological Need Thwarting Scale of Online Teaching (PNTSOT) was used to assess schoolteachers' psychological need thwarting toward online teaching during the period of school closure (Time 1). The PNTSOT was specifically designed to assess the extent of psychological need thwarting during online teaching tasks (9). The PNTSOT comprises three subscales (i.e., autonomy, competence, and relatedness thwarting). Example items include: "*I have to follow a prescribed online teaching style (way) during the pandemic*" (autonomy thwarting), "*Online teaching during the pandemic sometimes makes me feel powerless*" (competence thwarting) and "*I feel disconnected from other colleagues and leaders when teaching*

online during the pandemic" (relatedness thwarting). Items are rated on a seven-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*), and higher scores indicates more serious psychological need thwarting during online teaching tasks. A sound factorial validity was found in Yi et al.'s (9) study among schoolteachers (CFI = 0.97, NNFI = 0.95, RMSEA = 0.09, and SRMR = 0.05). The internal reliability of the PNTSOT was very good in the present study (Cronbach's α = 0.88, McDonald's ω = 0.88). Following other studies (9, 49), the three kinds of PNT were treated as an overall construct, therefore individual subscales of PNT were not included in the data analysis.

Psychological distress

The Depression, Anxiety, and Stress Scale (DASS-21) developed by Lovibond and Lovibond (53) was used to assess schoolteachers' psychological distress at both Time 1 and Time 2, given that recent studies have demonstrated the overall score of DASS-21 reflects general psychological distress rather than distinct emotional disorders (54, 55). Items in the DASS-21 are rated on a four-point scale from 0 (*never*) to 3 (*almost always*) with higher scores indicating higher levels of psychological distress. The summed score of all items in the DASS-21 was used for further processing during HLM analysis. The Chinese version of the DASS-21 has satisfactory psychometric properties (56, 57). In this present study, the internal reliability of the DASS-21 was excellent (Cronbach's α = 0.94, McDonald's ω = 0.95 at Time 1 and Cronbach's α = 0.96, McDonald's ω = 0.96 at Time 2).

Problematic social media use

The Bergen Social Media Addiction Scale (BSMAS) was used to assess schoolteachers' PSMU. The BSMAS was developed by Andreassen et al. (58) and comprises six items (e.g., "*I feel an urge to use social media more and more*") rated on a five-point Likert-type scale from 1 (*very rarely*) to 5 (*almost always*). Higher scores indicate greater risk of problematic social media use. The Chinese BSMAS has demonstrated very good psychometric properties (59, 60). The internal reliability of the BSMAS in the present study was satisfactory (Cronbach's α = 0.86, McDonald's ω = 0.87 at Time 1 and Cronbach's α = 0.88, McDonald's ω = 0.88 at Time 2).

Problematic gaming

The nine-item Internet Gaming Disorder Scale (IGDS-SF9) was used to assess the level of PG among schoolteachers. The IGDS-SF9 was developed by Pontes and Griffiths (46) and has a unidimensional structure. Items (e.g., "*Do you feel the need to spend increasing amount of time engaged gaming in order to achieve satisfaction or pleasure?*") on the IGDS-SF9

are rated on a five-point Likert-type scale from 1 (*strongly disagree*) to 5 (*strongly agree*) with higher scores indicating more problematic gaming. The Chinese IGDS-SF9 has good psychometric properties (59, 60). In this present study, the internal reliability of IGDS-SF9 was excellent (Cronbach's α = 0.95, McDonald's ω = 0.95 at Time 1 and Cronbach's α = 0.96, McDonald's ω = 0.96 at Time 2).

Data analysis strategy

Descriptive statistics and Pearson correlations were first used to analyze the characteristics of the participants and the association among all study variables, respectively. For H_{1a} and H_{1b}, a cross-lagged panel model with LISREL 8.80 on PSMU and PG was conducted. The analysis first evaluated the overall model fit indices and then scrutinized the significance of the path coefficients reflecting the cross-lagged effects. The criteria for evaluating model fit included a comparative fit index (CFI), a non-normal fit index (NNFI), a root mean square error of approximation (RMSEA), and a standardized root mean square residual (SRMR). Model fit was considered acceptable when the following criteria were met: RMSEA values of 0.08 or lower, SRMR values of 0.08 or lower, CFI values of 0.95 or higher, and NNFI values of 0.95 or higher (61). In terms of H_{2a}, H_{2b}, and H_{2c}, a cross-level serial mediation model with HLM 7.0 was conducted on PSMU and PG, respectively. Before testing H_{2a}, H_{2b}, and H_{2c}, a fully unconditional model (null model, without adding any explanatory variables) was used to calculate the intra-class correlation (ICC). If the ICC exceeded 0.059, HLM analysis was considered appropriate (62). Subsequently, for testing H_{2a}, H_{2b}, and H_{2c}, HLM equations for the three path coefficients are shown below.

For H_{2a}: Teacher-level: PIU $_{ij}$ = β_{0j} + β_{1j}(sex $_{ij}$) + β_{2j}(age $_{ij}$) + β_{3j}(psychological distress $_{ij}$) + γ_{ij}

School-level: β_{0j} = γ_{00} + γ_{01} (school type $_j$) + U_{0j}, β_1 = γ_{10}, β_{2j} = γ_{20}, β_{3j} = γ_{30}

For H_{2b}: Teacher-level: PNT of online teaching $_{ij}$ = β_{0j} + β_{1j}(sex $_{ij}$) + β_{2j}(age $_{ij}$) + γ_{ij}

School-level: β_{0j} = γ_{00} + γ_{01} (school type $_j$) + γ_{02}(administrator support $_j$) + U_{0j}, β_1 = γ_{10}, β_{2j} = γ_{20}

For H_{2c}: Teacher-level: Psychological distress $_{ij}$ = β_{0j} + β_{1j}(sex $_{ij}$) + β_{2j}(age $_{ij}$) + β_{4j}(PNT of online teaching $_{ij}$) + γ_{ij}

School-level: β_{0j} = γ_{00} + γ_{01} (school type $_j$) + U_{0j}; β_1 = γ_{10}, β_{2j} = γ_{20}, β_{4j} = γ_{40}.

Finally, in order to test H_{2d}, the bootstrap method (63) with 5,000 random samples was used to test the indirect effect from administrator support on two forms of PIU through the serial mediators (PNT of online teaching and psychological distress). More specifically, the path of interest is labeled as 2-1-1-1 model since the antecedent variable (independent variable; administrator support) was assessed at level-2 (school level), while the two mediators and dependent variables were assessed

at level-1 (individual teacher level; PNT of online teaching, psychological distress, PIU). According to Zhang et al., for 2-1-1-1 models, where the cross-level mediation of interest could exist only across level-2 units, they recommend that the estimation of the indirect effect should be conducted separately for between-group and within-group effects, rather than combining them into a single estimate (64). Following Zhang et al.'s suggestion, the test of the serial mediation effect was conducted at the school level. Namely, aggregated PNT of online teaching, and aggregated psychological distress mediates the relationship between administrators' support and aggregated PIU. Model 6 in Hayes' PROCESS macro (65) was used to test the significance of the indirect effect. The bootstrapping procedure was used in the PROCESS macro to estimate the path parameters and the confidence interval (CI) of the indirect effect in this serial mediation model. We used bootstrapping with 95% bias-corrected and accelerated (BCa) confidence intervals for 5,000 random samples.

Relevant assumptions for statistical analysis, including linearity, normality, and homoscedasticity of residuals, were confirmed with a scatter plots (for linearity and homoscedasticity of residuals) and Quantile-Quantile (Q-Q) plots (for normality of residuals). The residual scatter plots (residuals vs. predicted; see Supplementary Figures S1, S2) and Q–Q plots (see Supplementary Figures S3, S4) showed that there was no obvious non-linear pattern for the residual plots, and an approximately normal distribution of residuals was found. However, homogeneity of variance was violated according to the pattern illustrated in Supplementary Figures S1, S2. To provide unbiased estimation for the coefficients, results with robust standard errors (SE) displayed in HLM 7.0 are reported. Results from HLM 7.0 produce two tables containing the coefficient parameters for ordinary SEs and robust SEs. In cases where data distributions violate the assumption of homogeneity of variance, it is recommended that the results are reported for robust SEs (66).

Results

Descriptive statistics and Pearson correlations

Table 1 presents the demographic characteristics of the participants in the present study. The average age of the participants was 34.76 years, mostly teaching in primary schools (76.8%), with the majority being female (82.9%). In terms of years of working experience, teachers with <10 years of experience (47.3%) and more than 10 years of experience (52.7%) were relatively balanced. The demographic variables in the present sample were close to the overall population statistics (i.e., from all primary and secondary schoolteachers in mainland China) (67) in relation to age (mean age for the population of

TABLE 1 Characteristics of participants.

	N = 980
Age in years; M (SD)	34.76 (8.22)
School type; n (%)	
Primary school	753 (76.8%)
Secondary school	227 (23.2%)
Gender; n (%)	
Male	168 (17.1%)
Female	812 (82.9%)
Years of teaching experience; n (%)	
Under 5 years	222 (22.7%)
6–10 years	241 (24.6%)
11–15 years	188 (19.1%)
16–20 years	108 (11.0%)
Over 20 years	221 (22.6%)
Teaching subject; n (%)	
Chinese	387 (39.5%)
English	108 (11.0%)
Mathematics	333 (34.0%)
Science	36 (3.6%)
Social science	32 (3.2%)
Other (e.g., music, art, physics, politics)	84 (8.7%)

schoolteachers is 37.78), school type (64% of schools nationwide are primary schools), and gender (70% of schoolteachers are female).

Table 2 displays the means (and *SDs*) and Pearson correlation coefficients of the variables in this study. The results of the Pearson correlations showed that, except for the association between administrators' support and PSMU at Time 1 being statistically nonsignificant, all other paired relationships were statistically significant. Among these coefficients, negative relationships were found for administrators' support and PNT of online teaching, psychological distress, and PIU ($r = -0.30$ to -0.08). PNT of online teaching, psychological distress, and PIU were all mutually and positively significant ($r = 0.18$–0.44).

Cross-lagged panel model

Regarding the results of cross-lagged panel models including control variables (i.e., age, sex, and school type), the model for PSMU and PG had acceptable model fit indices except for RMSEA, which was slightly higher than the criterion (0.08): PSMU: $\chi^2 (162) = 1{,}287.85$, CFI $= 0.959$, NNFI $= 0.947$, RMSEA $= 0.083$, and SRMR $= 0.052$; PG: $\chi^2 (292) = 2{,}495.28$, CFI $= 0.973$, NNFI $= 0.968$, RMSEA $= 0.087$, and SRMR $= 0.027$. Subsequently, data from the cross-lagged panel model (see Figures 3, 4) found that psychological distress was significantly

TABLE 2 Descriptive statistics and Pearson correlation matrix of the study variables.

	Mean (SD)	Cronbach's α	McDonald's ω	1	2	3	4	5	6	7	8
1. Administrators' support	15.33 (2.68)	0.85	0.85	1.00							
2. PNT of online teaching[a]	40.31 (11.35)	0.88	0.88	-0.30**	1						
3. Psychological distress_Time 1[b]	18.94 (18.92)	0.94	0.95	-0.17**	0.35**	1					
4. Psychological distress_Time 2[b]	18.72 (21.69)	0.96	0.96	-0.15**	0.25**	0.61**	1				
5. PSMU_Time 1[c]	14.09 (4.74)	0.86	0.87	-0.01	0.22**	0.32**	0.21**	1			
6. PSMU_Time 2[c]	13.35 (4.55)	0.88	0.88	-0.08*	0.19**	0.28**	0.35**	0.44**	1		
7. PG_Time 1[d]	12.92 (5.49)	0.95	0.95	-0.19**	0.18**	0.36**	0.26**	0.27**	0.24**	1	
8. PG_Time 2[d]	13.59 (6.22)	0.96	0.96	-0.19**	0.21**	0.32**	0.43**	0.22**	0.44**	0.50**	1

$^*p < 0.05$, $^{**}p < 0.01$.
[a]PNT of online teaching = Psychological need thwarting of online teaching, assessed using Psychological Need Thwarting Scale of Online Teaching (PNTSOT).
[b]Assessed using Depression, Anxiety, Stress Scale–21 multiplied by 2.
[c]PSMU = Problematic social media use, assessed using Bergen Social Media Addiction Scale (BSMAS).
[d]PG = Problematic gaming, assessed using Internet Gaming Disorder Scale-Short Form (IGDS-SF9).

Cross-lagged panel model of problematic social media use and psychological distress; PSMU, Problematic social media use; BSMAS, Bergen Social Media Addiction Scale. **$p < 0.01$.
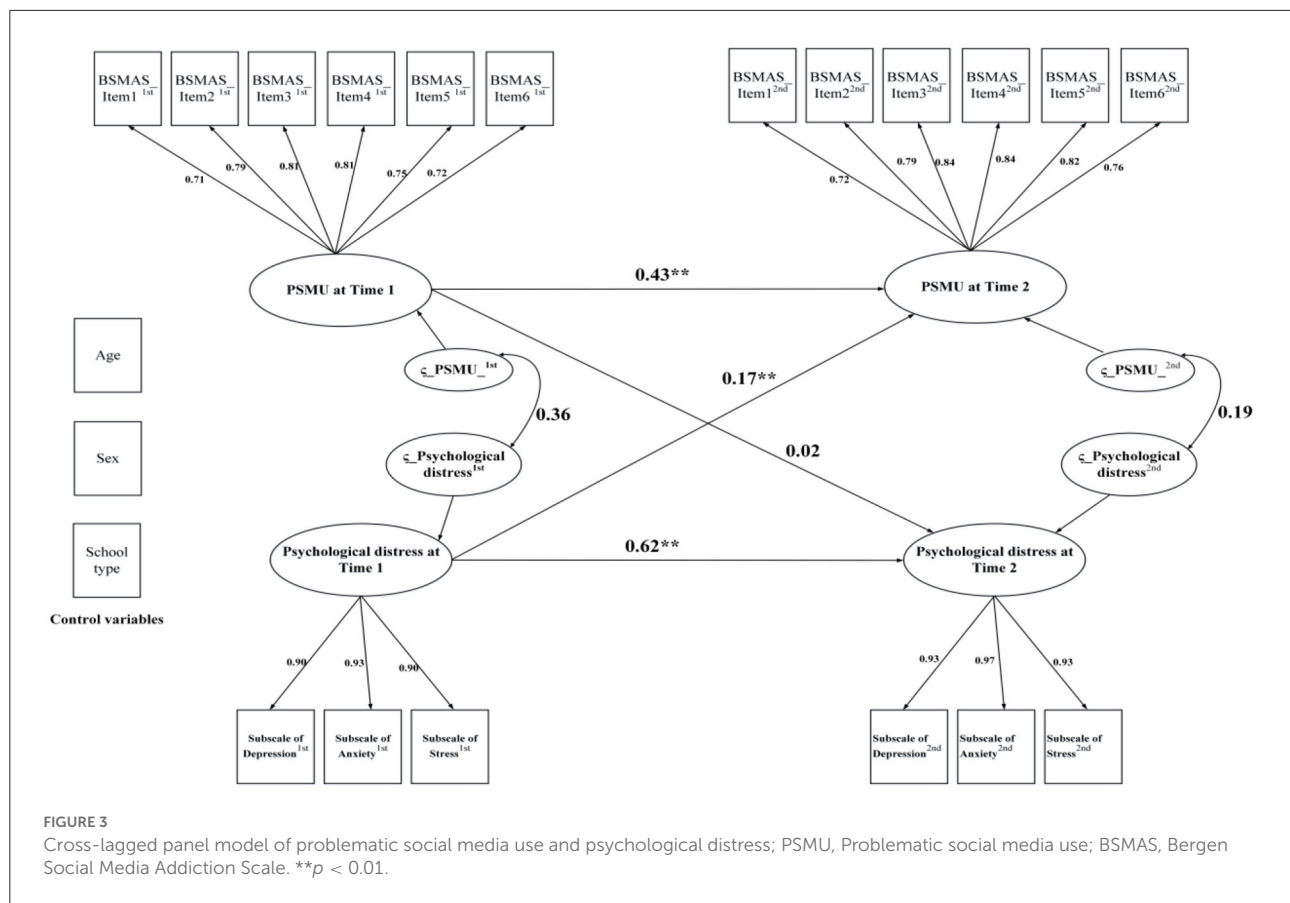
associated with both PSMU ($\beta = 0.17$, $p < 0.01$) and PG ($\beta = 0.14$, $p < 0.01$), which supported H$_{1a}$. However, since cross-lagged panel model analysis found that PG had a significant effect on psychological distress ($\beta = 0.07$, $p = 0.03$) whereas PSMU did not ($\beta = 0.01$, $p = 0.28$), the data only partially supported H$_{1b}$.

The cross-level mediation model

For the cross-level mediation model (see Table 3), ICCs were 0.0537, 0.0709, 0.0055, and 0.0046, respectively, for the null models which treated PNT of online teaching, psychological distress, PSMU and PG as outcomes. The results showed that considerable ICCs were found for PNT of online teaching and psychological distress, which were close to or exceeding 0.059, whereas small ICCs were found for the two types of PIU. Despite a minimal clustering effect for PIU, it is still necessary to consider the intra-group effect for teachers' PNT of online teaching and psychological distress. Moreover, studies have also cautioned that small ICCs may not warrant abandoning HLM, since additional dependence on higher-level groupings can arise after explanatory variables are entered into the models (68, 69). As such, considering that small values for ICCs

should not immediately rule out the use of multi-level analysis (70), HLM was considered suitable for use in addressing this research aim.

Regarding the results of HLM, there was a positive association between teachers' psychological distress and the two types of PIU (PSMU: $B = 0.15$, SE $= 0.01$, $p < 0.01$; PG: $B = 0.20$, SE $= 0.02$, $p < 0.01$), providing support for H$_{2a}$. Furthermore, the results showed a significant and negative effect of administrator support on teachers' PNT of online teaching ($B = -2.18$, SE $= 0.34$, $p < 0.01$), providing support for H$_{2b}$. Moreover, HLM analysis also showed a significant and positive effect for PNT of online teaching on psychological distress ($B = 0.29$, SE $= 0.03$, $p < 0.01$), supporting H$_{2c}$. For testing H$_{2d}$, using bootstrapping with 5,000 random samples, the results demonstrated that the serial indirect effect was significant [indirect effect $= -0.12$, 95% CI (-0.18, -0.07)] (administrators' support $\rightarrow$ PNT of online teaching $\rightarrow$ psychological distress $\rightarrow$ PG), whereas other indirect effects of administrators' support on PG with PNT of online teaching or psychological distress as sole mediators were not significant. Finally, no serial mediation effect was found for administrators' support on PSMU. Likewise, no other indirect effects via solo mediators were found for PSMU. Consequently, the data only partially supported H$_{2d}$.
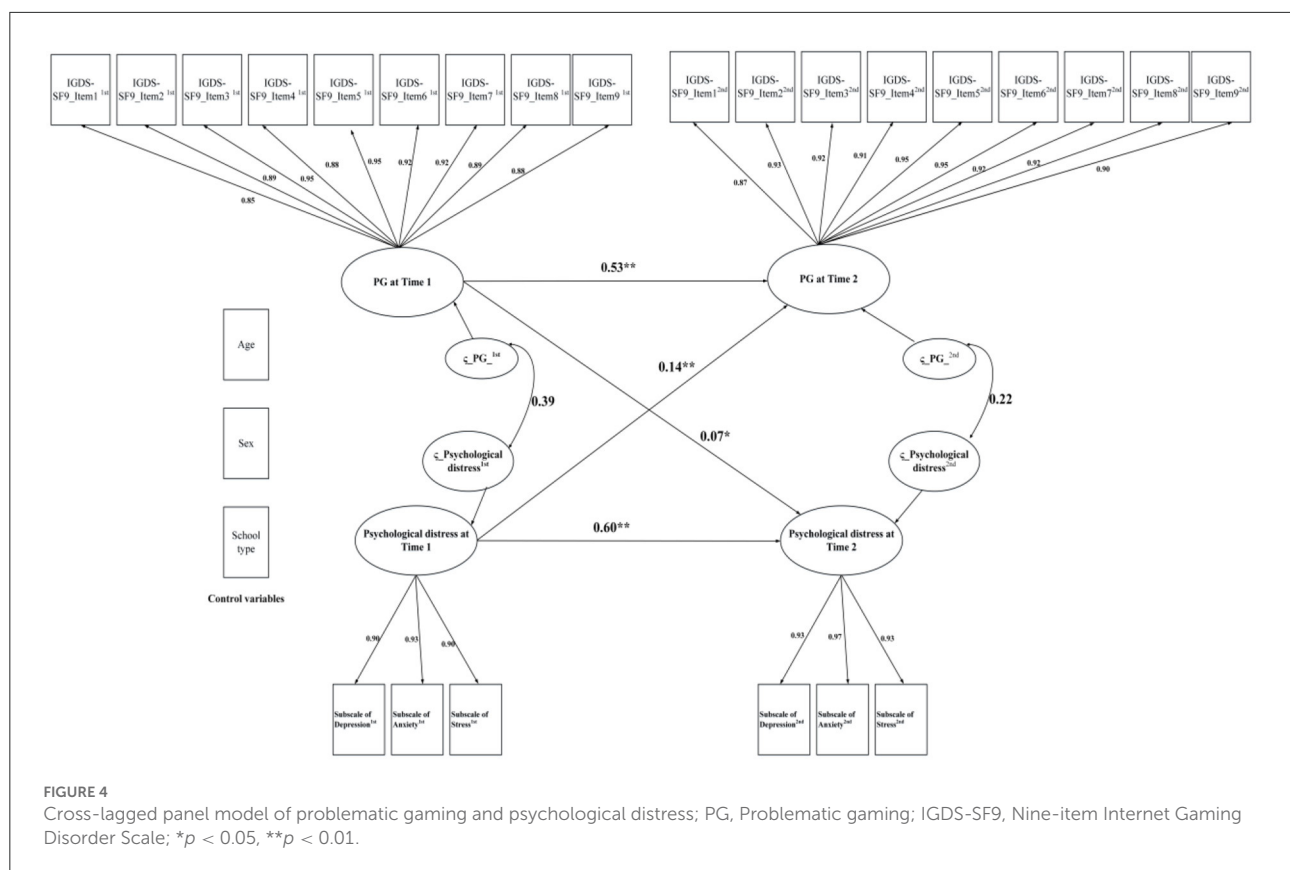
Discussion

While online learning is an emergency response to sustain learning, its impact on faculty and students is also of considerable concern. More specifically, in the early months of the global outbreak (i.e., March to June 2020), many studies described various situations encountered by teachers when rushing to teach online, including insufficient digital resources (e.g., no available e-books) (12, 16, 27, 71), inadequate infrastructure (internet access) (16, 72), increased work time due to the technology restrictions (16, 72), inexperience with integrating technology into teaching (11, 73, 74), insufficient autonomy of online teaching (27, 28), redundant work and high overlap of work and personal time (75–77), and anxiety about the lives and learning of specific disadvantaged (low socioeconomic status) students (73, 75, 78). These phenomena, combined with general fear of the pandemic, restrictions on physical activity imposed by home quarantine measures, and possible excessive internet use (24, 25), could easily lead to a negative impact on teachers' mental health. Therefore, the present study used a longitudinal study design with a relatively large sample size to investigate mental health issues among schoolteachers during the COVID-19 pandemic. The findings demonstrated that (i) schoolteachers' psychological distress and

PG had a reciprocal relationship, although this bidirectional association was not significant for PSMU as a predictor of psychological distress, despite the fact that psychological distress did predict PSMU; and (ii) serial mediation provided support for the potential influence of administrators' support on schoolteachers' PG via the mediators of PNT of online teaching and psychological distress. Interestingly, there was no significant indirect effect of administrator support through serial mediation on PSMU. In fact, according to the correlation matrix in Table 2, PSMU was the only variable not significantly correlated with administrator support. This finding, along with the lack of an effect of PSMU at Time 1 on psychological distress at Time 2, deserves further evaluation.

Concerning hypotheses tested in the cross-lagged panel model, most schools around the world adopted mandatory online teaching to maintain uninterrupted learning (1, 2, 5, 79) which exposed schoolteachers to high levels of stress and may have induced inappropriate coping methods among some individuals (e.g., PIU). The findings here lend support to the I-PACE model (39, 40) and the bidirectional lens adopted in prior studies (18, 19, 45). For example, prior studies have reported increased PIU among normal adults during home restriction (80–82) and the COVID-19 literature also shows that for individuals who needed to work from home, PIU

TABLE 3 Unstandardized coefficients (SE) obtained from hierarchical linear modeling using robust SEs.

Parameter	Model for ICC_PNT_ online teaching	Model for ICC_PD	Model for ICC_PSMU	Model for ICC_PG	Model for H_{2a}_PSMU	Model for H_{2a}_ PG	Model for H_{2b}	Model for H_{2c}
Fixed effects Intercept γ_{00}	40.33 (0.45)**	9.49 (0.31)**	14.09 (0.15)**	12.92 (0.16)**	15.18 (0.97)**	16.02 (1.00)**	44.23(2.16)**	10.29(2.15)**
γ_{01} School type (secondary school)					−0.16 (0.39)	0.02 (0.34)	−1.21(1.02)	0.17(0.74)
γ_{02} Support							−2.18(0.34)**	
γ_{10} Sex (male)					−0.44 (0.41)	−1.73 (0.49)**	−1.06(0.97)	−0.62(0.98)
γ_{20} Age					−0.06 (0.02)**	−0.07 (0.02)**	0.03(0.05)	−0.003(0.04)
γ_{30} PD					0.15 (0.01)**	(0.20 0.02)**		
γ_{40} PNT_ Online Teaching								0.29(0.03)**
Random effects σ^2 (within-group variation)	114.42	88.90	16.38	17.14	12.63	12.43	100.61	76.89
τ_{00} (between-group variation)	6.49	6.78	0.09	0.08	0.16	0.23	9.72	10.60
ICC	0.0537	0.0709	0.0055	0.0046				

ICC, Intra-class correlation; PD, Psychological distress; PNT_Online Teaching, Psychological need thwarting of online teaching; PSMU, Problematic social media use; PG, Problematic gaming.
**$p < 0.01$.

was significantly correlated with psychological distress during this period (83, 84). However, most research assessing the associations between psychological distress and PIU has focused on children (85–88), adolescents (89, 90), and individuals with existing psychiatric illnesses (91, 92). Rarely has such evidence been reported among individuals with specific occupations, such as schoolteachers. Therefore, the present study's findings extend the current literature in an understudied, and potentially vulnerable, population (i.e., schoolteachers). Notably, despite the fact that the adverse effect of PG on teachers' psychological distress was relatively small, the significant association reported in our findings is sufficient to suggest that it is necessary to be aware of schoolteachers' PIU and provide guidance to avoid PIU in addition to assisting teachers in managing psychological distress across different pandemic periods. In fact, the relatively lower association between PIU and psychological distress may be due to the age of the participants in the sample, as Lathabhavan and Padhy found that adults over the age of 40 (Generation X, similar to our participants) had significantly lower PIU-stress associations than those aged 10–35 (Generations Y and Z) (84).

A notable finding of this study was that the PG assessed at the time of school closure had a greater lasting negative impact on teachers' mental health after returning to campus as compared with PSMU. Internet gaming and social media use have different characteristics. We speculate that, for Chinese teachers, the use of social media often involves dealing with day-to-day work tasks (such as interacting with parents in online communities and dealing with work tasks assigned by leaders in online teacher work groups), and such online behavior would not unduly hinder teachers' work adaptation after returning to offline teaching. Comparatively, internet gaming is mainly a competitive game activity, in which teachers, as players, often need to spend a lot of time and energy in this virtual world in order to win, which is more likely to hinder their adaptation when returning to an offline work environment. Consequently, higher severity psychological distress was induced by PG. Our finding is in line with Wang et al. (93) and Pontes (94) in which PG contributes more harm to mental health than PSMU. Despite this, the effects of these two forms of PIU on individual mental health require further investigation, as some studies have yielded inconsistent results [e.g., no clear pattern between PG and PSMU in terms of clinically relevant depressive symptoms in Wartberg et al. (95)].

Given that the hypotheses regarding the cross-level mediation model were partial supported, this confirms the importance of administrative support on teacher wellbeing as detailed in many past studies (1, 5, 10, 16, 75) which could indirectly reduce the extent of PIU (especially PG) among schoolteachers. There are several reasons for this, including organizational dehumanization, the pressure of school authority, and the anxiety of communicating with administrators that produce an increased level of PNT and daily

anxiety among employees (10, 49, 50). Moreover, supportive leadership has been associated with greater work buoyancy and reduced stress among schoolteachers (35). Consequently, the present study speculates that administrators' support would first alleviate the PNT of online teaching, consequently lowering teachers' psychological distress. As such, with lower frustration of psychological needs and increased mental health, lower levels of PG would be reported among schoolteachers. In order to find an indirect effect of administrators' support on PG, serial mediators were necessary. In fact, if sole mediators were included (either PNT of online teaching or psychological distress), this indirect effect was not significant. This finding highlights the unique contribution of this study wherein serial mediation demonstrates how administrators' support alleviated teachers' PG as assessed during the onset of the pandemic. However, since the direct relationship between administrator support and psychological distress was not tested, only partial mediation can be stated with a degree of certainty. The development of alternative models wherein administrator support is directly associated with other variables of interest is recommended for future research in this area.

As noted above, there are some limitations in the present study which must be addressed. First, because the sample was not drawn randomly, it is possible that it does not represent the entire population of primary and secondary schoolteachers in mainland China. Moreover, the participants in our study were all primary or secondary schoolteachers. Therefore, the present findings cannot be generalized to teachers working in other schools (e.g., kindergartens or colleges). Second, the present sample was recruited from mainland China, which adopted different policies in COVID-19 pandemic control as compared to other countries (e.g., China's zero-COVID-19 policy). Therefore, the impacts of the COVID-19 pandemic on the variables found in the present study (i.e., psychological distress and PIU) might be different in other contexts. Therefore, studies using samples from other countries are needed to corroborate the findings reported here. Third, all the variables in this study were collected using self-report data, introducing potential biases such as memory recall and social desirability, which are difficult to avoid. Therefore, more objective measures for PIU, such as the total amount of time spent playing games per day should be evaluated in future research. Fourth, because the survey did not include data from before campus closure, it is not possible to assess teachers' internet use before mandatory online teaching began (e.g., time spent engaging in online activities and associated PIU levels). The present study, while attempting to collect data with a sample representative of the population of teachers in China (including teachers with minimal problematic internet use), did not include any items to assess teachers' amount of time spend in online gaming or social media use. Therefore, future research is encouraged to collect data on game and social media use experience in able to better interpret the

findings. Consequently, the results of the present study may be affected by the fact that these factors were not controlled. Finally, as PNT of online teaching serves as a prominent source of stress during mandatory online teaching (9, 35), we hypothesized the role of this variable as an antecedent factor influencing the development of teachers' psychological distress and subsequently problems with PIU. However, we also acknowledge that teachers, as a group at high risk for mental illness, may experience other outcomes or contributing factors, in addition to PNT of online teaching, in relation to psychological distress. While distress may lead to other problems, in addition to PIU, during emergency situations like the pandemic, the limited scope of this study did not evaluate these issues. Therefore, other factors related to teachers' psychological distress, in addition to PNT of online teaching, and whether administrative support can alleviate teachers' psychological distress and common negative coping responses (e.g., drug and alcohol abuse) during mandatory online teaching, or similar conditions, should continue to be explored in future studies.

In conclusion, the present study found that schoolteachers in mainland China were likely to develop PIU because of the psychological distress caused by PNT of online teaching during the COVID-19 pandemic. Moreover, this PIU could further elevate psychological distress among schoolteachers. Additionally, the present study found that administrators' support was a significant protective factor for schoolteacher in not developing PIU. Therefore, healthcare providers and related stakeholders (e.g., governments and school managers) need to consider how to support teachers more effectively during times when online teaching is mandatory. This should help alleviate psychological distress and PIU issues among schoolteachers.

Data availability statement

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

Ethics statement

Electronic informed consent was obtained on the first page of the online survey, and the study was approved by Jianxi Psychological Consultant Association (IRB ref: JXSXL-2020-J013). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.987366/full#supplementary-material

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Latent profile analysis of security among patients with COVID-19 infection in mobile cabin hospitals and its relationship with psychological capital

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Aim: COVID-19 patients' security is related to their mental health. However, the classification of this group's sense of security is still unclear. The aim of our research is to clarify the subtypes of security of patients infected with COVID-19, explore the factors affecting profile membership, and examine the relationship between security and psychological capital for the purpose of providing a reference for improving patients' sense of security and mental health.

Methods: A total of 650 COVID-19 patients in a mobile cabin hospital were selected for a cross-sectional survey from April to May 2022. They completed online self-report questionnaires that included a demographic questionnaire, security scale, and psychological capital scale. Data analysis included latent profile analysis, variance analysis, the Chi-square test, multiple comparisons, multivariate logistical regression, and hierarchical regression analysis.

Results: Three latent profiles were identified—low security (Class 1), moderate security (Class 2), and high security (Class 3)—accounting for 12.00, 49.51, and 38.49% of the total surveyed patients, respectively. In terms of the score of security and its two dimensions, Class 3 was higher than Class 2, and Class 2 was higher than Class 1 (all $P < 0.001$). Patients with difficulty falling asleep, sleep quality as usual, and lower tenacity were more likely to be grouped into Class 1 rather than Class 3; Patients from families with a per capita monthly household income <3,000 and lower self-efficacy and hope were more likely to be grouped into Classes 1 and 2 than into Class 3. Psychological capital was an important predictor of security, which could independently explain 18.70% of the variation in the patients' security.

Conclusions: Security has different classification features among patients with COVID-19 infection in mobile cabin hospitals. The security of over half of the patients surveyed is at the lower or middle level, and psychological capital is an important predictor of the patients' security. Medical staff should actively pay

attention to patients with low security and help them to improve their security level and psychological capital.

Introduction

At present, the COVID-19 pandemic continues to spread among countries and regions, and there is no specific antiviral therapy so far (1, 2). It has greatly changed the global political and economic development model, the trend of international relations, and even people's daily lives (3). The scope, scale, destructive power, and consequences of COVID-19 are unprecedented in history (4, 5). It has a strong transmission capacity, and once human beings are infected with the novel coronavirus, they can develop chest pain, cough, expectoration, fever, and other infection symptoms (6, 7). Severe infections can lead to respiratory failure or even multiple organ failure (8). To some extent, COVID-19 has created panic and fear among people.

Now in China, the COVID-19 pandemic is still existing, and the fight against the pandemic is ongoing. In March 2022, COVID-19 broke out on a large scale in Shanghai, China. By the end of May, there had been more than 600,000 confirmed cases of COVID-19 and asymptomatic infections in Shanghai. As an effective epidemic control measure for COVID-19 pandemic, the mobile cabin hospital is an effective way to cut off the potential route of infection in society (9). Medical staff are dispatched to mobile cabin hospitals to take care of patients who test positive for the virus but show no severe symptoms. This can relieve the pressure of hospital reception and achieve the goal of zero transmission in communities outside quarantine (10, 11). The mobile cabin hospital has many advantages, such as its rapid deployment, good mobility, and strong environmental adaptability, and can apply well to emergency medical rescue tasks, so it has been highly valued by various countries (12, 13). In this round of the pandemic in Shanghai, a great number of cabin hospitals were needed to curb the COVID-19 pandemic, and exhibition halls, gymnasiums, and other buildings were transformed into mobile cabin hospitals.

As a kind of stressor, the outbreak of an epidemic can easily lead to individual psychological stress (14, 15). Research shows that the psychological status of patients with diagnosed COVID-19 is not optimistic, and they have varying degrees of anxiety and panic due to their worrying about the prognosis of the disease (16, 17). Patients who entered mobile cabin hospitals for centralized isolation treatment were highly concentrated in a relatively narrow but open space. Such an unfamiliar environment can easily induce mental health problems and

hinder the rehabilitation of the disease (18). Furthermore, with the virus becoming less and less aggressive, most patients will have mild or moderate symptoms, to whom more attention should be paid. The source of their negative emotions and mental health problems is mainly their uncertainty and lack of security (19, 20).

Sense of security refers to the individual's feeling of confidence and freedom when faced with fear and danger (21), as well as the psychological feeling when dealing with these risks (22). It is one of the important factors affecting mental health and is mainly manifested as a sense of certainty and control (23). In recent years, because security is a basic psychological need, it has received a lot of attention and been widely studied. When individuals' security is threatened, they will be nervous and afraid, and their normal life and work will even be affected (24). Since COVID-19 pandemic is a public health emergency and is highly contagious, it threatens people's security (25). When the confirmed cases enter the mobile cabin hospital for centralized isolation, facing the unfamiliar environment and uncertain conditions, their security is threatened. This will cause them to have negative emotions such as anxiety and fear and affect the treatment of the disease (26). Therefore, patients' security in mobile cabin hospitals needs attention.

Psychological capital refers to a positive psychological state that individuals show in the process of growth and development, including self-efficacy, hope, optimism, and tenacity (27). Research shows that psychological capital is positively correlated with a sense of security; that is, individuals with good psychological capital will have a strong sense of security (28). In the face of threats, psychological capital has a good buffer effect to counter fear and anxiety (29). Under the same situation, the security of individuals with high psychological capital is higher than that of those with low psychological capital (30, 31).

However, currently there are few investigations into the security of patients with COVID-19 infection in mobile cabin hospitals, and their security levels are not clear. Moreover, there are rare researches on the relationship between the security and psychological capital of patients with COVID-19 infection in mobile cabin hospitals. Therefore, the purpose of our study is to take the COVID-19 patients in mobile cabin hospitals during the outbreak of COVID-19 in Shanghai as the research objects and to investigate their sense of security and related influencing factors to provide a reference for further optimizing the management

of mobile cabin hospitals and improving the patients' sense of security.

Methods

Sample size

The sample size was equal to 10 times the number of items being tested. There were 49 items in our questionnaire. Therefore, the calculation formula of sample size was $n = (7 \text{ items} + 16 \text{ items} + 26 \text{ items}) \times 10 = 490$, which meant that at least 490 subjects were required for this study. Considering an expected sample loss rate of 20%, the sample size needed be further expanded. Therefore, the final sample size required was $n = 490 \div (1\text{–}20\%) \approx 612.5$, and the final sample size required was 613 at least.

Participants

The study was conducted in accordance with the Declaration of Helsinki (32) and the guidelines of the Air Force Medical University. Participants were patients with confirmed COVID-19 recruited from a mobile cabin hospital during the outbreak of COVID-19 in Shanghai. All patients were informed that participation in this study was voluntary. They could withdraw from the study at any time for any reason, and the questionnaires were completed anonymously. The inclusion criteria were COVID-19 patients in a mobile cabin hospital. The exclusion criteria were those who had recently experienced major life events and those who were unwilling to participate in the survey. A total of 650 patients with COVID-19 were selected for the cross-sectional survey from April to May 2022. However, 18 subjects withdrew from the survey, 13 did not fill out the questionnaire completely, and 11 filled out the questionnaire with too much homogeneity, which was regarded as an invalid questionnaire. The final sample included 608 patients (270 men, 338 women) from the mobile cabin hospital, aged 11–76 years ($M_{age} = 38.08$, $SD = 13.47$).

Measures

Descriptive measures

Data on demographic variables (i.e., sex, age, place of residence, education background, marital status, monthly income per capita in family, sleep quality after diagnosis with COVID-19) were collected through a self-reported questionnaire.

Security

Participants' security levels were measured using the Security Scale (33). The Security Scale is applicable to Chinese cultural background and is widely used in China, as well as has good reliability and validity among Chinese people (34, 35). The Security Scale contains 16 items and two dimensions: interpersonal security and certainty in control. Among them, the interpersonal security dimension contains eight items, which mainly reflect the individual's security in the process of interpersonal communication. The certainty in control dimension contains eight items, which mainly reflect the individual's prediction of life and their sense of certainty and control. The scale adopts Likert's 5-level scoring method, with 1–5 points from very consistent to very inconsistent, respectively. The highest possible score is 80, with higher scores indicating more security. For example, "I always worry that something bad will happen." The Cronbach's alpha for the interpersonal security dimension and the certainty in control dimension were 0.868 and 0.934, and for the total scale was 0.902.

Psychological capital

Participants' psychological capital was measured using the Psychological Capital Scale (36). The psychological capital Scale is widely used in China and has good reliability and validity among Chinese people (37, 38). The scale contains 26 items and four dimensions: self-efficacy, hope, optimism, and tenacity. The higher the score of the scale, the higher the positive tendency of psychological capital. The scale adopts Likert's 7-level scoring method, with 1–7 points from completely non-compliant to fully compliant, respectively. The Cronbach's alpha coefficient of the scale was 0.873 and ranged between 0.855 and 0.920 for the four dimensions.

Procedure and data analysis

Before beginning the formal investigation, we trained the researchers to ensure the quality of the research. With the consent of the mobile cabin hospital managers, researchers explained the purpose of the survey to the patients to obtain their approval and support prior to data collection, and the patients gave their consent to participate in the research. With the help of head nurses in the mobile cabin hospital, questionnaires were distributed to the patients. The questionnaire was collected on the spot. We eliminated invalid questionnaires that were not filled in completely and answered randomly. The method of double check was used to input the data of the valid questionnaires to ensure accuracy.

SPSS 26.0 statistical software and Mplus 8.3 were used for statistical analysis. Descriptive statistics (mean, standard

TABLE 1   Model fit indexes of latent profile analysis (N = 608).

Model	K	AIC	BIC	aBIC	Entropy	LMR	VLMR	BLRT	Category probability
One-profile	32	32,574.753	32,715.878	32,614.286	–	–	–	–	–
Two-profile	49	29,853.625	30,069.723	29,914.159	0.907	<0.001	<0.001	<0.001	49.67/50.33
Three-profile	**66**	**28,730.713**	**29,021.784**	**28,812.250**	**0.920**	**<0.001**	**<0.001**	**<0.001**	**12.00/49.51/38.49**
Four-profile	83	28,401.722	28,767.767	28,504.261	0.888	0.002	0.002	<0.001	10.86/31.91/39.97/17.27
Five-profile	100	28,206.084	28,647.102	28,329.625	0.909	0.453	0.449	<0.001	38.65/11.02/31.74/1.65/16.94

AIC, Akaike information criterion; BIC, Bayesian information criterion; ABIC, same-size adjusted Bayesian information criterion; LMR, Lo-Mendell-Rubin likelihood ratio test; VLMR, Vuong-Lo-Mendell-Rubin likelihood ratio test; BLRT, Bootstrapped likelihood ratio test.

deviation, frequency and percentage) were used to describe the sample's characteristics. The Chi-square test and variance analysis were used to screen statistically significant indicators. Logistic regression analysis was used to evaluate the influencing factors of potential categories. The data for security were entered into the latent profile analysis, with one class initially and additional classes added incrementally until a unique solution could not be determined with maximum likelihood methods. The latent profile analysis model evaluation indicators included the Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size-adjusted BIC (aBIC), bootstrapped likelihood ratio test (BLRT), Lo-Mendell-Rubin (LMR) adjusted likelihood ratio test, Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR), and entropy. A higher entropy value, which is an important indicator, indicates a more accurate classification of the model. The smaller the AIC, BIC, and aBIC values, the better the model fit. LMR, BLRT, and VLMR are often used in model comparison, and a significant P-value indicates that K model categories are better than K – 1 model categories. The best-fitting models were selected through comprehensive evaluation of the above indexes, and the security among patients infected with COVID-19 in the mobile cabin hospital was divided into different categories. Hierarchical regression analysis was used to explore the impact of psychological capital on the security of patients. All tests conducted were two-sided, with a significance level of 0.05.

Ethical considerations

Our research was in accordance with the ethical standards formulated in the Declaration of Helsinki (39) and was confirmed by the Fourth Military Medical University ethics committee approval (KY20224143-1). Informed consent was provided by the participants prior to their participation. The survey was anonymous, and the confidentiality of the information was assured.

Results

Common method deviation

The Harman single-factor method was used to test the common method deviation. The variance explained by the maximum factor variance was 27.8%, less than the critical value of 40% (40). The statistical test results showed that there was no significant common method bias in the measurement.

Exploratory latent profile analysis

The best-fitting latent profile analysis was the three-class model (Table 1). The P-values of the LMR test (<0.001), VLMR test (<0.001), and BLRT test (<0.001) of the three-class model were the smallest, suggesting that this model was statistically significant at the $\alpha = 0.05$ level. This model had the highest entropy value (0.920) and the lower AIC (28,730.713), BIC (29,021.784), and aBIC (28,812.250). Figure 1 shows the subtypes of patients' security (Classes 1, 2, and 3); the proportion of each type was 12.00, 49.51, and 38.49%. According to this model, they could be distinguished as having relatively low (Class 1), medium (Class 2), or high (Class 3) security. The correct classification probabilities mean the average latent class probabilities for the most likely latent class membership by latent class. The larger the proportion, the more accurate the result. In order to further verify the reliability of the classification results, the correct classification probabilities of the three categories of patients' safety were calculated to be 97.1, 96.6, and 95.7% respectively (Table 2).

Security of patients with COVID-19 in different categories and characteristics of the different classes

Table 3 presents the security and its two dimensions of the three classes. The results of the analysis of variance of the total score and two dimensions of patient security

FIGURE 1
The latent profiles of the security of patients infected with COVID-19.
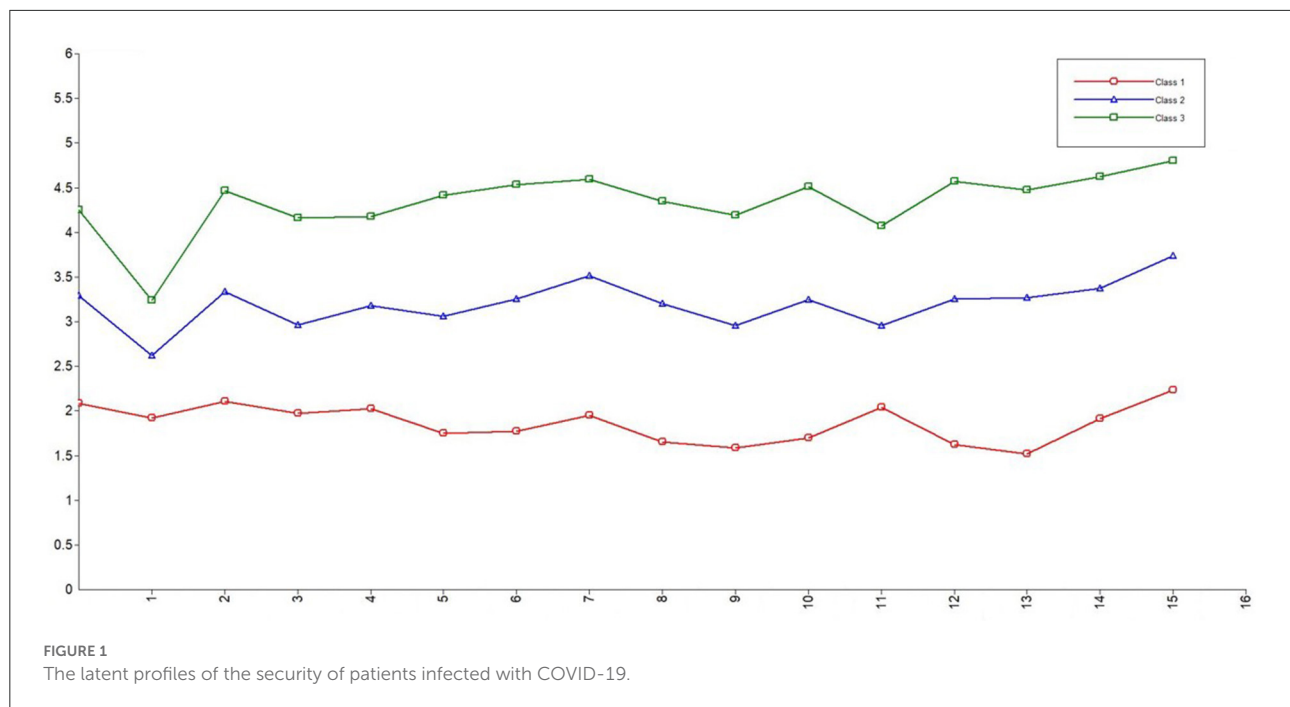
in each group were statistically significant ($F = 1,329.070$, $P < 0.001$; $F = 645.427$, $P < 0.001$; $F = 1,141.546$, $P < 0.001$). Further least significant difference (LSD) analysis showed that Class 1 < Class 2 < Class 3 in terms of security and its two dimensions ($P < 0.001$). Univariate analysis showed that there were significant differences among the three groups in educational level ($\chi^2 = 9.956$, $P = 0.007$), family income ($\chi^2 = 22.936$, $P = 0.001$), psychological capital ($F = 35.907$, $P < 0.001$), and its four dimensions ($F = 52.296$, $P < 0.001$; $F = 43.750$, $P < 0.001$; $F = 23.610$, $P < 0.001$; $F = 7.192$, $P = 0.001$). There was no difference among the three groups in other demographic characteristics (Table 4).

Influencing factors of security in different groups of patients with COVID-19

The security of patients with COVID-19 determined by latent profile analysis was used as the dependent variable, and Class 3 was used as the control group. Compared with Class 3, those with trouble falling asleep (OR = 6.572, $P < 0.05$), sleep quality as usual (OR = 3.693, $P < 0.05$), and lower tenacity (OR = 0.831, $P < 0.05$) were more likely to be grouped into Class 1. Those with a monthly per capita family income <3,000 ($OR_{class1} = 3.131$, $P < 0.05$; $OR_{class2} = 2.383$, $P < 0.05$), lower self-efficacy ($OR_{class1} = 0.678$, $P < 0.001$; $OR_{class2} = 0.783$, $P < 0.001$), and lower hope ($OR_{class1} = 0.739$, $P < 0.001$; $OR_{class2} =$

TABLE 2 Average latent class probabilities for most likely latent class membership (row) by latent class (column).

Class	C1 (%)	C2 (%)	C3 (%)
C1	**0.971**	0.029	0.000
C2	0.005	**0.966**	0.029
C3	0.000	0.043	**0.957**

C1: Class 1, C2: Class2; C3: Class 3.

0.868, $P < 0.001$) were more likely to be grouped into Classes 1 and 2 (Table 5).

Hierarchical regression analysis of COVID-19 patients' security

Table 6 shows the results of hierarchical regression analysis with security as the dependent variable. The results showed that family income and sleep quality had entered the regression equation of the security of COVID-19 patients ($F = 3.182$, $R^2 = 0.089$, $P < 0.001$). On the basis of model 1, four dimensions of psychological capital were included in model 2 ($F = 10.093$, $R^2 = 0.275$, $P < 0.001$). Variance expansion factors were <10, indicating that there was no obvious collinearity among variables. Psychological capital was an important predictor of patients' security that could independently explain 18.70% of its variation ($\Delta R^2 = 0.187$, $P < 0.001$).

TABLE 3   Security of patients with COVID-19 in different categories.

	N	Security	Interpersonal security	Certainty in control
C1: Low security	73	29.95 ± 7.79	15.68 ± 4.77	14.26 ± 4.28
C2: Moderate security	301	51.12 ± 5.23	25.13 ± 3.91	25.99 ± 3.20
C3: High security	234	69.46 ± 6.54	33.87 ± 4.03	35.59 ± 3.67
F		1,329.070	645.427	1,141.546
P		<0.001	<0.001	<0.001
LSD		C1 < C2 < C3	C1 < C2 < C3	C1 < C2 < C3

TABLE 4   The differences in the security types of COVID-19 patients in demography and psychological capital.

Variable	Respondents	Low security	Moderate security	High security	χ^2/F	P
Gender						
Male	270 (44.41%)	29 (39.73%)	136 (45.18%)	105 (44.87%)	0.742	0.690
Female	338 (55.59%)	44 (60.27%)	165 (54.82%)	129 (55.13%)		
Age						
<30	202 (33.22%)	23 (31.50%)	107 (35.55%)	72 (30.77%)	4.245	0.374
30–50	269 (44.24%)	31 (42.47%)	123 (40.86%)	115 (49.14%)		
>50	137 (22.53%)	19 (26.03%)	71 (23.59%)	47 (20.09%)		
Place of residence						
City	380 (62.50%)	42 (57.53%)	189 (62.79%)	149 (63.68%)	0.917	0.632
Countryside	228 (37.50%)	31 (42.47%)	112 (37.21%)	85 (36.32%)		
Education background						
Junior college or below	499 (82.07%)	65 (89.04%)	256 (85.05%)	178 (76.07%)	9.956	0.007
Undergraduate or above	109 (17.93%)	8 (10.96%)	45 (14.95%)	56 (23.93%)		
Marital status						
Unmarried	198 (32.57%)	23 (31.51%)	105 (34.88%)	70 (29.91%)	2.589	0.629
Married	382 (62.83%)	47 (64.38%)	180 (59.80%)	155 (66.24%)		
Widowed or separated	28 (4.61%)	3 (4.11%)	16 (5.32%)	9 (3.85%)		
Monthly income per capita in family (yuan)						
<3,000	126 (20.72%)	25 (34.25%)	66 (21.93%)	35 (14.96%)	22.936	0.001
3,000–5,000	224 (36.84%)	26 (35.62%)	117 (38.87%)	81 (34.62%)		
5,001–10,000	163 (26.81%)	23 (17.81%)	83 (27.57%)	67 (28.63%)		
>10,000	95 (15.63%)	9 (12.33%)	35 (11.63%)	51 (21.79%)		
Sleep quality after diagnosis with COVID-19						
Have trouble falling asleep	80 (13.16%)	15 (20.55%)	39 (12.96%)	26 (11.11%)	6.531	0.366
Poor sleep	165 (27.14%)	17 (23.29%)	87 (28.90%)	61 (26.07%)		
As usual	307 (50.49%)	37 (50.68%)	148 (49.17%)	122 (52.14%)		
Good sleep	56(9.21%)	4 (5.48%)	27 (8.97%)	25 (10.68%)		
Psychological capital	110.39 ± 22.70	97.36 ± 34.30	106.90 ± 19.49	118.94 ± 18.65	35.907	<0.001
Self-efficacy	28.47 ± 6.50	24.16 ± 9.34	27.25 ± 5.73	31.38 ± 4.94	52.296	<0.001
Hope	27.91 ± 6.75	23.59 ± 9.30	26.82 ± 6.10	30.66 ± 5.38	43.750	<0.001
Tenacity	27.17 ± 6.17	24.22 ± 8.99	26.40 ± 5.46	29.09 ± 5.35	23.610	<0.001
Optimistic	26.83 ± 5.54	25.38 ± 8.33	26.42 ± 4.90	27.82 ± 5.08	7.192	0.001

TABLE 5 The multifactor analysis of security of patients infected with COVID-19 by logistic regression.

Variable	C1 VS C3					C2 VS C3				
	β	SE	OR	95%CI	P	β	SE	OR	95%CI	P
Gender (take female as reference)										
Male	0.171	0.324	1.187	(0.630, 2.238)	0.596	0.219	0.203	1.244	(0.836, 1.852)	0.281
Age (take >50 as reference)										
<30	−0.438	0.529	0.645	(0.229, 1.820)	0.407	−0.291	0.342	0.474	(0.382, 1.462)	0.395
30–50	−0.175	0.404	0.839	(0.380, 1.853)	0.665	−0.185	0.263	0.831	(0.496, 1.393)	0.483
Place of residence (take countryside as reference)										
City	0.099	0.342	1.104	(0.564, 2.160)	0.773	0.166	0.222	1.181	(0.764, 1.824)	0.454
Education background (take undergraduate or above as reference)										
Junior college or below	0.422	0.494	1.525	(0.579, 4.017)	0.393	0.324	0.273	1.383	(0.809, 2.363)	0.236
Marital status										
Unmarried	1.084	0.909	2.958	(0.498, 17.572)	0.233	0.153	0.537	1.166	(0.407, 3.338)	0.775
Married	0.847	0.826	2.332	(0.462, 11.765)	0.305	−0.176	0.483	0.839	(0.325, 2.161)	0.716
Monthly income per capita in family (yuan) (take >10,000 as reference)										
<3,000	1.142	0.571	3.131	(1.023, 9.589)	**0.046**	0.869	0.380	2.383	(1.131, 5.022)	**0.022**
3,000–5,000	−0.093	0.536	0.911	(0.319, 2.603)	0.862	0.323	0.328	1.382	(0.726, 2.629)	0.324
5,001~10,000	−0.313	0.546	0.731	(0.251, 2.130)	0.566	0.221	0.317	1.247	(0.671, 2.320)	0.486
Sleep quality after diagnosis with COVID-19 (take good sleep as reference)										
Have trouble falling asleep	1.883	0.778	6.572	(1.429, 30.219)	**0.016**	0.686	0.468	1.987	(0.794, 4.969)	0.142
Poor sleep	1.142	0.735	3.134	(0.742, 13.238)	0.120	0.602	0.415	1.825	(0.810, 4.115)	0.147
As usual	1.306	0.662	3.693	(1.008, 13.527)	**0.049**	0.431	0.365	1.539	(0.753, 3.144)	0.237
Psychological capital (take optimistic as reference)										
Self-efficacy	−0.388	0.072	0.678	(0.589, 0.780)	**<0.001**	−0.244	0.048	0.783	(0.712, 0.861)	**<0.001**
Hope	−0.302	0.070	0.739	(0.644, 0.848)	**<0.001**	−0.141	0.047	0.868	(0.791, 0.953)	**0.003**
Tenacity	−0.185	0.083	0.831	(0.706, 0.978)	**0.026**	−0.090	0.056	0.914	(0.820, 1.019)	0.106

SE: Standard error, OR: Odds ratio, CI: Confidence interval.

Discussion

Necessity of the study on the security of patients with COVID-19 infection in mobile cabin hospitals

The establishment of mobile cabin hospitals to treat a large number of patients with mild or moderate COVID-19 is an effective way to deal with the outbreak of the pandemic and block its spread at the social level (41). In the face of the special isolation environment in these hospitals, patients' security is threatened, which has an impact on their psychological health and disease treatment. However, there is a lack of research on the sense of security of this group, and limited studies have examined whether psychological capital might impact the sense of security of patients with COVID-19 infection in mobile cabin hospitals. Therefore, the purpose of this study was to clarify the subtypes of security of patients infected with COVID-19, to explore the influencing factors of different types of security,

and to examine the relationship between patients' security and psychological capital. To our knowledge, this is the first research to study the security of patients with COVID-19 infection in mobile cabin hospitals.

More attention should be paid to patients with low sense of security

Our study used latent profile analysis to classify patients' sense of security into three categories: low security (Class 1), moderate security (Class 2), and high security (Class 3). Among them, Class 2 had the largest number, accounting for 49.51%, which indicates that nearly half of the patients had moderate security. Although the number of patients in Class 1 was the lowest, accounting for 12%, this group needs the most attention.

More and more attentions have been paid to patients' sense of security in recent years, and it is an important aspect of patient-centered care (42). Previous studies have shown that

TABLE 6 Hierarchical regression analysis of psychological capital on the security of COVID-19 patients.

Variable	M1					M2				
	b	Sb	b'	t	P	b	Sb	b'	t	P
Constant	47.555	4.448		10.692	<0.001	26.777	4.778		5.605	<0.001
Family income (yuan per month)										
3,000–5,000	4.159	1.583	0.142	2.627	0.009	4.643	1.423	0.158	3.263	0.001
5,001–10,000	7.459	1.840	0.234	4.053	<0.001	6.190	1.652	0.194	3.747	<0.001
>10,000	9.274	2.186	0.238	4.242	<0.001	6.672	1.970	0.171	3.387	0.001
Sleep quality after diagnosis with COVID-19										
Good sleep	7.324	2.476	0.150	2.958	0.003	6.732	2.232	0.138	3.015	0.003
Psychological capital										
Self-efficacy						0.796	0.154	0.365	5.182	<0.001
Hope						0.477	0.159	0.227	2.993	0.003
Tenacity						0.125	0.168	0.054	0.744	0.457
Optimistic						−0.685	0.150	−0.269	−4.570	<0.001
F			3.182***					10.093***		
R^2			0.089					0.275		
Adjusted R^2			0.061					0.248		
$\triangle R^2$								0.187***		

M1, Model 1; M2, Model 2.
***: P < 0.001.

patients with low sense of security were more worried about their economic situation (43). A longitudinal study showed that patients with high security always had good psychological health (44). The patient's sense of security includes many influencing factors, such as external environmental factors and self-related factors, such as economic and psychological conditions (45, 46). In our study, we explored the sense of security of patients with COVID-19 from different perspectives, which were showed in Tables 4, 5. However, the results in Tables 4, 5 were not consistent because that a multivariable logistic regression model was performed to include all independent variables.

Those whose per capita family income was <3,000 tend to have a low or medium sense of security. This is because under COVID-19, people in controlled zones are restricted from going to work, which has a great impact on people's income, especially in low-income families (47, 48). Such people have to worry about disease, but also their living expenses and loan repayment, so they are more likely to have a low sense of security. Furthermore, our results showed that the sleep quality of patients after diagnosed with COVID-19 also affected their security, and that the two are closely related. Our results are consistent with Hoyniak et al.'s (49) finding that emotional security is conducive to sleep. A cross-sectional study showed that COVID-19 is associated with changes in sleep schedule and in the quantity and quality of nighttime sleep because of the new stressors, altered roles, and uncertainties about health and economic security (50). Therefore, in the management and nursing of COVID-19 patients in mobile cabin hospitals, from the perspective of improving their security, we should focus on patients with low income and poor sleep quality.

The important role of psychological capital in patients' safety

Psychological capital belongs to the category of positive psychology, which emphasizes individual strength and enthusiasm (51, 52). Our study shows that COVID-19 patients with good psychological capital tend to have a high sense of security, and it is an important predictor of patients' security that can independently explain 18.70% of the variation in security, which is consistent with the results of Eweida et al. (28). In the hierarchical regression analysis of this study, tenacity was not significant in model 2. The reason for this may be that tenacity is a persistent quality that has few impacts on the sense of security. Research shows that individuals with low psychological capital have a low sense of security (53, 54). Psychological capital can buffer the uncertainty, stress, and anxiety of patients in mobile cabin hospitals, which can easily lead to an increase in security (55, 56). Therefore, managers of shelter hospitals can improve patients' security by improving their psychological capital level (28). Medical staff can guide patients to adjust their mentality and help them to adjust their negative emotions, which is conducive to the acquisition of a sense of security. According to Bandura's social cognitive theory, people who have subjective initiative can actively adapt

to and change the environment (57). Research shows that mindfulness can improve the level of individual psychological capital (58). Therefore, mindfulness-based cognitive therapy can be conducted for patients in shelters to treat and alleviate their emotional and psychological problems, such as anxiety, depression, and impulsiveness, so as to improve their self-efficacy, hope, and optimism (59, 60). Individuals with a high level of psychological capital are more willing to take initiative and face difficulties and turning points, are more optimistic, confident, and hopeful, and can recover quickly even if they encounter setbacks (61).

Limitations

There are some limitations to our study. Firstly, because of the impact of the pandemic, our research group only conducted a questionnaire survey on COVID-19 patients in the shelter unit within our own management, and we did not investigate the patients in the whole mobile cabin hospital. Secondly, our study was conducted in the form of self-report questionnaires, and the results tended to be subjective. Third, we only preliminarily explored the relationship between the psychological capital and the security of patients, without combining the clusters of security. In future research, we will further explore the relationship between security and psychological capital in combination with the type of security.

Conclusion

Our study explored the characteristics of security among patients with COVID-19 infection in mobile cabin hospitals and its relationship with psychological capital. Based on latent profile analysis, we identified their security as low security (Class 1), moderate security (Class 2), or high security (Class 3), accounting for 12.00, 49.51, and 38.49%, respectively, of the total number of patients. The predictors of COVID-19 patients' security were monthly income per capita in the family,

sleep quality, and psychological capital. Psychological capital was an important predictor of security that could independently explain 18.70% of the variation in the patients' security. All these predictive factors are of great significance to improve COVID-19 patients' security, which managers of shelter hospitals should pay attention to.

Data availability statement

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

Author contributions

CW, J-rY, and C-yH wrote the main manuscript text. H-jL, JW, and C-nH distributed questionnaires. Y-jZ and JD contributed to the writing and revision of articles. Y-wL and Y-hZ contributed to the analysis and processing of data. 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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Check for updates

Effects of general and corona-specific stressors on mental burden during the SARS-CoV-2 pandemic in Germany

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The SARS-CoV-2 pandemic turned out to be a serious threat to mental and physical health. However, the relative contribution of corona-specific (DH_s) and general stressors (DH_g) on mental burden, and specific protective and risk factors for mental health are still not well understood. In a representative sample ($N = 3{,}055$) of the German adult population, mental health, potential risk, and protective factors as well as DH_s and DH_g exposure were assessed online during the SARS-CoV-2 pandemic (June and July 2020). The impact of these factors on mental health was analyzed using descriptive statistics, data visualizations, multiple regressions, and moderation analyses. The most burdensome DH_g were financial and sleeping problems, respectively, and DH_s corona-media reports and exclusion from recreational activities/important social events. 31 and 24% of total mental health was explained by DH_g and DH_s, respectively. Both predictors combined explained 36%, resulting in an increase in variance due to DH_s of only 5% (R^2 adjusted). Being female, older and a lower educational level were identified as general risk factors, somatic diseases as a corona-specific risk factor, and self-efficacy and locus of control (LOC) proved to be corona-specific protective factors. Further analyses showed that older age and being diagnosed with a somatic illness attenuated the positive influence of LOC, self-efficacy, and social support on resilience. Although the data showed that after the first easing restrictions, the stressor load was comparable to pre-pandemic data (with DH_s not making a significant contribution), different risk and protective factors could be identified for general and corona-specific stressors. In line with observations from network analysis from other groups, the positive impact of resilience factors was

especially diminished in the most vulnerable groups (elderly and somatically ill). This highlights the need to especially target these vulnerable groups to foster their resilience in upcoming waves of the corona pandemic.

Introduction

The SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) pandemic has shown to be a threat to physical as well as mental health [e.g., (1, 2)]. Not only the existential fears evoked by the virus itself (fear of illness, suffering, and death) are stressful, but also the regulatory policies such as lockdown and their resulting social distancing, self-isolation, financial insecurity, or travel restrictions. Moreover, secondary consequences such as an impending economic crisis and recession are feared (3, 4). Different systematic reviews showed that the COVID-19 pandemic evoked significant increases in depression, anxiety, and posttraumatic stress symptoms in the general population during (5, 6) and after the first (3, 7) and subsequent COVID waves (8, 9). In the general population, studies also showed slightly higher levels of psychological distress compared to pre-pandemic data (3, 10, 11). Quarantine measures appeared to have a particularly negative impact on psychological wellbeing, with higher prevalence rates of psychological distress symptoms (e.g., irritability, insomnia, and emotional exhaustion) and mental disorders (e.g., depression) demonstrated thereafter [e.g., (12, 13)]. Both, fear appeals, that have intentionally been used to increase compliance rates for infection control measures (14, 15), as well as the spread of rumors (16) have also been shown to have negative psychological effects (including the loss of trust in mental health services or policies) (13).

Thereby, those with chronical illness or poorer health (7, 9, 17) or a relative or acquaintance infected with COVID-19 (17, 18) as well as women (3, 11, 19–23) were identified as particularly vulnerable. Further risk factors were catastrophizing thinking, the personality trait neuroticism, and the need for instrumental support (2). Research shows that specific resilience factors (as social support or optimism) help humans to cope with stressful life events (24, 25) and mitigate risk factors (26–28). There is corresponding evidence that some of those factors, e.g., positive appraisal and optimism (2, 29), perceived social support (18, 30, 31), self-efficacy, cognitive flexibility (32) and locus of control (LOC) (7, 30, 33), strengthened mental health during the pandemic. It should be noted, however, that these strategies were more difficult to apply (e.g., optimism) during periods of closure or constant negative news (34).

Although corona-specific stressors significantly contribute to the total stressor load experienced during a pandemic, also general micro-stressors (35, 36) or "daily hassles" ["demands that, to some degree, characterize everyday transactions with the environment and are classified as irritating, frustrating, and unsettling" (37), p. 3] are present, which also contribute to the total stressor load. Daily hassles are considered a good predictor of psychological symptoms, because they involve immediate adjustment processes (37) and may also have profound negative effects on mental health, especially if they are numerous and enduring (38). Seery et al. (39) examined u-shaped relationships across the lifespan between adversities and wellbeing (lower global distress, posttraumatic stress symptoms and functional impairment, and higher life satisfaction). Their results showed that individuals who experienced less lifetime adversity suffered comparatively more from being confronted with current adversity compared to people with moderate lifetime adversities. However, when there were too many cumulative stressors, this turned into a negative effect on wellbeing (e.g., stress-associated diseases).

Objective

Although numerous studies have been published researching stressor load as well as risk and resilience factors during the pandemic, only a few examined this in representative samples (3). Moreover, none of these studies examined the specific contribution of corona-specific (DH_s) and general stressors (DH_g) and their relative impact on mental burden during the pandemic. Our study, therefore, used a representative sample of the German population in order to investigate: (1) the stressor load (DH_s and DH_g and their relative contributions) in the German population during the SARS-CoV-2 pandemic in summer 2020, (2) the relative impact of DH_s and DH_g and their combination on mental health, and (3) risk and resilience factors with a special focus on their relevance in vulnerable groups such as older people. The study aim is also graphically represented in Figure 1.
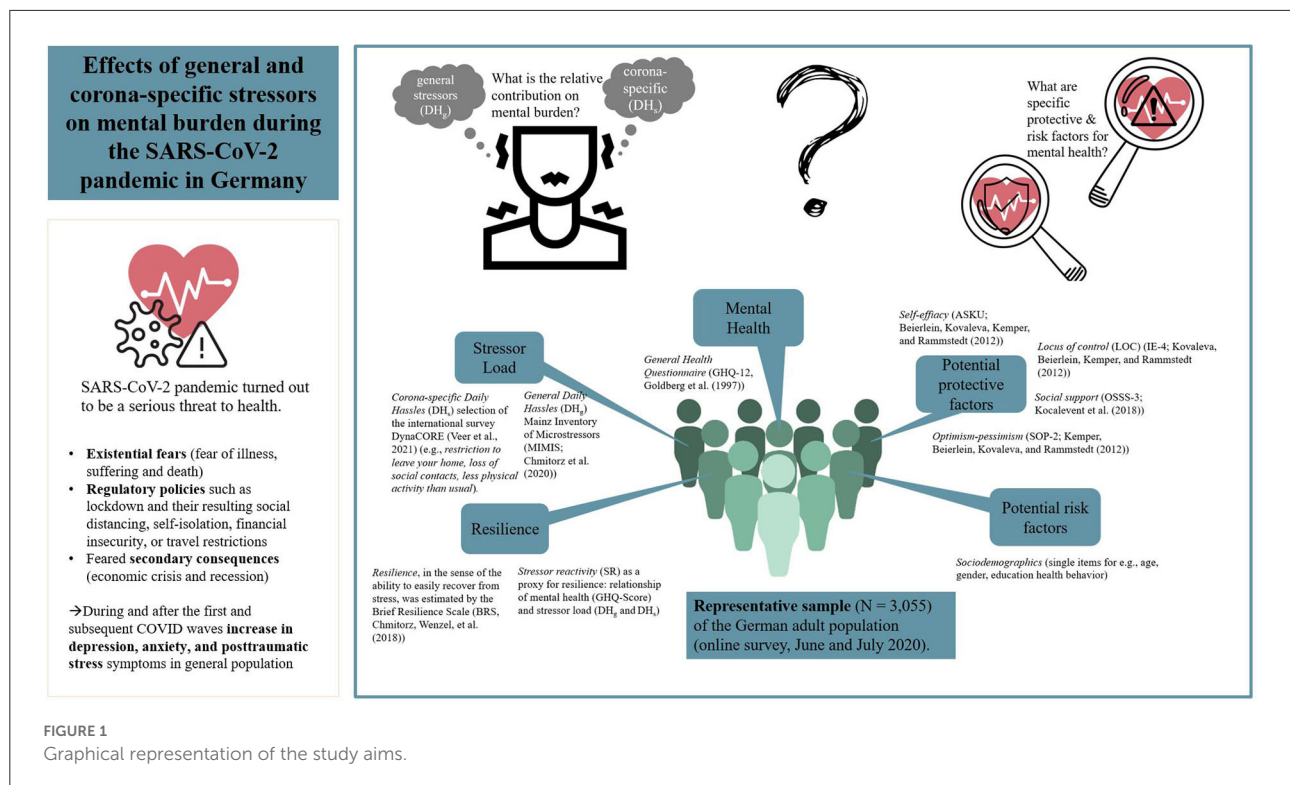
FIGURE 1
Graphical representation of the study aims.

Materials and methods

Sample

A representative sample ($N = 3,055$) of the adult German population (18+ years) was assessed in cooperation with the infratest dimap polling institute between June 26th and July 19th, 2020. This time period was characterized by a steady decline in 7-day incidence (3.3 per 100,000 cases) after the first wave of the pandemic in March 2020. The hospitalization rate was 17%, and the mortality rate was just under 5%. Testing capacity was significantly expanded, and the Corona alert app for contact tracking was just introduced (40). Contact restrictions were lifted, stores and restaurants reopened, and schools resumed regular operations. Nevertheless corona-specific protective measures and restrictions (e.g., social distancing) and fears of infection and of the next wave were present (41). By using a weighting variable (with the variables age, education, state, and gender), slightly overrepresented populations can be weighted downward, and underrepresented populations can be weighted upward in the dataset so that the weighted dataset reflects the population. All calculations were computed once with and once without the weighting variable, and no differences emerged. We adopted the minimal correction by using the weighting variable. The design weights were used throughout the manuscript. The sample characteristics are shown in Table 1.

Survey questionnaire

The survey questionnaire contained 182 items and included the following sections: sociodemographics, mental health, resilience and resilience-associated constructs, stressor exposure as well as individual and social values. Except for the sociodemographic assessments, only validated questionnaires were used.

Sociodemographics were assessed using single items for, e.g., age, gender, or education as well as health behavior (in total 32 items). Based on the variables education, occupation and income, a socioeconomic status (SES) index was created using a predefined scoring system (42) and from there dividing participants into five equally populated groups (quintiles). This resulted in a classification into low (1st quintile), medium (2nd–4th quintile) and high (5th quintile) SES. *Mental health* was assessed by the General Health Questionnaire [GHQ-12, Goldberg et al. (43), 12 items on a 4-point Likert scale] for the last few weeks. *Resilience*, in the sense of the ability to easily recover from stress, was estimated by the Brief Resilience Scale [BRS, Chmitorz et al. (44); 6 items on a five-point Likert scale—"strongly disagree" to "strongly agree"].Total scores were obtained by taking the mean of the item scores. Due to restrictions of the questionnaire length, only four well established *resilience-associated constructs* (45–47) were included: *optimism-pessimism* [SOP-2; (48), 2 items; from "not optimistic/pessimistic at all" to "very optimistic/pessimistic" on

TABLE 1 Demographic characteristics of the sample.

	Overall ($N = 3{,}055$)	Males ($n = 1{,}494$)	Females ($n = 1{,}561$)
Age (years)			
Mean (*SD*)	50.59 (*17.25*)	49.40 (*17.49*)	51.06 (*17.67*)
Median (*Min; Max*)	52.00 (*18;93*)	50.00 (*18;93*)	52.00 (*18;91*)
Education (frequency, %)			
No school-leaving qualification	40 (*1.3%*)	17 (*1.2%*)	23 (*1.5%*)
Still in school education	15 (*0.5%*)	5 (*0.4%*)	9 (*0.6%*)
Low secondary education	1,013 (*33.1%*)	493 (*33.6%*)	520 (*33.3%*)
Medium secondary education	964 (*31.5%*)	438 (*29.3%*)	526 (*33.7%*)
High school	470 (*15.4%*)	233 (*15.6%*)	236 (*15.1%*)
University degree	555 (*18.2%*)	309 (*20.7%*)	245 (*15.7%*)
Somatic illness (frequency, %)			
Self reported diagnosis	1,231 (*40.3%*)	554 (*37.00%*)	676 (*43.4%*)
no diagnosis	1,812 (*59.3%*)	939 (*62.7%*)	873 (*56.1%*)
N/A	12 (*0.4%*)	5 (*0.3%*)	7 (*0.4%*)
Mental disorder (frequency, %)			
Self reported diagnosis	350 (*11.5%*)	136 (*9.1%*)	213 (*13.7%*)
no diagnosis	2,680 (*87.7%*)	1,353 (*90.3%*)	1,327 (*85.3%*)
N/A	25 (*0.8%*)	9 (*0.6%*)	16 (*1%*)
Self estimated resilience (BRS)			
Mean (*SD*)	3.31 (*0.78*)	3.41 (*0.74*)	3.22 (*0.79*)
Median (*Min, Max*)	3.34 (*1;5*)	3.33 (*1;5*)	3.17 (*1;5*)
Mental health (GHQ-12)			
Mean (*SD*)	12.49 (*6.58*)	11.71 (*6.23*)	13.25 (*6.81*)
Median (*Min; Max*)	11 (*0;36*)	10 (*0;36*)	12 (*0;36*)
DH$_s$ (burden)			
Mean (SD)	1.82 (*0.91*)	1.80 (*0.91*)	1.85 (*0.91*)
Median (Min; Max)	1.77 (*0;5*)	1.70 (*0;5*)	1.77 (*0;5*)
DH$_s$ (binary count)			
Mean (SD)	9.54 (*3.54*)	9.67 (*3.53*)	9.46 (*3.54*)
Median (Min; Max)	11 (*0;14*)	11 (*0;14*)	11 (*0;14*)
DH$_g$ (burden) (MIMIs)			
Mean (SD)	1.20 (*0.81*)	1.24 (*0.81*)	1.17 (*0.82*)
Median (Min; Max)	1.10 (*0;3.09*)	1.18 (*0;2.97*)	1.03 (*0;3.09*)
DH$_g$ (frequency) (MIMIS)			
Mean (SD)	68.22 (*47.60*)	67.56 (*46.84*)	68.85 (*48.33*)
Median (Min; Max)	58.00 (*0;310*)	58.00 (*0;294*)	58.00 (*0;310*)
Optimism (SOP-2)			
Mean (*SD*)	5.02 (*1.46*)	5.03 (*1.42*)	5.01 (*1.49*)
Median (*Min; Max*)	5.50 (*1;7*)	5.5 (*1;7*)	5.5 (*1;7*)
Self-efficacy (ASKU-4)			
Mean (*SD*)	3.89 (*0.73*)	3.93 (*0.71*)	3.86 (*0.75*)
Median (*Min; Max*)	4.00 (*1;5*)	4.00 (*3;5*)	4.00 (*1;5*)
Social support (OSSS-3)			
Mean (*SD*)	9.81 (*0.73*)	9.69 (*1.92*)	9.92 (*2.07*)
Median (*Min; Max*)	10.00 (*3;14*)	10.00 (*3;14*)	10.00 (*3;14*)

N, number of population; *n*, number of cases; SD, Standard Deviation; Min, minimum; Max, maximum; N/A, not applicable; BRS, Brief Resilience Scale; GHQ-12, General Health Questionnaire (12 item version); DH$_g$, general daily hassles; DH$_s$, corona-specific daily hassles; MIMIS, Mainz Inventory of Microstressors; SOP-2, Skala Optimismus-Pessimismus-2; ASKU-4, Allgemeine Selbstwirksamkeit Kurzskala; OSSS-3, Oslo Social Support Scale-3.

a seven-point Likert scale], *locus of control* (LOC) [IE-4; (49), 4 items; from "does not apply at all" to "applies fully" on a five-point Likert scale], *self-efficacy* [ASKU; (50), 3 items; from "does not apply at all" to "applies fully" on a five-point Likert scale], and *social support* [OSSS-3; (51), 3 items; response format differs on a 4 resp. 5-point Likert scale].

For *stressor exposure,* we assessed three different types of stressors, *general daily hassles* (DH_g), *corona specific daily hassles* (DH_s) and *life events* (LE). For assessing DH_g, we used the Mainz Inventory of Microstressors [MIMIS; (52); 58 items]. The MIMIS assessed the frequency each stressor occurs (up to the last 7 days, DH_{fg}) as well as the perceived burden (from "not at all burdensome" to "very burdensome" on a five-point Likert scale, DH_{bg}). DH_s were measured with a selection of 13 items of the international survey DynaCORE (29), which had been introduced to assess stress due to the pandemic and respective measures (e.g., *restriction to leave your home, loss of social contacts, less physical activity than usual*). We asked whether a stressor occurred (on up to the last 7 days, total binary frequency, DH_{fs}), and if so—how the burden was classified (from "not at all burdensome" to "very burdensome" on a five-point Likert scale, DH_{bs}). For LE as macro stressors, we used a self-developed question that queried one LE within the last 12 months. The *Response to Stressful Experiences Scale* [RSES-4; (53), 4 items, "strongly disagree" to "strongly agree" on a five-point Likert scale] was used to determine the burden of it. Additionally, we used the Perceived Stress Scale [PSS-4; (54), 4 items "never" to "very often" on a five-point Likert scale] in order to assess the subjectively perceived stress. We also collected *Social Identification with social groups* [adapted from Doosje et al. (55), 4 items, "strongly disagree" to "strongly agree" on a five-point Likert scale], *values* [Individuelle reflexive Werte: (56); 16 items, "very unimportant" to "very important" on a seven-point Likert scale], *political attitudes* [Sozio-Politische Einstellungen, (57), 16 items, "correct" and "not correct"] and *cultural diversity* [Pro-diversity beliefs; adapted from Kauff and Wagner (58), 2 items, "not at all" to "full" on a four-point Likert scale]. The complete questionnaire is shown in Supplementary material 1. In this manuscript, we focus on the following outcomes and risk/protective factors: resilience (BRS), mental health (GHQ-12), stressor exposure (DH_g, DH_s) as well as risk (sociodemographic and health behavior) and protective factors (SOP-2, IE-4, ASKU, OSSS-3). Detailed results of the other items will be published elsewhere.

Statistical analyses

For all statistical analyses a significance level of $\alpha = 0.05$, two-tailed, was adopted. All analyses were conducted with the weighting variable included. Data analysis was performed in R (v4.2.0, www.r-project.org/), in particular the packages

ggplot2 (59), effects (60) and lavaan (all regressions were calculated with the scores of the confirmatory factor analysis) (61). All analyses are exploratory in nature; hence, *p*-values and 95% confidence bands are descriptive and not corrected for multiple comparisons.

Stressor load

To investigate the most frequent and most burdensome DH, descriptive methods (mean values and frequencies) were used. In addition, (weighted) heat maps—frequency of general DH (DH_{fg}) and burden of corona-specific DH (DH_{bs})—were generated. A clustered heat map is a data visualization technique for showing patterns based on color intensities. To obtain information about which stressors (general vs. corona-specific) had a stronger impact on mental health, we calculated a regression analysis with either DH_{fg}, DH_{fs} or both combined (DH_{fc}) as well as DH_{bg} and DH_{bs} or both combined (DH_{bc}) (each modeled as a second-degree polynomial) as independent variable.

Operationalization of stressor reactivity as a proxy for resilience

Following Kalisch et al. (62), resilience has been defined as a mental health outcome. However, since this study was a cross-sectional study which did not allow for a longitudinal assessment of mental health outcomes, we used the relationship of mental health (here the GHQ score) and stressor load (general daily hassles and corona-specific daily hassles) as a proxy for resilience. The GHQ-DH regression curve shows the normative predicted stressor reactivity (SR). Subjects residuals, which deviate from the normative predicted SR, contain information about their individuals SR (i.e., their vulnerability/resilience level): If the individual residual is located above this curve, it expresses a relative over-reactivity (=vulnerable), a value below the curve expresses a relative under-reactivity (=resilience) (29, 45, 62). We aimed to assess the stressor load as objectively as possible and therefore summed up the frequency of occurrence of each stressor as a total sum value: DH_{fg} were counted continuously (Range: 0–406), DH_{fs} were counted binarily (Range: 0–13). For the conceptualization of resilience, three different univariate regression analyses were applied considering the best model fit to get the subjects' stressor reactivity (SR) score: The GHQ score served in each calculation as criterion and either DH_{fg}, DH_{fs} or both combined (DH_{fc}) as predictors. For convenience of interpretation, we calculated individuals' inverse residuals, so that high values indicate high resilience (63). The retrospectively assessed single, most burdensome life event didn't explain any variance in regression analysis, therefore, we omitted it from further analysis. The BRS, which measures

the ability to recover from stress, is also frequently used as a resilience measure (44). It therefore served as a benchmark to compare the results of this study with those before and during the pandemic.

Vulnerable groups, protective factors, and in-depth analysis of previously identified vulnerable groups

To identify risk factors, we used moderation analyses with the GHQ score as criterion and DH_{fg} or DH_{fs} as predictor. Sociodemographic characteristics (age, gender, education) and health status (physical illness or mental disorder) were used as moderators of this analysis. We controlled either for DH_{fg} or DH_{fs}. To identify protective factors, we also calculated the same moderation analyses, but with the different resilience factors (RF), i.e., optimism, self-efficacy, LOC and social support, as moderators. We controlled either for DH_{fg} and DH_{fs} and for age, gender, education, somatic illness, and mental disorder. To identify protective factors for the previously identified vulnerable groups, moderation analyses were calculated using SR score as the criterion and the RF as independent variables and the previously identified risk factors as moderators.
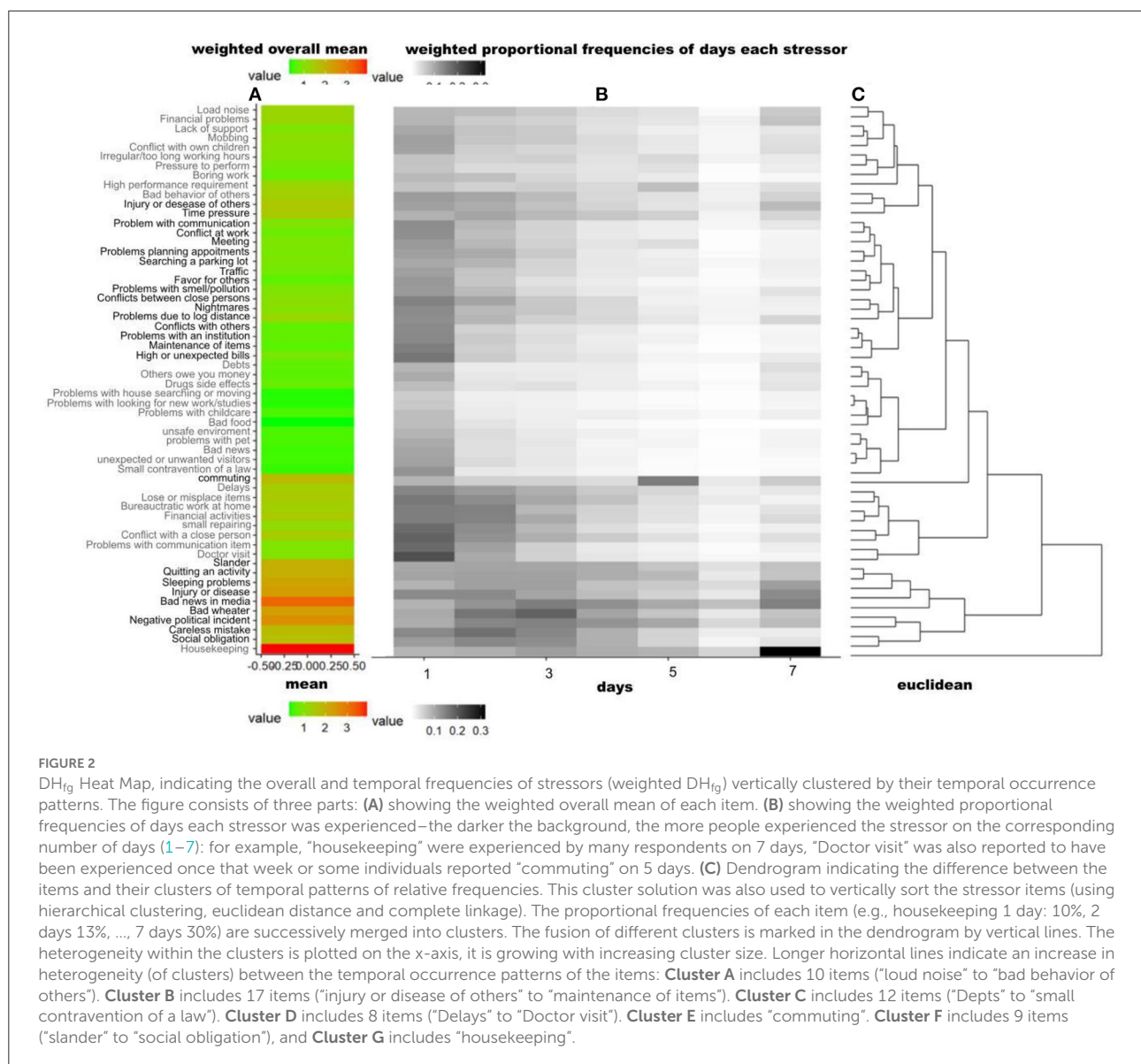
Results

Sample

The final sample included 3,055 participants. Table 1 shows the demographic characteristics. Around half of the participants were women (51.1%). Age was distributed equally between18 and 93 years (median age = 52.00 years; mean age = 50.59 years; SD = 17.25 years). About one-third had either the low secondary education (33.5%) or medium secondary education (33.1%), and nearly one-sixth of participants had a university degree (18.2%) or high school (15.4%). Only 1.3% of the participants had no school-leaving qualification or were still in school (0.5%). About 40% of the respondents reported to be affected by any somatic disease, about 12% by a mental disorder. The proportion of women was higher in both groups (43% in females vs. 37% in males and 14% in females and 9% in males, respectively). The mean BRS score of respondents was 3.31 (SD = 0.78), with men's scores (mean = 3.41, SD = 0.74) indicating higher self-estimated resilience than women's (mean = 3.22, SD = 0.74). Similar results were found regarding GHQ (mean = 12.49; SD = 6.58; lower values indicate better mental health): mean values were higher in women (mean = 13.25; SD= 6.81) than in men (mean = 11.71; SD = 6.23). The values of frequency and burden of DH and the resilience-associated constructs (e.g., optimism) are shown in Table 1 (total and gender-separated).

Stressor load

Our first aim was to gain insights into the stressor load of the German population during the SARS-CoV-2 pandemic: The most frequent and most burdensome DH_g and DH_s were examined. The most frequently reported DH_{fg} were housekeeping [reported by 83.64% of participants occurring on at least one and up to 7 day(s) in each case], followed by bad news in media (80.73%), negative political incident (72.42%), own physical complaints (65.95%), bad weather (71.15%), and sleeping problems (59.41%). Financial problems (average severity rating mean 2.31, possible answer range 1–4, percentage of those affected 28.5%), followed by sleeping problems (2.29; 51.30%), own physical complaints (2.13; 57.34%), and bad behavior of others and time pressure (both 2.10; 38.04% resp. 38.27%) were the most burdensome DH_{bg}. Among the most frequently stated DH_g, the average perceived burden was relatively low: housekeeping (1.23; 53.49%), negative political incident (1.71; 58.23%), and bad weather (1.61; 52.64%). To gain more knowledge about the temporal structure of the stressors, clustered heat maps for the DH_{fg} are presented in Figure 2: It shows the overall mean and temporal frequency patterns of stressors (weighted, DH_g), which were vertically sorted according to the cluster solution. By visual inspection of the dendrogram, seven distinct clusters can be identified regarding the temporal occurrence: In Cluster A it is characteristic that DH_g tended to occur not at all or very often, i.e., on no or up to 7 days. In Cluster B DH_{fg} occurred rather rarely (i.e., once, or twice or three times). This temporal clustering also unveils some contentual structure: Cluster A and B primarily contain problems with others or at work (e.g., "boring work" or "problems with an institution"). Cluster C primarily concerns insecurity (related to financial, health, or environmental status). This cluster was characterized by a low stressor load, i.e., DH did not occur just once. Cluster D includes external conditions (e.g., "delays" to "doctor visit"). In Cluster D stressors load is slightly elevated, by stressor occurrence on either 1–2 days or not at all. Cluster E includes "commuting" and has a clear peak at 5 days (every workday). Cluster F primarily indicates internal problems (e.g., "slander" or "careless mistake") and the frequency of occurrence is highest for this cluster (on at least one or two up to 7 days). And Cluster G ("housekeeping"), has the highest frequency of occurrence on 7 days.

The most frequently reported corona-specific DH_{fs} were corona-media reports (reported by 96.60% of participants occurring on up to the last 7 days), followed by the loss of ability to participate in recreational activities or in important social events (93.29%), loss of social contacts (87.24%), less physical activity (83.84%), restrictions to leave home (81.87%), and economic damage (69.68%). The DH_{bs}, sorted according to their degree of burden, are shown in the heat map of Figure 3. As shown in Figure 2A, which demonstrates the weighted overall mean of each stressor item, the most burdensome

FIGURE 2
DH$_{fg}$ Heat Map, indicating the overall and temporal frequencies of stressors (weighted DH$_{fg}$) vertically clustered by their temporal occurrence patterns. The figure consists of three parts: **(A)** showing the weighted overall mean of each item. **(B)** showing the weighted proportional frequencies of days each stressor was experienced–the darker the background, the more people experienced the stressor on the corresponding number of days (1–7): for example, "housekeeping" were experienced by many respondents on 7 days, "Doctor visit" was also reported to have been experienced once that week or some individuals reported "commuting" on 5 days. **(C)** Dendrogram indicating the difference between the items and their clusters of temporal patterns of relative frequencies. This cluster solution was also used to vertically sort the stressor items (using hierarchical clustering, euclidean distance and complete linkage). The proportional frequencies of each item (e.g., housekeeping 1 day: 10%, 2 days 13%, ..., 7 days 30%) are successively merged into clusters. The fusion of different clusters is marked in the dendrogram by vertical lines. The heterogeneity within the clusters is plotted on the x-axis, it is growing with increasing cluster size. Longer horizontal lines indicate an increase in heterogeneity (of clusters) between the temporal occurrence patterns of the items: **Cluster A** includes 10 items ("loud noise" to "bad behavior of others"). **Cluster B** includes 17 items ("injury or disease of others" to "maintenance of items"). **Cluster C** includes 12 items ("Depts" to "small contravention of a law"). **Cluster D** includes 8 items ("Delays" to "Doctor visit"). **Cluster E** includes "commuting". **Cluster F** includes 9 items ("slander" to "social obligation"), and **Cluster G** includes "housekeeping".

DH$_s$ were corona-media reports (average severity rating mean: 2.88, possible answer range: 1–5, percentage of those affected: 96.60%), followed by the loss of ability to participate in recreational activities or in important social events ("Loss of activity": 2.80; 93.52%), private or professional travel not feasible ("No journey": 2.53; 85.07%), loss of social contacts ("Loss of contacts": 2.35; 87.36%), and less physical activity than usual ("Less physical activity": 2.23; 84.08%). As shown in Figure 3B, which illustrates the weighted proportional load with which a particular stressor was experienced, corona-specific stressors were clustered into 3 clusters according to their relative degree of stress and sorted vertically (see right part C). It was frequently stated that Cluster A's items, e.g., "Restriction to leave home" or "Work/ childcare problems", occurred, but most of participants

did not associate burden with them. Cluster B includes "Other", which included answers concerning additional problems (e.g., "Goods and services problems"), fears (e.g., second wave) and anger (e.g., ignoring measures/recklessness). Cluster C, e.g., "corona-media reports", most often had a medium load (2).

In order to analyze the perceived stressor load, we used univariate regression models: 31 and 24% of the variance in mental health outcome (GHQ score, dependent variable) was explained by DH$_{bg}$ [R^2 adjusted: 0.31; $F_{(2,3054)} = 683.74$, $p < 0.001$] and DH$_{bs}$ [R^2 adjusted: 0.24; $F_{(2,3054)} = 481.77$, $p < 0.001$], respectively. DH$_{bg}$ and DH$_{bs}$ were modeled as second-degree polynomial considering best model fit. In the model with combined stressors (DH$_{bc}$), DH$_{bs}$ explained only an additional 5% in the total perceived stressor load [determined by univariate
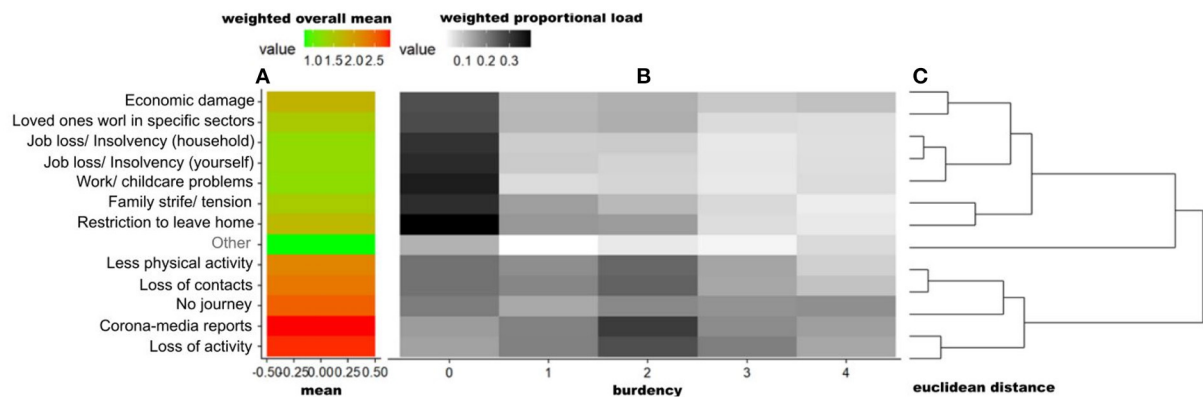
FIGURE 3

DH_{bs} Heat Map, indicating the burden's mean of stressors (weighted DH_{bs}) vertically clustered by their burden patterns. The figure consists of three parts: **(A)** showing the weighted overall mean of each item. **(B)** illustrates the weighted proportional load with which a particular stressor was experienced–the darker the background, the more burdensome the stressor was experienced (from "not at all burdensome" to "very burdensome" on a five-point Likert scale). For example, "media-corona reports" were experienced by many respondents as burdensome (average severity rating mean: 2.88). **(C)** Dendrogram indicating the difference between the items and their clusters of patterns of relative burden. This cluster solution was also used to vertically sort the stressor items (using hierarchical clustering, euclidean distance and complete linkage). The proportional burden of each item (e.g., loss of activity "not at all burdensome": 13%, ..., "very burdensome" 10%) are successively merged into clusters. The fusion of different clusters is marked in the dendrogram by vertical lines. The heterogeneity within the clusters is plotted on the x-axis, it is growing with increasing cluster size. Longer horizontal lines indicate an increase in heterogeneity (of clusters) between the temporal occurrence patterns of the items: **Cluster A** includes 7 items ("economic damage" to "restriction to leave home"). **Cluster B** includes "Other" with answers concerning additional problems ("Goods & services problems", "Burden due to mandatory masks", "Deterioration of mental situation" or "Digital study/school"), fears ("Second wave", "economic impact/lockdown", "Social change", "Infection itself/others" and "Further measures") and anger ("Ignoring measures/recklessness", "Measures/policy" and "Media reporting"). **Cluster C** includes 5 items ("Less physical activity" to "loss of activities").

regression with GHQ score as the dependent variable and DH_{bg} and DH_{bs} as the independent variables; adjusted R^2 increase: 0.05–0.36, $F_{(4,3052)} = 434.99$, $p < 0.001$].

Stressor reactivity as a proxy for resilience

Our second goal was to estimate the SR, i.e., the stressor-mental health relationship (determined by univariate regression with GHQ score as the dependent variable and DH_{fg} and DH_{fs} as the independent variables). We found a curvilinear relationship due to a good model fit with DH_{fg} and DH_{fs} each modeled with a quadratic polynomial simultaneously (without controlling for LE, see Section Operationalization of stressor reactivity as a proxy for resilience). In the GHQ-DH regression, both predictors combined (DH_{fc}) explained a substantial amount of variance of the GHQ score [adjusted $R^2 = 0.27$; $F_{(4,3052)} = 277.3$, $p < 2.2e-16$]. Figures 4A,B show the normative predicted stressor-mental health models with GHQ score as dependent and DH_{fs} or DH_{fg}, respectively, as independent variables.

Regression analyses indicated that GHQ score is significantly related to DH_{fg} (see Figure 4A). A peak was reached at about 250 DH_{fg}, and then leveled off ($\beta_1 = 0.079$; $p < 2e-16$; $\beta_2 = -0.0002$; $p < 4.94e-9$). The higher the DH, the worse the mental health status until a specific saturation point (see Figure 4A).

Regarding DH_{fs} (see Figure 4B), regression analyses indicated that the GHQ score increased with increasing DH_{fs} and then reached a peak at about 9 DH_{fs} and flattened out. Statistically, only the main effect of the second polynomial in the GHQ- DH_{fs} score relationship became significant ($\beta_1 = -0.04373$; $p = 0.261$; $\beta_2 = -0.0337636$; $p = 0.0004$). The relationship between DH_{fg} and GHQ is considerably stronger than the relationship of DH_{fs} with GHQ, as visible from comparing Figure 4A with Figure 4B.

Vulnerable groups

Our third goal was to identify risk factors resp. vulnerable groups based on the different stressors (general or corona-specific). All results are presented in Table 2. To identify general vulnerable groups, we examined the effect of sociodemographic characteristics (e.g., age) or health status (e.g., physical illness) on the DH_{fg}-health relationship (controlling for DH_{fs}). Gender, age, and education level significantly influenced the relationship: female gender ($p = 0.000$) and higher age ($p = 5.11e-6$) were identified as general risk factors. Participants with higher educational attainment, i.e., high school ($p = 0.002$), and those with a university degree ($p = 0.009$) were less vulnerable compared to those with low secondary or medium secondary education (also see Supplementary Figure 5). Socioeconomic status and a diagnosed mental disorder or somatic illness did not
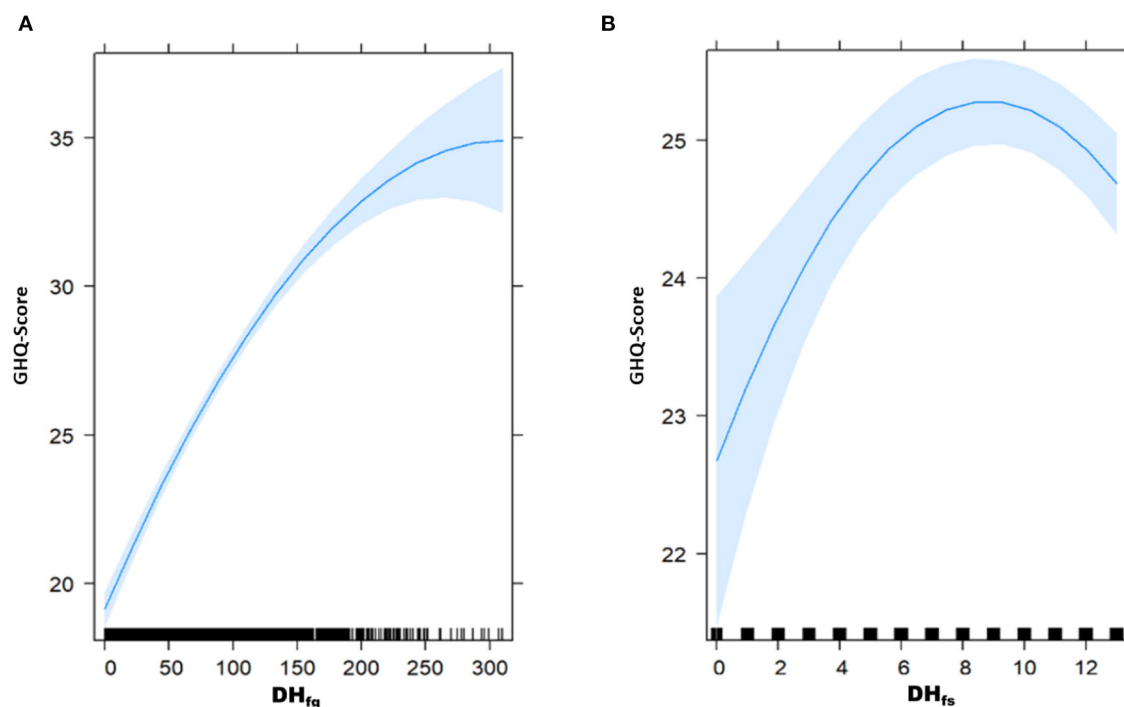
Predicted stressor-health relationship [multivariate regression analyses with GHQ score as criterion and DH$_{fg}$ **(A)** or DH$_{fs}$ **(B)** as predictors, respectively].

significantly influence the DH$_{fg}$-health relationship, i.e., they were not identified as general risk factors. To identify corona-specific vulnerable groups, we examined the moderating effect of sociodemographic characteristics and health status on the DH$_{fs}$-health relationship (controlling for DH$_{fg}$). Being diagnosed with a somatic illness significantly and negatively influenced the relationship ($p = 0.037$). Neither gender, age, SES, education level or a diagnosis of a mental disorder were identified as corona-specific risk factors.

Protective factors

Our fourth objective was to identify protective factors based on the different stressors (general or corona specific). To identify general protective factors, we examined the effect of resilience factors (RF; e.g., optimism) on the DH$_{fg}$-mental health relationship (controlling for DH$_{fs}$, age, gender, education, somatic illness, and mental disorder). All results are presented in Table 3. We found that social support is a significant moderator of the DH$_{fg}$-health relationship ($p = 0.047$). Neither self-efficacy, LOC, nor optimism were identified as protective factors. Regarding DH$_{fs}$-health relationship, self-efficacy ($p = 0.004$) and LOC ($p = 0.003$) were significant moderators (reinforcing effect on the second polynomial negative relationship between

DH$_{fs}$ and GHQ score). Optimism and social support were not identified as protective factors regarding coping with DH$_{fs}$.

In-depth analysis of previously identified vulnerable groups

Finally, moderation analyses were conducted to identify protective factors for the vulnerable groups previously identified. For the in-depth analysis, we examined the moderating effect of gender, age, education, and being diagnosed with a somatic illness on the relationship between RF (optimism, LOC, social support, and self-efficacy as independent variable) and the stressor reactivity score (SR$_c$ combined predictor of DH$_{fg}$ and DH$_{fs}$). The results are presented in Table 4. They did not indicate any specific protective factor for the previously identified vulnerable groups (all analyses with $p > 0.05$). Rather, they showed that some protective factors lost their mitigating effect: Regarding female gender, the relationship between SR$_c$ and optimism, or LOC, or self-efficacy or social support was not moderated by female gender. Neither optimism nor social support could be identified as protective factors for higher age. The otherwise positive relationship between LOC or self-efficacy and SR$_c$ is even weakened by the moderating age effect ($p_{2LOC} = 0.007$; $p_{1self-efficacy} = 0.0129$; $p_{2self-efficacy} = 0.0001$). The

TABLE 2 Moderation analysis—vulnerable groups (controlling for DH_{fg} or DH_{fs}).

	GHQ score x DH_{fg}					GHQ score x DH_{fs}				
	R^2	F	p-value	b	p-value	R^2	F	p-value	b	p-value
Gender	0.285	$F_{(7,3047)} = 174.6$	<0.001	$\beta_1 = -40.74$	<0.001	0.282	$F_{(7,3047)} = 172.3$	<0.001	$\beta_1 = -9.58$	0.392
				$\beta_2 = -16.60$	0.150				$\beta_2 = 20.81$	0.062
Age	0.281	$F_{(10,3046)} = 120.7$	<0.001	$\beta_1 = -1934.43$	<0.001	0.276	$F_{(10,3046)} = 174.4$	<0.001	$\beta_1 = -252.74$	0.462
				$\beta_2 = -76.37$	0.845				$\beta_2 = 492.92$	0.138
Education level										
Medium secondary education	0.28	$F_{(13,2992)} = 88.41$	<0.001	$\beta_1 = 17.75$	0.20751	0.270	$F_{(13,86.32)} = 2992$	<0.001	$\beta_1 = -0.62$	0.964
				$\beta_2 = -2.82$	0.84514				$\beta_2 = -3.54$	0.794
High school				$\beta_1 = 14.08$	0.405				$\beta_1 = -1.49$	0.933
				$\beta_2 = -53.24$	0.002				$\beta_2 = -2.81$	0.869
University degree				$\beta_1 = -27.97$	0.125				$\beta_1 = -0.584$	0.974
				$\beta_2 = -49.14$	0.009				$\beta_2 = 11.99$	0.529
SES	0.285	$F_{(7,3047)} = 174.6$	<0.001	$\beta_1 = -2.87$	0.250	0.285	$F_{(7,3047)} = 174.6$	<0.001	$\beta_1 = 2.21$	0.418
				$\beta_2 = -0.45$	0.839				$\beta_2 = 3.28$	0.236
Mental disorder	0.310	$F_{(7,3024)} = 195.1$	<0.001	$\beta_1 = -28.03$	0.115	0.309	$F_{(7,3024)} = 194.8$	<0.001	$\beta_1 = 0.304$	0.988
				$\beta_2 = 11.83$	0.436				$\beta_2 = 20.65$	0.328
Somatic illness	0.273	$F_{(7,3037)} = 164.5$	<0.001	$\beta_1 = -5.57$	0.628	0.274	$F_{(7,3037)} = 165.1$	<0.001	$\beta_1 = -23.87$	0.037
				$\beta_2 = 15.86$	0.169				$\beta_2 = -10.01$	0.380

TABLE 3 Moderation analysis—protective factors (controlling for DH_{fs} or DH_{fg}, age, gender, education, somatic illness, and mental disorder).

	GHQ score x DH_{fg}					GHQ score x DH_{fs}				
	R^2	F	p-value	b	p-value	R^2	F	p-value	b	p-value
Social support	0.343	$F_{(13,2955)} = 120.3$	<0.001	$\beta_1 = -20.56$	0.084	0.342	$F_{(13,2955)} = 119.6$	<0.001	$\beta_1 = -0.004$	0.100
				$\beta_2 = 20.50$	0.047				$\beta_2 = -3.15$	0.808
Self-efficacy	0.352	$F_{(13,2955)} = 125.1$	<0.001	$\beta_1 = -11.60$	0.116	0.353	$F_{(13,2955)} = 125.6$	<0.001	$\beta_1 = -3.638$	0.614
				$\beta_2 = -9.91$	0.189				$\beta_2 = 20.43$	0.004
LOC	0.348	$F_{(13,2955)} = 122.7$	<0.001	$\beta_1 = -5.06$	0.561	0.351	$F_{(13,2955)} = 124.3$	<0.001	$\beta_1 = -14.67$	0.070
				$\beta_2 = -1.89$	0.822				$\beta_2 = 23.24$	0.003
Optimism	0.362	$F_{(13,2955)} = 130.7$	<0.001	$\beta_1 = -8.38$	0.088	0.362	$F_{(13,2955)} = 130.5$	<0.001	$\beta_1 = -2.505$	0.613
				$\beta_2 = 5.01$	0.255				$\beta_2 = 7.780$	0.113

presence of somatic disease also weakened the otherwise positive effect of self-efficacy ($p = 0.034$) and social support ($p = 0.046$) on SR_c. LOC and optimism were not identified as protective factors for those with a somatic illness. Neither optimism ($p = 0.669$), nor LOC ($p = 0.193$) or self-efficacy ($p = 0.843$) were identified as protective factors for lower educational attainment.

Discussion

The present study gained deeper insight into the mental health burden and its contributing general and corona-specific stressor load, potential risk and protective factors as well vulnerable groups during an early stage of the SARS-CoV-2 pandemic in a representative sample of the German adult population. At first, we analyzed the stressor load of the representative sample regarding frequency and burden. 83–60% were affected by the general DH_{fg} such as housekeeping, bad news in media, negative political incident, own physical complaints or bad weather. Their average perceived burden, however, was relatively low (even almost not burdensome, ranging from 1.23 to 1.71). The most burdensome DH_{bg} were sleeping problems and own physical complaints (affecting 51–57% of respondents), bad behavior of others and time pressure (38%), as well as financial problems (28%). Among corona-specific DH_{fs}, almost all the responds (97–84%) were affected by media reports, loss of ability to participate in recreational activities or in important social events, not feasible

TABLE 4 Moderation analysis—in depth analysis (controlling for age, gender, education, somatic illness, and mental disorder, resp.).

	SR$_c$ x female gender					SR$_c$ x higher age					SR$_c$ x somatic illness				
	R^2	F	p-value	b	p-value	R^2	F	p-value	b	p-value	R^2	F	p-value	b	p-value
Social support	0.098	$F_{(10,2958)}=33.17$	<0.001	$\beta = 0.037$	0.292	0.098	$F_{(11,2957)}=30.31$	<0.001	$\beta_1 = -0.45$ $\beta_2 = -1.33$	0.645 0.123	0.099	$F_{(10,2958)}=33.49$	<0.001	$\beta = -0.07$	0.046
Self-efficacy	0.108	$F_{(10,2958)}=36.88$	<0.001	$\beta = 0.056$	0.110	0.107	$F_{(11,2957)}=35$	<0.001	$\beta_1 = 1.44$ $\beta_2 = -3.50$	0.013 0.000	0.108	$F_{(10,2958)}=37.01$	<0.001	$\beta = -0.08$	0.034
LOC	0.100	$F_{(10,2958)}=34.02$	<0.001	$\beta = 0.006$	0.872	0.100	$F_{(11,2957)}=31.67$	<0.001	$\beta_1 = -0.20$ $\beta_2 = -2.55$	0.838 0.007	0.100	$F_{(10,2958)}=34.02$	<0.001	$\beta = -0.00$	0.927
Optimism	0.117	$F_{(10,2958)}=40.17$	<0.001	$\beta = 0.024$	0.488	0.116	$F_{(11,2957)}=36.5$	<0.001	$\beta_1 = 0.33$ $\beta_2 = -0.89$	0.745 0.354	0.117	$F_{(10,2958)}=40.19$	<0.001	$\beta = 0.03$	0.415

private or professional travels, loss of social contacts, and less physical activity than usual. The perceived stressor burden had a high influence on mental health outcome (GHQ), i.e., higher occurrence of DH, resulted in higher mental burden. It explained about one-third of the variance: 36% by combined stressors, 31% by DH$_{bg}$, and 24% by DH$_{bs}$ alone, respectively. In comparison, almost 10% less variance of mental health is explained, if instead of stressor burden, their frequency of occurrence (DH$_{fg}$ and DH$_{fs}$) is used (R^2 adjusted: 26.56). Our third and fourth goal were to identify general resp. corona-specific vulnerable groups and protective factors: female gender, higher age, and lower education level (low secondary or medium secondary education) were identified as general, somatic diseases as a corona-specific risk factor. Whereas self-efficacy and locus of control (LOC) proved to be corona-specific protective factors, social support was not: a high degree of social support attenuated mental health among high occurrence of DH$_{fs}$. Further analysis did not indicate any specific protective factor for the previously identified vulnerable groups, they even showed that older age and being diagnosed with a somatic illness had a negative impact on RF, in the sense of attenuating the positive influence of LOC, self-efficacy, and social support on stressor reactivity (SR). In the following we will discuss the results in more detail.

Stressor load

An impact of the crisis on participants' mental health was evident since our sample showed a higher mean GHQ score (12.49, SD = 6.58) compared to pre-pandemic mean scores (mean = 9.70, SD = 4.94) measured in a representative German sample in 2012 (64), but also lower scores compared to the most intense phase of the lockdown in Europe (March 22 to April 19, 2020) (mean = 15.5, SD = 6.2) measured in Europe (29). This is in line with the observation that the impact of COVID-19 on mental health varied due to different time points of examination, different restrictions in different countries (6, 65), lockdown situations (66, 67) or during isolation in suspected COVID-19 cases (7, 19, 68). The German population was relatively less affected in an international comparison (i.e., less fear of job loss or financial losses due to government intervention) (29), but nevertheless showed elevated generalized or COVID-19-related anxiety symptoms as well as depressive symptoms (20, 69) and psychological distress compared with pre-pandemic data (34). Consistent with previous findings in a representative German sample (52) housekeeping, time pressure, and bad weather were also the most frequently occurring DH$_g$ in pre-pandemic times. However, in our sample, we observed a shift in attention to Corona-related issues, which was also identified from Veer et al. (29): while pre-pandemic bullying, problems with a pet and conflicts or disagreements with relatives were identified as the most distressing DH$_g$ (52), in our study negative political

events (DH_g) were also mentioned frequently. This is not only consistent with other findings during the pandemic in Germany (29), but also known to be a risk factor for mental burden (7, 20). The shift in attention to Corona-related issues could also be influenced by the use of fear-based media coverage implemented to prompt people to strictly adhere to the established guidelines (14, 15). A meta-analysis by Witte and Allen (70) showed that the dissemination of fear appeals, which are regularly used in other contexts (cf. deterrent images of a black lung in smoking prevention), can lead to behavioral changes when the concerned person feels able to deal with the threat. A lack of expectation to be able to deal with it, however, can lead to defensive reactions (e.g., questioning the meaningfulness of the measures). A paradoxical societal effect regarding the fear-based media coverage would be possible: The more mentally burdened the population, the lower the expectation of self-efficacy in dealing with the threat and therefore compliance with individual health-protective behaviors decreases (34). This might result in higher infection rates and, as a consequence, in even more fear-based appeals (71). The occurrence frequency of Corona-related stressors (e.g., corona media reports or negative political events) was particularly notable in our study (80.73 and 72.42%, respectively). At the same time, no excessive burden to Corona-related stressors was found in our study. One explanation could be the decrease in reports of deaths, as the mortality rate was often perceived as particularly threatening (72). At the time of our survey in Germany the mortality rate was just under 5% (40, 73). Nevertheless, worldwide corona reports were mostly negative (74) and therefore affected behavior (e.g., social distancing, lower willingness to be vaccinated) and emotions (e.g., loneliness) (72). The associated aversive emotions may also have led to psychological defense mechanisms: As a link between psychological distress and higher media consumption times has also been demonstrated during the pandemic (74, 75), experts recommend curbing media consumption so that negative news are not permanently consumed (76). Compared with the findings of Veer et al. (29), who cited serious consequences (such as death or hospitalization of a loved one and concern about one's infection) as the primary corona stressor, concerns in our study shifted toward financial, health-related (e.g., sleep problems, injury or illness, less physical activity than usual, corona reporting), and leisure problems (non-participation in social events, fewer social contacts, neither personal nor professional travel) during the phase investigated in this study.

Resilience and mental health

The mean scores of self-estimated resilience of our respondents (BRS: mean = 3.31; SD = 0.78) was similar to pre-pandemic data [mean = 3.35; SD = 0.95, for a study with N = 1,128 respondents in Germany (77)], but marginally lower as compared to other results obtained during the pandemic [April 2020, mean = 3.41; SD = 0.49, German sample sizes:

1.012 (3)]. However, these resilience scores are self-estimates of probands who are asked to describe how quickly they bounce back from stressful events, but no "real life" measures how their mental health relates to the number and burden of stressful experiences. We therefore calculated the SR score as a proxy for resilience as current psychological responsiveness (as measured by the GHQ) to daily stressors [as measured by MIMIS and/or a DynaCORE item selection (29)]. In our cross-sectional data, we observed a concave DH_{fg}-health relationship (see Figure 4): The leveling of the mental health-stressor relationship, i.e., that it flattens out from a certain number of daily hassles, shows that in our sample from around 250 DH_{fg} onward, further stressors have a less severely deteriorating effect on mental health. This could carefully be interpreted as a possible adaptation process to stressors (78). Our finding that corona-specific stressors frequently occurred, but were not perceived as burdensome by a large majority, may also be interpreted as hint for a possible adaptation process. Manchia et al. (33) showed that, after the restrictions were lifted, a large portion of the population recovered from the pandemic related stressor impact. This could be attributable to the corona-induced slowdown (79), but also to a successful adaption process described as "psychological gain from adversity" as suggested by Ahrens et al. (80). The sole occurrence of corona-specific stressors had little impact on mental health (corona-specific stress items clarified only 5% of the variance of the GHQ score additionally and non-significant effect in the regression; first polynomial, i.e., no decreasing GHQ score with increasing DH_{fs}), which implies that DH_g had more impact on the mental health than DH_s. Counterintuitive our results also show with a higher incidence of corona-specific DH less mental burden (significant effect in the second polynomial). This might be a result of the summed binary operationalization of corona-specific DH_{fs} (left skewed distribution), i.e., just under half of the respondents reported an occurrence corresponding to data point 13 (see Figure 4B) of the DH_{fs}, leading to an underrepresentation of data points to the left of it.

The combined stressors (general and corona-specific) explained more variance of the GHQ score than the predictors separately. Furthermore, the perceived stressor burden is a better predictor (36%) than the frequency of its occurrence (26%), which is in line with other findings (29, 81) as well as with the Transactional Model of Stress and Coping (28), highlighting that the stress reaction depends on the specific appraisal of the stressor (i.e., as harm/loss, threats, and challenge) in relation to the resources available.

Vulnerable groups, protective factors, and in-depth analysis of previously identified vulnerable groups

In line with other findings (2, 3, 9, 11, 19–23), women were identified as particularly vulnerable to psychological stress

during the pandemic. Women's BRS (mean = 3.22, SD = 0.74) and GHQ scores (mean = 13.25; SD = 6.81) in our sample showed lower resilience and mental health, respectively, than men's BRS score (mean = 3.41, SD = 0.74) or GHQ score (mean = 11.71; SD = 6.23), which is consistent with other findings during the pandemic (8, 80). When considering the impact of general or corona-specific stressors on mental health, female gender was found to be a general risk factor. This may indicate that it is not a corona-specific vulnerability, e.g., because of domestic childcare, as has been cited in previous research (7, 33, 82). We also found lower education level (low and medium secondary education level) as risk factor: the GHQ score for the lower education groups continues to increase with more occurrence of DH$_{fg}$. However, this result is based on comparatively few data points, i.e., few respondents had more than 250 DH$_{fg}$ (shown by the dashes on the x-axis in Supplementary Figure 5), so it should be interpreted with caution. At the same time, this result is consistent with other studies (8, 17, 83).

In many studies, younger age groups (≤40 years) are highlighted as particularly vulnerable during crisis: Older people are suggested to be protected through life experiences, thus more problem-solving skills and a stronger locus of control, and ultimately a more efficient psychological coping and adaptive capacity during COVID-19 (2, 7, 22, 30). In our study, this finding could not be replicated, which may be due to our use of SR as a proxy of resilience (predicting mental health as a function of stress). Furthermore, although older people tend to be exposed to fewer stressors (19, 36, 84), they might be likely to be more responsive to them. We identified a diagnosed somatic disease as a risk factor for corona-specific stressors. Somatic diseases are a well-researched risk factor for mental health (7, 9, 17) and the risk for somatic diseases and infections grows with increasing age (31). As Taquet et al. (68) showed in a retrospective US cohort study in August 2020, there is also a bidirectional association between SARS-CoV-2 infection and risk of mental disorder and vice versa. Regarding resilience factors as protective factors for mental burden, self-efficacy and LOC were found to be corona-specific protective factors, which is consistent with earlier findings (7, 30, 33). However, contrary to our expectations (2, 3, 29, 69), optimism and social support were not found to be protective factors in our study. Individuals reporting high levels of social support were even more affected by stressors on GHQ. This implies that this resilience factor loses its effect in times of social distancing. This would at least be supported by the study results that reported increased loneliness (6, 85). We could not demonstrate a specific protective factor for the previously identified vulnerable groups, i.e., females, older age, and lower education level. In contrast, the elderly and the somatically ill showed lower RF scores, which otherwise has a positive effect on resilience (LOC, self-efficacy, and social support) (24, 25). This could be seen in the context of the findings of Fritz et al. (27) on the interaction

of different protective factors: Protective factors influence each other (intensification or inhibition), and network connectivity between protective factors is less responsive in vulnerable people, making already vulnerable groups even more vulnerable to stress. This may explain why vulnerable groups, e.g., elderly, or somatic ill, but also known from other findings have shown to be more vulnerable to the adversities of the pandemic (8, 68, 86).

Our data provide insights in especially vulnerable groups (women, older age, and lower education level) and specific starting points in order to strengthen protective factors, by identifying self-efficacy and LOC as protective factors during the pandemic. However, since we only researched a limited number of resilience factors, there are certainly other protective factors which we did not study here but which might be important to fostering mental health (e.g., certain coping styles). In other peri-pandemic analyses, for example, positive appraisal style (29, 80) was identified as a protective factor.

Strengths and limitations

The strengths of the study are the large and representative sample, the use of well-established standardized measures that allow comparisons with other pre- as well as pandemic populations. We also not only relied on self-estimated resilience capability of the probands, but used the SR score (62) to describe a proxy for resilience which relates mental burden to the perceived stressor load. The study is also new as it disentangles the relative contributions of general and corona-specific DH to mental burden and resilience.

On the other hand, our study has the following limitations: First, we collected the representative data in an online survey, so we cannot exclude selection bias. In addition, we did not collect longitudinal data, which are considered the gold standard (52, 62). Furthermore, changes in mental health were assessed retrospectively over the past 2 weeks, which might have led to memory bias. In addition, the survey was conducted during a less severe phase of the pandemic, meaning that some of the restrictions (e.g., social distancing, closing of restaurants, closing of recreational and cultural facilities) had already been lifted. Although the corona pandemic caused measurable burden, it is likely that at a different time point during the course of the pandemic, corona-specific stress would have been more pronounced. Due to a reasonable questionnaire length, we had to severely limit the constructs we examined, which is why we only queried a selection of the RF and only examined a selection of corona-specific stressors. The last made the comparison to the general stressors more difficult. To the extent that resilience was operationalized as an outcome (stressor exposure relative to mental health), survey inaccuracies may have crept in: It cannot be ruled out that mental health problems have their genesis in other stressors or LE that were not surveyed in this instrument.

Conclusions

The corona pandemic seems to have an impact on the general population in the sense that corona-specific stressors were perceived but not as burdensome during this phase of the pandemic (e.g., general stressors such as bad news in the media or own physical complaints). At the same time, the corona-specific stressor load was hardly perceived as a burden: This is also reflected in the low impact on mental health. This result should be viewed in the context of the data collection period, for which some restrictions had already been lifted and may have led to adaption. As in many other studies, we were also able to show that there are vulnerable groups (women, lower education level, older age, and somatic illness), who are at a higher risk of being negatively affected by the pandemic. In addition, specific protective factors (self-efficacy and LOC) for the corona-specific stressors were identified in our study. Extending previous studies, we were also able to show that older people and people with somatic illnesses are particularly affected by corona-specific stressors, which again underlines their need for special support regarding an adaptive coping during and after the pandemic.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the Department of Psychology and Sports Science of the Johann-Wolfgang-Goethe University Frankfurt (Prof. Andreas Klein). The patients/participants provided their written informed consent to participate in this study.

Author contributions

LH, IH, DG, and SF: conceptualization, methodology, and validation. GK: statistical analysis and data visualization. LH: investigation and writing of the original draft. KL and RD: project management, monitoring, and validation. IH, DG, and KL: writing—revised draft, monitoring, and validation. 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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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.991292/full#supplementary-material

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Intolerance of uncertainty and future career anxiety among Chinese undergraduate students during COVID-19 period: Fear of COVID-19 and depression as mediators

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Uncertainty is mushrooming throughout COVID-19, and intolerance of uncertainty (IoU) nudges people into mental health difficulties involving fear, depression, and anxiety. The objective of this study was to investigate the role of depression and fear of COVID-19 (FoC) in the association between IoU and future career anxiety (FCA) among Chinese university students during the COVID-19 pandemic. This study involved 1,919 Chinese undergraduate students from 11 universities in eight Chinese cities with an online self-administered survey that included demographic information, IoU, FoC, depression, and FCA completed by all participants. Our study demonstrated a positive relationship between IoU and FCA and the chain mediation effect of FoC and depression. Thus, understanding how FoC affects FCA not only informs university career professionals and assists students in preparing for employment, but also motivates schools to offer career opportunities workshops and, most importantly, provides mental health support to help students effectively cope with uncertainty and overcome COVID-19-related stress.

KEYWORDS

intolerance of uncertainty, future career anxiety, fear of COVID-19, depression, Chinese undergraduate students

Introduction

The worldwide spectrum of the COVID-19 pandemic that erupted in 2019 is still propagating, which poses an unprecedented public health challenge, with at least 500 million infections and 6 million fatalities projected by May 2022; meanwhile, the world faces economic collapse, with GDP hovering around 3.3% in 2020 (1, 2).

The economic spillover effects of unemployment put college students in white-hot competition (3, 4). The equilibrium between supply and demand in China's labor market has been unbalanced, as positions have declined while applicants have surged (5, 6). Chinese students fear for their future job opportunities when COVID-19 dulls the economy's glitter and jacks up the unemployment rate (7). Meanwhile, industrial contraction led to job losses, and rapidly changing hiring requirements fueled career uncertainty.

Although the government's COVID-19 restrictions strategy effectively prevented the spread of the virus, it had a detrimental impact on the mental health of the population, particularly the long-term quarantine. Studies of health workers who were quarantined during the SARS pandemic demonstrated a high level of psychological distress, post-traumatic symptoms, anxiety, and depressive symptoms (8, 9). In addition, studies from the current COVID-19 pandemic support the harmful effects of government restrictions, particularly for college students. In addition to a significant increase in psychological distress, college students also faced financial difficulties, limited supplies, and fears of infection (10, 11). A meta-analysis revealed that approximately 28.4% of college students in China might exhibit depressive symptoms, indicating that depression is prevalent among Chinese college students (12). The pandemic unquestionably worsens the psychological health of students and leads many university students to exhibit depression (11).

Intolerance of uncertainty (IoU) is a personality characteristic in which people perceive unpredictable situations as time bombs threatening their lives (13, 14). When people are aware of uncertainty in their external environment, their anxiety may merge (15–17). Return to life, recurring breakouts and lockdowns, and waves of bankruptcy not only plunge current life into uncertainty but also leave individuals worried about the future (18–20). Lockdown regulation helps predict people's negative emotions because it can happen at any time, making them feel that the world is unpredictable and difficult to control (21). In terms of work, individuals report anxiety and depression when they perceive COVID-19 as a threat to job stability, which is closely connected to survival and social needs (6, 22). When the global economy stays sluggish, Chinese undergraduates were also trapped in an unsteady labor market (23, 24). Whereas, according to Hofstede's dimension theory (25), Chinese culture values certainty, job insecurity is more threatening to those who care about stability (26, 27). Not surprisingly, Chinese students' anxiety about their future careers spikes when they perceive through first-hand experience or social media that COVID-19 disrupts their work plans (5, 28). Moreover, early adulthood is a launching phase for developing job blueprints (29). According to Erikson's developmental theory (30), successful self-exploration of a career path contributes to healthy personal development. However, COVID-19 outbreak,

occupational safety, and decreased job expectations for students may challenge students' personal development (31).

Intolerance of uncertainty and future career anxiety

Uncertainty rains down throughout COVID-19, and IoU nudges people into mental health difficulties involving fear, depression, and anxiety (32). During COVID-19, uncertainty unsettles the general population, but also hurts potential college graduates who are looking for jobs. In their early 20s, they are transitioning from students to workers, making career decisions, and establishing job market commitments (33). However, COVID-19 may undermine the economy and restrict employment, making it difficult for those preparing to graduate from college to determine their job prospects and career opportunities. Thus, students may feel anxious and worried as they explore career options. FCA is the mental stress that people feel when they worry about their future career paths (34). When COVID-19 spreads and labor markets shrink, FCA among college students becomes a critical concern for educators and researchers (23, 35). Grupe and Nitschke (36) pointed out that a steady environment creates a sense of security, whereas volatile circumstances incubate anxiety. Past studies have also emphasized the strong link between anxiety and the need for control (37–40). People have cognitive control when they can predict the presence of a threat and assess their ability to respond (41). However, when people perceive uncertainty and unpredictability in the present, it would make them feel anxious about the future (39, 42). With a similar logic, IoU is tightly wired to FCA as students with higher IoU doubt their ability to eliminate threats in their job search (43). Students with a higher IoU have a more difficult time transitioning from student to work than students with a lower IoU because they are less likely to act in the job market, thereby worsening their FCA (44, 45). Unstable labor markets and fragile economies erode occupational uncertainty and security during COVID-19 (46, 47). Cross-cultural evidence suggested that IoU leads to FCA during COVID-19. In the United States, college students with intense IoU during COVID-19 report less job readiness, which results in FCA (48). Back to China, Chen and Zeng (43) proposed that IoU might lay the groundwork for FCA during COVID-19, not least for university students who anchor their career objectives. Li et al. (7) demonstrated that IoU and FCA are moving in a positive direction among the Chinese. On the contrary, employment is particularly meaningful in Confucian culture for bringing honor to the family, and students are worried about whether their future jobs will meet family needs (49, 50). Aside from social pressure, previous studies have also shown that students who carry higher IoU are more vulnerable

to FCA because IoU has a detrimental impact on cognitive resources and distracts them from coping with FCA (43).

Intolerance of uncertainty, fear of COVID-19, depression, and future career anxiety

Emotions are complex sensory states that affect psychological states and primarily influence thinking and action (51). The cognitive–motivational–relational theory of emotion demonstrates that individuals first label the external stimulus and both personal experiences and social culture influence labeling (52). Feelings are the result of labeling and have an impact on changes in mental states (53, 54). So far, dense IoU impedes normal emotional functioning (55). Individuals with dense IoU may perceive warning signals as overly sensitive and generalized (56). Thus, dealing with an unpredictable infection may induce fear; individuals commonly sound alarms and overuse cognitive resources to cope with all perceived threats (57). COVID-19 is an unpredictable health crisis that harms not only an individual's mental or physical health but also their career development, spreading fear among forthcoming university graduate students (1, 58). FoC is an alerted oriented emotional response to COVID-19 that threatens an individual's life, net health, social connections, and economic activities (59). COVID-19 fluctuates, and people are unsure when the virus will vanish; they yearn for pre-pandemic life, which fuels the FoC (60, 61). For instance, Millroth and Frey (2020) found a positive correlation between IoU and FoC, with deeper IoU predicting stronger FoC within a Swedish sample. Similarly, Satici et al. (21) also discovered that IoU remained positively affiliated with FoC in Turkey.

Furthermore, FoC predicted FCA in a positive way. During a pandemic, people first worry about their health, but they gradually fear a pandemic-induced economic slump, making individuals feel insecure about their current jobs and future career paths (22). The International Monetary Fund (IMF) reported during COVID-19 that the impending recession would lead to a multi-layered financial collapse caused by declining export growth and lower product market prices in countless countries (62–66). Alici and Copur (67) also demonstrated that Turkish nursing students suffer from FCA because they fear that pandemic will affect employment rates. Thus, FoC is mounting with FCA positively in a few developing countries (32, 68). However, future exploration in a Confucian developing state such as China is worthwhile. Given that Confucian culture emphasizes personal behaviors that affect family reputation and that students' careers are linked to family achievement, the pandemic may pose a formidable threat to the careers of Chinese

students (69). Asian values include high regard for family honor and a desire for careers to match family expectations (70).

In addition to anxiety, individuals are susceptible to depression when the external environment is varying (71). IoU contributes to depressive feelings, while intense FCA is positive relative to severe worry and rumination, but the underlying mechanisms remain puzzling (54, 61, 72). Depression is defined as intense negative feelings that let people's cognition, emotions, and behaviors to become dysfunctional, manifesting as persistent sadness, helplessness, and diminished desire (28, 73). According to the helplessness–hopelessness model, IoU and hopelessness are owing to future depression (74, 75). The model adds this approach to the cognitive process, explaining that IoU leads to a sense of instability in allergy and eventually to a chain of depression (76). Dupuy and Ladouceur (76) revealed that IoU triggers otiose concerns and people who have depression; they prefer to experience a disaster rather than uncertainty. Whenever fear is condensed enough to dig people into dysfunction, they might feel depressed (77).

Previous studies have noted that FoC impairs mental health and is related to depressive symptoms (78, 79). Erbiçer et al. (77) outlined a positive association between FoC and depression. Ashraf et al. (80) suggested that FoC connects positively with situational depression when an epidemic hinders social activities and reduces wellbeing in Pakistan. In China, Huang and Zhao (81) discovered that FoC is positively linked with depressive mood as people were concerned about the controllability of the epidemic. Furthermore, previous research has found that depression frequently coexists with anxiety (82). In various countries, depression is confluent with anxiety risk, including FCA (76, 83). People with more severe depressive symptoms exert indecision about their future occupations and foster FCA (61, 83). In the outbreak, Chowdhury et al. (84) concluded that depression and FCA are related in a positive way among Bangladeshi students. Thus, students who are distressed about employment opportunities are upset about economic stagnation and potential career advancement (84).

Whenever fear is condensed enough to dig people into dysfunction, they might feel depressed (77). Previous research has suggested that FoC is blamed for mental health issues such as depression and that people with higher FoC levels are more prone to suffer from depression (85). Sakib et al. (86) concluded that FoC was positively associated with depression in the general population and among health professionals, especially women and singles in Bangladesh. Yalçn et al. (79) also demonstrated that FoC correlates with depression positively among Turkish students. Most of the past research on IoU and FCA has focused on areas with a strong influence of Abrahamic religions, and relatively little research has been done on Confucian collectivist culture. In the United States, where

Christianity is the dominant religion, and in Turkey, where Islam is the dominant religion, the focus of Abraham's religion aligns with the aspirations of high power (87, 88). Thus, future research into Confucian culture, which values family obligations, is warranted.

The present study

The current study aims to explore the role of depression and FoC in the association between IoU and FCA among Chinese undergraduate students during the COVID-19 pandemic. Few studies have elucidated the relationship between IoU and future career concerns. However, most past studies have obtained strong evidence from South Asia, the Middle East, or Western countries. Considering Confucianism and the one-child policy, Chinese millennials may face more career-related pressure than their elders, as high-flying jobs serve not only as anchors in their lives but also polish family honor (89, 90). The enormous difficulty, however, is that the tumultuous work environment is changing with each passing day, yet the pandemic has not removed social expectations. Besides, even though several studies have been conducted with Chinese university students, they have focused on the buffering effects of FCA, such as resilience, rather than providing insight into the knock-on effects of negative emotions.

Thus, it is critical to comprehend FCA within the context of Confucian cultural heritage and unique population policy during the pandemic. Besides, FCA is a complex process threatened by a variety of negative resources, including anxiety, fear, and external stress reactions such as FoC. This study examines negative affective chains, depression, and FoC from a cultural and age perspective, aiming to analyze how these variables influence the relationship between IoU and FCA among Chinese college students.

To evaluate the relationships among the above variables, the following hypotheses were proposed:

Hypothesis 1 (H1): IoU will be positively correlated with FCA;
Hypothesis 2 (H2): FoC will mediate the association between IoU and FCA;
Hypothesis 3 (H3): Depression will mediate the association between IoU and FCA;
Hypothesis 4 (H4): The association between IoU and FCA will be mediated through the chain mediating effects of FoC and depression.

The conceptual model of hypotheses is shown in Figure 1.

Methods
Participants and procedures

Regarding the quarantine policies and social distance needs during the COVID-19 pandemic, an online self-administered survey was applied to collect data for this study. Online posters were used to distribute invitations to participate in the study, along with details about the survey link, the objectives of this study, confidentiality policies, and contact information for the researchers. All participation in this study was anonymous and voluntary. This study involved 1,947 participants, with 1,919 valid response (98.6%; mean age = 19.34 ± 1.55 years), including 802 males (41.5%), 1,111 females (51.3%), and 6 unwilling to report or other genders (0.3%) from 11 universities in eight Chinese cities. The data collection procedure was conducted from October 2021 to November 2021, and all valid participants were undergraduate students currently studying at Chinese universities, and all

FIGURE 1
Conceptual model.
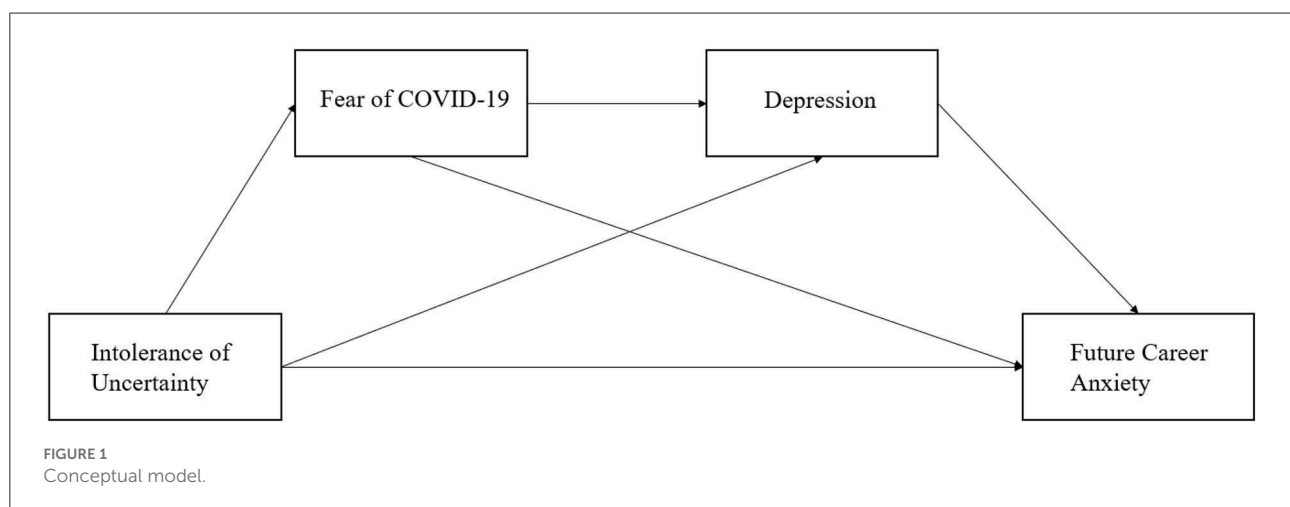
ineligible participants (non-undergraduate participants) or subjects in completed responses were excluded from the data analysis.

Measures

Demographic information

Participants were required to provide their age, gender (1 = males, 2 = females, and 3 = unwilling to report or other genders), and current institutions.

Intolerance of Uncertainty (IoU)

Intolerance of uncertainty was assessed by using the 12-item Intolerance of Uncertainty Scale (IUS-12) developed by Carleton et al. (91). This scale is a shortened version of the 27-item Intolerance of Uncertainty Scale (IUS-21) (92) used to describe negative attitudes and reactions to uncertainty, with each item rated on a five-point Likert scale (from 1 = not at all characteristic of me to 5 = entirely characteristic of me) with a higher mean score indicating a stronger reaction to uncertainty (e.g., "When I am uncertain I can't function well"). Wu et al. (93) validated IUS-12 in Chinese content of the IUS-12 with a Cronbach's alpha of 0.93 for the IUS-12.

Fear of COVID-19 (FoC)

This study measured FoC using the Fear of the COVID-19 Scale (FCV-19S) (94). The FCV-19S contains seven items that measured the level of FoC in two factors, namely, physical response of fear and fear thinking; each item was scored on a five-point scale (1 = disagree; 5 = completely agree), with a higher mean score reflecting a higher level of FoC (e.g., "I am most afraid of the COVID-19). The FCV-19S was validated in well-used Chinese content by Chi et al. (95), with a Cronbach's alpha of 0.89 for the FCV-19.

Depression

Depression was assessed using the Patient Health Questionnaire (PHQ-9) (96), which contains nine items that measure the presence and status of depression; each item was rated on a four-point scale (from 0 = not at all to 3 = nearly every day), with a higher score reflecting a higher level of depressive symptoms (e.g., "Little interest or pleasure in doing things). The previous study has validated PHQ-9 in different contents, including Chinese content (97). The Cronbach's alpha of the PHQ-9 was 0.94.

Future career anxiety (FCA)

Future career anxiety was assessed using the five-item Future Career-related Anxiety Scale developed by Mahmud et al. (22), an adapted version of the Career Anxiety Scale (33) to measure anxiety toward future careers. Each item was rated on a four-point scale (from 1 = strongly disagree to 4 = strongly agree), with a higher mean score indicating a stronger future career-related anxiety (e.g., "I worry about future employment because of a potential economic recession due to the outbreak of COVID-19). The Cronbach's alpha of the Future Career-related Anxiety Scale was 0.96.

Statistical analysis

Statistical Package of Social Science software version 26 (SPSS 26.0) was used for data analysis. Descriptive analyses were used to analyze demographic variables. To explore the bivariate correlations among IoU, FoC, depression, and FCA, Pearson's correlation was calculated. The mediating roles of FoC and depression were tested using Model 6 in SPSS PROCESS macro version 3.5.3 (98); 95% confidence intervals of the indirect effects were calculated on resampling of 5,000 bootstrap estimates, and the mediating effect was significant at $p < 0.05$ when the confidence interval did not include zero.

Results

Bivariate correlations between study variables

Descriptive statistics and correlations for all variables are given in Table 1. IoU was positively correlated with FoC ($r = 0.61$, $p < 0.001$), depression ($r = 0.52$, $p < 0.001$), and FCA ($r = 0.51$, $p < 0.001$). Besides, both FoC ($r = 0.46$, p < 0.001) and depression ($r = 0.62$, p < 0.001) were positively correlated with FCA. Meanwhile, FoC also showed a significant positive correlation with depression ($r = 0.48$, $p < 0.001$).

TABLE 1 Correlations between variables ($N = 1,919$).

	M	SD	1	2	3	4
1. Intolerance of Uncertainty	2.69	0.79	1			
2. Fear of COVID-19	2.37	0.84	0.51***	1		
3. Depression	4.55	4.30	0.46***	0.61***	1	
4. Future Career Anxiety	2.58	1.02	0.62***	0.52***	0.48***	1

***$p < 0.001$.

TABLE 2 Regression analysis of relationship between Fear of COVID-19 and Depression with mediation analyses (N = 1,919).

Regression equation		Fitting index			Significance		
Result variable	Predictor variable	R	R^2	F	Coeff	Standardized Coeff.	t
Fear of COVID-19		0.525	0.275	242.349***	0.509		2.321*
	Gender				0.209	0.125	6.402***
	Age				0.002	0.004	0.228
	Intolerance of Uncertainty				0.548	0.515	26.386***
Depression		0.639	0.408	330.020***	−1.051		−6.177***
	Gender				−0.041	−0.028	−1.588
	Age				0.0182	0.039	2.228*
	Intolerance of Uncertainty				0.177	0.194	9.442***
	Fear of COVID-19				0.442	0.516	24.989***
Future Career Anxiety		0.626	0.391	410.172***	−0.679		−2.758**
	Gender				0.073	0.035	1.979*
	Age				0.051	0.077	4.281**
	Intolerance of Uncertainty				0.805	0.617	34.54***
Future Career Anxiety		0.677	0.458	323.513***	−0.616		−2.623***
	Gender				0.012	0.006	0.035
	Age				0.045	0.069	0.011***
	Intolerance of Uncertainty				0.584	0.448	22.246***
	Fear of COVID-19				0.234	0.191	8.385***
	Depression				0.219	0.154	7.032***

*p < 0.05, **p < 0.01, ***p < 0.001.

TABLE 3 Fear of COVID-19 and depression in the mediation effect analysis (N = 1,919).

	Indirect effects	Boot SE	Boot LLCI	Boot LLCI
Total indirect effect	0.220	0.016	0.189	0.252
Indirect effect 1	0.128	0.017	0.095	0.162
Indirect effect 2	0.039	0.007	0.027	0.052
Indirect effect 3	0.053	0.008	0.038	0.069

Indirect effect 1 (H2): intolerance of uncertainty → fear of COVID-19 → future career anxiety;
Indirect effect 2 (H3): intolerance of uncertainty → depression → future career anxiety; and
Indirect effect 3 (H4): intolerance of uncertainty → fear of COVID-19 → depression → future career anxiety.

Chain mediation model analysis

After controlling for gender and age, the mediating effect of FoC and depression in the relationship between IoU and FCA was analyzed, as given in Table 2.

When gender and age were included in the regression model as four control variables, the results showed that IoU was a significant positive predictor of FCA ($B = 0.617$, $p < 0.001$), and H1 was supported.

Moreover, both FoC ($B = 0.191$, $p < 0.001$) and depression ($B = 0.154$, $p < 0.001$) were significant positive predictors of FCA, and the direct path from IoU to FCA ($B = 0.516$, $p < 0.001$) was significant. Meanwhile, the direct effect of IoU on

FoC ($B = 0.515$, $p < 0.001$) and depression ($B = 0.194$, $p < 0.001$) was significant.

The mediating effects of FoC and depression between IoU and FCA are given in Table 2, and Figure 2 shows a model of the cascading mediating effects between IoU and FCA. FoC and depression were significant mediators between IoU and FCA ($\beta = 0.220$, $SE = 0.016$, 95% $CI = 0.189$ to.252). All three indirect paths in the mediation model were significant (Table 3): path 1(H2) - IoU → FoC → FCA ($\beta = 0.128$, $SE = 0.017$, 95% $CI = 0.095$ to.162), path 2 (H3) - IoU → depression → FCA ($\beta = 0.039$, $SE = 0.007$, 95% $CI = 0.027$ to.052), path 3 (H4) - IoU → FoC → depression → FCA ($\beta = 0.053$, $SE = 0.008$, 95% $CI = 0.038$ to.069). As the 95% CI in all those paths did not

FIGURE 2
The chain mediation model. Note. ***p < 0.001.
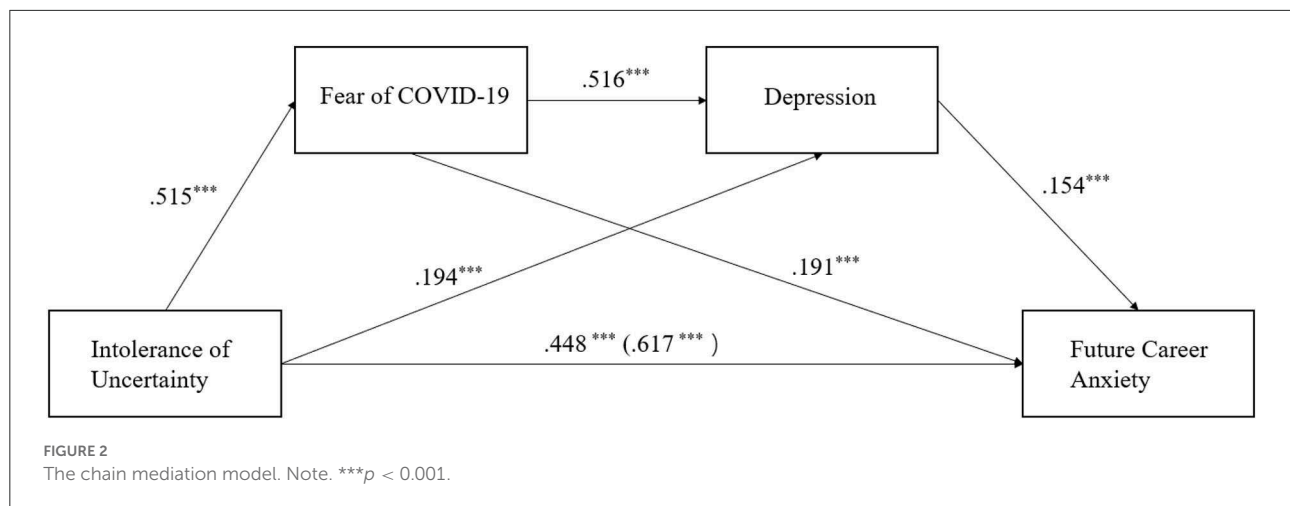
contain a value of 0, the results confirmed that H2, H3, and H4 were all supported.

Discussion and conclusion

Discussion

This study aimed to investigate whether a sequential mediation forecasts stress-induced factors and to estimate the contribution of these factors to the COVID-19 pandemic and FCA. Specifically, this study explored the fear and depression experienced by individuals during the COVID-19 pandemic and allows us to reveal potential mechanisms between their IoU and FCA levels. The results from a sequential mediation model indicated that IoU led to higher FoC, which increased levels of depressive symptoms and increased FCA. Explicitly, the results implied a significant positive relationship between IoU and FCA among Chinese students. Furthermore, FoC, depression, and the chain mediating effect of FoC and depression may act as mediating factors, indirectly affecting the relationships between IoU and FCA.

The findings of the bivariate correlations indicated that the direct effects of IoU on FCA were significant and positive, implying that IoU gives rise to FCA among undergraduate students during the COVID-19 epidemic in China, and that IoU is a breeding ground for adolescent anxiety symptoms associated with future career development, which brings them into correspondence with previous findings (23, 35). Drawing on He and Yu (23), which examined the career adjustment characteristics of 1,160 recent Chinese college graduates during COVID-19 in 2021, career adaptability was found to be affiliated with less IoU and anxiety sensitivity. Hite and McDonald (35) outlined how uncertainty shakes up job opportunities, reflected in how it shapes contracted careers, but in the end, students have no choice but to deal with these challenges.

According to the career construction theory, Brown and Lent (99) assume that youth's internal characteristics and external environmental factors would contribute to career development together. However, uncertainties make it hard for young people to decide what kind of person they want to be and what kind of work they want to do (like self-employment), which makes them worry even more about their future careers (22). Anxiety, on the contrary, is fired by the potential danger of spiraling, out of control (36). Those who fear the uncertainty of being drawn to negative cues, whether about life or work, trigger increasing symptoms of anxiety. In addition, young individuals with greater IoU have negative filters toward the world and they perceive themselves as having fewer resources to deal with unstable environments, which can diminish their self-efficacy to combat FCA (92, 100, 101).

Moreover, the results displayed that FoC significantly mediated the association between IoU and FCA. This result was a mirror of that of previous studies that found IoU in youth can increase their risk of FoC and potential occupational anxiety [e.g., 15, 72]. Pak et al. (102) conducted an online cross-sectional survey of 362 participants in Turkey and discovered that FoC has developed as a result of IoU. Satici et al. (21) investigated 1,772 Turkish individuals and suggested that FoC serially mediated the association between IoU and mental wellbeing. This may be explained by the fear generalization mode (103). Considering the above models, they suggested that people feel fear in the face of uncertainty, which depletes their decision-making capacity and drives them to feel more negative emotions, such as anxiety. Besides, high levels of uncertainty may discount individuals' cognitive functioning and exacerbate FoC as they become emotionally depressed while coping (103). Moreover, this study's result also confirmed that IoU exerted a significant indirect effect on depression *via* FoC, confirming previous findings (102, 104). Individuals with a high IoU were more likely to perceive the pandemic as a threat, and their anxiety levels skyrocketed, partly due to insufficient governmental support (102). Employees have

been floundering in an uncertain work environment and have been enduring job insecurity since the COVID-19 outbreak (35, 46). Living in a perilous environment, Chinese college students have become befuddled and doubted their employment opportunities (23).

Consistent with past research, the findings also suggested that depression mediated the association between IoU and FCA and IoU was related to depression and that young adults with depressive symptoms have higher chances of developing FCA (22, 102). The helplessness–hopelessness model suggests that depression is a psychological reaction driven by IoU characteristics and the hopelessness of future expectations (74). Besides, IoU triggers unnecessary individual concern and rumination, which can lead to depression (76). Depressive symptoms may affect individuals' cognitive functioning, with individuals with higher levels of depressive symptoms having low cognitive functioning and worrying about future careers, which can propagate worse FCA (83).

Moreover, this sequential mediation model led to a positive association between FoC and depression, with a chain mediating effect between FoC and depression mediating the relationship between IoU and FCA. These results were in line with former findings that individuals with higher FoC also exhibit severe depressive symptoms (11, 78). Bakioglu et al. (32) indicated that high levels of FoC incline to worsen depressive symptoms as they are fenced in by high infectivity, dangerous outcomes, social distance, and confinement together. In addition, as is the nature of all pandemics, the COVID-19 pandemic brings uncertainty drifting around every corner, neither finances, health, nor daily social activities. Such a dystopian environment steals positive emotions from the population (102).

Implications

The findings of this study have vital implications for the mental health of college students. First, past research has focused on how COVID-19-related stress predicts their current academic anxiety. However, this study concentrated on pandemic-induced unpleasant feelings that might influence future occupational anxiety (105, 106). Second, rather than concentrating on regions affected by Abraham's religion, such as the United States and the Middle East (48, 102, 107), this study examined the relationship between pandemic-induced negative emotions and FCA among Chinese college students raised in a Confucian culture whose personal careers were highly bonded to their family reputation (49, 50). This study showed these mental difficulties impact their lives: The higher the IoU among college graduates, the more FCA climbed. Students with stronger IoU have limited cognitive resources to overcome the FCA. An unstable environment prevents people

from effectively seeking jobs. This study identifies the former theory in the context of the pandemic and contributes to understanding these complex factors by training college students to have a healthy attitude toward future employment, which is indispensable for their current developmental stage. Uncovering how FoC impacts FCA can provide information to college occupational professionals to assist students' employment preparation. The adverse effects of FoC are comparable to the symptoms of general anxiety (21, 102). Students may be unaware that their nervousness or concerns about their future careers result from their dread of the epidemic. Therefore, understating how FoC affects FCA has practical implications. Professionals in school mental health may provide social or psychological assistance to students with depressive symptoms and pandemic anxiety. The college occupational counselor should advise students that the pandemic is not as fateful as it may seem and that it will not hinder the labor market in the long run.

Limitations

This study has some limitations that need to be declared. First, this study used a cross-sectional design and was unable to reveal the long-term stress caused by the pandemic and its effects on FCA. Second, this study did not categorize the participants' grade levels and majors, but students in upper grades or humanities may face greater job search stress. Third, self-reported questionnaires may include autobiographical memory bias, which tends to downplay their difficult experiences (108). Finally, geographic differences were evident. Participants from developed areas such as Suzhou may have different FCA levels than participants from developing regions such as Mudanjiang due to heterogeneous industrial structures and labor demand. Thus, how geographic and economic factors moderate the association between IoU and FCA is an exploratory option for the future.

Conclusion

In conclusion, this study demonstrated the mediating effect of FoC and depression on the relationship between IoU and FCA among Chinese undergraduate students during the COVID-19 pandemic; thereby, the finding provided empirical evidence to confirm not only a positive relationship between IoU and FCA but also the chain mediation effect of FoC and depression. Therefore, it is important to provide information to motivate schools to offer career opportunity workshops and, most importantly, mental health support to guide students to effectively cope with uncertainty and overcome the stress associated with COVID-19.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Suzhou University of Science and Technology. The patients/participants provided their written informed consent to participate in this study.

Author contributions

TZ and DG designed the research. TZ, DG, YBai, HL, and YH completed the manuscript writing. XC collected and analyzed the data. RW, YBao, and XC reviewed and edited 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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Relationship between behavioral inhibition/activation system and Internet addiction among Chinese college students: The mediating effects of intolerance of uncertainty and self-control and gender differences

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Background: Internet addiction is a global public health issue among college students that is associated with a range of negative outcomes. Especially the COVID-19 pandemic has forced them to shift most of their studies and life activities from offline to online, leading to a growing problem of Internet dependence and even Internet addiction. Although previous studies have indicated that the Behavioral Inhibition/Activation System (BIS/BAS) have important effects on college students' Internet addiction, the mechanisms underlying these associations and gender differences are still unclear.

Aims: The present study investigated the mediating roles of intolerance of uncertainty and self-control in the association between BIS/BAS and Internet addiction following the Interaction of Person-Affect-Cognition-Execution model. Gender differences in such associations between variables were also tested.

Method: A total of 747 Chinese college students were surveyed by using Young's Diagnostic Questionnaire for Internet Addiction, BIS/BAS Scales, the Intolerance of Uncertainty Scale and the Brief Self-Control Scale.

Results: The results from the structural equation modeling analysis showed that BIS was positively related to Internet addiction and that BAS had a negative association with Internet addiction. Moreover, intolerance of uncertainty and self-control mediated the relationships between BIS/BAS and Internet addiction. Multi-group analysis further revealed that the associations between BAS and Internet addiction and between intolerance of uncertainty and Internet addiction were stronger among the male students than

among female students. The relationship between self-control and Internet addiction was greater in the female sample than in the male sample.

Conclusions: These findings extend our understanding of how BIS/BAS influence Internet addiction among college students and suggest that not only should training approaches based on intolerance of uncertainty and self-control be fully considered, but different intervention programs should be focused on gender sensitivity to maximize the intervention effect.

Introduction

During the past two decades, access to the Internet has become widespread with the rapid development of information technology. The number of Internet users reached approximately 4.95 billion worldwide by 2022 (1), and Internet usage in developing countries increased from 7.7 to 45.3% between 2005 and 2018 (2). According to recent data released by the China Internet Network Information Center (CNNIC), the number of Chinese Internet users had reached 1.051 billion and the Internet penetration rate had reached 74.4% by June 2022 (3). There is no denying that reasonable Internet use is beneficial in many ways, but excessive Internet use may lead to Internet addiction (4). Internet addiction is conceptualized as an inability to control one's use of the Internet, which eventually causes psychological, social, school, and work problems (5). Many empirical studies have shown that Internet addiction is typically linked with a variety of psychological and behavioral problems, such as anxiety, depression, sleep disorders, poor interpersonal relationships, and even a high risk of suicide (6–10). Internet addiction has become a major global public health problem due to its harmful effects (11). To make matters worse, COVID-19 pandemic has exacerbated the problem. Since various prevention strategies have been adopted to prevent the spread of COVID-19, such as social distancing, quarantine and school closures. The way people work and daily lives have changed dramatically, and many activities have shifted from offline to online, making people inseparable from the Internet (12). As a result, many studies have shown higher rates of online activity and higher rates of Internet addiction than in the pre-pandemic period (13, 14). The risk of Internet addiction among teenagers is often mentioned, but college students are another particularly vulnerable age group. Previous studies have demonstrated that the average prevalence of Internet addiction was approximately 7.02% (15), while the prevalence of Internet addiction among Chinese college students was approximately 11.0% (16), which is 1.6 times higher than that of the general

population, and the prevalence rates might further increase in the coming years. Therefore, to develop effective prevention and intervention strategies, it is imperative to identify risk factors and underlying mechanisms associated with college students' Internet addiction.

In recent years, the Interaction-Person-Affect-Cognition-Execution (I-PACE) model has become a prominent theoretical framework to explain Internet addiction (17, 18). The model consists of four components, P-A-C-E, where the P-component refers to the individual's core characteristics, such as personality and psychopathological features. The A-component and C-component refer to the person's affective and cognitive responses to external or internal stimuli, respectively, such as cognitive biases and an urge for mood regulation. Finally, the E-component refers to one's executive function, such as inhibitory control and self-control. Brand explained the formation and maintenance of Internet addiction from the perspective of the interaction of personality, affective, cognitive response and execution, and the I-PACE model identifies personality as a predisposition factor that leads to Internet addiction by influencing the individual's affective-cognitive responses and executive function. Therefore, within the framework of the I-PACE model, this study aims to investigate the influence of personality factors (e.g., behavioral inhibition system/behavioral activation system) on Internet addiction and whether adverse cognitive and affective responses (e.g., intolerance of uncertainty) to environmental stressors and executive functioning (e.g., self-control) play a mediating role in the relationship between personality factors (e.g., behavioral inhibition system/behavioral activation system) and Internet addiction, using a sample of Chinese college students. Furthermore, because males and females differ in core characteristics including biopsychological constitution, psychopathological features, personality, and social cognitions, gender may play a moderating role in the relationships between these variables. Thus, this study will also explore the gender differences among the above variables to further enrich the I-PACE model.

Behavioral inhibition system/behavioral activation system and Internet addiction

Gray's reinforcement sensitivity theory is known as an effective view for understanding and explaining basic human behaviors, particularly regarding addiction. The theory suggests that there are individual differences in sensitivity to stimuli from two basic brain systems that regulate and control human motivation and behavior, namely, the behavioral inhibition system (BIS) and behavioral activation system (BAS) (19). The former is related to stimuli conditioned for punishment or the termination of rewards and is responsible for regulating avoidance behavior to avert threats and penalties. Thus, individuals with high BIS are more likely to experience negative emotions (e.g., anxiety, fear) and exhibit behavioral inhibition (20). The latter is associated with stimuli relevant to rewards or the termination of punishment and is responsible for regulating the acquisition of rewards and achieving goals. Therefore, high BAS-sensitive people are more prone to feeling positive emotions (e.g., hope, wellbeing) and engage in approach behavior to obtain greater advantage in the world (21). Gray's theory provided an essential perspective for understanding and explaining addiction, but previous findings about the associations between BIS/BAS and Internet addiction were inconsistent. For example, in a survey of 519 middle-school students, BIS and BAS activation were both associated with Internet addiction (21). Another study of 197 middle-school students indicated that BAS activation rather than BIS activation is a significant risk factor for predicting the occurrence of Internet addiction (22). However, a recent study divided 754 college students into addiction and non-addiction groups according to questionnaire results and Internet Gaming Disorder diagnostic criteria, and the results showed that BIS not BAS was statistically correlated with scores on the Internet Addiction Questionnaire (23). We speculate that a variety of factors may contribute to the differences in the results. First, different measurement tools examine different theories and constructs, which can have an impact on the degree of association between variables. Second, the performance and development of reward and punishment sensitivity of participants in the different developmental stages may vary with different living conditions and developmental tasks (23, 24). Third, the analysis of the mixed sample ignored the effect of the gender of the participants on the study results. Although there is no definite conclusion as to whether BIS or BAS or both have a significant effect on Internet addiction, many researchers suggest that the relationship between BIS/BAS and Internet addiction is closely related (25, 26). Moreover, since BIS/BAS is considered as relatively stable traits that is difficult to change directly (27), it is necessary to explore the mediating mechanisms of BIS/BAS leading to Internet addiction, which is helpful for providing a theoretical basis for the prevention and intervention for Internet addiction.

The mediating roles of intolerance of uncertainty and self-control

Intolerance of uncertainty (IU) may play a mediating role in the association between BIS/BAS and Internet addiction (28–31). IU is defined as a cognitive bias that affects how a person perceives, interprets, and responds to uncertain situations (32). On the one hand, BIS/BAS, as a core characteristic with individual differences, may be linked to IU. First, individuals with high BIS levels are likely to exhibit enhanced associative learning and readily learn to avoid aversive situations (33). Second, BIS is relevant to attempting to escape from or avoid novel, threatening or uncertain contexts, which may lead to negative interpretations of ambiguous stimuli in these environments by individuals (34). They may view uncertainty itself as an unavoidable threat and interpret it more negatively, leading to an inability to tolerate uncertainty. Furthermore, the results from children, adults, and females with substance use disorder showed a positive association between BIS and IU (35–37). Therefore, BIS appears to be an important predictive factor for IU. In contrast, BAS is a motivational system that promotes positive and exploratory behaviors (36). Individuals with higher levels of BAS show a greater tendency to respond to rewards and an increased motivation to engage in reward-seeking behaviors (38). Meanwhile, BAS is associated with positive emotions, and individuals with high levels of BAS may approach life with a more positive attitude (29). When faced with uncertain situations, they are more likely to adopt positive coping styles to reduce the penalties it may bring, which may increase the individual's tolerance for uncertainty (39). In addition, the results from adults provided support for the negative association between BAS and IU (36). Thus, BAS may be a protective factor for IU. On the other hand, IU may have a predictive role in the developmental mechanism of Internet addiction. First, individuals with higher IU are often likely to overestimate threat and underestimate their ability to handle them when coping with uncertain events (40); thus, these individuals experience increased levels of adverse emotions and adopt negative coping styles, such as using the Internet as an avoidance strategy to cope with uncertainty-induced negative experiences (41). Second, a high fear of uncertainty may lead them to seek comfort by spending a great deal of time excessively searching for information and answers on the Internet (42). Previous studies have focused more on the role of IU in mental diseases such as anxiety, depression and obsessive-compulsive disorder (43–45). In recent years, IU has been gradually extended to the field of addiction (such as drug addiction and Internet addiction) (46, 47). However, there are no relevant empirical studies that delve into whether IU plays a mediating role in the relationship between BIS/BAS and Internet addiction.

Self-control is the process by which an individual consciously overcomes impulses, habits or automatic reactions

and adjusts his or her behavior to pursue long-term goals (48, 49). First, the level of self-control may be affected by BIS/BAS. When the BIS system is activated, along with increased arousal and attention, there is a disposition for the individual to experience negative emotions (e.g., anxiety and sadness) and to show behavioral inhibition toward desired goals (50). Negative emotions caused by BIS can contribute to a decrease in personal self-control by consuming more cognitive resources (51). In contrast, when the BAS system is activated, individuals have a tendency to experience positive emotions (e.g., hope, happiness) and manifest behavior that helps them approach desired goals (52). In other words, individuals with high levels of BAS may be more likely to respond actively to positive information in their lives and are more willing to control behaviors for which they can receive emotional or material rewards and thus may show higher levels of self-control. In turn, self-control is an important predictor of Internet addiction. High self-control has been found to be closely related to various positive outcomes, such as more stable emotional states and better academic performance (49, 53, 54). However, low self-control was associated with a variety of negative psychological and behavioral problems, such as anxiety, depression, aggressive behavior and addictive behavior (55–57). Cross-sectional and longitudinal studies have shown that self-control plays an important role in the development of Internet addiction (58, 59). People with low self-control lack consideration of the consequences of their actions and tend to act impulsively, which raises the probability of Internet addiction (60, 61). Therefore, self-control may be a mediating variable in the connection between BIS/BAS and Internet addiction. However, to our knowledge, few studies have examined these associations in college student populations.

The moderating role of gender

Gender is an important demographic factor influencing Internet addiction. Previous studies have shown that there are gender differences in the prevalence of Internet addiction, with males having a relatively higher tendency toward Internet addiction than females (62). However, we should focus not only on the gender differences in the prevalence of Internet addiction, but also on the gender differences in the formation mechanism of Internet addiction. First, it was reported that there may be gender differences in the predictors of Internet addiction. For example, BAS can significantly predict Internet addiction in males, while BIS can significantly predict Internet addiction in females (63). A magnetic resonance imaging (MRI) study showed that females displayed a negative correlation between BIS sensitivity and regional gray matter volume (rGMV) in the parahippocampal gyrus (PHG), as well as positive correlations between BAS sensitivity and rGMV in the ventromedial prefrontal cortex (vmPFC) and inferior parietal lobule (IPL), whereas males

showed the opposite pattern, indicating that the relationships between neuroanatomical characteristics and BIS/BAS exhibit sex differences. Meanwhile, individual's BIS/BAS and the effect of BIS/BAS on an individual's cognition, emotion and behavior may be influenced by the individual's genetic, social and other characteristics (64). Then, social role theory provides a theoretical basis for understanding gender differences. It argues that different social divisions of labor can make a difference in the shaping of gender roles (65). Specifically, men are socialized to be strong, rational, and accustomed to solving problems alone, while women are socialized as warm, compassionate, sensitive, and emotionally expressive (66). Thus, when faced with uncertain situations, they may tend to adopt different coping strategies and exhibit different levels of tolerance, which in turn may affect their levels of Internet addiction. In addition, females are asked to manage their behavior effectively in the social contexts, so they may pay a greater emphasis on self-control in their daily activities than males (67). For example, females may be more inclined to avoid losses than males and may have greater self-control (68, 69). The difference in female's and male's ability to control their own behavior may also lead to differences in the formation mechanism of Internet addiction. The above findings provide potential evidence that the mechanism by which Internet addiction develops may be moderated by gender. However, previous studies have focused more on gender differences in a single variable, and the mechanisms underlying these differences have rarely been explored in more realistic and complex models.

The present study

The aim of this study was to investigate how BIS/BAS influences Internet addiction in college students. Specifically, this study examined the mediating effects of IU and self-control on BIS/BAS and Internet addiction as well as the gender differences among these associations. To the best of our knowledge, this is the first comprehensive empirical study incorporating BIS/BAS, IU, self-control and gender factors and their roles in Internet addiction. On the basis of I-PACE theory, the proposed model is shown in Figure 1. It is reasonable to hypothesize that BIS and BAS act as triggers for individual Internet addiction, IU and self-control serve as mediators between predisposing factors and Internet addiction, and gender plays a moderating role in these associations among college students. More specifically, we propose the following hypotheses: (1) BIS would be positively correlated with Internet addiction, while BAS would be negatively correlated with Internet addiction; (2) IU and self-control would play mediating roles between BIS/BAS and Internet addiction; and (3) the formation mechanism of Internet addiction may be moderated by gender.

FIGURE 1
The supposed model.
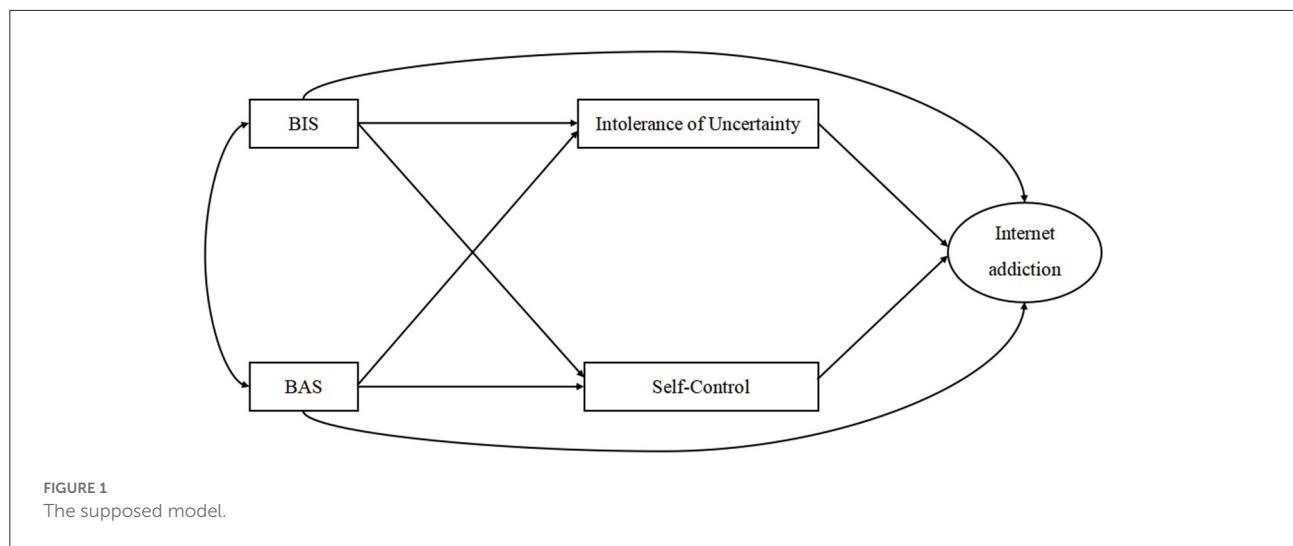
Materials and methods

Participants

This was a cross-sectional study conducted through an online survey during the COVID-19 pandemic from October 12 to November 8, 2021, when the campus implemented closed-off management to adopt offline learning. All participants were recruited through a convenient cluster sampling method from municipal key universities in Tianjin City, China. In order to ensure the quality of the questionnaire, a questionnaire item ("To check the quality of your response to the questionnaire, please select 2 for this question, which has five answer choices from 1 to 5.") was included at the end of the survey to reduce the risk of irresponsible answers. In total, 803 students participated in this survey and 56 participants were excluded (45 answered the questionnaire incompletely and 11 failed to answer the questionnaire item for evaluating the quality of survey correctly). Thus, data from 747 participants ($M_{age} = 18.062$ years, $SD = 0.651$ years, age range: 16–21 years) were analyzed in this study, including 228 male students (30.5%) and 519 female students (69.5%). Informed consent was obtained from all participants prior to the survey. The study and data collection procedure received approval from the Ethics Committee of Tianjin Medical University (study number: 190002).

Measures

Behavioral inhibition system/behavioral activation system (BIS/BAS) scales

The revised Chinese BIS/BAS Scale is an 18-item questionnaire measured on a 4-point Likert scale from 1 (totally disagree) to 4 (totally agree) (70). The questionnaire includes a 5-item BIS scale (e.g., "If I think something

unpleasant is going to happen, I usually get pretty worked up") and 13-item BAS scale (e.g., "If I see a chance to get something I want, I move on it right away") (71). The latter scale can be grouped into three subscales: drive (BAS-drive, 4 items), reward responsiveness (BAS-reward, 5 items), and fun seeking (BAS-fun, 4 items). In this study, we used the total score of all 5 BIS items and all 13 BAS items to generate a single BIS score and BAS score, respectively. The scale has been reported to have good reliability and validity among the Chinese population (72). The Cronbach's alpha coefficient was 0.756 for BIS and 0.867 for BAS in the present sample.

Intolerance of uncertainty scale (IUS-12)

Intolerance of uncertainty was assessed using the revised Chinese 12-item short-form Intolerance of Uncertainty Scale (73). This scale demonstrates a two-factor structure, evaluating prospective IU (7-item subscale; e.g., "Unforeseen events upset me greatly"), and inhibitory IU (5-item subscale; e.g., "When I am uncertain I can't function very well") (74). Items are scored on a 5-point Likert scale ranging from 1 (not at all characteristic of me) to 5 (entirely characteristic of me). The total score ranges between 12 and 60. Higher scores indicate higher intolerance of uncertainty. According to reports, the scale has good reliability and validity among Chinese college students (75). In this study, the Cronbach's alpha coefficient was 0.852.

Brief self-control scale (BSCS)

The Chinese version of the Brief Self-Control Scale was adopted in this study (76). The BSCS is a questionnaire that assesses one's degree of self-control on a 5-point Likert scale used ranging from 1 (Not at all like me) to 5 (Very much like me). It is composed of 7 items and is divided into two subscales: 3 items measure self-discipline (e.g., "People would say that I have

iron self-discipline") and 4 items measure impulse control (e.g., "I do certain things that are bad for me if they are fun") (77). The overall self-control score is determined by summing all seven items, with higher scores denoting greater self-control. The Chinese version of the BSCS shows good internal consistency and validity in Chinese individuals (76). In the present study, the Cronbach's alpha coefficient of the BSCS was 0.728.

Young's diagnostic questionnaire for Internet addiction

Internet addiction was measured using Young's 8-item diagnostic questionnaire for Internet addiction (5). Responses to each question were provided on a 6-point Likert scale (ranging from "1 = strongly disagree" to "6 = strongly agree"). A sample item is "Have you repeatedly made unsuccessful efforts to control, cut back, or stop Internet use?". Higher scores reflect a higher degree of Internet addiction. The scale has been used by many researchers and also has good reliability and validity in Chinese adolescents and college students (78, 79). In this study, Cronbach's alpha coefficient for Internet addiction was 0.875.

Data analysis

First, the common method bias test, descriptive statistics, Pearson's correlation analysis and independent samples t-test were examined with SPSS 26.0. Second, Amos 26.0 was used to examine the hypothesized model. Third, a bootstrap procedure was conducted to test the mediating roles of IU and self-control in the relationship between BIS/BAS and Internet addiction. Specifically, the bias-corrected percentile bootstrap method (5,000 bootstrap samples) with 95% confidence intervals (CIs) was performed to examine the significance of mediation effects. CIs excluding zero indicated significant effects. Fourth, participants were split into two groups based on their gender, and a multi-group analysis was used to examine the gender differences in the associations between the variables. In this step, we constructed three nested models, including an unrestricted free estimation model (M0), a model with equal restricted factor loadings (M1), and a model with equal restricted path coefficients (M2). The equivalence of the measurement model across gender was examined by the comparison of M0 and M1. Furthermore, we tested whether there are gender differences in the patterns of association between the variables by comparing M1 and M2.

The chi-square statistic was employed to evaluate the model fit. However, the chi-square statistic is sensitive to sample size (80). Therefore, we used the chi-square to degrees of freedom ratio (χ^2/df) to test model fit. A χ^2/df ratio value below 5 is regarded as an acceptable model fit (81). Meanwhile, the comparative fit index (CFI) (82), Tucker-Lewis index (TLI) (83), standardized root mean square residual

(SRMR) (84), and root mean square error of approximation (RMSEA) (85) were also used to evaluate the goodness of fit. The CFI and TLI equal to or above 0.95 and the RMSEA and SRMR lower than 0.08 indicate good model fit (84). For the comparison of the nested models, differences in the χ^2 ($\Delta\chi^2$) and the degrees of freedom (Δdf) were used to compare the models with the goodness of fit to determine the model that best fit the data (86, 87). Specifically, the criteria for comparing the two nested models are as follows: When the degrees of freedom increase, but the corresponding chi-square value does not increase significantly (that is, $\Delta\chi^2/\Delta df$ is not significant), the model with the higher degrees of freedom is better. Otherwise, the better model is the one with lower degrees of freedom. The predictive and explanatory powers of the model were assessed using path coefficients and R^2.

Results

Common method bias test

Participants replied to self-report questionnaires in the present study, which might lead to common method bias. To control this issue, we used the anonymous survey and reverse scores in some questions. Then, common method bias was assessed by Harman's single factor test before processing data (88). The results showed that 11 factors' eigenvalues were larger than 1. The load of the first factor was 17.016%, which was <40% of the covariance among all the items. It suggested that there was no serious common method bias in this study.

Descriptive statistics and t tests

Students' ranges, means and standard deviations of the continuous variables are presented in Table 1. There was a significant difference in age between females and males. The age of females ranged from 16 to 20 years old ($M = 18.023$, $SD = 0.651$) and males ranged from 16 to 21 years old ($M = 18.153$, $SD = 0.642$). These results indicate that males are slightly older than females. In addition, BIS yielded significant gender differences. Compared with males, females had higher scores on the BIS scales. Furthermore, the scores of IU were significantly higher in males than in females. However, the gender differences in Internet addiction, BAS and self-control were not significant.

Correlation analyses

Table 2 presents the correlations between variables included in the study. For both males and females, Internet addiction

TABLE 1 Descriptive statistics among the variables.

Variables	Whole sample ($n = 747$)			Females ($n = 519$)			Males ($n = 228$)			t-test
	Range	M	SD	Range	M	SD	Range	M	SD	
Age	16–21	18.062	0.651	16–20	18.023	0.651	16–21	18.153	0.642	−2.530*
Internet addiction	8–48	20.378	7.888	8–47	20.745	7.631	8–48	19.544	8.402	1.921
BIS	5–20	15.304	2.405	5–20	15.426	2.358	5–20	15.026	2.492	2.095*
BAS	13–52	41.815	5.122	13–52	41.703	4.919	19–52	42.070	5.562	−0.901
IU	12–60	27.415	7.613	12–60	27.049	7.308	12–60	28.272	8.218	−2.043*
Self-Control	7–35	22.240	4.270	7–35	22.380	4.061	7–35	21.921	4.704	1.352

BIS, Behavioral Inhibition System; BAS, Behavioral Activation System; IU, Intolerance of Uncertainty. *$p < 0.05$.

TABLE 2 Associations among the variables for females and males.

Variables	1	2	3	4	5	6
1. Age	-	−0.033	−0.047	−0.032	−0.038	0.048
2. Internet addiction	−0.083	-	0.215**	−0.127**	0.224**	−0.649**
3. BIS	0.124	0.040	-	0.337**	0.408**	−0.213**
4. BAS	0.082	−0.365**	0.433**	-	0.048	0.219**
5. IU	−0.046	0.354**	0.212**	−0.006	-	−0.168**
6. Self-Control	0.103	−0.533**	−0.089	0.331**	−0.257**	-

Females' correlations appear above the diagonal and males' correlations below the diagonal. **$p < 0.01$.

was found to be negatively correlated with both BAS and self-control but IU was shown to have a positive correlation with Internet addiction. Internet addiction was only positively related to BIS in females but had no correlations in males. For both females and males, BIS was significantly positively related to IU while BIS was only negatively related to self-control in females but had no correlations in males. BAS was positively related to self-control but was not significantly related to IU among all participants. In addition, age had no significant correlation with any of the variables included in the study. Furthermore, there were significant gender differences in the correlations based on a one-tailed z-test, with a stronger association between Internet addiction and BIS (z difference = 2.233, $p < 0.05$) for females than for males, a stronger association between Internet addiction and BAS (z difference = 3.191, $p < 0.001$) for males than for females, a stronger association between Internet addiction and IU (z difference = −1.779, $p < 0.05$) for males than for females, a stronger association between Internet addiction and self-control (z difference = −2.244, $p < 0.05$) for females than for males, and a stronger association between BIS and IU (z difference = 2.729, $p < 0.01$) for females than for males. According to the relevant models of these variables, the hypothesized models were analyzed as follows.

Structural equation modeling analyses

First, the hypothesized model contained four observed variables (BIS, BAS, IU, and self-control, representative of their total scores) and one latent variable (Internet addiction) to make it simpler and more efficient. Moreover, the Young's diagnostic questionnaire for Internet addiction was separated into two parcels, where the sum of odd items constituted the first parcel (parcel 1) and the sum of even items constituted the second parcel (parcel 2), to act as indicators of Internet addiction employing an item-to-construct balance approach (89). Then, structural equation modeling was used to analyze the hypotheses of this study. The standardized factor loadings of Internet addiction for parcel 1 and parcel 2 ranged from 0.866 to 0.913. According to the fit standards, the results of structural equation modeling yielded a good fit to the empirical data, $\chi^2 = 16.169$, $\chi^2/df = 4.042$, TLI = 0.968, CFI = 0.992, SRMR = 0.032, RMSEA = 0.064. In sum, BIS was positively related to Internet addiction and IU and negatively related to self-control. BAS was negatively related to Internet addiction and IU and positively related to self-control. IU was positively associated with Internet addiction, while self-control was negatively associated with Internet addiction (see Figure 2). Finally, the results of bootstrap analyses showed that the total, direct, and indirect effects of BIS/BAS on Internet
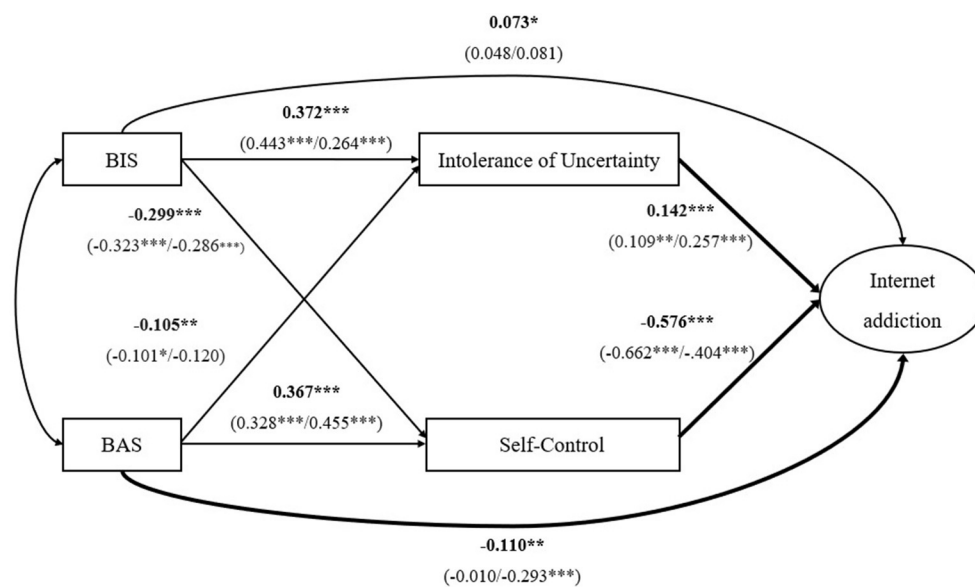
FIGURE 2
The relationships among BIS, BAS and Internet addiction are mediated by IU and Self-Control. Bold lines indicate significant gender differences in these paths. The parameters for whole participants are displayed outside of the parentheses, while the parameters for different subgroups are denoted within the parentheses (females in the left, males in the right) *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

addiction were significant (see Table 3). These results indicated that IU and self-control partially mediated the relationships between BIS/BAS and Internet addiction among Chinese college students.

Cross-group comparison was next used to examine the gender differences present in the model. First, the result of the comparison of M0 and M1, $\Delta\chi^2$ (1) = 0.288, $p > 0.05$, indicated that there was measurement equivalence between female and male groups. Second, to examine whether the relationship of each path differed across gender, two nested models (M1 and M2) were tested. The results demonstrated that these two models were significantly different, $\Delta\chi^2$ (8) = 32.432, $p < 0.001$, indicating that their path coefficients differed across gender. Next, the critical ratios of differences (CRDs) were calculated to test for differences between both groups among structural path coefficients. If the absolute value of CRD was equal to or greater than 1.96, then the association between these two variables were considered to be a significant gender difference at the $p < 0.05$ level. The results indicated that the relationships between BAS and Internet addiction and between IU and Internet addiction were stronger among male participants. The relationship between self-control and Internet addiction was stronger among female participants (see Table 4). Finally, we found that 49.0% of the variance in Internet addiction could be explained among females and 40.8% of the variance in Internet addiction could be explained among males by this model.

Discussion

To our knowledge, this is the first study to test the impact mechanism of BIS/BAS on Internet addiction through IU and self-control among Chinese college students by applying the I-PACE model and further consider the moderating role of gender among these variables. These results indicated that BIS was positively correlated with the level of Internet addiction, while BAS was negatively related to the level of Internet addiction of college students. Moreover, IU and self-control had statistically significant mediating effects between BIS/BAS and Internet addiction. Specifically, BAS and IU showed significantly greater predictive abilities for Internet addiction in males than in females, while the protective role of self-control on Internet addiction was greater in females than in males. Overall the results supported the I-PACE model that specific personal characteristics (e.g., BIS/BAS), affective and cognitive responses (e.g., IU), executive function (e.g., self-control) components resulted in adverse emotional reactions through the perception of the situation and led to certain addictive tendencies (17). The findings of this study extend previous studies about the effect of BIS/BAS on Internet addiction, and explore the mediation mechanisms and gender differences among these variables, which are helpful for understanding the mechanism of Internet addiction more accurately and providing more effective guidance for the Internet addiction intervention among college students.

TABLE 3 Total, direct, and indirect effects of BIS/BAS on Internet addiction.

Effects of predictors	β	Bias-correlated 95% CI
Whole sample		
BIS		
TE	0.298***	[0.222, 0.375]
DE	0.073*	[0.004, 0.145]
IE-IU	0.053***	[0.027, 0.083]
IE-SC	0.172***	[0.126, 0.222]
BAS		
TE	−0.336***	[−0.425, −0.251]
DE	−0.110**	[−0.185, −0.039]
IE-IU	−0.015**	[−0.032, −0.005]
IE-SC	−0.211***	[−0.268, −0.160]
Females		
BIS		
TE	0.311***	[0.218, 0.397]
DE	0.048	[−0.036, 0.128]
IE-IU	0.048**	[0.013, 0.091]
IE-SC	0.214***	[0.150, 0.281]
BAS		
TE	−0.238***	[−0.340, −0.141]
DE	−0.010	[−0.087, 0.065]
IE-IU	−0.011*	[−0.029, −0.002]
IE-SC	−0.217***	[−0.287, −0.149]
Males		
BIS		
TE	0.264**	[0.106, 0.417]
DE	0.081	[−0.044, 0.218]
IE-IU	0.068**	[0.031, 0.127]
IE-SC	0.116***	[0.054, 0.191]
BAS		
TE	−0.508***	[−0.656, −0.355]
DE	−0.293***	[−0.429, −0.157]
IE-IU	−0.031	[−0.078, 0.004]
IE-SC	−0.184***	[−0.276, −0.111]

All the estimates provided in the table are standardized estimates. TE, total effect; DE, direct effect; IE, indirect effect; IU, intolerance of uncertainty; SC, self-control; CI, confidence interval. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Associations between BIS/BAS and Internet addiction

In line with our speculation, Internet addiction has a significant positive correlation with BIS and a significant negative relationship with BAS. First, prior research showed that individuals who have higher BIS levels are more sensitive to punishment stimuli and have a higher risk of Internet addiction (63). Individuals with high BIS may have more avoidance behaviors in real life due to fear of failure, and they may have

anxiety and distress in face-to-face interpersonal interaction, preventing them from communicating normally. However, they can communicate anonymously to meet their psychological needs that cannot be met in real life and feel a sense of achievement and comfort in a virtual world. This experience would significantly increase the Internet use time, thereby increasing the possibility of Internet addiction (90). Next, college students who have higher BAS levels are more sensitive to reward stimuli and have a lower risk of Internet addiction (23). College is a vital stage of life development and learning plays a leading role in college life. During this period, students will strive to learn knowledge and improve their abilities to pursue a better career. Previous research suggests that BAS may play an important role in individuals' motivations to conduct goal-directed behavior (91, 92). Therefore, students with high BAS may aim for behaviors that benefit their developmental plans, and spend more time on positive choices that benefit growth and less time on negative behaviors that hinder growth, which may reduce the likelihood of Internet addiction. In addition, individuals with high BAS sensitivity tend to approach novel people or things, and they may invest more in social activities and obtain higher happiness (93), which further makes individuals less prone to Internet addiction behaviors.

IU and self-control as mediators

On the one hand, there was a mediating role of IU between BIS/BAS and Internet addiction. First, BIS can reinforce individual reactions to avoid or withdraw from novel, uncertain or threatening situations, which may trigger individuals to interpret unknown events more negatively (34). This is especially true for students at the college stage, who face constant academic and competency assessment and assume greater uncertainty about their future due to the rapid development of society and increased competition. Therefore, individuals with high BIS levels may experience higher levels of IU than individuals with low BIS levels. Second, BAS is closely related to reward seeking, and individuals with high-BAS sensitivity have a higher preference for novelty processing and reward dependence (94). They are highly motivated by both external and internal rewards and are able to devote themselves to an activity in which they feel a sense of pleasure and control (95). Thus, high-BAS individuals may have a higher desire to explore perceived goals, and uncertain situations may be perceived as novel and rewarding stimuli. When faced with an unknown situation, they may be more likely to choose to actively engage in exploring the environment and constantly challenge themselves compared to reacting with aversion and avoidance, which may increase their tolerance for uncertainty to some extent. Third, individuals with high IU tend to have more negative thinking patterns, believing that they lack sufficient coping or problem-solving skills to effectively face future negative outcomes, which

TABLE 4 Standardized coefficients from the multiple–group analysis.

Structural model	Female estimate (S.E.)	Male estimate (S.E.)	CRD
BIS to Internet addiction	0.048 (*0.017*)	0.081 (*0.027*)	−0.433
BAS to Internet addiction	−0.010 (*0.008*)	−0.293 (*0.013*)***	3.539*
BIS to intolerance of uncertainty	0.443 (*0.131*)***	0.264 (*0.236*)***	1.860
BIS to Self-Control	−0.323 (*0.075*)***	−0.286 (*0.126*)***	−0.112
BAS to intolerance of uncertainty	−0.101 (*0.063*)*	−0.120 (*0.106*)	0.216
BAS to Self-Control	0.328 (*0.036*)***	0.455 (*0.056*)***	−1.713
Intolerance of uncertainty to Internet addiction	0.109 (*0.005*)**	0.257 (*0.007*)***	−2.028*
Self-Control to Internet addiction	−0.662 (*0.009*)***	−0.404 (*0.014*)***	−4.008*

The numbers in italics in the parentheses represent the standard errors. S.E., standard error; CRD, critical ratio difference. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

may cause discomfort and negative emotions in individuals (96). To eliminate adverse experiences, individuals may seek temporary happiness on the Internet or increase the certainty of knowledge of unknowable events through excessive searching for information. However, these actions can only temporarily reduce anxiety and distress which may lead to heightened perceptions of uncertainty and anxiety in the long run (97). Especially, the repeated COVID-19 epidemic has increased the uncertainty of the current living environment and future development of college students (98). The perception of these serious uncertainties may reduce their tolerance for uncertainty, which also causes them to spend more time on the Internet and inadvertently further exacerbates the risk of Internet addiction among college students.

On the other hand, the results demonstrated that self-control serves as a mediator between BIS/BAS and Internet addiction and contributes to explaining how BIS/BAS influences Internet addiction. First, BIS was significantly negatively related to self-control, while BAS was significantly positively correlated with self-control. According to the strength model of self-control, an individual's emotional state has an important impact on the ability to control oneself. Negative emotions weaken self-control by depleting more cognitive resources, while positive emotions facilitate the recovery and maintenance of self-control resources (99, 100). Hence, negative emotions such as anxiety generated by high BIS activation may decrease the level of self-control, whereas positive emotions experienced during high BAS activation may allow individuals to maintain a higher level of self-control. Second, self-control was negatively linked to Internet addiction among college students. In general, individuals with low self-control are more likely to experience problem behaviors than those with high self-control (101–103). This may be because people with high self-control have a greater ability to delay gratification, reduce the impact of temptations in the moment, and restrain themselves to achieve greater satisfaction (104). However, individuals with low self-control tend to be highly impulsive and often choose to experience instant pleasure online when faced with the lure of the Internet

(105). Especially during the COVID-19 epidemic, entertainment options became limited, and the online world became one of the few entertainment options available to college students, which may increase the risk of Internet addiction in college students with low self-control.

Gender differences in the associations between BIS/BAS, IU, self-control and Internet addiction

The present study further illuminated gender differences in the strength of the associations between the variables being studied, and the findings support the third hypothesis that the formation mechanism of Internet addiction are moderated by gender. First, the direct predictive effect of BAS on Internet addiction was significant for males but non-significant for females. Meanwhile, the association between IU and Internet addiction was stronger in males than in females. In other words, Internet addiction in males was more likely to be influenced by BAS and IU. The social role theory indicates that men being expected to be independent and brave, to focus on the outside world, and to achieve academic and career success (65). As a result, males may be more motivated to choose positive behaviors and set higher goals for self-growth than females, which enables males with high BAS to use the Internet appropriately and be less prone to Internet addiction. In addition, most parents have a higher aptitude and educational expectations of men (106). Male college students who have high expectations place more value on these achievements and are more concerned about the adverse effects of poor performance on their future career prospects. Earlier research has identified that when dealing with negative emotions, females can seek social support and use effective emotion regulation strategies while males are more prone to suppress or avoid emotional expression (107). This puts male college students with high IU at a higher risk of Internet addiction as they

are likely to spend substantial amounts of time online. Second, the association between self-control and Internet addiction is more powerful among female college students than among male students. Females are more likely to have inappropriate behaviors monitored, identified, and corrected by their parents than males during the learning process of socialization (108), which may make self-control play a more important role in females than in males. Thus, females with high self-control may have strict demands on their study and life, and can show strong control in the face of temptation-filled behaviors and undesirable behaviors such as Internet addiction. Previous studies have shown that males and females differ in their preferences for Internet use (109). Males prefer to play games and watch videos online, while females prefer communication features and social networking services online. However, when females have low self-control, they may also choose online games for entertainment and relaxation because the virtual world of the Internet is always a temptation for people (110, 111). In addition, it was reported that females prefer online shopping features over males and that the diversity of online products may now be more skewed toward females (112). Thus, females with low self-control may also be more likely to spend too much time on the Internet than males with low self-control (113).

Implications for theory and practice

From a theoretical perspective, this study supplements and expands previous studies on the influence mechanism of BIS/BAS on Internet addiction among college students. In addition, it provides empirical support for the I-PACE model of Internet addiction among college students in the context of Chinese culture as well as a reference for further research on the formation mechanism of Internet addiction. From a practical point of view, our findings may be helpful for guiding the prevention and intervention of Internet addiction among college students. First of all, when screening and choosing a target population, the population with high BIS, low BAS, high IU and low self-control should be of particular concern. Second, to prevent and intervene in Internet addiction in college students, training techniques should be used to improve students' tolerance of uncertainty and self-control ability because improving specific behaviors may be more efficient than directly changing personality (114). On the one hand, cognitive behavioral therapy techniques for IU (CBT-IU) can help college students with high BIS and low BAS to improve their tolerance for uncertainty through worry awareness training, cognitive reappraisal of uncertainty, and other methods (43). On the other hand, mindfulness-based stress reduction techniques and general self-control intervention in a cognitive behavioral framework can have a positive impact on the self-control ability of

college students with Internet addiction (115, 116). Finally, more attention should be given to developing gender-specific Internet addiction prevention and intervention programs for male and female college students. For females, low self-control is the most critical factor contributing to their Internet addiction. Therefore, the prevention and intervention of Internet addiction for them should focus on the improvement of self-control. For males, apart from low self-control, low BAS and high IU also play important roles in the formation mechanism of Internet addiction. Thus, in addition to self-control enhancement training, more targeted guidance or training should be given to those with low BAS levels and high IU levels to reduce the occurrence and development of Internet addiction.

Limitations and further directions

Several limitations of the current study should be noted. First, this was a cross-sectional study. Although there is a certain theoretical basis, the research results can only provide the predictions of the relationships among these variables. The cross-sectional design of the study naturally limits any causal interpretation. It is also possible that people with different levels of IU and self-control may show various levels of BIS or BAS, which may further relate to Internet addiction. Thus, future studies should attempt to use longitudinal design and clinical trials to examine the causal relationship and mediating effect between BIS/BAS and Internet addiction. Second, all data were collected through self-report questionnaires, so recall bias and the subject-expectancy effect may be difficult to avoid. Future measures of peer nomination and behavioral tasks could be added, and data could be collected from multiple sources of information to make the data more realistic and reliable. Third, this study did not distinguish Internet addiction into specific subtypes. Previous researches have shown that it is important to distinguish generalized Internet addiction from specific Internet addiction and that there are significant gender differences between online game addiction and social media addiction (117, 118). Therefore, more information on Internet use needs to be included in future studies to verify whether the current findings are appropriate for generalized Internet addiction or specific Internet addiction. Fourth, this study only explores the formation mechanism of Internet addiction from the I-PACE model, but other theoretical approaches exist to view addiction from a different perspective. For example, the model of addiction based on affective neuroscience describes and interprets the phenomenon of addiction as an expression of vulnerability related to biological and social factors from a neuro-psycho-evolutionary perspective (119, 120). Future research should consider combining these different theories in a rigorous manner to further illuminate the underlying

mechanism of Internet addiction. Finally, participants were all college students from China. Considering the role of cultural factors on individual psychology and behavior, the model should be tested using different cultures, including collectivist and individualist societies.

Conclusion

In summary, this study explored the relationship between BIS/BAS and Internet addiction among Chinese college students by using the I-PACE model. The current study indicated that the BIS/BAS shows important association with Internet addiction, that BIS/BAS has indirect influence on Internet addiction through IU and self-control and that the relationships among these variables can also be moderated by gender. Specifically, Internet addiction is more likely to be negatively affected by low BAS and high IU in male college students, while high self-control has a greater potential protective effect on Internet addiction in female students. Given that Internet addiction is not only harmful to the physical and mental health of college students, but also places a large burden on their families and society, this study suggests that policy-makers should further implement strict regulatory measures (e.g., setting up anti-addiction or fatigue system) and actively guide college students to use the Internet and social networks rationally (121). Moreover, educators should combine IU intervention measures and self-control training when formulating prevention and intervention programs for Internet addiction among college students and adopt differentiated programs for males and females in the specific implementation process.

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 Tianjin Medical University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

BD, ZZ, and ZP designed the study and wrote the protocol. YL, XH, and BD collected the research data. YL, ZZ, BD, and ZP conducted the statistical analyses and wrote the manuscript. JL, GZ, and XH conducted the literature searches, created the figures, and proofread the language. All authors 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.

Publisher's note

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How do online users perceive health risks during public health emergencies? Empirical evidence from China

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Background: The global COVID-19 pandemic has posed a major threat to human life and health, and new media technologies have intensified the spread of risk perception.

Purpose: This study aimed to explore the impact of risk information ground on online users' perceived health risks, and further explore the mediating role of psychological distance and the moderating role of self-efficacy.

Methods: A total of 25 Internet users from different provinces in China were interviewed in-depth, NVIVO.11 was used to qualitatively analyze the interview text data and construct a theoretical model. A total of 492 interviewees were recruited in order to complete a scenario questionnaire, SPSS-27 was used to perform orthogonal experiments, generate eight combinatorial scenarios, analyze demographic data, and clean and prepare data for testing hypotheses. SmartPLS 3.0 was used to test the conceptual model using the structural equation model (SEM) of the partial least squares (PLS).

Results: The analysis of the SEM model shows that all planned hypotheses (Information fluency → Information diagnosability, Information extensibility → Information diagnosability, Information diagnosability → Psychological distance, Platform interactivity → Scenario embeddedness, Network connectivity → Scenario embeddedness, Scenario embeddedness → Psychological distance, Psychological distance → Risk perception, Psychological distance → Self-efficacy → Risk perception, Information fluency → Information diagnosability → Psychological distance → Risk perception, Information extensibility → Information diagnosability → Psychological distance → Risk perception, Platform interactivity → Scenario embeddedness → Psychological distance → Risk perception, Network connectivity → Scenario embeddedness → Psychological distance → Risk perception) are confirmed.

Conclusion: This study found that the information ground factors significantly affect online users' perceptions of health risks, psychological distance mediates the effect of information ground factors on risk perception, and self-efficacy negatively moderates the effect of psychological distance on risk perception.

1. Introduction

The outbreak of major public health emergencies (e.g., COVID-19) poses a major threat to people's lives and health, and also provides environmental conditions for the gathering and outbreak of social risks, especially the information explosion and fermentation in cyberspace, giving people a negative psychology of panic, rumors, superstition, and mistrust, causing serious disruption to the entire social order, and exposing society to extremely high risks (Li et al., 2020). Pandemic sociology considers emerging epidemics as a source of social instability, uncertainty, and even crisis, and holds that just as the biological environment changes as a result of epidemics, so does the social layout (Dingwall et al., 2013) and the way people learn and live (Noor et al., 2022; Younas et al., 2022). The extent of the damage caused by public health emergencies depends not only on the harm caused but also on the public's risk perception of and reaction to the event, on how the public obtains relevant risk information, and on how it perceives and interprets such information, thereby generating corresponding risk behavior. At present, online platforms are important carriers for users to obtain and disseminate risk information about public health emergencies. In the era of full-media information, the great abundance and rapid dissemination of information make users' online risk perceptions changeable and unpredictable. Online users' health risk perceptions of public health emergencies are an important constraint affecting government crisis management and risk communication. Therefore, understanding the formation mechanism of users' online risk perceptions in crisis is a prerequisite for the timely identification and prevention of other secondary social risks.

2. Literature review

The topic of public perception of health risks during public health emergencies has attracted the attention of many researchers in recent years (Dong et al., 2022; Ert et al., 2022), especially during the COVID-19 pandemic, which has triggered much discussion and reflection among health professionals (Attema et al., 2021).

2.1. Negative consequences of risk perception

Relevant studies have pointed out that the majority of members of the public may change their social group structure during such emergencies (Busby et al., 2016), and a poor sense of belonging or other mental pressures increase their degree of risk perception (Arteaga and Ugarte, 2015; Diotaiuti et al., 2022). On the one hand, risk information that has been much disseminated may contain more negative factors, deepen the fear and anxiety of individuals facing risk events (Zhao et al., 2021), and increase the probability of individuals suffering from depression and other forms of mental stress (Diotaiuti et al., 2021a,b). As a general rule, the tolerance threshold of society as a whole for risk is reduced (Bodoque et al., 2016). On the other hand, fear amplifies people's perception of risk, which urges people to adjust their behavior, thus leading to the formation and amplification of secondary risks (Abdulkareem et al., 2018). Based on this, researchers have speculated on the possible behavioral impact of public risk perception in emergency situations from different perspectives, including the impact of risk perception on protective behavior. Grothmann and Reusswig (2006) built a sociopsychological adaptation model and believed that the variable of risk perception could better explain and predict people's pre-disaster prevention behavior than other general factors. Knocke and Kolivras (2007) studied people's defense behavior during flood events, pointing out that the greater people's perception of life and health risks, the greater their probability of adopting appropriate flood defense behavior (Knocke and Kolivras, 2007). Some researchers have also discussed the impact of risk perception on information behavior. These studies have all pointed out that people's risk perception is constantly shaped and affected in their contact and communication with others in the face of crisis events (Liu et al., 2021). The stronger people's risk perception and the greater their concern about risk, the higher their frequency of risk communication and information searching and dissemination, which may lead to online public opinion risk (Major, 1993; Neuwirth et al., 2000).

2.2. Factors affecting public risk perception in public health emergencies

According to ecological theory, however, individual development is the product of interaction between individuals and the environment. Individuals in the same environment develop differently due to different individual characteristics. Not all individuals receiving the same information develop the same level of risk perception (Zhao et al., 2021). Different social groups also have different risk perception mechanisms. For example, risk experts and the general public have significantly different attitudes toward risk, and government managers maintain their own unique rules with regard to risk perception (Huang et al., 2021). In general, researchers believe that, in the context of public health emergencies, the factors affecting public risk perception are multidimensional, including:

1. *Risk characteristics*. The reason for individuals' fear of risk is due to the characteristics of the risk itself, such as the unknown, unobservable, and uncontrollable nature of risk (Covello and Merkhofer, 1993), and the strength of the relationship between individuals and public health emergencies is positively related to the degree of perceived risk and the intensity of their reactions (Gierlach et al., 2010).

2. *Subject factors*. Byamugisha et al. (2009) pointed out that demographic factors such as an individual's gender, age, and educational attainment level, as well as their past experiences of risky events, can affect an individual's risk perceptions. The older the person, the lower the probability of perceiving the risk of infection, but the higher the severity of the perceived risk (Rosi et al., 2021); people who know more about the causes of diseases are more worried about being infected, that is, there is a positive correlation between knowledge and risk perception (Iorfa et al., 2020). Moreover, emotion (Wang et al., 2013; De-Juan-Ripoll et al., 2021), cognitive bias (Prentice et al., 2005; Klein et al., 2010), and sense of self-efficacy (Blanton et al., 2001; Diotaiuti et al., 2021a,b) are also important predictors.

3. *Media message factors*. The characteristics of media information itself can directly affect individuals' risk perceptions, such as the type of information (Rotter, 1980), the amount of information (Mileti and Peek, 2000), the mode of access (Liu, 2022), and the dissemination of information (Yim and Vaganov, 2003).

4. *Governmental factors*. Studies have pointed out that the level of trust in government institutions also affects the public's perception of risk (Yokoyama and Ikkatai, 2022). Researchers also believe that social and cultural factors affect individuals' risk perceptions. In

short, individuals' social class, educational attainment level, values, family structure, religious beliefs, and group factors can all have an impact on risk perceptions (Liu et al., 2020).

2.3. Comments

A review of the relevant literature reveals that, among the "hot" research topics triggered by public health emergencies, risk perception is the core intermediary variable that triggers a series of psychological and behavioral responses in people, is widely used by researchers in the construction of both theoretical and empirical models, and is the central issue to be considered in emergency risk communication and management. The variable of risk perception is often used to explain and predict the network public opinion risk and other social risks of public health emergencies, which is also the theoretical and practical basis for risk communication and emergency management. However, in the current Internet environment, the formation of public risk perception increasingly depends on online risk information. How online users perceive the health risks of public health emergencies has become an important issue. Although existing studies have discussed the impact of various factors such as the amount, type (positive or negative), form (text and pictures) of risk information on online users' risk perception in different circumstances, the risk information factors extracted in previous studies may not necessarily match the perceptions of health risks by Chinese online users. Therefore, although the existing literature provides a considerable theoretical basis for this study, during the recent COVID-19 outbreak in China, which risk information factors affected the perception of health risks by Chinese online users to a greater extent need to be further investigated. Many studies have regarded various risk information factors as independent variables, and did not fully pay attention to the risk information ground formed by various characteristics of online risk information itself, nor have they divided risk information types, from both cognitive and perceptual perspectives, and measured the differences between different paths of influence at the same time. Moreover, most previous studies have used risk perception as an intermediary variable to explore its impact on other behaviors or reactions, while ignoring the results of studies on the generation process of risk perception itself. Risk perception is usually set to be directly affected by external environmental factors and individual characteristics among general models, that is, only the effect of the strength of various factors on risk perception is considered, while the mechanism that psychological distance adopts in the formation of various factors on risk perception is ignored.

2.4. Statement of the study

The purpose of this study is to explore the factors that influence online users' perceived health risks in the public health emergency scenario. Risk information dissemination leads to public panic during major emergencies (Tsao et al., 2019). Especially in today's Internet era, information has the characteristics of fast and wide dissemination, which will have a more obvious impact on public psychology and behavior (Rousseau et al., 2015). According to health information risk perception theory, the characteristics of information perceived by individuals directly affect health information risk perception (Zhao and Chen, 2020). High-quality information can reduce the uncertainty

of individuals facing unfamiliar information, increase the perceived value of exchanged information, and thus reduce the perception of risk. This study is important because it provides risk information publishers and policymakers with a new perspective on how to properly disseminate risk information about public health emergencies taking into account the psychological distance and self-efficacy of online users.

3. Qualitative study

3.1. Data collection and analysis

To identify the factors that influence online users' perceived health risks in the public health emergency scenario, we conducted 25 semi-structure interviews with online users from different regions of China.

3.1.1. Participants

Purposive sampling can provide the richest information for research questions. According to the 47th Statistical Report on the Development of China's Internet, by the end of June 2020, the age structure of Internet users in China was approximately 60% of those aged 20–49, and the proportion of those aged 50 and above had increased to approximately 20%; the gender ratio was approximately 51: 49 male to female. With respect to occupational structure, the netizen group had the largest number of middle school students, accounting for approximately 23.7%, followed by ordinary professionals or self-employed people. Therefore, when selecting interviewees, this study focused mainly on college students under 45 years old and ordinary office workers. Finally, a total of 25 interviewees were recruited for this study (including 20 for rooting analysis and five for a saturation test). The basic information relating to the interviewees is listed in Table 1. It can be seen that the ratio of men to women is basically balanced. The interviewees were mainly young and middle-aged people. Their occupations included: students at school, employees of state-owned enterprises and institutions, college teachers, self-employed people, etc. Their educational backgrounds were distributed mainly in junior colleges, undergraduate courses, masters and doctors degree courses. The regions where the interviewees were located include eastern, northern, central, southern China, and other areas. The interviewees had rich experience of using Internet platforms, and were more sensitive to network risk information perception.

3.1.2. Data collection process

The first stage of data collection lasted from July to November 2020, with 15 people interviewed; in the second stage, from July to August 2021, 10 people were interviewed. Because of COVID-19 restrictions, the 40-min semi-structured interviews took place by telephone or online. Before each interview, the topic and purpose of the interview were explained to the interviewees so that they could fully understand the intention behind the interview and ensure that comprehensive information was obtained and deeper content was uncovered. Before the formal interviews, pre-interviews were conducted with three interviewees who had experience of using online social networking platforms, and the interview outline was revised and improved based on the experience and feedback of these interviewees, following which, the formal interview outline was finally drawn up, which is presented in Table 2.

3.1.3. Data analysis process

This study aimed to analyze interview data based Grounded theory. The Grounded theory requires the researcher to start from actual observation without theoretical assumptions, conduct repeated searches

TABLE 1 Description of interviewees.

Demographics		Percentage (%)
Gender	Male	48
	Female	52
Age	20–29	60
	30–39	28
	40–49	12
Education	Junior college or belowe	8
	Undergraduate	36
	Master	52
	Doctor	4
Occupation	Student	28
	Staff of private enterprises	48
	Staff of state-owned enterprises	24
Area of residence	South China	8
	Central China	12
	North China	8
	East China	64
	Northeast	4
	Northwest	4
	Southwest	4
Network platform for obtaining information related to public health emergencies	Microblog	68
	Tiktok	28
	WeChat	40
	Zhihu	20
	Official government website	20
	News client	28
	Other platforms	40

for core concepts that can reflect the research phenomenon through systematically collected data, and finally realize the construction of a theoretical model through conceptual condensation and mapping of relationships. Grounded theory analysis consists of three classical stages. The first stage is the acquisition of primary data. In this stage, the research takes the form of one-on-one in-depth interviews with open-ended repeated multiple questions to obtain first-hand raw interview data. The second stage involves data coding. In this stage, the induction and abstract extraction of the raw data needs to be completed. This study adopted the procedural rooting process proposed by Strauss and Corbin (1994), and the specific implementation process included open-ended coding, spindle coding, and selective coding. In the third stage, the theoretical model was constructed based on the coded data. Three researchers executed the coding of the data, resolving differences through continuous comparison until members reached a consensus. The data from the first 22 interviews were analyzed first, and no new categories emerged in the data from the last three interviews, indicating that theoretical saturation was reached.

3.2. Hypotheses and theoretical model

Based on the interviews and inductive analyses, we identified eight factors that influence online users' perception of health risks including the following: information fluency, information extensibility, platform interactivity, network connectivity, information diagnosability, scenario embeddedness, psychological distance, and self-efficacy. By analyzing and comparing the internal relationships among the categories, the main categories were refined, and the core categories were obtained based on further sorting of the main category relationships, as well as the complete "storyline" and the typical relationships between the main categories, as shown in Table 3. In this section, we develop the hypotheses and research model (Figure 1) based on our interview transcripts and previous literature.

3.2.1. Antecedent factors

Information fluency (IF) refers to how easy it is for individuals to perceive or process information. Participants in the qualitative study reported Risk information that is easy to understand enables them to identify health risks more quickly. For example, an interviewee stated: "… it is probably the cold confirmatory number, which most intuitively

TABLE 2 Interview outline.

Number	Interview questions
1	What social platforms or network applications do you usually use to learn about the COVID-19?
2	What do you think is the difference between the information provided by these platforms or applications on the COVID-19? (Information features)
3	Talk about the different feelings of these platforms when you use them to view risk information about the COVID-19? (Platform features)
4	Do you think the risk information about the COVID-19 released by these platforms will affect your risk perception? Why? Please be specific (Information features)
5	Do you think different platforms will make you have different perceptions of the risk of COVID-19 epidemic? Why? Please be specific (Platform features)
6	Which platform environment (atmosphere) will make you feel that the risk of COVID-19 infection is relatively high or low? Why? Please give examples (Platform features)
7	What kind of content released by the platform makes you think the risk of COVID-19 infection is relatively high or low? Why? Please give examples (Information features)
8	How do you think your risk of COVID-19 infection is compared with other people (greater/smaller)? Why?(Individual features)
9	What do you think of the protection ability (stronger/weaker) compared with others in taking effective measures to ensure that you are not infected by viruses? Why? (Individual features)

TABLE 3 Core category and its relationship with main category.

Class	Main category	Category	Relationship
Antecedent cause			
Information factors	B4:Information fluency (IF)	AA10:Information acceptability	It is a component of information fluency, that is, it indicates the difficulty of individuals to obtain and process information
		AA11:Information comprehensibility	
	B5:Information extensibility (IE)	AA12:Information amount	It is an integral part of information extensibility, that is, the depth and breadth of risk information acquired by individuals
		AA13:Information comprehensiveness	
Platform factors	B7:Platform interactivity (PI)	AA15:Interaction convenience	It is a component of platform interactivity, that is, the degree of interaction convenience between individuals and platform users
		AA16:Interactive Visibility	
	B8:Network connectivity (NC)	AA17:Interaction intensity	It is a component of network connectivity, that is, the familiarity and interaction between platform users
		AA18:Interactive atmosphere	
Mediating Effects			
Information factors	B3: Information diagnosability (ID)	AA7:Information matching degree	It refers to the degree to which the individual perception of relevant epidemic information can meet the individual's information needs at that time and match the information content required by the individual
		AA8:Information usefulness	It refers to whether individual perception of relevant epidemic information is helpful to individual judgment of risk de
		AA9:Information interpretation	It refers to whether the information about the epidemic scenario perceived by individuals can explain the specific problems in depth, detail and reasonably
Platform factors	B:Scenario embeddedness (SE)	AA14:Scenario embeddedness	The information atmosphere created by the platform scenes and information reporting forms enables individuals to have a sense of substitution
Individual factors	B1:Psychological distance (PD)	AA1:Probability distance	It is a component of psychological distance, that is, the distance of individual subjective perception. When people take themselves or things as reference points, they will have subjective perception of certain things at this time, here and here.
		AA2:Spatial distance	
		AA3:social distance	
		AA4:Time distance	
Moderating Effects			
	B2:Self-efficacy (SEF)	AA5:Epidemic prevention and response capacity	It is a component of self-efficacy, that is, the ability of people to avoid risks by relying on their own knowledge and experience
		AA6:Individual comprehensive quality	
Results			
Results	B9:Risk perception (RP)	AA19:Risk perception decline	It is the presentation of individual's network perception of risk
		AA20 risk perception increase	

gives a sense of the risk of contracting a COVID … *Some animations in a more appealing form explain the transmission mechanism of this virus ….*"

Therefore, we hypothesize that:

> *H1*: Information fluency has a positive impact on users' perceived information diagnosability.

Information extensibility (IE) refers to whether the content of information is sufficiently specific, the vividness of the image, the presentation process of the details, and the quantity and richness of the information. In a time-constrained environment, individuals do not allocate more time to continue deep information processing, are more likely to accept and identify with the information they see, form risk diagnoses more quickly, and are more likely to resonate and reinforce cognitively and emotionally, leading to increased individual self-perception of risk. In the original data from the interviews, an interviewee clearly stated: "*It is better to have more information. I need to synthesize a*

lot of information from different aspects to judge, but the more information I read, especially in some in-depth reports, involving complex scientific knowledge, the easier it is to understand the information."

Therefore, we hypothesize that:

> *H2*: Information extensibility has a positive impact on users' perceived information diagnosability.

Platform interactivity (PI) refers to the immediacy and convenience of interactive communication between users and platform participants, access to information, and access to feedback. A more interactive platform makes it easier for online users to have a more realistic and contextual embedding of the outbreak information. For example, an interviewee said: "*The microblogging platform is more open and inclusive in discussing the epidemic, and I can often find real comments and feelings about the epidemic posted by individual users on the microblogging platform, so I feel a strong sense of immersion*".

Research model.
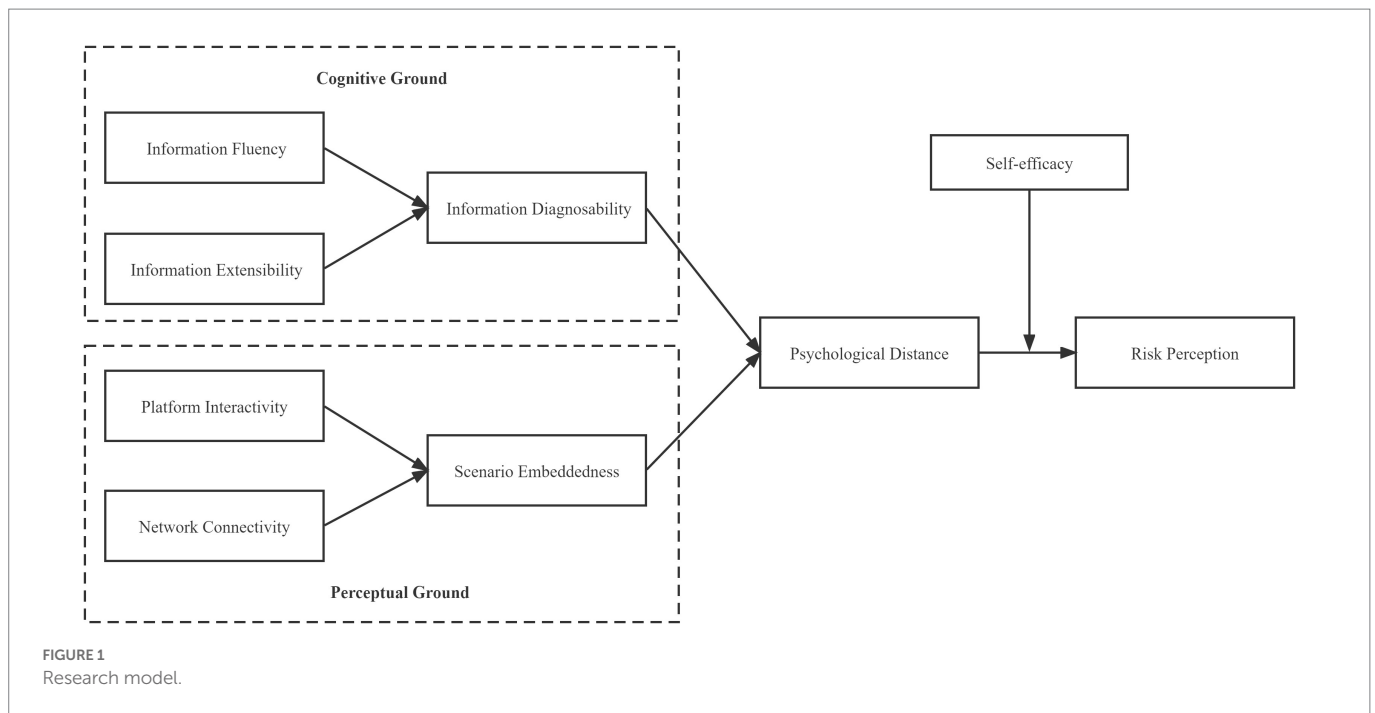
Therefore, we hypothesize that:

H3: Platform interactivity has a positive impact on users' perceived scenario embeddedness.

Network connectivity (NC) refers to the strength of relationships between platform users, as evidenced by the degree of mutual familiarity, frequency of interaction, and interactive atmosphere between users on a given platform. A high frequency of interaction and a high degree of familiarity between platform users will bring people closer to this type of information, giving people a stronger sense of self-connection, and people are more likely to be influenced by this type of information. For example, one respondent mentioned that: *"Most of the people in the WeChat group are people who know each other and are familiar with each other, and people usually share some useful knowledge and also some gossip …."* Therefore, we hypothesize that:

H4: Network connectivity has a positive impact on users' perceived scenario embeddedness.

3.2.2. Mediating factors

Information diagnosability (ID) refers to the extent to which it meets the information needs of online users, matches the content of the information needed, and can explain the relevant risk issues in a reasoned manner so as to help online users make judgments about the magnitude of the risk. Participant reports show that the higher the perceived diagnosability of risk by online users, the closer the psychological distance. For example, one respondent mentioned that: *"some information is detailed, including the person's occupation, family situation, various whereabouts before diagnosis, how one becomes infected,* etc. *Seeing the process of these people being diagnosed can have an emotional impact."*

Therefore, we hypothesize that:

H5a: Perceived information diagnosability has a negative impact on users' psychological distance.

H5b: There is a mediating role of information diagnosability between information fluency and psychological distance.
H5c: There is a mediating role of information diagnosability between information extensibility and psychological distance.

Situational embeddedness refers to the extent to which online users perceive vivid and diverse reports related to the epidemic, allowing them to relate these situations to themselves and create a sense of immersion in the scenario. Situational embeddedness makes online users reduce the psychological distance to health risk. As one of the interviewees related: *"If the information on Weibo has pictures and videos, it looks like it is real, and many people are talking about it. I will tend to think that it is real, and I will warn my friends and family about it in time."*

Therefore, we hypothesize that:

H6a: Scenario embeddedness has a negative impact on users' psychological distance.
H6b: Scenario embeddedness mediates the relationship between platform interactivity and psychological distance.
H6c: Scenario embeddedness mediates between network connectivity and psychological distance.

Psychological distance (PD) is used to characterize the subjective experience of a particular event close to or far from the self, here and now (Trope et al., 2007). Some scholars have argued that many risks are perceived as a psychological distancing of the general public and that this psychological distance reduces people's perception of risk (McDonald et al., 2015). For example, one respondent mentioned that:

When faced with a serious scenario of epidemic prevention and control, I will pay attention to the development of the epidemic in my neighborhood and get information about the development of the epidemic in many ways, especially when I see that there is a confirmed case of the disease in a local or nearby place. Then, I will feel that the current scenario is not optimistic and I will be worried.

Therefore, we hypothesize that:

> H7: Psychological distance has a negative impact on online users' risk perception.

Through the analysis of the materials, people in the epidemic will continue to receive detailed information from various sources, and in the case of a public health emergency, the longer the time, the more information obtained, and the greater the psychological ups and downs of people. There is no certainty about the risk of the epidemic. One interviewee said: *"It's useless just to know the numbers. We only know where and how many people have recovered. It can be good and bad when it's far away from us. We do not know whether it will be okay or not. We still have to get on with our lives".*

Therefore, we hypothesize that:

> H8a: Psychological distance mediates between perceived information diagnosability and risk perception.
> H8b: Information diagnosability and psychological distance have a chain mediating effect in the process of information fluency influencing risk perception.
> H8c: Information diagnosability and psychological distance have a chain mediating effect in the process of information extensibility influencing risk perception.

One respondent stated: *"I can see whether my place is at risk or not by using the epidemic map app, and I am relieved if the number is 0."* The number is an abstract expression, and it shows that information with a high level of interpretation will distance individuals psychologically and reduce their risk perception. However, another respondent said: *"I think the platform with live or short videos can suddenly make me worried and anxious, and then I am more susceptible to influence …"* This indicates that high scenario embedding allows individuals to shorten the psychological distance by indenting social distance, making individuals associate events with their current scenario, thereby increasing their risk perception.

Therefore, we hypothesize that:

> H9a: Psychological distance mediates the relationship between perceived scenario embeddedness and risk perception.

An interviewee noted that: *"when viewing the news of the epidemic, it is easier to see other people's comments, so I unconsciously want to read more about other online users' opinions."* This shows that with more interaction on the platform, people can share their views and opinions through retweeting and commenting, thereby shortening the social distance between people. Closer social distance makes individuals more sensitive and cautious about risky events.

Therefore, we hypothesize that:

> H9b: scenario embeddedness and psychological distance have a chain mediating effect in the process of platform interactivity affecting risk perception.
> H9c: scenario embeddedness and psychological distance have a chain mediating effect in the process of network connectivity affecting risk perception.

3.2.3. Moderating factors

Self-efficacy in this study is defined as the degree of confidence people have in their ability to take various types of measures to keep themselves safe from COVID infection while participating in social activities (Bandura, 1977). The interview reports show that even when online users are faced with the same risk information, they show higher levels of risk perception when their self-efficacy is low, while online users with higher self-efficacy have lower risk perceptions.

Therefore, we hypothesize that:

> H10: Individual self-efficacy positively moderates the effect of psychological distance on risk perception.

3.2.4. Result

Risk perception is the result of an individual's multidimensional perception and experience of possible risks in the external environment and that this risk perception is closely related to life and health in the context of public health emergencies (Slovic, 1987; Wildavsky and Dake, 1990; Kahlor et al., 2010). In the current era of highly prevalent social media, the media is more likely to influence users' risk perceptions by disseminating risk information, and the public relies more on media information for risk assessment and judgment. In this paper, since the issue of the influence of the information ground on online users' risk perception is explored in the specific context of a public health emergency, the object of risk perception refers to the perception of health risks, specifically the assessment of the possibility and severity of one's health being harmed by a specific public health emergency, and the concerns and fears of this health risk.

4. Quantitative study

4.1. Methodology

4.1.1. Study locale

The present study has been conducted in Nanjing, the capital of Jiangsu Province in China. The online survey was used to gather primary data according to the research goals. The research goal was explained to all survey participants and their agreement was obtained. The researchers did a quality check while the data were being gathered. All the people who participated in the study were entirely voluntary, and they were told their information would only be used for research purposes.

4.1.2. Study design

In order to avoid the influence of factors such as subjects' memory and platform usage preferences, and to ensure the validity of the study data and the accuracy of the results, this study used a scenario questionnaire to collect research data.

According to the theoretical model, information fluency, information extensibility, platform interactivity, and network connectivity are all scenario variables, and can be manipulated. Based on construal level theory (CLT; Trope et al., 2007) and the results of our previous paper, it can be shown that these scenario variables were characterized by both high and low construal levels, but there are multiple levels of combination between different information ground elements. In other words, the information fluency of a specific information ground may show a high construal level, but its place characteristics, such as interactivity, may show a low construal level. Based on this, we took different levels of values for each explanatory variable at the construal level. The scenario grouping design was based on factorial design and orthogonal design methods. The four scenario

variables involved in the experiment were combined according to different levels. In line with the full factor experimental design, all combinations of the factors at different levels were obtained, with a total of $2^4 = 16$ scenarios. In order to improve the efficiency of scenario design, this study used the orthogonal experimental design function of SPSS-27 software[1] to finally generate eight combined scenarios. In the actual questionnaire distribution, scenarios were randomly assigned to the subjects. The specific scenario grouping is listed in Table 4.

Eight sets of scenario materials were designed for the study scenarios, consisting of textual descriptions, pictures, and video links. After repeated rounds of small-scale studies, modification, and testing, the scenario materials were considered capable of enabling respondents to accurately perceive the high and low levels of different scenario variables. They were therefore used in the formal questionnaire. Specific scenario groupings and scenario descriptions are listed in Table 5.

4.1.3. Sampling

The sample size for this research was $N = 468$, which was chosen using purposive sampling. The criteria were online users who are

proficient in using Internet platforms to access health risk information about COVID-19. The information gathered during data collection was divided into categories depending on the frequency and percentages of each question in demographics, and Table 6 summarizes the findings.

There were 231 male and 237 female among the responders. A total of 208 respondents were under 26 years, 150 were between the ages of 26 and 30 years, 101 were between the ages of 31 and 40 years, nine respondents were over 41 years old. Thirteen respondents were high school graduates or below, 42 respondents had a college degree, 347 were from bachelor's degree, 66 were from master's degree or above. About 65% of respondents use micro-blog to get information about public health emergencies, more than half use news clients, and about 46% use WeChat or other social networking platforms.

The sample distribution of each scenario is presented in Table 7. Each scenario has at least 55 samples, and the sample distribution was relatively uniform. A one-way analysis of variance (ANOVA) test was performed in order to test the variability of the demographic characteristics between the different scenario groups to ensure the validity of the subsequent hypothesis testing. According to Table 8, the aspects of gender, age, educational attainment level, and whether the subject or people around them were infected with COVID-19 were not significantly different at the 0.01 level, which means that there were no significant differences between the sample demographic characteristics of each scenario grouping. Next, a one-way ANOVA analysis of each variable was performed with the aim of testing whether the scenario subgroups had a significant effect on the study variables. The test results showed that all study variables in each subgroup were significantly different at the 0.01 level, indicating that the scenario grouping was valid.

4.1.4. Data collection

The measurement items of the scale were based on the scale information used in the existing domestic and international literature, and the scale suitable for this study was designed by combining the results of open coding in the rooting analysis of this paper. A 5-level Likert scale was used to measure each latent variable, with response options of "1" (strongly disagree) to "5" (strongly agree). Demographic

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1 https://www.ibm.com/spss

TABLE 4 Design of scenario grouping.

Scenario	IF	IE	PI	NC
1	High	Low	High	Low
2	Low	Low	High	High
3	High	Low	Low	High
4	Low	High	Low	High
5	Low	Low	Low	Low
6	Low	High	High	Low
7	High	High	Low	Low
8	High	High	High	High

TABLE 5 Scenario variable description.

Scenario variables	Level	Specific text description of the scenario
IF	High	You want to know about the epidemic scenario of the new type of coronary pneumonia. You have seen the following reports, including text, pictures or videos. The text part succinctly introduces the course and consequences of the event, and the writing is smooth. The number of infected people and the location of the incident and other important information are clear; Pictures and videos provide more detailed information.
	Low	You want to know about the epidemic scenario of the new type of coronary pneumonia. You can see the following report. The text organization of the report is quite lengthy, which takes a long time to read. The key figures and locations need to be carefully searched to determine. There are some professional terms that make it difficult to understand.
IE	High	You want to know more about the epidemic scenario of this new type of coronary pneumonia. The pictures or videos provide a more detailed introduction. In addition, the titles and network links of more relevant information are also provided to help you further explore.
	Low	You want to know more about the epidemic scenario of this new type of coronary pneumonia, but there is no more information to show.
PI	High	You want to check the views of other network users on the new coronary pneumonia epidemic. It is found that the platform has a user comment function. You can easily see the comments of other users and publish your own views. At the same time, you can also like or forward the information and communicate with other friends.
	Low	You want to check the views of other network users on this new type of coronary pneumonia epidemic, but you find that the platform has not opened the user comment function, and you can neither see nor comment on other users' comments.
NC	High	You often use this platform to communicate with others, and your family and friends are using this platform.
	Low	You rarely use this platform to communicate with others, and your family and friends rarely use this platform.

TABLE 6 Sample description and statistical results.

Content	Category	Frequency	Percentage (%)
Gender	Male	231	49.36
	Female	237	50.64
Age	Under 18	5	1.07
	18–25	203	43.38
	26–30	150	32.05
	31–40	101	21.58
	41–50	7	1.5
	Over 50	2	0.43
Education level	High school and below	13	2.78
	Higher vocational colleges	42	8.97
	Undergraduate college	347	74.15
	Master or above	66	14.1
Have you personally experienced the COVID-19	Yes	44	9.4
	No	424	90.6
Platforms for understanding information related to public health emergencies	Micro-blog	306	65.38
	News client	240	51.28
	Baidu and other search platforms	54	11.54
	WeChat and other social platforms	218	46.58
	Zhihu question and answer platform	120	25.64
	Short video platforms such as Tiktok	121	25.85
	Other	10	2.14

TABLE 7 Sample distribution.

Scene	Number of samples	Proportion of samples	Scene	Number of samples	Proportion of samples
1	55	11.75%	5	58	12.39%
2	59	12.61%	6	60	12.82%
3	57	12.18%	7	57	12.18%
4	63	13.46%	8	59	12.61%

TABLE 8 One-way ANOVA results of demographic characteristics of each scenario group.

Demographic characteristics		Gender	Age	Education level	Experience or not	Significance
Grouping (mean ± standard deviation)	1.0 ($n = 55$)	1.45 ± 0.50	2.74 ± 0.80	3.02 ± 0.47	1.98 ± 0.15	*$p < 0.05$
	2.0 ($n = 59$)	1.49 ± 0.51	2.82 ± 0.85	3.00 ± 0.56	1.90 ± 0.31	**$p < 0.01$
	3.0 ($n = 57$)	1.46 ± 0.51	2.95 ± 0.97	2.95 ± 0.76	1.85 ± 0.37	
	4.0 ($n = 63$)	1.47 ± 0.51	2.79 ± 0.91	2.82 ± 0.69	1.92 ± 0.27	
	5.0 ($n = 58$)	1.47 ± 0.51	2.89 ± 0.95	2.84 ± 0.68	1.97 ± 0.16	
	6.0 ($n = 60$)	1.50 ± 0.51	2.88 ± 0.85	3.02 ± 0.58	1.98 ± 0.16	
	7.0 ($n = 57$)	1.54 ± 0.51	2.90 ± 0.99	3.00 ± 0.61	1.82 ± 0.39	
	8.0 ($n = 59$)	1.49 ± 0.51	2.76 ± 0.80	2.97 ± 0.60	1.89 ± 0.31	
F		0.254	0.395	0.921	1.563	
p		0.993	0.958	0.519	0.107	

variables such as gender, age, education, and experience have been shown to have an effect on individual risk perception. Therefore, to control for the potential role of these variables on individual perception of risk in major public health emergencies, gender, age, education, and any experience of major public health emergencies were selected as control variables.

In this study, a pilot study was conducted before the formal distribution of the questionnaire. A total of 45 pre-survey questionnaires were collected during the pre-survey stage. Based on the results of the pre-survey, the scenario materials and individual measurement items of the questionnaire were modified and improved, the final questionnaire is shown in Supplementary Appendix 1.

The questionnaires were produced and distributed by Questionnaire Star. A total of 492 questionnaires were distributed to the target research groups through social media platforms such as WeChat, QQ, and Pinning between July 25 and August 20, 2021. Participants received a link to the website and were invited to participate freely in the study by answering the online questionnaire. Each participant was randomly assigned to one of eight situational experimental groups. Participants saw the material display matching the situation, including text descriptions and picture information. After reading these background materials, they answered the questions in the scale.

After eliminating invalid questionnaires, 468 valid forms remained, with a validity rate of 95.1%.

4.1.5. Operationalization of study variables

The questionnaires included nine variables to gather data, and 41 items were included in the questionnaires. The study's conceptual framework contained four independent variables (such as information fluency, information extensibility, platform interactivity, and network connectivity), three mediators (such as information diagnosability, scenario embeddedness, and psychological distance), one moderator (such as self-efficacy) and one dependent variable (such as risk perception).

4.2. Results

4.2.1. Measurement model

4.2.1.1. Descriptive statistics of measurement indicators

SPSS-27 was used to describe and statistically analyze the measurement items, and the normality of each indicator was tested. The specific data are listed in Table 9. It can be seen that the data distribution is not normal. Therefore, when selecting the analysis method for the data analysis stage, we considered selecting the structural equation model (SEM) of the partial least squares (PLS) method, and used SmartPLS3.0 software[2] to test the model.

4.2.1.2. Reliability and validity test

The test of internal consistency in this study used the Cronbach coefficient in combination with validated factor analysis to assess the internal structure of the scale. As Table 10 presents, the Cronbach coefficients of the nine constructs presented in this study were all greater than 0.9, and the factor loadings of most of the measured variables were above 0.9. The factor loadings of SE1 and SE6 were 0.796 and 0.796, respectively, which is generally acceptable insofar as the factor loadings were greater than 0.7. In short, the scales in this study had good reliability.

Structural validity is generally judged by calculating the convergent validity and discriminant validity values. The CR values of all the

constructs in this paper exceeded 0.9, as is clear from Table 11, and the AVE values exceeded 0.7, indicating that the convergent validity of the measures was good and could satisfy further analysis. Comparing the open-square value of AVE with its lower correlation coefficient value shows that the open-square value of AVE was always greater than the correlation coefficient value. Therefore, the discriminant validity passed the test.

4.2.1.3. Common method bias test

The nine extracted common factors explained 90.854% of the total variance. Moreover, nine factors had characteristic roots greater than 1, and the percentage of cumulative variance explained by the first factor was 26.124%, less than the critical value of 40%, indicating that there was no significant common method bias in the measurement and there was no serious impact on the validity of the results.

4.2.1.4. Model fitting evaluation

The indicators used by SmartPLS to evaluate the model fit were R^2 and Q^2, with R^2 measuring the extent to which the endogenous latent variables could be explained and Q^2 measuring the predictive power of the model. The fitting results of the model are listed in Table 12. The R^2 of the endogenous latent variables presented in this model were all greater than 0.3, and the R^2 of risk perception reached 0.449, indicating that the model had good explanatory strength. The Q^2 of each endogenous latent variable was greater than 0, indicating that the research model used in this study had some predictive validity.

4.2.2. Structural equation model

The significance of the path coefficients was calculated using bootstrapping.

The standard beta was utilized to determine the significance of the hypotheses, and the beta value indicates how distinct variables may differ. The hypothesized research model was used to obtain the standardized beta (β) value for each connection. The importance of endogenous latent variables will be judged crucial if beta (β) values are large and significant. The importance of each path's beta value was determined using T-statistics and p-value.

4.2.2.1. Direct effects

The direct effect relationships between the variables in the model were tested. Overall, as Table 13 shows, 6 of our hypotheses are supported and significant at the $p < 0.01$ level, one hypotheses is supported and significant at the $p < 0.05$ level. Our results highlight information fluency and information extensibility may enhance information diagnosability (H1, $\beta = 0.136$, $t = 2.271$, $p < 0.05$; H2, $\beta = 0.267$, $t = 4.631$, $p < 0.01$), platform interactivity and network connectivity may enhance scenario embeddedness (H3, $\beta = 0.276$, $t = 5.527$, $p < 0.01$; H4, $\beta = 0.354$, $t = 6.907$, $p < 0.01$), information diagnosability and scenario embeddedness have negative impact on users' psychological distance (H5a, $\beta = -0.182$, $t = 6.857$, $p < 0.01$; H6a, $\beta = -0.635$, $t = 19.773$, $p < 0.01$), and psychological distance has a negative impact on online users' risk perception (H7, $\beta = -0.408$, $t = 10.689$, $p < 0.01$).

4.2.2.2. Mediating effects

For the test of multiple mediating effects, the bootstrapping method was used to test the total indirect and specific indirect effects of the mediating effects. The results of the test are compiled and summarized in Table 14.

TABLE 9 Descriptive statistical results of measurement fluency indicators.

Variables	Measurement items	Average value	Standard deviation	Skewness	Kurtosis	Kolmogorov-Smirnov test		Shapro-Wilk test	
						D	P	W	P
IF	IF1	3.207	1.395	−0.027	−1.335	0.181	0.000**	0.876	0.000**
	IF2	3.22	1.402	0.067	−1.547	0.267	0.000**	0.83	0.000**
	IF3	3.049	1.42	0.26	−1.351	0.229	0.000**	0.844	0.000**
	IF4	3.141	1.44	0.088	−1.47	0.235	0.000**	0.851	0.000**
IE	IS1	2.936	1.322	−0.021	−1.374	0.251	0.000**	0.864	0.000**
	IS2	2.947	1.328	−0.017	−1.377	0.25	0.000**	0.864	0.000**
	IS3	2.885	1.269	0.079	−1.101	0.185	0.000**	0.906	0.000**
	IS4	3.291	1.405	−0.35	−1.334	0.287	0.000**	0.841	0.000**
ID	ID1	3.13	1.377	−0.167	−1.181	0.17	0.000**	0.892	0.000**
	ID2	3.209	1.277	−0.025	−1.119	0.162	0.000**	0.899	0.000**
	ID3	3.269	1.287	−0.149	−1.197	0.2	0.000**	0.891	0.000**
PI	PI1	3.56	1.444	−0.752	−0.848	0.291	0.000**	0.805	0.000**
	PI2	3.543	1.341	−0.525	−1.05	0.253	0.000**	0.849	0.000**
	PI3	3.382	1.278	−0.349	−1.03	0.222	0.000**	0.888	0.000**
SE	PE1	3.246	1.278	−0.097	−1.122	0.165	0.000**	0.9	0.000**
	SE2	3.308	1.362	−0.115	−1.343	0.191	0.000**	0.873	0.000**
	SE3	3.355	1.375	−0.171	−1.354	0.188	0.000**	0.866	0.000**
	SE4	3.361	1.376	−0.184	−1.354	0.189	0.000**	0.866	0.000**
NC	NC1	3.041	1.196	−0.018	−1.146	0.22	0.000**	0.89	0.000**
	NC2	3.039	1.223	0.011	−1.208	0.228	0.000**	0.884	0.000**
	NC3	2.94	1.294	0.266	−1.375	0.315	0.000**	0.825	0.000**
	NC4	2.853	1.339	0.266	−1.341	0.296	0.000**	0.845	0.000**
PD	PD1	3.643	1.044	−0.424	−1.014	0.292	0.000**	0.831	0.000**
	PD2	3.878	0.955	−0.524	−0.634	0.249	0.000**	0.851	0.000**
	PD3	3.667	1.178	−0.664	−0.305	0.208	0.000**	0.87	0.000**
	PD4	3.748	1.02	−0.329	−1.01	0.219	0.000**	0.863	0.000**
	PD5	3.737	0.965	−0.272	−0.894	0.221	0.000**	0.871	0.000**
RP	RP1	2.673	1.301	0.296	−1.201	0.251	0.000**	0.872	0.000**
	RP2	2.938	1.408	0.096	−1.355	0.211	0.000**	0.88	0.000**
	RP3	2.897	1.306	0.121	−1.081	0.168	0.000**	0.905	0.000**
	RR4	2.774	1.299	0.415	−1.088	0.28	0.000**	0.864	0.000**
SEF	SE1	3.635	0.823	−0.136	−0.5	0.25	0.000**	0.867	0.000**
	SE2	3.239	0.931	0.018	−1.092	0.237	0.000**	0.853	0.000**
	SE3	3.041	1.057	−0.07	−1.215	0.258	0.000**	0.85	0.000**
	SE4	3.107	1.023	0.291	−1.041	0.219	0.000**	0.864	0.000**
	SE5	2.942	1.003	0.359	−1.25	0.292	0.000**	0.806	0.000**
	SE6	3.47	0.949	−0.14	−0.933	0.246	0.000**	0.871	0.000**
	SE7	3.254	0.924	0.112	−0.941	0.209	0.000**	0.868	0.000**
	SE8	3.105	0.981	−0.198	−0.734	0.219	0.000**	0.89	0.000**
	SE9	3.382	0.896	−0.2	−0.906	0.27	0.000**	0.852	0.000**
	SE10	2.9	1.062	0.029	−0.926	0.21	0.000**	0.896	0.000**

**$p < 0.01$.

H5b was supported because information fluency had a significant direct effect on psychological distance ($\beta = 0.076$, $t = 2.372$, $p < 0.05$), the mediating effect of information diagnosability on information fluency and psychological distance was significant ($\beta = -0.025$, $t = 2.120$, $p < 0.05$). H5c also was supported where the mediating effect of information diagnosability on information extensibility and

psychological distance was significant ($\beta = -0.042$, $t = 2.617$, $p < 0.01$); however, the direct effect of information extensibility on psychological distance was not significant, and it could be inferred that information diagnosability completely mediated the impact of information extensibility on psychological distance. H6b was supported because platform interactivity had a significant direct effect on psychological distance ($\beta = 0.214$, $t = 6.299$, $p < 0.01$), and the mediating effect of scenario embeddedness on platform interactivity and psychological distance was significant ($\beta = -0.141$, $t = 5.485$, $p < 0.01$). H6c was supported because network connectivity had a significant direct effect on psychological distance ($\beta = -0.558$, $t = 13.420$, $p < 0.01$). Moreover, scenario embeddedness mediated the relationship between network connectivity and psychological distance ($\beta = -0.175$, $t = 6.205$, $p < 0.01$). H8a and H9a were supported because the mediating effect of psychological distance on information diagnosability and risk perception was significant ($\beta = 0.138$, $t = 4.507$, $p < 0.01$); the mediating effect of psychological distance on scenario embeddedness and risk perception was significant ($\beta = 0.407$, $t = 8.798$, $p < 0.01$). Information diagnosability had a significant direct effect on risk perception ($\beta = -0.209$, $t = 6.755$, $p < 0.01$), scenario embeddedness had a significant direct effect on risk perception ($\beta = -0.407$, $t = 6.284$, $p < 0.01$), and thus it could be inferred that psychological distance played significant mediating roles in the multivariate relationships. Information fluency and information extensibility were chain mediated by information diagnosability and psychological distance in the process of affecting risk perception ($\beta = 0.020$, $t = 2.079$, $p < 0.05$; $\beta = 0.034$, $t = 2.596$, $p < 0.01$), and the total effect of information fluency on risk perception and information

extensibility on risk perception was significant, but the direct effect of information extensibility on risk perception was not significant. It could therefore be inferred that H8b and H8c were both valid. Platform interactivity and network connectivity were chain mediated by scenario embeddedness and psychological distance in the process of affecting risk perception ($\beta = 0.114$, $t = 4.835$, $p < 0.01$; $\beta = 0.142$, $t = 5.820$, $p < 0.01$), and the total effect of platform interactivity on risk perception and network connectivity on risk perception was significant; therefore, it could be inferred that H9b and H9c were both valid.

4.2.2.3. Moderating effect

The analysis of the moderating effect was first based on the analysis of the main effect, and the direction of the moderating effect could be determined only after the direction of the main effect influencing relationship was determined. The original hypothesis of this study pointed out that psychological distance negatively affected users' risk perceptions. Having tested this hypothesis, we obtained data to support it. According to the process of moderating effect analysis, as psychological distance and risk perception are negatively related, self-efficacy and risk perception were also negatively related. Therefore, this study concluded that users' self-efficacy could play a positive moderating role in the relationship between psychological distance and risk perception. We proposed hypothesis H10 to investigate the role of different levels of self-efficacy on the degree to which psychological distance affected risk perception. We tested this hypothesis, and the results showed that, after adding the moderating effect, the path test was passed ($\beta = -0.209$, $t = 5.737$, $p < 0.01$), indicating that the moderating effect was significant and, simultaneously, the main effect of psychological distance on risk perception was significant; the risk perception's R^2 rose to 0.449 compared with when not including moderating variables, indicating that the overall explanatory power of the model was higher with inclusion of the moderating effect of self-efficacy.

5. Discussion and implications

5.1. Discussion

COVID-19 threatens people's physical and psychological health (Peng et al., 2022). This study investigates the factors affecting online users' perceived health risks in China during COVID-19, and all hypotheses were proven valid.

Cognitive processing theory states that different cognitive activities imply different levels of difficulty for individuals (Jacoby et al., 1989), lower levels of fluency trigger individuals' fine-tuned processing of

TABLE 10 Results of reliability and validity tests.

Variables	Cronbach's α	CR	AVE	Square root of AVE
IF	0.993	0.991	0.982	0.965
IE	0.924	0.927	0.876	0.768
ID	0.949	0.986	0.98	0.96
PI	0.978	0.957	0.939	0.881
SE	0.991	0.983	0.968	0.937
NC	0.968	0.973	0.95	0.902
PD	0.959	0.96	0.911	0.831
RP	0.963	0.964	0.933	0.87
SEF	0.966	0.968	0.868	0.754

TABLE 11 Results of discrimination validity test.

	IF	IE	ID	PI	SE	NC	PD	PR	SEF
IF	0.982								
IE	−0.256	0.876							
ID	0.043	0.048	0.980						
PI	−0.096	0.077	0.185	0.939					
SE	0.121	0.271	−0.502	−0.006	0.968				
NC	−0.281	0.238	−0.108	0.419	0.092	0.950			
PD	−0.053	−0.014	0.074	−0.038	0.317	0.265	0.911		
PR	0.010	−0.085	0.108	0.254	0.189	0.144	0.470	0.933	
SEF	−0.193	0.210	0.010	−0.092	−0.238	0.156	−0.236	−0.520	0.868

stimuli and require more cognitive resources from the cognizer, whereas higher levels of fluency trigger individuals' heuristic processing, which does not require individuals to consume excessive cognitive resources and allow for easier processing of information in a short period time (Kruger and Evans, 2004). Information with higher fluency will reduce individual cognitive load, improve individual information processing efficiency, help individuals form risk perceptions faster, reduce the psychological distance (McDonald et al., 2015) and enhance their perceptions of the diagnosability of information (Korfiatis et al., 2012; Karimi and Wang, 2016). According to the result of the SEM model, these hypotheses (H1: Information fluency $\rightarrow$ Information diagnosability, $\beta = 0.136$, $t = 2.271$, $p < 0.05$; H5b: Information fluency $\rightarrow$ Information diagnosability $\rightarrow$ Psychological distance, $\beta = -0.025$, $t = 2.120$, $p < 0.05$; H7: Psychological distance $\rightarrow$ Risk perception, $\beta = -0.408$, $t = 10.689$, $p < 0.01$; H8b: Information fluency $\rightarrow$ Information diagnosability $\rightarrow$ Psychological distance $\rightarrow$ Risk perception, $\beta = 0.020$, $t = 2.079$, $p < 0.05$) are confirmed.

The demand for information is a reflection of the online users' demand for complete openness and transparency of information at the beginning of the epidemic. The individual believes that more information can effectively help them make judgments, and at the same time, the individual clearly recognizes that the perception and judgment of risks in the process of information processing requires individuals to improve their discernment and comprehensive understanding of the vast amount of information. The richer the information, the more conducive it is to the perception and memory of the information receiver, which affects an individual's risk perception (Byron et al., 2018). Our study confirms these points (H2: Information extensibility $\rightarrow$ Information diagnosability, $\beta = 0.267$, $t = 4.631$, $p < 0.01$; H5c: Information extensibility $\rightarrow$ Information diagnosability $\rightarrow$ Psychological distance, $\beta = -0.042$, $t = 2.617$, $p < 0.01$; H8c: Information extensibility $\rightarrow$ Information diagnosability $\rightarrow$ Psychological distance $\rightarrow$ Risk perception, $\beta = 0.034$, $t = 2.596$, $p < 0.01$).

Studies have shown that the presence of interactive features on platforms can effectively increase the sense of user presence on commercial websites (Vendemia, 2017), and the reviewability and

permanence of content allow users to repeatedly view and communicate across time and space (Bucy, 2004). Therefore, good interactivity enhances communication between users and information publishers as well as other users, and will quickly increase the psychological distance between users and generate empathy. Our findings suggest that platform interactivity can influence users' perceptions of health risks (H3: Platform interactivity $\rightarrow$ Scenario embeddedness, $\beta = 0.276$, $t = 5.527$, $p < 0.01$; H6b: Platform interactivity $\rightarrow$ Scenario embeddedness $\rightarrow$ Psychological distance, $\beta = -0.141$, $t = 5.485$, $p < 0.01$; H9b: Platform interactivity $\rightarrow$ Scenario embeddedness $\rightarrow$ Psychological distance $\rightarrow$ Risk perception, $\beta = 0.114$, $t = 4.835$, $p < 0.01$).

Network connectivity refers to the frequency of user interactions in a platform and is mainly characterized by a higher frequency of interactions, emotional intimacy, and reciprocity (Sparrow et al., 2001). The study shows that if the internal network connectivity among members is stronger, it is more likely to generate stable emotional connections and higher internal trust. In addition, based on higher quality internal relationships, information flow between members is more frequent, and it is easier to pass on hidden personal information (Kanter, 2009). The more frequent the interaction between users on the platform, the more familiar the users are with each other, then the users will have a stronger sense of connection with each other and will be more susceptible to the risk information on the platform, as the results of our empirical study demonstrate (H4: Network connectivity $\rightarrow$ Scenario embeddedness, $\beta = 0.354$, $t = 6.907$, $p < 0.01$; H6c: Network connectivity $\rightarrow$ Scenario embeddedness $\rightarrow$ Psychological distance, $\beta = -0.175$, $t = 6.205$, $p < 0.01$; H9c: Network connectivity $\rightarrow$ Scenario embeddedness $\rightarrow$ Psychological distance $\rightarrow$ Risk perception, $\beta = 0.142$, $t = 5.820$, $p < 0.01$).

The result of H5a (Information diagnosability $\rightarrow$ Psychological distance, $\beta = -0.182$, $t = 6.857$, $p < 0.01$) indicates information diagnosability may negatively affect a user's psychological distance to perceiving health risk. This means that when online users are dealing with risk information related to public health emergencies, the more the risk information they perceive matches their needs and helps them identify and judge risks, the more likely individuals are to have a closer psychological distance to physical risks; in contrast, low diagnostic risk information makes users more likely to have a greater psychological distance. The result of H6a (Scenario embeddedness $\rightarrow$ Psychological distance, $\beta = -0.635$, $t = 19.773$, $p < 0.01$) reveals scenario embeddedness has a significant negative impact on psychological distance, which is consistent with the findings of previous studies (Lerche et al., 2018). High interactivity can enhance communication between users and information publishers, as well as other users. However, different from the findings of previous studies, we found that platform interactivity and

TABLE 12 Model fit evaluation.

Variable	R^2	Adjusted-R^2	RMSE	MAE	Q^2
ID	0.314	0.310	0.953	0.778	0.19
PD	0.431	0.428	0.820	0.682	0.333
SE	0.323	0.320	0.830	0.678	0.316
RP	0.525	0.518	0.865	0.756	0.257

TABLE 13 Results of direct effect test.

Hypotheses	Path coefficients	Sample means	Standard deviation	T-statistics	p-Value
H1	0.267	0.269	0.058	4.631	0.000**
H2	0.136	0.139	0.06	2.271	0.024*
H3	0.276	0.274	0.05	5.527	0.000**
H4	0.354	0.357	0.051	6.907	0.000**
H5a	−0.182	−0.183	0.027	6.857	0.000**
H6a	−0.635	−0.633	0.032	19.773	0.000**
H7	−0.408	−0.404	0.038	10.689	0.000**

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

TABLE 14 Results of mediating effect test.

Hypotheses	Indirect effect	T-statistics	p-value	Direct effect	T-statistics	p-value	Total effect	T-statistics	p-value	Types
H5b	−0.025	2.120	0.034*	0.076	2.372	0.014*	0.051	1.583	0.095	Partial mediation
H5c	−0.042	2.617	0.009**	0.044	1.024	0.323	0.002	0.055	0.957	Full mediation
H6b	−0.141	5.485	0.000**	0.214	6.299	0.000**	0.073	1.623	0.097	Partial mediation
H6c	−0.175	6.205	0.000**	−0.558	13.420	0.000**	−0.733	21.821	0.000**	Partial mediation
H8a	0.138	4.507	0.000**	−0.269	6.755	0.000**	−0.131	2.317	0.029	Partial mediation
H8b	0.020	2.079	0.038*	−0.184	3.801	0.000**	−0.265	4.733	0.000**	Partial mediation
H8c	0.034	2.596	0.005**	−0.048	0.940	0.366	−0.116	1.897	0.058	Full mediation
H9a	0.407	8.798	0.000**	−0.407	6.284	0.000**	0.001	0.010	0.992	Partial mediation
H9b	0.114	4.835	0.000**	0.308	7.537	0.000**	0.135	2.984	0.004**	Partial mediation
H9c	0.142	5.820	0.000**	−0.277	5.635	0.000**	0.175	3.351	0.002**	Partial mediation

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

network connectivity have a different impact on the psychological distance; compared with platform interactivity, network connectivity had a greater impact, which indicated that the interaction intensity and atmosphere between platform users could make it easier for users to embed scenarios, thus narrowing the psychological distance.

Through SEM examination of the overall model, we found that, in the context of public health emergencies in China, various elements of the risk information ground indirectly affect the perception of health risks through individual psychological distance. By comparison, under the condition of controlling the diagnostic ability and psychological distance of information, information extensibility has a greater impact on individual risk perception (H8a: Information diagnosability → Psychological distance → Risk perception, $\beta = 0.407$, $t = 8.798$, $p < 0.01$; H9a: Scenario embeddedness → Psychological distance → Risk perception, $\beta = -0.407$, $t = 6.284$, $p < 0.01$). This also shows that, compared with the comprehensibility of information, a large amount of rich information about public health emergencies can cause online users to have a higher risk perception, platform interaction, and network connectivity to have a higher impact on individual risk perception than information fluency and information extensibility.

Self-efficacy strengthens the negative impact of psychological distance on risk perception. Previous studies have confirmed that self-efficacy affects users' processing of risk information, thus negatively affecting individuals' risk perception (Zhang et al., 1999). Some researchers have used self-efficacy as an intermediary factor to predict the role of media use on risk perception (Engelman et al., 2017; Gao, 2021). Different from these studies, this study regards self-efficacy as a moderating factor due to the fact that in the pre-interview we found different individuals showed significant differences in risk perception against the same or similar risk information background, and the significant differences in their reported self-efficacy attracted our attention. The result of H10 reveals the moderating effect of self-efficacy. The psychological distance of individuals with low self-efficacy had a greater negative impact on risk perception than that of individuals with high self-efficacy. With increasing psychological distance, the risk perception of individuals with high self-efficacy reduces more quickly than that of individuals with low self-efficacy. For users with the latter, psychological distance has less impact on their perceived risk. At the same level of psychological distance, the risk perception level of individuals with low self-efficacy is significantly higher than that of individuals with high self-efficacy.

5.2. Implications

In order to guide online users to form rational risk perceptions in public health emergencies, the psychological distance of individuals from risk can be influenced by rationally publishing online risk information and managing the features of online platforms to adjust their perceptions of risk. This psychological distance can originate from two directions: information features and place features. From the perspective of information features, we should first pay attention to the role of information diagnosability. We have noticed that, for online users in specific situations, individuals pay more attention to the quality of information than to its quantity. Whether the information about risks is clearly defined, has sufficient depth of interpretation of risks, or is useful for users to judge risks, affects the psychological distance of individuals to those risks. On this premise, information providers should give priority to ensuring the quantity and richness of information in order to meet the information needs of online users, followed by the readability

and understandability of that information, that is, the smoothness of information. From the perspective of site characteristics, we have noticed that, as an edge path, information platform features play a greater role in individual risk perception, and are the key source of individual "magnifying" or "narrowing" risk perception. Therefore, different types of risk information need to be matched with appropriate release platforms. In addition, the moderating role of self-efficacy needs to be emphasized, especially in the early stages of public health emergencies. By providing rich and effective self-help health information to help users build confidence in the face of risks, on the one hand this can reduce the risk amplification effect of users being flooded with a large quantity of risk information, and on the other hand can also help users establish a rational attitude toward objective risks as soon as possible.

6. Conclusion

With the widespread use of Internet platforms, people have more diverse ways to obtain health risk information and have easy and abundant access to information about public health emergencies. The wealth of information affects online users' perceptions of health risks, and different risk perceptions can lead to differentiated attitudes and behaviors, which in turn bring about risk consequences. This study investigates the information ground factors affecting online users' perception of health risks in China during COVID-19. The empirical results show that information fluency, information extensibility, platform interactivity, and network connectivity affect online users' perception of health risks, while information diagnosability, scenario embeddedness, and psychological distance mediate and self-efficacy moderates these relationships. This study is valuable because it provides a new perspective and useful recommendations for online platform managers and risk managers.

7. Study limitations

This study also had several limitations, given that different types of public health emergencies exhibit certain differences in their involved populations, hazard characteristics, and that this study was conducted in a Chinese scenario. Future studies will need to identify the mechanisms that affect online users' perceived health risks in different types of public health emergencies and different cultural contexts and conduct cross-cultural comparative studies.

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

SH was responsible for data analysis and manuscript writing. QY was responsible for conceptualization. CZ, GC, and HS were responsible for formal analysis, and all of us were jointly responsible for the data coding. 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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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1087229/full#supplementary-material

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Effects of resourcefulness on internet game addiction among college students: The mediating role of anxiety and the moderating role of gender

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Introduction: The mechanism of internet game addiction is unclear. Whether anxiety mediates between resourcefulness and internet game addiction and whether gender affect its mediation role have not been studied previously.

Methods: A total of 4,889 college students from a college in southwest China were included in this study to complete the investigation, in which three questionnaires were used for evaluation.

Results: Pearson's correlation analysis indicated a remarkable negative correlation between resourcefulness with internet game addiction and anxiety, as well as a significant positive correlation between anxiety and this addiction. The structural equation model confirmed the mediation role of anxiety. The multi-group analysis confirmed the moderating role of gender in the mediation model.

Discussion: These findings have advanced the results of existing studies, indicating the buffering effect of resourcefulness on internet game addiction and revealing the potential mechanism of this relationship.

KEYWORDS

resourcefulness, anxiety, internet game addiction, gender, college students

Introduction

With the popularity of the internet comes potential problems. There is evidence that some college students are using the internet irrationally and are even addicted to online games (1). Internet game addiction refers to "the persistent and repeated use of the internet to engage in games that result in impairment of daily life, and the tendency to isolate oneself socially" (2, 3). This phenomenon is prevalent around the world, with one meta-analysis showing a global prevalence of 3.05% for internet game addiction (4). Studies have also reported that the prevalence of internet game addiction is 11% in the Chinese college student population (5). Internet game addiction has been officially listed under ICD-11 (the International Classification of Diseases 11th Revision) and has become a public health issue that can have a range of negative effects on college students. Internet game addiction could lead to sleep insufficiency, depression, academic difficulties, and poor creativity and productivity. It impairs the physiological, psychological and social functioning of college students (6).

"Resourcefulness is a combination of an individual's ability to carry out everyday tasks independently and the ability to seek help from outside sources when appropriate" (7, 8). It typically comprises of personal and social dimensions. "Personal resourcefulness" is the ability of an individual to maintain daily life independently, for example by using personal effort or internal resources to achieve goals in the face of potentially adverse stressful situations and stimuli (7). "Social resourcefulness" is the ability to seek help from formal or informal sources when an individual is unable to deal with a problem on his or her own (8). Although there are no previous theories that directly discuss resourcefulness and internet game addiction, Zauszniewski's *Theory of Resourcefulness and Quality of Life*© may provide support. This theory suggests that resourcefulness has a direct impact on a person's quality of life and that internet game addiction can be considered an indicator of quality of life (8–10). Although this is the first study of personal and social resourcefulness and internet game addiction, there have been empirical studies that have examined the relationship between closely related construct and addictive behavior. For example, two studies have examined the relationship between "learned resourcefulness" and addictive behavior. In these studies, "learned resourcefulness" was operationalized through self-control, which did not consider seeking help from others as a characteristic of resourcefulness (8). Accordingly, Kennett et al. reported that persons with greater "learned resourcefulness" were better able to change their alcohol-drinking and smoking habits (11). Bulut and Zeren found that Internet addiction could be predicted by "learned resourcefulness" (12). In terms of social resourcefulness, Rapp et al. reported that social resourcefulness leads to more social support (13). According to the main effect model of social support, social support affects internet addiction (14), and this relationship has similarly been tested in empirical studies (15–17). Taken together, *the Theory of Resourcefulness and Quality of Life*©, the main effect model of social support (14), and related empirical studies all suggest that resourcefulness may be an important variable in predicting internet game addiction.

The mechanism of the influence of resourcefulness on internet game addiction is unclear, and whether anxiety plays a mediating role has not been studied before. The Interaction of Person-Affect-Cognition-Execution (I-PACE) model was chosen as the framework for this study. This model emphasizes that addictive behaviors are the consequence of interactions between predisposing factors (Person's characteristics), mediators (affective and cognitive responses) and execution (Figure 1) (18). In this study, resourcefulness is a relatively stable personal characteristic, and it refers to the ability to learn (19, 20). Therefore, resourcefulness is considered a predisposing variable. Anxiety is included as a mediating variable. Internet game addiction is considered a dependent variable. Specifically, individuals who are not good at using personal and social resources may face real-world difficulties and a worse emotional state (21), and they may develop internet addiction in regulating emotions (22). Regarding personal resourcefulness, studies have shown that anxiety and depression mediate between personal resourcefulness and life satisfaction (23). As for social dimension, social resourcefulness will bring more social support (13). Social support may indirectly affects human behaviors (e.g., internet addiction and suicide) *via* emotional state (14). This is supported by a related empirical study that suggests depression mediates

between social support and suicidal ideation (24). Based on the reasoning above, the relationship between resourcefulness and internet gaming addiction should consider a psychological model that includes anxiety.

The Theory of Resourcefulness and Quality of Life© has four components, i.e., antecedent situational factors (internal demographic characteristics and external environmental factors), process regulators (perceptive, cognitive, affective, motivational, and volitional), resourcefulness (personal resourcefulness and social resourcefulness), and life quality indicators (8). Resourcefulness can directly influence quality of life, and both anxiety and internet game addiction were conceptualized as quality of life indicators in this study. Zauszniewski et al. mentioned in a previous study resourcefulness influenced anxiety (anxiety as a quality of life indicator) and vice versa (anxiety as a process regulator) (25), and this study focused on the former. Previous studies in caregivers of people with dementia (26), older adults (27), adolescents (28), and pregnant women (29) have found that resourcefulness negatively predicts anxiety, depression. And, anxiety is a major risk factor for Internet addiction, with both cross-sectional and longitudinal studies providing empirical evidence for the relationship (30, 31). One study found that cognition mediates the relationship between "learned resourcefulness" and adaptive functioning (32). Another study among college students showed that self-control influenced social anxiety, which in turn led to negative emotions and internet addiction (33). Thus, anxiety may play a mediating role.

In evaluating the factors associated with online game addiction, researchers consider demographic factors. Gender differences in addictive behaviors have been studied and are important evidence in understanding online game addiction. Some studies have noted that compared with females, males have poorer self-control ability and are bad at seeking social support (34), so they may have a higher risk of developing negative emotions and online games (35, 36). However, the opposite finding still exists, with females scoring higher than males in online gaming addiction (37). In addition, there are studies that do not find an association between gender and online addiction, possibly due to factors such as the popularity of the internet and the purpose of use (38). In summary, although no unanimous conclusion has been reached regarding the effect of gender on self-control, anxiety, and internet game addiction, the greater extent suggests that resourcefulness, anxiety, and internet game addiction may change with gender differences, and the mediating role of anxiety may also vary.

In summary, this study proposes the hypotheses that: resourcefulness has a predictive effect on internet game addiction, and anxiety is one of the mediating factor. This study also hypothesize that gender moderates the mediating effect, i.e., the mediating role of anxiety vary between male and female groups.

Methods

Participants

This is a cross-sectional survey study conducted in Southwest China in October 2022. A convenient sampling method was used
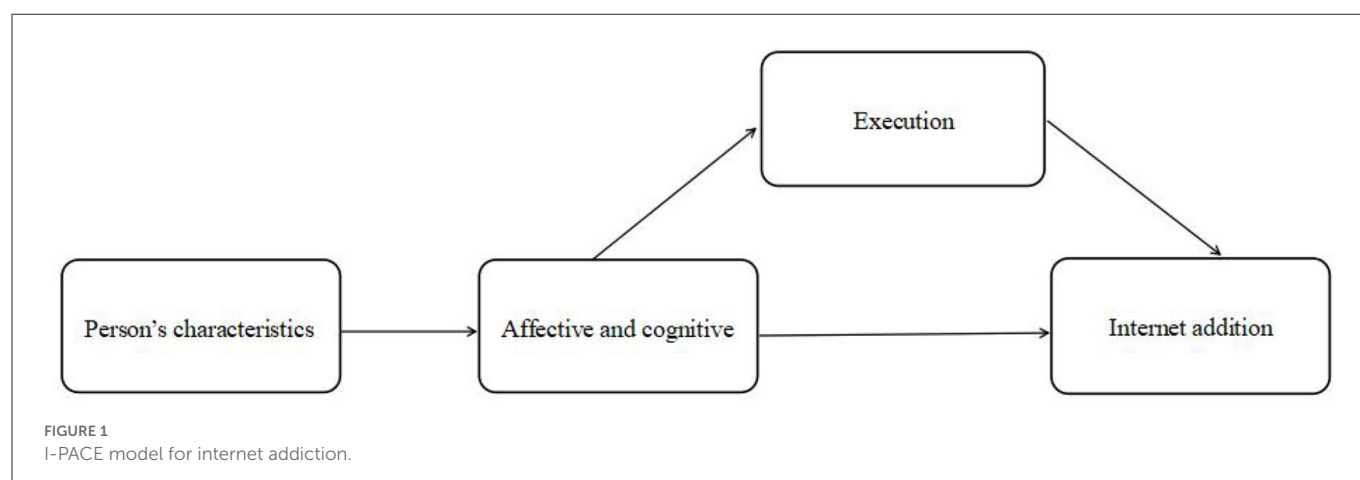
to administer a questionnaire to students of clinical medicine, nursing science, medical imagology, clinical medicine of traditional Chinese medicine and western medicine, anesthesiology, pharmacy, preventive medicine, stomatology, optometric medicine and ophthalmology, medical laboratory technology, midwifery, management science, foreign language and culture, biomedical engineering, and athletic rehabilitation. Inclusion criteria: college students at school; signed an informed consent form and voluntarily joined the study. Exclusion criteria: those with severe mental disorders that prevented them from cooperating with the survey; those who did not wish to join the study. The researcher distributed the questionnaire star QR code or link to the subjects through social media platforms, and the participants voluntarily filled in the questionnaire after reading the informed consent form. A total of 5,523 questionnaires were distributed in this study and 4,899 valid questionnaires were collected, with a response rate of 88.7%. Among them, 1,758 (35.9%) were male students and 3,141 (64.1%) were female students. The number of freshmen to 5th-year students were: 2,003 (40.9%), 970 (19.8%), 1,219 (24.9%), 574 (11.7%), and 133 (2.7%), respectively. The age of the subjects ranged from 16 to 25 years, with an average age of 19.54 ± 1.46 years. The Ethics Committee of North Sichuan Medical College confirmed that the present study adhered to ethical principles.

Measures

Demographics

Several demographic variables were collected for this study: age, grade, major, gender (1 = boy, 2 = girl), place of residence (1 = urban, 2 = rural), and whether or not the child was an only child (1 = parent with one child, 2 = parent with more than one child).

Resourcefulness

Resourcefulness was measured using the Chinese version of the Resourcefulness Scale[©], which was the translated version by Lai and Wang et al. (39, 40) of RS[©] developed by Zauszniewski et al. (7). The C-RS[©] consists of two dimensions of personal resourcefulness (16 items) and social resourcefulness (12 items). The Likert 6-point scale is used, with higher scores indicating higher levels of resourcefulness.

The Cronbach's alpha coefficient for the Chinese version of the scale was 0.898, and those for the dimensions were 0.875 and 0.797.

Anxiety

SAS was designed by Zung (41). This study used the Chinese translation of the SAS to measure anxiety (42). The scale has 20 items and is rated on a 4-point scale, with higher scores indicating higher levels of anxiety. The Cronbach's alpha coefficient for the Chinese translated version of the SAS in this study was 0.844.

Internet game addiction

Nine diagnostic criteria for internet game disorder were put forward in *The Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (43, 44). On this basis, Pontes et al. developed Nine-Item Internet Gaming Disorder Scale (IGDS9-SF) (45). This study used the revised IGDS9-SF to measure internet game addiction (46, 47). The scale has nine question items and is scored on a five-point scale, with higher scores associated with higher levels of internet game addiction. The Cronbach's alpha coefficient for the revised IGDS9-SF in this study was 0.902.

Quality control

The research design phase involved forming a research team with psychiatry and psychology professionals to discuss the research design, select survey instruments and determine survey procedures and methods.

The data collection phase was conducted in a classroom setting, with the researcher distributing the QR code of wjx.cn through social media platforms and subjects scanning the code to access the web-based questionnaire system. Before subjects completed the survey, they were required to read the purpose of the survey, the method of completion, informed consent, and informed that the survey was anonymous. After consenting, subjects voluntarily participated in the online questionnaire to ensure that the study data were authentic and valid.

In the stage of data completion and analysis, researchers exported the data from wjx.cn and imported them into the SPSS24.0 software. The data analysts were trained uniformly, thus ensuring the accuracy of data.

Data analysis

The data were analyzed using SPSS 24.0. Cronbach's alpha coefficient represented the reliability of the questionnaire. Harman's one-factor test was performed to assess the common method bias. Pearson's correlation analysis was conducted to analyze the correlation among variables. A structural equation model was established by Amos 24.0. The mediating effect was tested by the percentile Bootstrap method for bias calibration; the moderating effect was measured by multi-group analysis. Due to the impact of sample size on chi-square values, the model's fitting result was evaluated by comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). According to the researcher's recommendation, CFI and TLI > 0.90 and RMSEA and SRMR < 0.08 were used as the criteria to evaluate the goodness of fit data of the model.

Results

Common method biases analyses

To control the possible common method bias, this study used questionnaires with reverse scoring and different rating scales. The Harman's One-factor Test was used to test for common method bias. The results showed that nine factors with a characteristic root >1. The first factor explained 17.53% of the variation, which was much less than the critical value of 40% (48). Therefore, there was no significant common method bias in this study.

Correlation analysis of variables

Pearson's correlation analysis was conducted on resourcefulness, anxiety and internet game addiction (Table 1). The results showed that resourcefulness was significantly and negatively correlated with both internet game addiction ($r = -0.150$, $P < 0.001$) and anxiety ($r = -0.243$, $P < 0.001$). Besides, anxiety was significantly and positively correlated with internet game addiction ($r = 0.322$, $P < 0.001$). This provided initial support for further testing.

Analysis of the mediating effect of anxiety

To address the problem of latent variables containing multiple observing indexes, this study used a completely random packing method to pack resourcefulness, anxiety, and internet game addiction into 2, 3, and 3 indexes, respectively (49). A structural equation model was developed with resourcefulness as the independent variable, internet game addiction as the dependent variable, and anxiety as the mediating variable (Figure 2). The results showed that the model fitted well, with all fit indices within a reasonable range ($\chi^2/df =$ 16.87, CFI = 0.98, TLI = 0.97, SRMR = 0.03, RMSEA = 0.05). Based on these fitting results, the non-parametric percentile Bootstrap method for bias calibration was used to test the mediating effect and evaluate the confidence interval (CI), during which the sampling was repeated 5,000 times. Results showed that resourcefulness negatively predicted internet game addiction (-0.16, $P < 0.001$) and anxiety partially mediated the process ($\beta = -0.09$, 95% CI $= -0.1$ to -0.07),

accounting for 56.25% of the total effect. The 95% CI did not include 0, which verified the mediating effect of anxiety (Table 2).

Analysis of the moderating effect

Multi-group analysis was conducted to identify whether the path coefficients differ significantly between females and males. Unconstrained model M1, structural weight model M2, and structural residual model M3 were developed, respectively. As displayed in Table 3, the results showed that the constrained models (M2 and M3) were significantly different from the unconstrained model (M1; $P < 0.001$), suggesting significant gender difference. Further comparing the difference in the coefficients, we found gender played a role in the following pathways.

From resourcefulness to anxiety, the path coefficients were -0.24 ($p < 0.001$) and -0.29 ($p < 0.001$) for the male and female groups, respectively. The absolute value of critical ratios for differences between parameters was 4.66 (>1.96), significantly different at the 0.05 level. Resourcefulness could reduce anxiety more effectively in females than in males.

From anxiety to internet game addiction, the path coefficients were 0.40 ($p < 0.001$) and 0.30 ($p < 0.001$) for the male and female groups, respectively. The critical ratios for differences between parameters showed an absolute value of 3.08 (>1.96), significantly different at the 0.05 level. The predictive effect of anxiety on internet game addiction was stronger for males compared to females.

Discussion

This study examined the relationship between resourcefulness, anxiety and internet game addiction among Chinese college students. This is the first time that the potential influence mechanism of resourcefulness on college students' addiction to online games has been discussed. This study extended the results of previous studies on internet game addiction and its internal psychological mechanism. Also, it provided an empirical reference for preventing and intervening such addiction among college students.

The relationship between resourcefulness and internet game addiction

The present study found that resourcefulness significantly and negatively predicted internet game addiction, supporting our hypothesis. That is, having resourcefulness is effective in reducing the risk of internet game addiction, which is similar to previous findings. For example, Bulut and Zeren found that learned resourcefulness reduced online addiction (12). One possible explanation for this is that resourcefulness is similar to a resilient defense that serves as a protective buffer. Individuals who possess resourcefulness are more resilient, have better coordination and adaptability, and are less likely to become addicted to the Internet (50). Another possible explanation is that individuals who lack resourcefulness have a poor level of self-control. Their behaviors are mainly controlled by immediate gratification and short-term goals. They tend to seek immediate pleasure and rewards in online games (51, 52).

TABLE 1 Correlation analysis of variables.

Variable	M	SD	1	2	3	4
1 Gender[a]	0.64	0.48	1			
2 Resourcefulness	3.39	0.53	−0.025	1		
3 Anxiety	1.64	0.36	−0.058***	−0.243***	1	
4 Internet game addiction	1.74	0.66	−0.365***	−0.150***	0.322***	1

[a]Gender is a dummy variable (males = 0; females = 1) and the mean value represents the proportion of females.
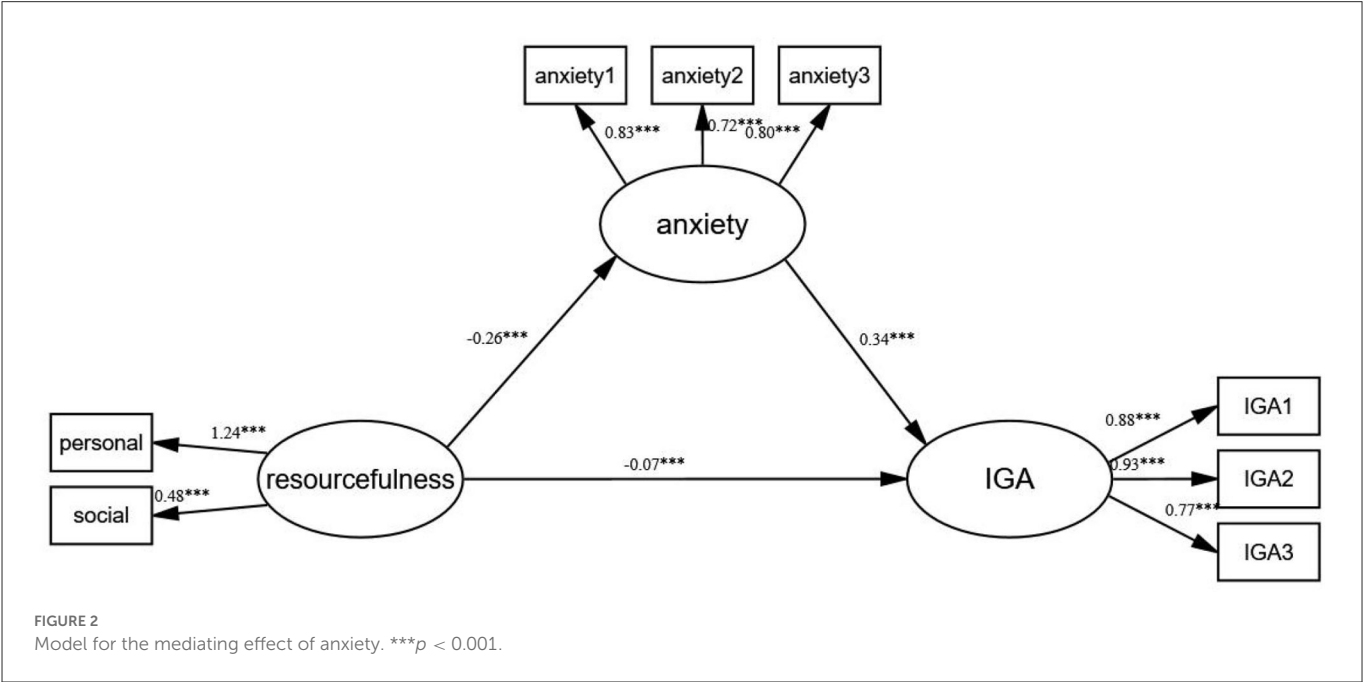***$p < 0.001$.

FIGURE 2
Model for the mediating effect of anxiety. ***$p < 0.001$.

TABLE 2 The mediating effect of anxiety.

Effect	β	SE	95% CI	P
Total effect	−0.16	0.01	[−0.18, −0.14]	<0.001
Direct effect	−0.07	0.01	[−0.09, −0.05]	<0.001
Indirect effect	−0.09	0.008	[−0.1, −0.07]	<0.001

TABLE 3 The multi-group analysis results.

Model	χ^2	Df	CFI	RMSEA	$\Delta\chi^2$	Δdf	P
M$_1$	320.79	34	0.98	0.04	-	-	-
M$_2$	350.71	39	0.98	0.04	29.93	5	<0.001
M$_3$	387.10	42	0.98	0.04	66.31	8	<0.001

The mediating effect of anxiety

The main finding of the present study is that anxiety partially mediated the relationship between resourcefulness and internet game addiction, supporting our hypothesis, which, to our knowledge, has not been directly examined. Thus, our study, to a certain extent, fills the gap in exploring the influence mechanism of resourcefulness on internet game addiction. The mediating role of anxiety can be explained by the I-PACE model, which assumes that the occurrence and development of addictive behaviors result from predisposing variables, affective and cognitive responses, and executive (18). In

this study, resourcefulness serves as the independent variable that influences internet game addiction through anxiety. A person's inability to self-regulate and lack of social support may lead to real-world difficulties and worsen the individual's emotional state (21). They may seek satisfaction in the virtual online world when regulating their emotions and develop a dependency (53). Overall, individuals who lack resourcefulness are prone to develop more anxiety. In this instance, they often vent their anxiety by playing online games, which will easily result in addiction to these games. Conversely, individuals who have resourcefulness may have less anxiety and are less vulnerable to internet game addiction.

The moderating effect of gender

Another important finding of this study was that the effect of resourcefulness on anxiety was more obvious in females than in males. The "protective-responsiveness model" states that the effect of a protective factor is stronger when another risk factor is high (54). Resourcefulness is like an elastic line of defense, performing protective and buffer functions. Studies have shown that females are more emotionally sensitive and may be at higher risk for anxiety (55–57). Thus, the effect of resourcefulness on anxiety is more obvious in females.

In addition, the effect of anxiety on internet game addiction was stronger in males than in females. One explanation for this result could be that social norms and expectations of males play a reinforcing role. According to social role theory, males and females play different roles in society. In the Chinese cultural context, males are portrayed as independent, strong and successful, while females are portrayed as docile, affectionate and easy to ask for help. They may behave according to their own understanding of their roles and society's expectations of them (58). Among people who feel anxious, females may be more inclined to express themselves, shop, and seek interpersonal support, influenced by social roles and norms. Whereas, males may be more inclined to work through it alone, online gaming would be an option. Another possible explanation is that neural mechanisms make the effect of anxiety on internet game addiction more obvious in males. According to the gender difference in neural mechanism, gaming cues will induce a stronger desire in males, so they can easily experience something new through online games. In the meantime, the competitive structure in these games is more attractive to males, which activates the area of the brain related to awards (59, 60).

Limitations and implications

The findings confirm that resourcefulness can negatively predict internet game addiction, with anxiety playing the meditating role. Besides, gender moderates this mediating effect. These findings to a certain extent enrich the existing research on internet game addiction and its underlying psychological mechanisms. The present study suggests that we should pay more attention to college students' state in playing online games and improve their mental health by enhancing resourcefulness and balancing emotions. Further, we should make greater efforts to evaluate and educate females about their resourcefulness level and males about their emotion management.

However, there are some limitations in the present study, which indicates the direction of future research. First, despite the large sample size, more representative samples shall be selected from a wider range. Besides, the large sample size may affect the significance of correlation analysis, as well as mediation, and moderating effects. Second, we cannot conduct causal inference since this is a cross-sectional study. In this respect, a longitudinal tracking study shall be conducted to make a more detailed exploration. Third, there may be some other potential variables that affect the results. For instance, depression may also mediate the association between resourcefulness and internet game addiction. So we shall explore other variables further to provide more references for the intervention and treatment of individuals' internet game addiction.

Conclusion

Resourcefulness can negatively predict the internet game addiction of individuals in a significant way.

Resourcefulness can indirectly predict the internet game addiction of individuals through anxiety.

Anxiety mediates the relationship of resourcefulness and internet game addiction differently between males and females.

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 North Sichuan Medical College. The patients/participants or patients/participants' legal guardians/next of kin provided their written informed consent to participate in this study.

Author contributions

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Conflict of interest

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

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Manual development and efficacy of Mindful Living Group activities to promote trauma healing during the COVID-19 pandemic in China

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Introduction: Disasters can be traumatic with a profound and lasting impact on individuals. During the COVID-19 pandemic, our team developed the Mindful Living Group (MLG) activities manual based on Eastern body-mind wisdom and Western trauma healing theory to provide psychological assistance for trauma healing.

Methods: In this study, we introduce a framework developed for the 10-session MLG activities manual, which consists of three core modules. Thirty-one participants living all over the country who had experienced traumatic stress resulting from the COVID-19 pandemic received the MLG intervention. This single-arm intervention study offered psychological assistance during the pandemic. The MLG intervention included 10 weekly 2-h sessions held online. Participants completed the initial interview, pre-test, post-test, and 1-month follow-up interviews. The effectiveness of the MLG activities manual was evaluated using psychological measures, including Self-Rating Depression Scale, Self-Rating Anxiety Scale, Mindful Attention Awareness Scale, Post-traumatic Growth Inventory, General Self-Efficacy Scale, and the Perceived Social Support Scale.

Results: Compared with the pretest level, the post-test levels of depression (F = 42.78, $p < 0.001$, $\eta^2 = 0.59$) and anxiety ($F = 23.40$, $p < 0.001$, $\eta^2 = 0.44$) were significantly lower; and mindfulness ($F = 12.98$, $p = 0.001$, $\eta^2 = 0.30$), posttraumatic growth ($F = 27.06$, $p < 0.001$, $\eta^2 = 0.48$), general self-efficacy ($F = 13.20$, $p = 0.001$, $\eta^2 = 0.31$), and perceived social support ($F = 16.27$, $p < 0.001$, $\eta^2 = 0.35$) were significantly higher (ANOVA). Further correlation analysis revealed a significant negative relationship of mindfulness with both depression ($r = -0.43$, $p = 0.015$) and anxiety ($r = -0.35$, $p = 0.053$), and significant positive relationships of mindfulness with posttraumatic growth ($r = 0.40$, $p = 0.025$), general self-efficacy ($r = 0.52$, $p = 0.003$), and perceived social support ($r = 0.40$, $p = 0.024$).

Discussion: These preliminary findings showed the effectiveness of MLG activities for trauma healing. The mechanisms underlying mindfulness promoting trauma healing are discussed based on both Eastern body-mind wisdom and Western theories of trauma healing.

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1. Introduction

As an infectious pandemic, COVID-19 has had a profound and lasting traumatic impact on the global population. The prevalence of post-traumatic stress disorder (PTSD) has been estimated at 1–67% in some countries (1). Other psychological morbidities associated with the COVID-19 pandemic include poor sleep quality, stress,

psychological distress, insomnia, anxiety, and depression (2). Poorer self-efficacy and social support (3) during the COVID-19 pandemic than before the pandemic have also been reported. Nevertheless, individuals can achieve positive experiences from adversity (4, 5), such as posttraumatic growth (PTG) (6). Identifying effective interventions and treatments will help individuals to heal trauma caused by disasters.

Clinical treatment for PTSD, including prolonged exposure therapy and cognitive processing therapy, focuses on trauma symptoms and has been shown to reduce PTSD symptoms (7–9). However, there is a high dropout rate during treatment (9, 10) and some patients continue to experience residual symptoms after treatment (8, 9). Moreover, treatments have often resulted in poor outcomes in patients with chronic or complex PTSD, such as PTSD combined with dissociation (11). Additional adjunctive or alternative treatments for trauma healing need to be explored (12).

It has been suggested that body-oriented treatments, rather than trauma-focused approaches, are more effective strategies (13, 14), such as somatic experiencing therapy (14, 15). Peter Levine proposed that trauma is retained in the nervous system of an individual's body, which is followed by the brain, such that talking therapies alone cannot offer sufficient healing. He suggested that individuals experiencing trauma should begin their healing process by learning to cultivate a perception of their body sensations and an awareness of their body's feelings (14). This is in agreement with the mindfulness practice that originated from the ancient Eastern tradition (15). As Zen Master Thich Nhat Hanh explained, "mindfulness is a kind of energy that we generate when we bring our mind back to our body and get in touch with what is going on in the present moment, within us and around us" (16). Emerging mindfulness-based interventions (MBIs) have shown effectiveness in the treatment of PTSD.

Among the mostly cited MBIs are mindfulness-based stress reduction and mindfulness-based cognitive therapy, which were initially developed for the rehabilitation of chronic illnesses (17) and to prevent relapse among patients with major depressive disorder (18), respectively. Both MBI types have been reported to effectively reduce PTSD symptoms such as re-experiencing, avoidance, emotional numbing, and hyperarousal (19–21) and to alleviate depression (19, 20, 22, 23), anxiety (20, 23), shame (22), and self-blame (21). Other MBIs, including loving-kindness meditation (24), mantrum repetition approaches (25), and transcendental meditation (26) have also been reported to have good efficacy in PTSD treatment.

The polyvagal theory, proposed by Porges, is one of the most important theories in trauma healing and has been applied in clinical therapies (27–31). According to the polyvagal theory, the evolutionary autonomic nervous system was composed of three subsystems: the dorsal vagal system (parasympathetic), the sympathetic system, and the ventral vagal system (also part of the parasympathetic nervous system). In individuals experiencing trauma, the sympathetic nervous system is strongly activated and the resulting constant state of fight-or-flight in response to unseen dangers leave them with fatigue, burnout, insomnia, and asthenia. In addition, the dorsal vagal nervous system can be activated, leading to frozen, collapse, and dissociation, which often occur in chronic or complex PTSD. Therefore, individuals experiencing trauma are often stuck in the past by traumatic memories and are unable to engage in the present moment (13). The activation or co-activation of the sympathetic and dorsal vagal nervous systems suppresses the social engagement system governed by the ventral vagal nervous system, making traumatized individuals isolated, which in turn aggravates their sense of powerlessness, helplessness, and hopelessness (13). The ventral vagal nervous system has evolved more recently and is unique to mammals; it acts to inhibit the excessive activation of the older dorsal vagal and sympathetic nervous systems and calms the body state (e.g., visceral homeostasis) to promote growth and restoration and to reduce stress through engaging socially with others. Most importantly, the social engagement system is integrated by bidirectional neural regulation between the visceral state and striated muscles of the face and head, which have an important function in social communication (32, 33). Therefore, this integrated social engagement system can be activated by both paths. One is to provide supportive environments to individuals with trauma through facial expression, eye contact, and voice to arouse feelings of safety and security. The other one is that individuals with trauma can also learn to calm their body and visceral state through body-mind practice to achieve inner peace and balance during daily life, in the absence of danger or threats.

In eastern tradition, mindfulness practices have been used for thousands of years to maintain a healthy body-mind state and to release oneself from suffering. Thich Nhat Hanh, who has brought mindfulness practices to the West since the 1970s, applied ancient wisdom to the challenges of modern life and developed Plum Village original teachings and practices of mindfulness for secular people. Plum Village mindfulness practice, also called "the Art of Mindful Living," closely follows the Buddha's teachings and practices of mindfulness meditation, based on the Manifestation Only Psychology, with Mindfulness of Breathing (Anapanasati Sutta) and Four Establishments of Mindfulness (Satipatthana Sutta) as the guidelines. It provides a set of practical mindfulness activities to be practiced in all moments of daily life, such as mindful breathing, walking meditation, eating meditation, singing meditation, mindful movements, deep relaxation, deep listening, and loving speech (16, 34). These mindfulness practices are introduced in an explicit way to help people easily understand and enjoy their practice, which is expected to restore their inner peace and transform their sufferings. Moreover, Plum Village mindfulness emphasizes practicing within a group or community, which helps to rebuild connectedness with the self, others, and nature and helps to generate powerful collective mindfulness energy for healing. In Western trauma healing therapy, it has been suggested that a solidary and supportive group may provide the most direct, powerful, and persuasive experiences of connectedness and safety to people who have experienced trauma (35).

Our team have taken part in Plum Village retreats to practice mindfulness since 2007 and has applied these mindfulness practices to provide psychological assistance after the Wenchuan Earthquake disaster in China in 2008 to help people heal their trauma. We offered Mindful Living Group (MLG) activities to local people and practiced mindfulness with them over a period of more than 3 years and found that MLG activities were easily accepted and were effective in healing trauma. Since then, our team has continuously used MLG activities to serve different groups of individuals, such as those who experienced the Ludian earthquake disaster in 2014 and

schoolteachers of primary and secondary schools in Beijing in 2017 and 2018, to restore body-mind energy, transform their suffering, and promote the healing process of trauma.

During the COVID-19 pandemic, our team programmed and developed the MLG activities manual based on Plum Village mindfulness practice combined with Western trauma healing theory, while removing the religious reference and expressions to provide psychological assistance to individuals experiencing trauma. This study evaluated the effectiveness of the intervention. To our knowledge, there are currently no published peer-reviewed studies that introduce a well-programmed mindfulness-based intervention based on Eastern tradition combined with Western trauma healing theory, and its effectiveness in an interventional study. Herein, we describe the development and effectiveness of MLG activities in promoting trauma healing during the 2020 COVID-19 pandemic in China.

2. Materials and methods

2.1. Participants

We recruited participants through the WeChat public account of the Institute of Psychology, Chinese Academy of Sciences across the country. Both recruitment and MLG activities were conducted online during the COVID-19 pandemic, allowing individuals living in different areas of China to participate. The eligibility criteria for enrollment in the study included individuals: (1) aged between 18 and 60 years; (2) experiencing mental distress during the COVID-19 pandemic, with symptoms such as insomnia, headache, chest tightness, fear, anxiety, guilt, self-blame, irritability, loneliness, and sadness; and (3) hoping to improve their body-mind states and return to enjoying their lives again, and (4) able to participate in online MLG activities with group members. Individuals requiring crisis intervention were not suitable for study participation and were instead referred to the appropriate services. Permission from clinical doctors was required for patients currently receiving medical treatment. The participants were preliminarily screened according to their registration information and further assessed during the initial interview. A total of 31 participants entered and completed the study. Demographic characteristics of the participants are presented in Table 2.

2.2. Procedures

2.2.1. Development of the MLG activities manual

This study was funded by the Institute of Psychology, Chinese Academy of Sciences (No. E0CX331008, 2020–2021). We developed the MLG activities manual, drawing from Plum Village mindfulness practice and trauma healing theories, to provide psychological assistance during the COVID-19 pandemic.

The MLG activities manual consists of 10 sessions, including the first session of "Getting to know each other" and the final session of "Setting off again." The eight themed sessions focus on three interconnected core modules, which are named "Watering our inner seeds of peace and joy," "Transforming suffering," and "Rebuilding connectedness" (see Table 1).

Following the first session, participants proceed to Module 1, "Watering our inner seeds of peace and joy," which consists of three sessions. Participants engage in basic mindfulness practices together with 3–5 group leaders, including mindful breathing, sitting meditation, walking meditation, eating meditation, singing meditation, mindful movements, deep relaxation, deep listening, loving speech, and service meditation, all of which can be applied in daily life (16, 34). Singing meditation may help participants become settled with their bodies and surroundings with ease and joy and is practiced at the very beginning and at the end of each session. As sung in the mindful songs, "Happiness is here and now. I have dropped my worries. Nowhere to go, nothing to do, no longer in a hurry," "Breathing in, I go back to the island within myself … Breathing out, I enjoy going back to my island," and "The mind can go in a thousand directions. But on this lovely path, I walk in peace" (36). Mindful breathing and walking meditation are simple practices that can bring profound experiences to practitioners. By naturally following in- and out-breathing and becoming more aware of the contact of their feet with the ground, participants may come back to their body and fully live in the present moment, thus setting themselves free from regrets of the past and worries about the future. Sitting meditation may help participants feel relaxed, peaceful, and at ease in the present moment, thereby allowing them to become more concentrated. Sitting meditation and deep relaxation can be very healing and nourishing and can help participants restore their body-mind energy. Eating meditation can be helpful in achieving connectedness with food, other people, and nature, to experience the interbeing with the planet that is nourishing and sustaining us and can release feelings of loneliness and disconnection. Participants are encouraged to practice mindfulness during their daily routines and enjoy the moment.

It is expected that when practicing the basic mindfulness activities in Module 1, participants would become calm in their body-mind state, reduce unnecessary energy consumption, and nourish their inner peace and joy to inspire feelings of safety and security. Participants may also perceive peaceful facial expressions, voices, and smiles of others during mindfulness practice with other group members, in which, according to the polyvagal theory, the activated social engagement system and cultivated collective mindfulness energy contribute to heal each other.

Participants deepen their mindfulness practice in Module 2, denominated "transforming suffering," which consists of three sessions. Each session focus on a specific theme that participants concern such as interpersonal relationship difficulties, distress within a family, dealing with bereavement and grief, and facing serious illness (e.g., cancer) and death. Focusing on each specific theme, guided sitting meditation (adapted from Plum Village practices) (37), the Five Mindfulness Trainings (16), mindful reading (selected short stories, poems, or essays about mindfulness practice), mindful sharing, and mindful responding (34) are conducted. Building on the energy of mindfulness and concentration accumulated during Module 1, Module 2 guides participants to practice looking deeply into what was happening within them and around them, which may bring insights such as Impermanence, Non-self, and Interbeing. These insights can help participants transform their

TABLE 1 The MLG manual framework of activities.

Session	Theme	Aims	Mindfulness practices
Session 1	1. Getting to know each other 2. Starting to live a mindful life	1. Introducing the MLG activities 2. Group members getting to know each other	• Mindful breathing • Deep relaxation
Module 1: Watering our inner seeds of peace and joy (sessions 2–4)	1. Experiencing the mindful life 2. Taking care of the body and mind, settled in the present moment	1. Learning basic mindfulness practices 2. Being aware of the mind-body state 3. Nourishing inner peace and joy 4. Accumulating mindfulness energy	• Singing meditation • Mindful breathing • Guided sitting meditation • Walking meditation • Eating meditation • Mindful Movements • Mindful reading • Mindful sharing
Module 2: Transforming suffering (sessions 5–7)	1. Embracing our suffering 2. Taking a deep look at our daily lives 3. Parents, myself	1. Looking deeply into daily life 2. Looking deeply into impermanence, non-self, and interbeing 3. Looking deeply into the "inner child," having better understanding of one's parents	• Singing meditation • Guided sitting meditation • Deep relaxation • The Five Mindfulness Trainings • Mindful reading • Mindful sharing
Module 3: Rebuilding connectedness (sessions 8–9)	1. Touching the Earth 2. Connecting with the past, present, and future	Reconstructing life meaning by restoring a connectedness with the Earth Mother and past (ancestors and parents), present (self), and future (offspring)	• Singing meditation • Guided sitting meditation • Walking meditation • Touch the Earth • The Five Mindfulness Trainings • Mindful reading • Mindful sharing
Session 10	Setting off again	1. Reviewing the mindfulness practices 2. Looking forward on how to continue mindful living practices in the future	• Singing meditation • Guided sitting meditation • Mindful sharing and blessing

suffering in a transcendent or sublimated way, which can help individuals with trauma to heal. However, it is difficult to look deeply without sufficient calmness and concentration (i.e., the practice of Stopping (止) in eastern tradition), which can be generated and strengthened by continuous mindfulness practice and the collective mindfulness energy created by all group members. Therefore, continuous group practice is required. Within the group, participants and group leaders can learn from each other's experiences and discoveries, and together will witness the wisdom of suffering transformation occurring in their lives.

Module 3, named "Rebuilding connectedness," consists of two sessions, "Touching the Earth" and "Connecting the past, present, and future," in which participants extend their practice of looking deeply. When touching the earth with their body, participants are guided to look deeply into the connectedness and continuity of ancestors (past), the self (present), their offspring (future), and all other creatures and materials (34). These practices can bring insight into the non-self in that personal suffering and inadequacy are shared human experiences, which can release participants from frustration, guilt, and self-criticism. Through this experience, participants can come back to the present moment to understand and integrate their trauma experience in an extended and continuous system (i.e., the whole nature of everything connected with each other) using Impermanence, Non-self, and Interbeing. The healing process occurs when participants can recount their life stories in an integrated way and are deeply listened to by other group members or when participants are enlightened by other group members sharing discoveries, rather than listening to a discourse by specialists. Touching the earth with

their bodies also brings participants feelings of stability, security, warmth, and a sense of reality. In this way, participants can fully live in the present, knowing that past distress is not themselves, and can decide to live in the present mindfully, which is the only solid way to achieve a better future. In the final session, participants review the mindfulness practices together and discuss how to apply mindfulness practice in the future before setting off to continue their life journey. Table 1 shows the framework of the MLG activities manual.

Each MLG activity group consists of 10–20 participants with 3–5 group leaders. The group leaders work as a team and comprise counselors, social workers, and non-professionals with experienced mindful living practices. In this way, the intervention would deliver comprehensive life experiences and wisdom while avoiding professional authority over group members. Group leaders practice mindfulness together with others while guiding or responding to group members. Each participant in the MLG contributes their own practice to the collective mindfulness energy, regardless of whether they are group leaders or participants. When participants share their confusion or questions about mindfulness practice, group leaders respond mindfully, with both trauma-informed care knowledge and Eastern wisdom, such as Impermanence, Non-self, and Interbeing.

2.2.2. Effectiveness evaluation of MLG activities

Figure 1 shows the flow of participants throughout the course of the study. Participants' assessments for entry into the study were completed via an online one-on-one initial interview by the interviewers of our team. Written informed consent was

FIGURE 1
Flow of participants throughout the study.
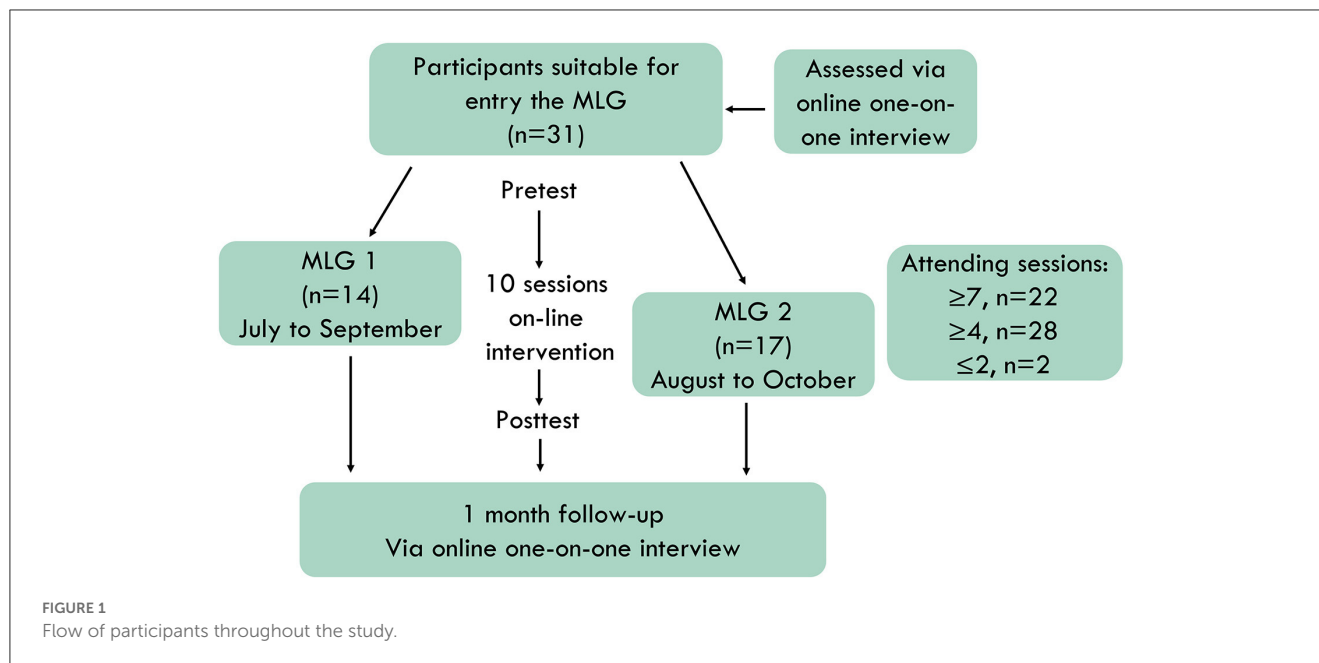
obtained from all the participants. Data collection on demographic characteristics and outcome measures of the pre- and post-test periods was conducted using the Questionnaire Star platform (Changsha Ranxing Information Technology Co., Ltd). Follow-up was conducted 1 month after the MLG activities *via* online one-on-one interviews. Both online interviews and MLG activities were conducted *via* the Zhumu online meeting room (Suirui Technology Group Co., Ltd.).

Participants entered the MLG 1 or MLG 2 successively, according to their entry order and available time. The first MLG completed the intervention between July and September 2020. The second MLG completed the intervention between August and October 2020. Each intervention consisted of 10 weekly 2-h sessions. Of the 31 participants in both groups, 22 attended at least seven sessions, 28 attended at least four sessions, and two attended two or one sessions because of difficult working hours. Each participant completed the measures at both pre- and post-test, which were conducted within 1 week of the start and end of MLG activities. All participants completed the follow-up interviews. Data from all participants were included in the analysis.

2.3. Measures

The following measures were completed by participants in both the pre- and post-test periods.

2.3.1. Self-rating depression scale

The Self-Rating Depression Scale (SDS) (38) was used to assess depression. The SDS is a self-reported scale used to measure the severity of depressive state and changes during treatment. The SDS consists of 20 questions that are scored on a Likert-type scale ranging from 1 to 4. The total scores range from 20 to 80, with higher scores reflecting more severe depression. The

Chinese version of the SDS has been validated in various Chinese populations (39).

2.3.2. Self-rating anxiety scale

The Self-Rating Anxiety Scale (SAS) (40) was used to assess anxiety. The SAS is a self-report scale used to measure subjective feelings of anxiety. The SAS consists of 20 questions that assess the frequency of anxiety symptoms within the previous week, which are scored on a four-point Likert-type scale. The total scores are summed and range from 20 to 80, with higher scores indicating more severe anxiety. The Chinese version of SAS has been validated and widely applied in clinical treatment and research (39).

2.3.3. Mindful attention awareness scale

The Mindful Attention Awareness Scale [MAAS, (41)] is a 15-item self-report instrument used to measure an individual's mindfulness level. The frequency of mindful states over time was assessed, with higher scores indicating higher levels of mindfulness. Participants were asked to rate a series of statements on a six-point scale ranging from "almost always" (1) to "almost never" (6). The total score was obtained by summing the scores of all 15 items. The Chinese version of MAAS has been reported to have good reliability and validity (42, 43).

2.3.4. Post-traumatic growth inventory

The Post-traumatic Growth Inventory (PTGI) (6) was used to measure the perceived benefits after a traumatic event. The questionnaire consists of 21 items covering five dimensions: relating to others, new possibilities, personal strength, spiritual change, and appreciation of life. Each item is scored on a 6-point Likert-type scale ranging from 0 ("no change") to 5 ("a great deal of change"). Higher scores reflect greater perceived

benefits from traumatic experiences. The Chinese version of the PTGI has been reported to have good reliability and validity (44). We added one item ("A better understanding of the existence of some uncontrollable force") considering the cultural differences and interviews after the Wenchuan Earthquake of China (45).

2.3.5. General self-efficacy scale

The General Self-Efficacy Scale (GSES) (46) was used to assess individuals' general perception of their ability to cope with difficult situations. The GSES is a 10-item self-report instrument and items are scored on a four-point Likert-type scale ranging from 1 ("not at all true") to 4 ("completely true"). Higher scores indicate a higher level of self-efficacy. The Chinese version of the GSES has been reported to have good reliability and validity (47).

2.3.6. Perceived social support scale

The Perceived Social Support Scale (PSSS) (48) was used to assess individuals' perceptions of the social support they received from family, friends, and others. The PSSS is a 12-item self-report instrument, and the items are scored on a seven-point Likert-type scale ranging from 1 ("very strongly disagree") to 7 ("very strongly agree"). The total score is calculated by summing the scores of all 12 items, with higher scores indicating a higher level of perceived social support. The Chinese version of the scale has been reported to have good reliability and validity, including two dimensions consisting of social support within the family and outside of the family (39).

2.4. Data analysis

Data are presented as mean ± standard deviation (SD). Assumptions of a normal distribution were checked. A repeated measures one-way ANOVA was used to evaluate the effectiveness of participating in MLG activities on increasing mindfulness, reducing negative emotional symptoms, and promoting trauma healing. Pearson's correlation coefficient (r) was used to examine the relationships between the changes (i.e., pre-post-differences) in mindfulness and other measures, between the changes in general self-efficacy and other measures, and between the changes in perceived social support and other measures. Significance was set at 0.05 (2-tailed) for all analyses. All data analyses were performed using Statistical Package for the Social Sciences (SPSS version 22, IBM, NY, USA).

3. Results

The demographics of the two intervention groups are shown in Table 2. In addition to the traumatic experiences directly related to the COVID-19 pandemic, participants also talked about family trauma, bereavement, interpersonal relationship difficulties, income shock, vicarious trauma, sexual abuse in childhood, and serious illness (cancer). Some of the experiences occurred during the pandemic, whereas others were older traumas that predated the pandemic.

TABLE 2 Participants' demographic information (N = 31).

Demographic features	
Number of participants (group 1/group 2)	31 (14/17)
Mean age (SD)	37.06 (8.70)
18–29 years, n (%)	5 (16.13)
30–39 years, n (%)	15 (48.39)
40–49 years, n (%)	8 (25.81)
50–60 years, n (%)	3 (9.68)
Female, n (%)	27 (87.10)
History of mental illness diagnosis, n (%)	5 (16.13)
Religion of Buddhism, n (%)	2 (6.45)
Level of education	
Degree or professional qualification, n (%)	9 (29.03)
College or junior college qualification, n (%)	21 (67.74)
Senior high school or below, n (%)	1 (3.23)
Traumatic experience	
COVID-19 epidemic stress	18
Origin family trauma	9
Bereavement	8
Interpersonal relationship difficulty	8
Income shock	6
Vicarious trauma	4
Sexually abuse in childhood	1
Serious illness (cancer)	1
Marital status	
Single, n (%)	11 (35.48)
Married, n (%)	12 (38.71)
Divorced, n (%)	6 (19.35)
Widowed, n (%)	2 (6.45)
Residence	
Beijing, n (%)	8 (25.81)
Hubei, n (%)	7 (22.58)
Shandong, n (%)	4 (12.90)
Guangdong, n (%)	4 (12.90)
Jiangsu, n (%)	3 (9.68)
Hebei, n (%)	2 (6.45)
Shanxi, n (%)	1 (3.23)
Neimenggu, n (%)	1 (3.23)
Yunnan, n (%)	1 (3.23)

Table 3 shows the pre-post changes in the outcome measures. Compared with pretest scores, participants showed a significant decrease in SDS ($F = 42.78$, $p < 0.001$, $\eta^2 = 0.59$) and SAS ($F = 23.40$, $p < 0.001$, $\eta^2 = 0.44$) scores, which indicates that the level of depression and anxiety decreased after the MLG intervention.

Measure	Before mean (SD)	After mean (SD)	F-value	p-value	η^2
SDS	46.16 (7.03)	35.23 (7.68)	42.78	<0.001	0.59
SAS	40.87 (8.34)	33.29 (6.52)	23.40	<0.001	0.44
MAAS	55.32 (13.50)	62.32 (12.04)	12.98	0.001	0.30
PTGI	83.42 (22.1)	100.65 (20.36)	27.06	<0.001	0.48
PTGI-PS	15.06 (4.61)	18.61 (4.34)	23.07	<0.001	0.44
PTGI-NP	18.03 (6.19)	21.90 (5.62)	16.84	<0.001	0.36
PTGI-RTO	26.81 (6.88)	32.55 (5.91)	29.37	<0.001	0.50
PTGI-AOL	12.29 (3.63)	14.52 (2.58)	14.52	0.001	0.33
PTGI-SC	11.23 (4.22)	13.06 (3.71)	11.06	0.002	0.27
GSES	2.44 (0.48)	2.78 (0.50)	13.20	0.001	0.31
PSSS	53.16 (14.32)	63.29 (12.61)	16.27	<0.001	0.35
PSSS-WF	18.03 (5.55)	22.29 (4.63)	22.07	<0.001	0.42
PSSS-OOF	35.13 (9.82)	41.00 (8.91)	10.69	0.003	0.26

SDS, Self-rating depression scale; SAS, Self-rating anxiety scale; MAAS, Mindful attention awareness scale; PTGI, Post-traumatic growth inventory (–PS, personal strength; –NP, new possibilities; –RTO, relating to others; –AOL, appreciation of life; –SC, spiritual change); GSES, General self-efficacy scale; PSSS, Perceived social support scale; (–WF, perceived social support from within the family; –OOF, perceived social support outside of the family).

Compared with pretest scores, the average MAAS ($F = 12.98$, $p = 0.001$, $\eta^2 = 0.30$), PTGI ($F = 27.06$, $p < 0.001$, $\eta^2 = 0.48$), GSES ($F = 13.20$, $p = 0.001$, $\eta^2 = 0.31$), and PSSS ($F = 16.27$, $p < 0.001$, $\eta^2 = 0.35$) scores were significantly higher at the post-test assessment, indicating an increase in the level of mindfulness, post-traumatic growth, general self-efficacy, and perceived social support after the MLG intervention. Participants showed a significant increase in scores on all five PTGI dimensions at post-test vs. pre-test (PTGI-Personal Strength, $F = 23.07$, $p < 0.001$, $\eta^2 = 0.43$; PTGI-New Possibilities, $F = 16.84$, $p < 0.001$, $\eta^2 = 0.36$; PTGI-Relating To Others, $F = 29.37$, $p < 0.001$, $\eta^2 = 0.50$; PTGI-Appreciation Of Life, $F = 14.52$, $p = 0.001$, $\eta^2 = 0.33$; PTGI-Spiritual Change, $F = 11.06$, $p < 0.01$, $\eta^2 = 0.27$; see Table 3). Participants showed significant increases in PSSS scores for both the within-family ($F = 22.07$, $p < 0.001$, $\eta^2 = 0.42$) and outside-of-family ($F = 10.69$, $p < 0.01$, $\eta^2 = 0.26$) dimensions.

Further correlation analysis using the pre-post score difference revealed a significant negative relationship of mindfulness with both depression ($r = -0.43$, $p = 0.015$) and anxiety ($r = -0.35$, $p = 0.053$). Significant positive relationships were also found between mindfulness and posttraumatic growth ($r = 0.40$, $p = 0.025$), mindfulness and general self-efficacy ($r = 0.52$, $p = 0.003$), and mindfulness and perceived social support ($r = 0.40$, $p = 0.024$). When considering the PTGI dimensions, mindfulness was significantly associated with personal strength ($r = 0.44$, $p = 0.014$), relating to others ($r = 0.38$, $p = 0.034$), and appreciation of life ($r = 0.51$, $p = 0.003$). There were no significant correlations between mindfulness and new possibilities ($r = 0.22$, $p = 0.226$) or spiritual changes ($r = 0.17$, $p = 0.375$). When considering the PSSS dimensions, mindfulness was significantly correlated with

perceived social support from people outside of the family (such as friends and colleagues) ($r = 0.43$, $p = 0.015$). Mindfulness was not significantly correlated with perceived social support from persons within the family members ($r = 0.18$, $p = 0.344$). Moreover, general self-efficacy was significantly correlated with decreased depression ($r = -0.40$, $p = 0.026$). The PSSS significantly correlated with the relating to others factor of the PTGI ($r = 0.40$, $p = 0.025$).

4. Discussion

Our team developed the MLG activities manual over a 10-year period, drawing from both Eastern mindfulness practice and Western trauma healing theory, and used this program to provide psychological assistance during the COVID-19 pandemic. The efficacy of interventions specified in the MLG activities manual was evaluated using psychological measures before and after the intervention combined with follow-up interviews.

The results showed that the MLG interventions may help cultivate mindfulness and decrease depression and anxiety. This is consistent with previous findings that MBIs, such as mindfulness-based stress reduction or mindfulness-based cognitive therapy, decreased depression and anxiety, and increased mindfulness (19, 20, 22, 23, 49). Recent systematic reviews and meta-analyses have demonstrated that MBIs that are based on mindfulness or use mindfulness as the foundation of therapeutic intervention, rather than integrating mindfulness elements or using mindfulness as an ancillary component (50, 51), have a moderate effect size on reducing depression and anxiety (51, 52). This demonstrates the efficacy of well-programmed MBIs in improving psychological wellbeing.

Our results also suggest that engaging in MLG activities can promote posttraumatic growth, general self-efficacy, and perceived social support, which could contribute to trauma healing. Correlation analysis further revealed that increased mindfulness was associated with decreased depression and anxiety and increased posttraumatic growth, general self-efficacy, and perceived social support. This indicates that the trauma-healing process may be promoted through increased mindfulness. Moreover, general self-efficacy was negatively associated with depression and perceived social support was positively associated with posttraumatic growth. Additionally, the analysis revealed that mindfulness is associated with increased personal strength, relating to others, appreciation of life, and perceived social support outside of the family. Together, these results demonstrate the efficacy of the MLG intervention in cultivating mindfulness to promote the trauma-healing process by improving general self-efficacy and perceived social support and reducing negative emotions. These results also support the use of the three modules of the MLG activities manual; that is, through mindfulness practice, participants can reduce unnecessary energy consumption, nourish their inner peace and joy, rebuild connectedness, and transform their suffering.

The present results are consistent with previous evidence of the efficacy of MBI in reducing PTSD symptoms (12) and promoting PTG (53). A recent meta-analysis reported significant associations between specific components of mindfulness and symptoms of PTSD, from the robust effect to the strong and small effects are the

total mindfulness, acting with awareness, non-judging, describing, and non-reacting, and no significant association was found with observation (54). Another meta-analysis reported positive short-term effects of MBIs on PTG in participants with medical trauma (most were cancer-related) with a small effect size (53). Social support has also been reported to have a direct effect on PTSD and PTG, and affects PTSD negatively and PTG positively through self-efficacy (55, 56). Other studies have investigated the association between specific mindfulness traits and certain symptoms of PTSD (12, 54, 57). However, the mechanisms underlying the ability of mindfulness to promote healing of trauma remain unclear.

In this study, we referred to both Eastern body-mind wisdom and Western trauma healing theory. Body-mind unity has consistently been the theoretical and practical foundation for the traditional healing system of human beings; however, as Peter Levine stated, such an integration of body and mind has unfortunately been neglected in modern trauma treatment (58). Neuroscience studies have provided evidence for the existence of complex bidirectional interactions between the body and mind. For example, the polyvagal theory, which is the foundation for trauma healing therapy, proposes that perception of the inner body state (e.g., feeling peaceful or restless) influences the way people perceive their surroundings (e.g., as safe or dangerous) and vice versa (33). The social engagement system of individuals with trauma can only be activated to reduce stress when they perceive safety and security from both their inner body state and outer environment. When the body and mind are united in this manner, ventral vagal activities can be activated to suppress the excessive activities of sympathetic and dorsal vagal and promote body growth and restoration. In the Eastern tradition, mindfulness practices are used to achieve body-mind unity. For example, mindful breathing, which is the most commonly used practice, can directly influence the activity of the autonomic nervous system by decreasing the activity of the sympathetic nervous system and increasing that of the parasympathetic nervous system. This helps people feel relaxed and allows their mind to be present in their breath and body and live mindfully in the present. As another example, the embodied experiences of Impermanent, Non-self, and Interbeing, which can be achieved through practicing looking deeply based on body-mind unity or human-nature unity during mindfulness practice, brings individuals with a sense of connectedness and belonging and may also promote their social engagement system and the process of trauma healing. Further studies should be conducted to reveal the neural mechanisms underlying the effects of traditional practices.

For thousands of years, eastern traditional practices have provided systematic teachings and practice steps to follow. First, mindfulness ("nian," 念in Chinese) practice helps to bring our mind back to our breath and our body to the present moment, through which our body and mind are united. Second, continuous mindfulness practice and body-mind unity help to generate the energy of concentration ("ding," 定in Chinese), which means calm and still. Third, when our mind is calm and still, we are able to look deeply to understand and clarify what happens within and around us, through which insight ("hui," 慧in Chinese) can be attained, such as Impermanence, Non-self, and Interbeing. Transformation and healing can only take place when insight is attained. Mindfulness, concentration, and insight give birth to

one another. The Plum Village method closely follows the eastern traditional teachings and practices, based on the Manifestation Only Psychology, with Mindfulness of Breathing (Anapanasati Sutta) and Four Establishments of Mindfulness (Satipatthana Sutta) as the guidelines of mindfulness meditation. In this study, the MLG activities manual is developed according to Plum Village teachings and practices of mindfulness. The three traditional practice steps (i.e., mindfulness, concentration, and insight) are involved in three interconnected modules (see Methods and Table 1).

Through the participants' sharing during the MLG activities and the follow-up interviews, we were able to understand how the embodied experiences with the insight of Impermanence, Non-self, and Interbeing promoted trauma healing over the 10 sessions and three modules of continuous mindfulness practice. For example, participant A with pandemic stress and vicarious traumatic experience attended all 10 sessions. After practicing eating meditation in the fourth session, despite other participants reporting feeling nourished and connected, she stated that she felt intensely uncomfortable when eating the food that she grew together with her neighbor, whose death in car accident had made it difficult for her to return to her vegetable garden. During the eighth session, after the guided meditation of looking deeply into connectedness with the past, present, and future, as well as with various elements in nature, such as the sunlight, water, air, earth, animal, plants, and minerals, the participant began to talk about the death of her nephew, which had caused her much distress for many years. She said that she realized during our group mindfulness practice that her nephew had gone his own way and she could start a life and enjoy her present life with her grandson. After sharing this with the group, she stated that she felt relieved, as if a huge stone had been expelled from her body. In the last session, "Setting off again," she chose to attend the MLG activities while in her vegetable garden, showing us the vigorous grew vegetables in the sunlight, which inspired other group members and leaders.

Participant B shared the endless work-related stress experienced during the pandemic and the bodily feelings brought by mindfulness practice over the first 8 sessions. At the ninth session, she shared how, during the guided meditation, she was able to deeply examine her distress and understand that this was not a part of her and could be detached from her. At that moment, she felt hopeful for the future, because she knew that she could fully live in the present and thus make the future better.

Participant C attended six sessions due to work and family reasons and talked about her early trauma experience during the follow-up interview. "I thought I would bring my experiences to the grave without telling anyone else," she said, "but I would like to talk about it now … I didn't share a lot during the MLG activities, and, more often, I sat there listening to others and watching the smiles on your faces. I was sure that I didn't need advice from anyone else because I knew what I should do. However, after these weeks attending the MLG activities, I found that I could talk about what I experienced."

Participant D attended only four sessions due to work hour conflicts and talked about her difficult experience of providing assistance to hospitals during the early period of the pandemic. She was unexpectedly relieved to talk extensively about these experiences and feelings during the follow-up interview, as she was unable to speak about them before.

Participants started the MLG intervention with the common complaint of pandemic stress or related distress symptoms. However, each participant had a different requirement for healing given their different life experiences. It was not necessary for participants to share their traumatizing experiences in the past to accept the MLG intervention. In the MLG activities, participants decided individually when and how much to share of their mindfulness practice and the changes they were experiencing. Other group members practiced deep listening to the sharing. Together, the group members and group leaders witnessed changes and transformation within the group and learnt from and inspired each other. Most participants mentioned that it was important and meaningful for them to witness the peaceful state and smile of others, and the way that group leaders interacted with each other without worry or hurry helped them to relax. These findings agree with the polyvagal theory and suggest that social engagement can be achieved through group activities rather than through individual practice. In such grouped mindfulness practices, group leaders also reported being nourished and achieved growth together with the participants.

Although many MBIs are conducted in groups, they were more individual focused, lacking information on the interconnected nature of all lives, which is meaningful for trauma healing. As Deb Dana suggested, when people are anchored in ventral vagal regulation, they have a sense of being connected to others and the world. It is essential to help individuals experiencing trauma to create autonomic pathways of safety and connection (32, 33). The Plum Village method is based on the notion of Interbeing, a word coined by Thich Nhat Hanh, to help individuals to understand their deep connection to each other, nature, and all things. The insight of Impermanence, Non-self and Interbeing tells that everything changes constantly, "self" is composed of non-self elements because nothing exists independently and everything is interconnected and interacts with each other (59). If participants can perceive their interdependence and interconnection to others and the world in their daily lives, and behave with the awareness of interaction to each other, they are able to release themselves from sufferings and wrong perceptions, such as self-blaming, guilt, and shame caused by the senses of powerlessness, helplessness, and hopelessness. In fact, Impermanence, Non-self, and Interbeing are not religious terms exclusive to Buddhism, but these are universal concepts that exist across cultures. For example, the ancient Chinese philosophers Lao Zi and Zhuang Zi, who lived more than 2000 years ago, proposed that individuals should learn from nature, that is, they should understand that everything is interconnected and inter-transformed with each other in an endless succession. Individuals who adopt these perspectives in their lives can achieve release and ease. Therefore, we anticipate that Chinese individuals would be familiar with this discourse system and would be able to apply it wisely to heal themselves.

The body-mind healing wisdom also exists in Western therapies and is supported by scientific research. For example, Somatic Experiencing therapy, which is based on the polyvagal theory, helps individuals become aware of their inner body experience of interoception, kinesthesia, and proprioception by means of embodied imagery of kinesthesia and interoception; this helps clients to achieve biological completion of the thwarted response. Meanwhile, the therapist provides considerable social support using eye contact, verbal interaction, and all other factors that could draw clients toward a safe and comfortable state to activate their social engagement system and promote a balanced nervous system (15). Another recently reported body-mind treatment is the Moving to Emptiness Technique, which draws from core elements of traditional Chinese practice combined with western structural process. This technique helps clients remove their symptoms by means of transferring their target symptoms into perceivable objects and move them into a psychological emptiness realm through a series of embodied operations (60, 61). Comprehensive healing options can provide appropriate and personalized treatment that allow individuals to heal themselves and transform their suffering.

In this study, we did not observe any significant correlations of mindfulness with new possibilities or with spiritual change, which are two dimensions of posttraumatic growth. This might be a result of the limited 10-week period of the online MLG activities. Although this was not a short-term intervention as compared with other MBIs, new possibilities and spiritual changes might be generated from longer-term mindfulness practice. It might also be necessary for participants to have access to practical help, external resources, and services to generate new possibilities in their lives. The finding that mindfulness was not significantly associated with social support within the family suggests that family members should be involved in future MLG activities, for example, multifamily groups practicing MLG activities together.

In this study, we conducted MLG activities online due to the COVID-19 pandemic, which had both advantages and disadvantages. We recommend that MLG interventions be conducted in person to allow group members to interact with each other in a real-life setting, which favors the creation of real experiences and feelings that can generate a stronger collective energy of mindfulness than that obtained from remote online activities. However, conducting MLG activities over the internet is convenient and allowed people from all over the country to participate, with promising results. In addition, engaging in activities over the internet means that it is easy for participants to see their own expressions and the smiles on their own and on the faces of other participants.

5. Conclusion

In this study, we introduced the MLG activities that integrated the Plum Village original teachings and practices developed by the late renowned Buddhist Zen Master Thich Nhat Hanh and other trauma healing modalities developed by Western theorists and therapists such as the polyvagal theory proposed by Stephen Porges and Somatic Experiencing developed by Peter Levine. The effectiveness of interventions defined by the MLG activities manual was evaluated using psychological measures and was validated by the preliminary results of this study. We also discussed potential mechanisms underlying the promoting effect of MLG activities on trauma healing, while referring to both Eastern body-mind wisdom and Western trauma healing theory. Further studies using in-depth qualitative interviews are needed to further explore changes resulting from this intervention in the subjective experience of participants. In this study all participants received the intervention

after enrollment, and there was no control or wait-list group due to the pandemic. Further studies with a more rigorous experimental design are needed, either off- or online, to examine the effectiveness of MLG activities in different populations.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Institute of Psychology, Chinese Academy of Sciences. The patients/participants provided their written informed consent to participate in this study.

Author contributions

DL designed the MLG program and the conceptualization of this article, and supervised the MLG activities and the manual development. Y-NN participated in the leading of MLG activities and drafted the manuscript. DL and Y-NN contributed to critical revision 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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Causing trouble and being transmissible: COVID-19 survivors' experiences of stigma and discrimination in South Korea

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Background: The stigma associated with coronavirus disease (COVID-19) is relatively neglected in policies for handling the disease. Stigmatization occurs only within specific social contexts in local societies.

Objective: This study aims to examine COVID-19 survivors' experiences of social stigma and discrimination in South Korea in the first 2 years of the pandemic.

Methods: Semi-structured interviews were conducted.

Results: Of 52 participants, 45 reported that they had to cope with stigma and discrimination in their intimate social relationships, workplaces, and children's schools, ranging from subtle actions to job loss. Sexual minorities who were involved in mass disease transmission in the early part of the pandemic experienced a higher level of stigmatization. The stigmatization dealt with in this study was related to two themes: survivors' sense of causing trouble and possibility of transmission.

Conclusion: By intertwining this stigma with the experiences of public health measures through the voices of survivors, this study reveals the local context of East Asia in terms of culture-specific aspects of COVID-19-related stigma.

KEYWORDS

COVID-19, stigma, South Korea, psychosocial distress, emerging infectious disease, pandemic

1. Introduction

Emerging infectious diseases (EIDs) are accompanied by stigma (1, 2), and coronavirus disease (COVID-19) is no exception. Since January 30, 2020, when the World Health Organization (WHO) declared this outbreak to be an international public health emergency, governments around the world have exercised all their authority to curb the spread of the virus. While controlling this infectious disease has become the top priority in political, social, economic, and public health sectors, the stigma associated with COVID-19, which can be seen throughout the world, is relatively neglected in policies for handling this disease (3).

Stigma is defined as an defining characteristic of disgrace that is related to a particular context, quality, or person. It is a deleterious label that makes the stigmatized person or group feel secluded from main stream society and that can further lead to segregation, devaluation, and discrimination (4–8). Since the Erving Goffman's seminal work (5), stigmatization has been explored in various area, ranging from poverty, mental disease, and disability to gift in childhood. Stigma can be classified into three types: enacted stigma, perceived stigma, and internalized stigma (8). Enacted stigma refers to actual negative actions experienced by the stigmatized person or group, whereas perceived stigma means the anticipation of being discriminated against. If the stigmatized person or group accept a negative stereotype and act in a way that endorses this stereotype, this refers to internalized stigma. To avoid the stigmatization, the stigmatized person or group may adopt diverse strategies, such as passing as normal, shunning the stigmatized, and selective disclosure (5).

Disease-related stigma is originated fear of infection and death, disfiguring caused by the disease and ignorance of the cause, infectivity and the nature of the disease (9). Particularly, as an emerging respiratory infectious disease, COVID-19 evokes the fear of infection and dying that is associated with ignorance of the disease. Although in some cases people can positively appropriate stigma as an identity and self-esteem as defined "stigma allure (10)," stigmatization in general has the power to harm certain groups' or individuals' psychological and social wellbeing. The stigma and discrimination related to diseases impact survivors' mental health, and the infected may even hide their symptoms or fail to cooperate in getting treatment to avoid stigmatization (11, 12). Due to its adverse effects, stigma is even considered an independent social determinant of health (7, 13). Most of all, stigma impacts not only the stigmatized themselves but also the caregivers, families and friends, and the whole society (14). In terms of stigma, patients and survivors are able to conceal their infectious history while the preventive measures endangers them to be disclosed. COVID-19-related stigma can be classified into personal traits one and situational one.

As seen in the cases of HIV (15, 16), Ebola virus (17, 18), and SARS (19), survivors of emerging infectious diseases have faced social exclusion and blame (20) and discrimination against privileges and opportunities (9), which led to the affected patients and healthcare workers' psychological distress and post-traumatic stress (8, 21, 22). Similarly, since the onset of the COVID-19 pandemic, verbal and physical attacks and avoidance have been perpetrated against individuals of Chinese descent, other Asians, healthcare workers, COVID-19 patients and survivors, and the family members of patients in Latin American countries, European countries, the U.S., India, and some African countries (1, 2, 23–26). When it comes to public discourse scapegoating foreigners and travelers—individuals who are commonly singled out for their responsibility in the spread of the virus—COVID-19-related stigma can be found everywhere (27).

Nowadays, no one in the public health sector would disagree that disease-related stigma is as harmful as the disease itself and that we should be prepared for effective stigma-reduction interventions for the future occurrence of EID. To do so, it is crucial to understand what attributes were attached to COVID-19 survivors and how stigmatization was enacted in local societies. Stigma is recently explored as situational social process. In other words, although stigmatization can be observed everywhere and at any time (28) and the biological traits of disease may be universal, individual stigmatization occurs only within specific social contexts in local societies (12, 29, 30). In the case of COVID-19 pandemic, preventative measures, ethnicity dynamics, the medical capacity, and other cultural beliefs and political stances may impact the ways in which stigmatization enactivated in each society in different ways. For example, in Euro-American countries, the public fear of COVID-19 cast Asians as "others" (31–33), and cultural ideas and norms regarding wearing masks facilitate avoidance behavior and even physical attacks on those wearing masks in public spaces. By contrast, in East Asian countries, the social stigma regarding COVID-19 has unfolded in different ways. For instance, in South Korea and China, where people are used to wearing masks to prevent infectious diseases and protect themselves from inhaling fine dust, those who do not wear masks are declined access to public spaces. The degree and type of preventive measures that each government has adopted have also affected how laypeople make sense of the pandemic (34).

South Korea is well-known for its rapid and nation-wide preventative interventions. Wearing masks both indoor and outdoor was mandatory and people cooperated with the government-leading policies while the fatality of COVID-19 remained low. This paper examines how COVID-19 survivors in South Korea experienced social stigma and discrimination in the first 2 years of the pandemic. By probing what COVID-19 survivors went through from the time of infection to after recovery, this paper answers the following questions: (1) What kind of stigmatization, either perceived or enacted one, did survivors encounter? (2) What was the attributes of stigma that were attached to COVID-19 survivors in South Korea? (3) In what social relationships and under what circumstances did survivors experience stigmatization? By seeking answers to those questions, we would like to make suggestions to prevent future EID-related stigma.

2. Materials and methods

2.1. Design

This study was part of a large-scale research project exploring COVID-19 survivors' experiences and psychosocial distress related to COVID-19 treatment, quarantine/isolation, and post-recovery experiences. Semi-structured, in-depth interviews were conducted with the participants.

2.2. Recruitment

Coronavirus disease survivors were recruited from six hospitals in Seoul and Gyeonggi-do. A total of 61 participants were recruited through their attending physician's suggestions, advertisement flyers distributed to the hospitals, and snowball sampling. Among the recruited patients, 52 participants finally enrolled and participated in this study; nine patients lost contact for unknown reasons. All participants were informed about the purpose and methods of the study. Written consent was waived by the hospitals' IRB because the study took place when the survivors were reluctant to meet in person due to their deteriorated condition, fear of stigma, and the possibility of a second infection. Instead, verbal consent was recorded at the beginning of each interview. All interviews except one were conducted *via* phone.

In the research preparation stage, a list of questions was prepared to guide the semi-structured interviews (Table 1). The interviews were designed to follow the narrative flows of participants from the appearance of symptoms to their return to everyday life. The themes of stigma appeared through natural narrative flows, in particular, in the questions regarding concerns, disclosure, and changes.

Four members of the research team, with experience in qualitative research in the fields of medical anthropology, gender studies, and pedagogy, conducted the semi-structured interviews. With the participants' approval, the interviews were recorded and transcribed. All identifying data were deleted from the transcripts. Theoretical saturation was reached when no new issues were addressed in the interviews, and consequently, recruitment was closed.

TABLE 1   The interview questions.

General experiences of COVID-19 infection
"I would like to understand your experience of COVID-19 since the appearance of symptoms to post-discharge."
Responses from others
"Who knows about your infection and how did they react to the news?"
"What did you feel about the reaction?"
Disclosure
"Did you voluntarily disclose your infection to people? If yes, to whom did you disclose it?"
"Was there any involuntary disclosure? If yes, what situation led to the disclosure?"
Concerns and suffering
"What was your concern while going through the infection?"
Support
"Who (or what) helped and supported you?"
Changes
"Have you experienced any changes since your infection?"
Suggestion
"What could have helped you return to everyday life after the COVID-19 infection?"

2.3. Analysis

The transcripts were analyzed based on grounded theory (35). In the open coding stage, four members of the research team independently created core categories and key themes using memos that emerged while iteratively reading the transcripts. Through constant discussions, these categories and themes were integrated into one chart, and a detailed guideline for coding was shared with other team members. According to the integrated codes and themes, the entire interview transcription was cross-reviewed by the team members, and the codes and themes were revised again through discussions. The final comprehensive code structure of the relationships between the core categories and themes was approved by all research team members. Through discussions, reviews, and supervision, all team members, having diverse qualifications (M.D., Ph.D., doctoral candidate, and B.A.) and backgrounds (psychiatry, medical anthropology, gender studies, and pedagogy), examined the interview data in a reflexive manner; this process contributed to minimizing biased interpretations.

2.4. Ethics

The ethics committees of Seoul National University Hospital (No. H-2010-048-1163), Seoul National University Bundang Hospital, National Medical Center, Armed Forces Capital Hospital, Seongnam Citizens Medical Center, and Boramae Medical Center approved the study protocol and materials between April and June 2020. This study adhered to the Declaration of Helsinki. All names used in this paper are pseudonyms.

3. Results

3.1. Demographic features

In total, 52 COVID-19 survivors participated in the study between February 2020 and October 2021. All interviews lasted 60–90 min. The participants' demographic characteristics are displayed in Table 2.

3.2. Experiences of COVID-19 test and treatment process

The period in which the participants were infected span between January 2020 and August 2021 was the time that "3T policy" and social distancing policy of the Korea Disease Control and Prevention Agency (KDCA) were strongly enforced until the third vaccination (2021.10.12) and deregulation of social distancing (2021.11.1) began (36). The 3T policy, which was adopted by KDCA in the first 2 years of the COVID-19 pandemic, entailed preemptive testing, prompt tracing, and proper treatment. Along with test, trace, and treatment, isolation of patient and quarantine of those who had physical contact with the patient were strictly enforced. The details of this policy that impacted the participants are outlined in the following.

The participants took a PCR test when symptoms such as coughing, fever, and muscle pain appeared or when they had physical contact with a confirmed COVID-19 patient. After receiving PCR tests at screening centers, which were installed at hospitals, public health centers, schools, and sports facilities, near their homes or workplaces, they received positive results the same day or at least the next day. Subsequently, they were soon transferred to a hospital isolation ward or residential treatment center *via* ambulance; the latter was reserved for those with only minor symptoms.

After the participants were taken away, their homes were disinfected by the public health center staff. In the treatment center or hospital, all physical contact with the outside world was prohibited, except for extremely limited contact with medical staff. Voice/video calls, the internet, and TV were allowed. If the participants no longer had severe symptoms 10 days after being admitted, they were discharged.

Once a COVID-19 patient was identified *via* PCR test, everyone who had physical contact with the patient in the last 3–7 days also received a PCR test. Those who tested positive were taken to a hospital or residential treatment center, where they had to remain for at least 10 days. Those who were in close contact with a patient

also had to self-quarantine at home for the incubation period (14 days), even if they had a negative result. If a negative result was obtained on the last day of quarantine, the at-home quarantine order was lifted. Some patients and individuals in isolation were provided with short-term emergency COVID-19 relief funds for their labor loss.

An epidemiological investigation was conducted after each positive result. Through phone calls, epidemic intelligence officers (epidemiological investigators) asked the participants about their whereabouts, whom they had met, and whether they had followed the COVID-19 guidelines during their incubation period. In addition to the interviews, the epidemiological investigators sometimes reviewed CCTV footage and patients' credit card records. Those who were identified as close contacts of infected patients were tested for COVID-19.

From the onset of the COVID-19 pandemic, the KDCA disclosed statistics (e.g., the number of confirmed cases, the rate of severe cases, the number of recoveries, and the fatality rate) in press briefings and on its website every day. Each patient was given a case number by the local government. The local government sent a text message to all residents every morning to notify them of the number of new and accumulated confirmed cases in the local district. The recent routes of each case number were disclosed on the KDCA and local government websites. In the early phase of the pandemic, each patient's routes and times of visitation at each location were disclosed; however, as concerns about privacy infringement increased, information about newly infected patients' routes was collectively disclosed so that an individual patient's route was untraceable.

The requirement to wear a mask in public spaces, including in public transport vehicles, movie theaters, religious facilities, educational institutes, schools, bus, and train stations, and department stores, was enforced beginning in May 2020. Enforcement was limited to indoor places, but people always wore masks both indoors and outdoors. Public facilities, such as restaurants, provided thermometer machines and hand sanitizers at their entrances. All visitors were supposed to fill in entry logs (or tag a QR code) to access the facilities, and these logs were used to trace close contacts whenever a patient was confirmed.

3.3. Experiences of stigma and discrimination

3.3.1. Common features

Of the 52 participants, 45 (86.5%) reported that they recognized perceived stigma against COVID-19 survivors and that this expectation was a major concern after being infected. From the moment of diagnosis, they internalized COVID-19-related stigma. They felt as if they became "conspicuous" and "separated from ordinary people," and they were afraid that people would see them as "virus carriers." Mr. Eom (#031), in his early thirties, remarked, "I feel like no one will try to set me up on dates anymore because I caught COVID-19." Feelings of guilt, shame, and labeling were experienced, as Ms. Hahm (#058), a woman in her forties and a senior staff member at her workplace, described: "When I went back to my workplace, even though no one mentioned my infection, I felt as if a scarlet letter was on my chest. At lunchtime,

TABLE 2 Demographic features.

		N = 52	
		N	%
Gender	Male	23	44.2%
	Female	29	54.8%
Age	≤19	1	1.9%
	20–29	5	9.6%
	30–39	9	17.3%
	40–49	10	19.2%
	50–59	9	17.3%
	≥60	18	34.6%
Working/Student	Working	36	69.2%
	Student	1	1.9%
	N/A	15	28.8%
Working status	Self-employed	15	28.8%
	Employed	20	38.5%
	Others	1	1.9%
Date of infection	Jan to Dec, 2020	20	38.%
	Jan to Mar, 2021	23	44.2%
	Apr to Aug, 2021	9	17.3%
Hospitalization period	≤14 days	24	46.2%
	15–30 days	20	38.5%
	≥30 days	8	15.4%
Psychiatric intervention during hospitalization		5	9.6%
Cessation of work		15	28.8%
Move		0	0%
Acquaintance's death		0	0%
Public disclosure of infection		14	26.9%

I could not hold my head up in the cafeteria. I felt guilty. The effect of self-stigmatizing was powerful."

Of those 45 participants, 37 reported experiences of enacted stigma as well. The scope and type of enacted stigma addressed by the participants included both subtle and indirect reactions, such as uncomfortable looks, rumors, and attempts to uncover the infected, and obvious and direct reactions, such as avoidance, termination of a relationship, expressions of fear against the survivors, public blame, and job loss. As consequences of stigma and discrimination, the participants reported depression, anxiety, feeling of isolation, guilt feeling, psychological shrinking, and suicidal thought. Some of the participants reported that the perceived stigma delayed them to get a test promptly.

The attributes of COVID-19-related stigma appeared as two themes: the sense of causing trouble and the possibility of transmission. First, the participants shared the idea that COVID-19 patients ended up creating "big troubles" for people around them by causing others to get tested and quaranteened, become infected, and be hospitalized. The participants tended to internalize this attribute and consider themselves, in part, contributors to others' "troubles," and some of them were faced with overt blame for their "carelessness." For instance, Ms. Ahn's (#029) neighbor accusingly commented, "You could have avoided catching COVID-19 if you wore a mask properly and washed your hands. Didn't you wear a mask?" With the sense of responsibility the participants felt for their infection and transmission of the virus, it was critical to their psychological distress whether they actually caused an additional infection. Mr. Koo (#012) expressed relief that he did not cause any additional infections, saying, "I was much relieved that no one was infected by me. That was why I could go back to everyday life quickly." In contrast, Mr. Jang (#009), in his seventies, blamed himself, "Because of me, five family members out of six were infected. It was beyond expression."

In the participants' accounts, COVID-19 survivors were classified into two groups: innocent victims and individuals responsible for their own infection and after management. For example, if a patient became infected despite their best efforts to follow preventive policies (e.g., by refraining from eating out and wearing a mask in all circumstances) and tried to minimize the scope of close contact with people (e.g., by preemptively getting tested), they deserved to receive enough sympathy and support. However, if a patient visited multiple places while having symptoms or concealed some locations they had visited during the epidemiological investigation, they deserved criticism. While interacting with people in their everyday lives, such as in conversations with neighbors and through online forums, the participants learned about this classification and internalized it both before and after their infections. Ms. Joo (#056) recalled how she recognized people blamed for COVID-19 patients before her own infection, "I kept reading things on the mom forum, like critical comments, and it was like a witch hunt. I was very nervous. People on the forum blamed those who did not follow the rules, such as those who wandered around after their test."

By going through the screening, treatment, and quarantine/isolation, the participants learned that it was impossible to prevent infection and transmission through perfect self-discipline and that rules may often be violated without selfish intentions. Yet, they reflected with anxiety on whether their "carelessness" caused the infection. Simultaneously, the participants tried to differentiate themselves from the "irresponsible" survivors, thinking that it would be unfair if they were generalized as "the careless infected." For instance, Mr. Choi (#004), who was infected by an unknown source, said, "It would be less unfair if I went to a pub, but I did not. I felt it was very unfair." In contrast, Ms. Min (#019) felt guilty and blamed herself. She was infected by a taxi driver and passed it on to her entire family. She believed that the adversity of her family resulted from her negligence of hygiene. "My friend and I took the taxi and had a lot of conversation with the driver. I did not wash my hands right after going home. I think that was the problem because my friend was not infected."

This attribute of causing trouble could be applied to those who passed COVID-19 on to the participants. Although many participants commented on those infected them, "They did not do it intentionally," some participants criticized their carelessness. Mr. Paeng (#056) did not hide his anger against his colleague at work. Four of colleague went on a trip together during a weekend and were infected. Even though they all had a fever, they took a Tylenol and went to the office, which led a dozen of infection cases at the company. "I was so pissed off and was going to sue them. I wanted to kill them in the ICU. I still feel anger. When I hear their voice at work, I feel rage."

The second attribute of COVID-19-related stigma was a collective fear that recovered patients might still be able to transmit the virus because some "dead virus" could remain in their bodies. Not to mention the people around them, the participants were also unsure whether they were "totally safe" to others. Hence, many participants commented that they understood their friends' and neighbors' avoidance and voluntarily tried to avoid physical contact for a while. Ms. Moon (#018) reported, "Because we had been infected, I was hesitant to meet people. We (she and her children) could not go to the playground, of course, and when we encountered people there, I kept a distance and told them, "I was isolated. Would it be okay? You'd better keep away from me." I did this for a couple of weeks."

The discharge process also reinforced the fears of transmissibility, as the participants did not receive any tests when they were released. Instead, they were informed by the medical staff that they would test positive for a while because of the remaining virus in their bodies. This explanation of the remaining virus and the process of discharge without assurance failed to end the anxiety and fear of the participants and the people around them. Mr. Hong (#005), a man in his sixties, said, "People asked, 'Did you receive the negative result or not? Can't we trust my safety only after you test negative?'"

This no-test discharge policy caused problems, particularly in schools and workplaces. Due to the fear of transmission, some schools and workplaces required the participants to submit a negative result, and the KDCA and the healthcare center did not endorse the participants' return in an official way. Some participants, thus, had to wait an additional couple of weeks for their negative results, which jeopardized their job stability. We will return to this issue in "section 3.3.3 Contexts in workplaces."

3.3.2. Contexts within private networks

The participants' infections were known to their relatives, friends, acquaintances, and neighbors through voluntary disclosure or involuntary disclosure such as official notice, transportation

and disinfection processes, rumors, and notices from educational institutes (e.g., kindergartens). This category was most frequently addressed as the stigmatizers. Compared to their workplaces, their private social networks were places where the participants could control information disclosure to some degree. They carefully selected to whom and in what circumstances they disclosed this information and often chose to hide their infection to avoid uncomfortable situations. The scope of disclosure varied, ranging from no one (including family members) to only family members and close friends or to those the participants interacted with in daily life. Some participants thought that not telling about the infection could be considered a lie and they were reluctant to meet people for a while to avoid this distress.

Because of the intimate nature of their relationships, the participants' relatives and friends tended to explicitly reveal their fear of COVID-19 and blame the participants for "the trouble." For example, Ms. Yim (#036), a woman in her thirties, was infected by an unknown source. She had met many relatives and friends before her positive COVID-19 result since it was during a holiday break. Among the friends she had met, only one was infected, and the rest tested negative. However, her friends still suffered economic damage due to quarantine and isolation. Ms. Yim's friend's husband called Ms. Yim and swore at her. The rest of Ms. Yim's friends did not blame her to her face, but she heard from others about the difficulties her friends endured. When she gathered up the courage to call some of her friends, she sensed that they were avoiding her. Ms. Yim felt very regretful that she could no longer reach out to her friends.

Ms. Yim's parents-in-law were also forced to be quarantined at home. This 2 weeks quarantine caused such great psychological distress that her father-in-law could not eat properly for several months. While going through a hard time, Ms. Yim's father-in-law asserted that she should not have included her parents-in-law on the contact list. He vowed to disown Ms. Yim and her husband. It took a long time for Ms. Yim and her husband to convince Ms. Yim's father-in-law that cooperation with the epidemiological investigation was inevitable.

Ms. Jee (#040), a woman in her forties who was infected at her workplace, recalled a scene from her discharge day. Coming back home, she passed by a supermarket across from her house, and some people who were hanging out there literally ran away as soon as they saw her. "Word must have spread throughout the neighborhood. They looked at me and ran away. The adults took their children's hands. I was really shocked."

This outright avoidance of her close neighbors shocked Ms. Jee so deeply that, for a while, she avoided any encounter. She developed a new habit of looking around when she left home to make sure no one was around her. Although she had regularly frequented the market before her COVID-19 infection, she stopped going post-discharge because she believed that she would no longer be welcome. Ms. Jee remarked, "They treated me as if I made a huge mistake. You would not do that, even for sex offenders. They are not strangers; they are my next-door neighbors."

Due to the government's policy of posting notices of infected individuals' routes, some participants were involuntarily detected as infected. Ms. Ahn (#029), who was infected in a club, said, "The epidemiological investigators told me that they would not reveal the name of my store unless I wanted to do so, but the address and name of the store were posted on the city homepage. I got calls from

everyone I knew. I was so freaked out and made up a story that a patient had come by my store. I felt like I was being bullied."

Even when infected individuals' personal information were not revealed, their neighbors tried to investigate and identify who the infected were out of fear. Although these investigations might be an adaptive behavior to make sure their own safety (to avoid the place, to determine whether or not to get a test, etc.), but, resultingly, these investigations in many cases ended up blames the survivors for their carelessness and made the participants feel guilty and isolation. South Korea has well-established online communities for each local society, and these web-based forums acted as channels through which public opinions and information regarding COVID-19 were shared. Ms. Hahm (#058), who lived in an apartment complex, experienced the following after her family's infection: "(On the online community of the apartment complex), (t)he neighbors tried to find out which house was the one. It was an atmosphere in which people would say, "Why on earth did they (not stay at home but) thoughtlessly wander around during this pandemic crisis?" People living in the same building posted on the forum, saying, "I have just called my boss, and she told me to take the day off tomorrow because the infected lives in the same building as me. Should I get a test now? Please tell me which floor the infected lives on." I thought it was just a matter of time before people detected us. I thought people would hate us because they suffered damage because of us. (B)ut I wondered if I really made such a big mistake. I could not stop self-flagellating."

It is natural for people to expect warm support and empathy from their relatives, friends, and neighbors, especially during a crisis. On the one hand, close relationships were the main source of emotional and financial support for the participants. On the other hand, these close people's casting of blame and attempts to detect who was infected deeply impacted the participants psychologically. In particular, the negative reactions from neighbors broke their sense of serenity in their homes, and some participants reported that they had considered moving after being infected. When faced with the responses of their relatives, friends, and neighbors, some participants felt skepticism about the social relationships they had built, which caused psychological shrinkage, feelings of isolation, alienation, and depression to the participants.

3.3.3. Contexts in workplaces

Unlike the private networks, the participants hardly controlled the scope and timing of disclosure at their workplaces. Once they reported their infection, this news was immediately delivered to their seniors and teams, and, in nine cases, the whole workforce was notified. For instance, Mr. Eom (#031), who was a soldier, found out that his name as the infected was disclosed to the whole military. Within the military intranet, anyone could figure out his private information, including his university, military service number, and contact number. He said: "It was just like how laypeople know a celebrity, but the celebrity does not know the laypeople. "He is the infected." People at work knew everything about me, and not because of a good event but because of my COVID-19 infection. This made me scared."

The sense of causing trouble amplified in terms of workplaces because the participants could not go to the office at least 10 days, and, further, their infection resulted in the colleague's COVID-19 test and quarantine. Particularly, in the case of workplaces, there were many cases that the first patient of serial infection was

clear. After returning to work, some participants sensed reinforced policies, such as wearing only KF94 masks, not being allowed to talk during breaks, and undergoing surveillance through CCTV, which made the participants feel guilty.

The perceived and internalized stigma at workplaces caused the participants to feeling of guilt, being overt blamed, rumors, and being distracted. In some cases, involuntary disclosure hampered the participants' work. After Mr. Oh's (#032) infection, the epidemiological investigators contacted every business he worked with, and a rumor that Mr. Oh was infected at a political rally, which was regarded as an inappropriate site to visit "during this crisis," spread among his business contacts. Some of them were so upset that they considered suing Mr. Oh, which intimidated him for a while.

The most distinguishable and critical feature of workplace stigmatization was that survivors could end up experiencing serious economic damage including job loss if they were held responsible for the "trouble" they caused their workplaces. Some participants, such as Mr. Shin (#028), a financial company employee who was hospitalized in an ICU for 3 weeks, reported that he was more worried about whether he would be paid properly and whether he would be dismissed due to the labor loss and great trouble he caused than the actual physical pain. Although Mr. Shin was not face with a threat of layoff, some participants' concerns turned out to be valid. Ms. Jung (#008) recalled her return: "All hell broke loose at my workplace. About 30 people worked together, and everything stopped for almost 2 weeks. I was totally on my boss' blocklist because three more people were infected by me. My boss was not willing to let me work again, which caused me a lot of distress."

Some participants ended up quitting their jobs after returning to their workplaces. Mr. Jin (#041) was working as a facility manager at a middle school when he and his three children were infected by his wife. After the news of his infection broke out, many teachers and students at his school were tested and isolated for 2 weeks. Mr. Jin was very hurt and intimidated when one of the teachers reproached him, "If your wife was so sick, you should have gotten her tested. Why did you do nothing and cause everyone such trouble?" After being released from the 2 weeks isolation, Mr. Jin was faced with an impossible demand from the school: provide a certificate of COVID-19 negative result. In response to this unfair demand, the public health center did nothing except say, "You talk to the school." Eventually, Mr. Jin quit his job.

A total of 15 participants reported cases similar to Mr. Jin's. After returning to the workplace, they were asked to quit for different reasons. Some of the participants thought that they deserved it because of the "great damage" they caused to their workplace. Ms. Yim (#036) also felt pressure from her boss and finally submitted her resignation. Recalling her last week at work, she said, "I could not help but cry. I thought, "This company fired me, so why am I working here for them?" I could have quit immediately, but I insisted on working until the end of the month so that I could earn 100,000 won. But I was upset about that."

3.3.4. Children's schools

Children's school was one of the places where the perceived stigma of survivors was most salient. The participants with young children were most worried and anxious about their children's social lives after infection. In this study, there were no cases of children being exposed to enacted stigma, but the participants

were widely concerned about whether their children would be disadvantaged at school or bullied by friends, particularly due to the sense of causing trouble. Since schools did not announce who was infected, the participants could exert control over disclosure in some sense, but the fact that children were involved in it often made handling disclosure more complicated.

At schools and private educational institutes, students' infections were followed by all their close contacts' being tested and quarantined for 2 weeks. This caused the participants the greatest psychological pressure and anxiety about bullying. Ms. Pyo (#057) said: "There was an long line at the screening station when one infection case was confirmed at the school. Working mothers had to take the day off to take their children to the screening center and wait there for a couple of hours. I knew what it was like, and it was a great psychological burden when we were infected." This guilty feeling was observed in participants who were mothers of young children. They were afraid if their children would be teased, blamed, or excluded for causing the troubles to friends and their families. For this reason, many participants with minor children reported that protecting children from COVID-19-related stigma by hiding their infection was the most crucial mission to them.

Officially, schools did not reveal who was infected to protect the children. However, the participants had to juggle with crisis of involuntary disclosure that their child's infection would become known to other students, particularly through online mom forums and social network services. For instance, Ms. Pyo (#057) related to the group chat for her child's class. Each class has its own group chat, where the class teacher and all the students' parents gather. This group chat is supposed to circulate relevant information in real-time, but during the COVID-19 pandemic, it could function as a channel through which information about who was infected was circulated. After Ms. Pyo's daughter's infection, the whole class was tested: "Mothers began to report the test results in the group chat, saying, "My kid tested negative." I could not say anything. One mother said, "It will be so obvious soon who is the (infected) one." The teacher interrupted and notified the group, "Please report it (the children's test results) to me directly, not in this group chat." After this notification, the reports of negative results stopped, and I avoided the awkward situation."

Regarding the issue of disclosure, some participants addressed the difficulty of having their young children hide their infection. They felt that they had no choice but to hide it and told their children not to talk about the infection as well. However, this instruction confused the children. Every time the participants chose to make up a story of "self-quarantine at home" (not isolation of infected patient) in front of their children, they were worried if the young children knew that their parents were lying.

As seen in Ms. Pyo's case, it was because of individual teachers' efforts to protect infected students from involuntary disclosure that no participants reported their children's exposure to stigmatization. Ms. Joo (#039) and her 9 years-old girl, Ajin, were infected. Ms. Joo thought that they were fortunate because her daughter tested positive during the at-home quarantine period, which was not followed by other students getting tested. Yet, it was natural for the children in Ajin's class to wonder why Ajin did not come to school. Ajin's teacher told them that Ajin was absent because of her atopy treatment. Ms. Joo considered this "gloss over" and a "white lie," to convince the children of the situation from their level. She felt much gratitude toward the teacher for her efforts to protect Ajin

from being exposed to social blame as well as her daily calls to Ajin to tell her how the school day was.

3.3.5. Sexual minorities in mass transmissions

In South Korea, mass infections occurred in some LGBTQ clubs in May 2020, and the mass media heavily covered these cases with sensational expressions, such as "94 infected out of gay clubs" (37). In this study, two participants, Mr. Chae (#043) and Mr. Hahn (#046), who identified themselves as sexual minorities who were infected in this mass transmission. It was these two participants who went through most harsh enacted stigma, breach of privacy, and its consequences among the whole participants.

First, while the KDCA did not address concerns regarding hate speech toward sexual minorities and the risk of outing them, LGBTQ patients were directly exposed to the public's accusations. Combined with the idea that they were infected in "clubs," which were regarded as inappropriate places to visit during the pandemic, they were regarded to be responsible for both their own infection and troubles to the whole country. Their sexual identities stimulated further blame with the use of homophobic slurs. Reading the newspapers and the replies the papers received that insulted the gay COVID_19 patients from the mass infections, Mr. Chae and Mr. Hahn experienced a traumatic shock to the extent that Mr. Hahn thought of suicide. He said, "I should not have read them, but I had to. Since then, I have felt the urge to jump out of the window during nights of broken sleep. I was prescribed psychotropic medication because of it."

Although both Mr. Chae and Mr. Hahn voluntarily visited a screening center to get tested even before the KDCA's recommendation, it did not help lessen the responsibility of transmission or the public blame. They could not receive emotional support from the gay community either. Mr. Chae said, "Many of my friends regarded going to a club as my fault, and I could not confidently claim that I did not do anything wrong." Both had many relationships severed. Mr. Chae was rejected by someone he was dating after telling that person about his infection. Mr. Hahn recalled, "I had lost half of my friends in the gay community. I drifted apart from them."

With regard to the exposure of personal affairs, Mr. Hahn was more acutely afflicted than anyone in this study. In the period of his infection, the KDCA revealed the names of infected parties' worksites, the names of apartments, ages, and whereabouts by time. Being covered by the mass media, Mr. Hahn's information was publicly exposed. Even the mayor of the city posted his information on the official social network service. When combined, these pieces of information could easily identify Mr. Hahn such that acquaintances were able to determine that the infected person in question was Mr. Hahn. Being continuously asked, "Is this you?" he felt terrified and resentful: "It was more painful and traumatic than getting COVID-19. I was skeptical if I could go back home after discharge and was thinking of moving away."

Involuntary disclosure posed an additional risk to Mr. Chae and Mr. Hahn, which was the risk of being outed. Inevitably, Mr. Chae had to hide his infection from his parents who were unaware of his sexuality. Mr. Hahn also recounted: "The issue of sexual identity was the hardest thing because even my family, work colleagues, and friends from high school came to know it (my sexuality). Even though I told my mom a good excuse, (she) heard an insult directed at me in her workplace."

Mr. Chae and Mr. Hahn both reported discrimination from healthcare workers, which was rarely mentioned by the rest of the participants. In Mr. Chae's case, a staff member from a local healthcare center came to his home to pick him up and instructed him not to use the elevator. As a result, Mr. Chae had to climb down the stairs to the ground floor from his 18th-floor-apartment. The staff also instructed him to wear a protective suit and to spray disinfectant around himself on his way down to the ground. Of the participants, Mr. Chae was the only one who was instructed to do so. Although Mr. Chae was deeply ashamed of this instruction, feeling as though he had become "a carrier," he thought to himself, "The virus is coming out of me, so I must do this."

Neither Mr. Chae nor Mr. Hahn could return to work, even after recovery. Mr. Hahn reported that he still had not been able to visit near his workplace at the time of the interview (1 year after his infection). "I could not go back to my work. They said I could, but honestly, everyone knows it (the infected gay) was me. How can I go there? I still cannot go the area, even though it is so close to my home. It would be correct to say that I gave up on being reinstated. The company said I could, but they felt uncomfortable, and I heard a rumor that I would be sent to another branch. I just quit."

4. Discussion

This study showed that the attributes, contexts, consequences, and disclosure management of COVID-19-rerlated stigma that the survivors went through in South Korea in the first 2 years. The main attributes of stigma that were attached to the COVID-19 survivors were the sense of causing trouble and the fear of transmission. The survivors had to cope with both perceived and enacted stigma in their intimate social relationships, workplaces, and children's schools, ranging from subtle actions to job loss, and some of them reported internalized stigma. While the survivors could control over the disclosure of infection in their private network to some degree, they experienced involuntary disclosure at workplace. Due to the sense of causing trouble and the fear of transmission after the recovery, the survivors could not be treated merely as a patient who needed care and support.

The results of the study revealed that labeling, attributes, and disclosure of COVID-19-related stigma were closely linked not only to the biological characteristics of the disease but also to socio-cultural aspects of the public health preventive measures (3, 38–41). At the core of stigma are difference and deviance (5). The process of taking a screening test, receiving a positive result, being taken away to a healthcare center *via* ambulance, being assigned a case number, having their route posted publicly, and enduring isolation and quarantine maximized the participants' sense of being distinguished and becoming "other." The no-test discharge policy played a barrier to the survivor's return to workplaces and schools, and the public post regarding a patient's whereabout policy was in part abused to detect who was infected.

Particularly, it is noteworth that the sense of causing trouble appeared as a main attribute. In the participants' account, "trouble" refers to implicating family, friends, neighbors, and colleagues at work in a test, quarantine at home, and isolation. Through the preventative measure process, the survivors were changed from

"a patient" to "a transmitter," which was susceptible to blaming. The survivors were easily internalized the subdivision those who do not follow public health guidelines ("moral other") and those who do ("moral us"), viewing the latter as responsible citizens (42), which is in line with the prominent pandemic discourse in Canada (31) and Italy (43). To minimize this accusation, the survivors, on the one hand, utilized the sense of division between innocent victims and those being held responsible for infection transmission while internalizing this blame and trying to see themselves as the former, which reproduced the stigmatization. However, the survivors in this study highlighted that they ended up being blamed regardless of how sincerely they observed the rules and whether they caused any additional infections. To sum up the above, it seems apparent that the preventative measures to some extent played as a role of predisposing and precipitating factors of stigma (6) in South Korea.

The underlying idea of responsibility and causing trouble reflects the belief that the prevention of infectious disease depends upon an individual's efforts and self-discipline. This silent pressure, both from inside and outside, may function to encourage individuals to discipline themselves (28). However, given that there are no perfect preventive measures against a respiratory infectious disease such as COVID-19, this idea contributed to the survivors' anxiety, feeling of guilt, and shame.

Another aspect essential to stigma is the fear of transmissibility. This fear has been regarded as the representative driving factor of COVID-19-related stigma (3, 44, 45). Yet, this study discovered the specific context in which the scientific explanation of the remaining virus in the body and the discharge process without a final test together resulted in the fear of post-recovery-transmissibility and barriers to returning to everyday life. This result suggests that how to explain the scientific fact to the public and the processual aspect of public health may be as important as the provision of accurate information (46) in order to mitigate infectious disease-related stigma.

The LGBTQ survivors' cases in this study revealed the power structure of stigma (47). The high level of stigmatization that these survivors endured is by no means irrelevant to the preexisting stereotypes attached to sexual minorities (e.g., that they carelessly have sex) and the hate discourse against them that has its foundations firmly rooted in the larger social structure (13). This result indicates that socially vulnerable individuals are not only easily targeted as scapegoats (48–50) but also face harsher blame and less social support after infection, regardless of how responsibly they manage their condition (51, 52). Particularly, this study revealed that when a social minority group is engaged in the mass transmission of disease, the public accusation occurs more relentlessly.

5. Suggestions

Drawing upon the results of this study, we would like to make some suggestions for the next pandemic. Since stigma is ultimately a matter of power structures, eliminating disease-related stigma must not be left to individuals. Active governmental intervention is needed to reduce the stigma related to COVID-19 and new EIDs (11). The findings of this study indicate the

necessity of two layers of efforts: (1) to invent preventative measures that do not contribute creating stigma and (2) to take care of survivors. First, the preventive measures must include how to return the patients to everyday life. The process of diagnosis and isolation plays a significant role in differentiation and otherizing. If so, the government and public health authority are responsible for bringing the patient back to workplace and schools. As reported in the U.S. as well (53), an official certification that those who have finished treatment and been released from isolation/quarantine are no longer transmittable and can return to daily activities can lessen stigmatization. Also, as pointed out in a previous study (6, 54, 55), the provision of accurate and focused information about COVID-19 from a reliable source can reduce stigmatization. Yet, this information should contain not only guidelines to avoid infection and the statistics of infection cases but also guidance on how to support patients and survivors, what survivors should do after recovery, and the meta-message that the infected are not perpetrators but merely patients who need treatment and support.

Third, the government and the mass media industry should reach an agreement on how to cover EIDs and their patients/survivors. As noted, the discriminatory and exclusive metaphors used by some media and newspaper outlets often fuel stigma (11, 42, 55–58) and cause psychological distress to the infected (59). In this study, the stories of "gay club mass infections" left LGBTQ survivors exposed to hate speech and contributed to justifying discrimination against them. Also, as this study reveals, highlighting the collateral damage and inconvenience of individual infection (e.g., how many people had to get a test due to the confirmed case) that resultingly condemns the patients would exacerbate the infectious-disease-related stigma. Further, attention should be given to the social network services and online forums through which public blame, stereotyping, labeling, detecting, and involuntary disclosing are carried out in order to mitigate stigmatization, not only in South Korea but also in other countries (24, 32, 60).

With regard to taking care of the survivors, mental health care for survivors must be provided. Previous studies have reported that COVID-19 patients and survivors may suffer from psychological symptoms, such as post-traumatic stress symptoms, depressive symptoms, insomnia, and suicidal thoughts (61–64). In this study, survivors struggled due to the double bind of stigma: on the one hand, they faced post-recovery discrimination; on the other hand, the fear of stigmatization prevented them from talking about this discrimination and social stigma, as well as the psychological distress that originated from quarantine and the physical isolation they experienced during treatment, which can harm body–mind wellbeing (65, 66). Most of all, more proactive and preemptive approaches to avoid stigma should be taken rather than to counteract already existing patterns of stigma.

6. Conclusion

To successfully prevent a new EID, civil cooperation with the policies is crucial, especially, the cooperation of the affected people.

The COVID-19-related stigma that survivors have undergone is detrimental to halting and controlling pandemics. If the public health guidelines focus on only the narrow biomedical aspects, this limits our understanding of how policies should be shaped to offer the most effective and equitable response (3). This study has several implications: it reports the unique features of South Korea in East Asia where the preventive measures have unfolded in different ways from Euro-American countries. Particularly, by listening to the voices of the COVID-19 survivors, this study provides empirical evidence of the local context in which the survivors encountered stigmatization.

7. Limitation

The limitation of this study is that this study focused on survivors in the first 2 years of the infection onset. Since then, public anxiety and the intensity of preventive measures have decreased. Because stigma is essentially historical and circumstantial (13), further studies are needed to identify the ways in which these changes impact the transformation of stigmatization patterns in South Korea.

Data availability statement

The datasets presented in this article are not readily available because of participant privacy. Requests to access the datasets should be directed to HYoP, psychepark@gmail.com.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committees of Seoul National University Hospital (No. H-2010-048-1163), Seoul National University Bundang Hospital, National Medical Center, Armed Forces Capital Hospital, Seongnam Citizens Medical Center, and Boramae Medical Center. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

HYoP and J-WP: conceptualization. JK, HK, HJY, and YL: data curation. JK, HK, HJY, YL, and HYoP: formal analysis. JK, K-HS, HO, MS, SL, J-WP, and HYoP: methodology. JK: draft of the manuscript. All authors: investigation, critical revision and editing of the manuscript, and 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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Protecting public's wellbeing against COVID-19 infodemic: The role of trust in information sources and rapid dissemination and transparency of information over time

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Objectives: This study examined how trust in the information about COVID-19 from social media and official media as well as how the information was disseminated affect public's wellbeing directly and indirectly through perceived safety over time.

Methods: Two online surveys were conducted in China, with the first survey (Time1, N=22,718) being at the early stage of the pandemic outbreak and the second one (Time 2, N=2,901) two and a half years later during the zero-COVID policy lockdown period. Key measured variables include trust in official media and social media, perceived rapid dissemination and transparency of COVID-19-related information, perceived safety, and emotional responses toward the pandemic. Data analysis includes descriptive statistical analysis, independent samples t-test, Pearson correlations, and structural equation modeling.

Results: Trust in official media, perceived rapid dissemination and transparency of COVID-19-related information, perceived safety, as well as positive emotional response toward COVID-19 increased over time, while trust in social media and depressive response decreased over time. Trust in social media and official media played different roles in affecting public's wellbeing over time. Trust in social media was positively associated with depressive emotions and negatively associated with positive emotion directly and indirectly through decreased perceived safety at Time 1. However, the negative effect of trust in social media on public's wellbeing was largely decreased at Time 2. In contrast, trust in official media was linked to reduced depressive response and increased positive response directly and indirectly through perceived safety at both times. Rapid dissemination and transparency of COVID-19 information contributed to enhanced trust in official media at both times.

Conclusion: The findings highlight the important role of fostering public trust in official media through rapid dissemination and transparency of information in mitigating the negative impact of COVID-19 infodemic on public's wellbeing over time.

1. Introduction

COVID-19 has been constantly evolving since its outbreak in early 2020. At the beginning, there was limited scientific understanding and knowledge about the coronavirus. Due to the unknown nature of the novel virus, misinformation and rumors were widely spread across social media platforms, which instilled a strong sense of out-controlled crisis (1–6). Over 2 years into the pandemic, scientific understanding of COVID-19 has been advanced, and vaccines have been developed. Protective measures such as wearing mask, sanitizing hands, and keeping social distance have been commonly adopted in daily life, which is regarded as a "new normal." While the virus has been constantly mutating, so were rumors and misinformation, especially regarding the COVID-19 vaccines. For example, exaggeration of side effects (e.g., infertility, chronic illness, mental illness) as well as distrust in vaccine development (e.g., crucial trials skipped) were widespread on social media, leading to vaccine hesitancy (7–13). Meanwhile, the preventive measures and COVID-19-related policies taken by governments were also changing over time and different from country to country. While most of countries have reopened by early to mid-2022, strict lockdown and COVID-zero policy were still in place in China. Such misinformation and differences in government policies have kept sending confusing message to the public. This situation highlights the remarkable characteristics of the concurrence of virology and virality of COVID-19, where fast virus spreading is coupled with rapidly spreading of information and misinformation (14). Precisely as WHO Director-General Dr. Ghebreyesus pointed out, "We're not just fighting an epidemic; we are fighting an infodemic" (15).

Extensive empirical studies from different countries have demonstrated that a broad range of rumors and misinformation about COVID-19 spread across social media, which negatively impacted public's wellbeing and posited challenge for pandemic control (1–7). Research has shown that trust in COVID-19 information from social media was negatively linked to accurate knowledge about COVID-19 (16), positively linked to beliefs in COVID-19 myths and false information (17) as well as vaccine hesitancy (5, 18, 19). Moreover, rumors and misinformation fueled fears and led to psychological distress among the public over the course of COVID-19 pandemic (20–29). Frequently using social media as an information source for COVID-19 was significantly related to poorer psychological wellbeing (28, 30–32). Moreover, erroneous, inconsistent, unverified, and often conflicting news and messages led to uncertainty, which caused intense stress to the public (33). Emerging research indicates that perceived vulnerability to COVID-19 mediated the relationship between exposure to COVID-19 news and depressive symptoms (34). In addition, when people used social media to obtain COVID-19-related information, their perceived risk of being infected heightened as the level of concern increased (35). In turn, higher risk perception and lack of perceived safety toward COVID-19 led to increased anxiety and depressive symptoms (36–39). Those findings suggest that

the conflicting information and uncertainty on social media made people feel unsafe as it is not clear how to protect oneself. This led to fear and stress, and hence, impacted wellbeing. However, how trust in social media affect public's wellbeing during COVID-19 pandemic, and the mediating role of perceived safety are not yet directly examined. Informed by the research reviewed above, we hypothesized that:

> H1: Trust in COVID-19-related information from social media was negatively associated with positive emotional response and positively associated with depressive emotional response toward COVID-19.

> H2: Perceived safety mediates the relationship between trust in social media with positive and negative responses toward COVID-19, respectively.

To minimize public fear and confusion caused by social media, transparency and rapid dissemination of information by government agencies has been suggested crucial (40–42). The role of transparency and trust was also demonstrated in managing public fear and panic in SARS outbreak in Singapore (43) as well as during other outbreaks including Ebola in West Africa and MERS-CoV in South Korea (44). Indeed, timely, accurate and transparent information from officials is foundational for the public to implement protective measures, mitigate the negative impact of the pandemic, and to reduce psychological distress in the crisis (45, 46). The satisfaction with governments' communication about COVID-19 was linked to public trust in government (47, 48). These findings suggest that transparency and rapid dissemination of information about COVID-19 is the key factors to build public trust in official media. Therefore, we hypothesized:

> H3: Perceived rapid dissemination and transparency of the information about COVID-19 are positively related to trust in official media.

With respect to how trust in official media would affect public's wellbeing, existing literature pointed to different directions. Some studies indicated that official media in some countries applied a fear-based communication strategy (e.g., showing realistic pictures and giving direct information on COVID-19 death statistics) and suppressed scientific debate to persuade public to adhere to recommended health behaviors such as wearing mask, practicing social distance, and getting vaccinations (49–52). Such fear-inducing approach can increase levels of perceived threat, cause psychological distress, and affect wellbeing among the public (51, 53–55). In this case, trust in official media would negatively affect public's wellbeing through decreasing perceived safety from being infected. Meanwhile, other studies suggested the opposite. These studies found trust in the

government and obtaining information from official media reduced perceived risk toward COVID-19, mitigated mental distress, and improved psychological wellbeing among the public (35, 56–58). These findings suggested that receiving information from trusted and authoritative source would give people certainty and efficacy, hence, increasing perceived safety and enhancing mental wellbeing. In summary, the research findings reviewed above indicate that trust in COVID-19-related information from official media could either positively, or negatively affect public's wellbeing and that perceived safety might play a mediating role. Hence, we proposed that trust in official media was significantly related to public's wellbeing both directly and indirectly through perceived safety (Hypotheses 4 and 5), but we left the direction of the relationships (i.e., positive or negative) open.

H4: Trust in COVID-19-related information from official media was significantly (either positively or negatively) associated with positive and depressive emotional responses toward COVID-19 respectively.

H5: Perceived safety mediates the relationship between trust in official media with positive and negative responses toward COVID-19 respectively.

The present study

The present study aimed to investigate how trust in the information about COVID-19 from official media and social media affect public's wellbeing (i.e., positive response and depressive response) through perceived safety, and how the dissemination of information impact public trust in official media both at the early stage of COVID-19 outbreak and 2 years later in China. To our best knowledge, this is the first study to examine the impacts of trust in media sources on public's wellbeing toward COVID-19 over time. The insights developed through

this study will help policy makers and health intervention initiatives develop targeted strategies to address the mental health challenges presented by the COVID-19 pandemic and protect public's wellbeing.

Figure 1 presents a path model which summarizes the hypotheses proposed above. In this model, we propose that trust in COVID-19 information received from social media was negatively associated with positive emotional response and positively associated with depressive emotional response toward COVID-19 both directly and indirectly through decreased perceived safety (H1-H2); that perceived transparency and rapid dissemination of COVID-19-related information are positively related to trust in official media (H3). In turn, trust in official media was either positively or negatively associated with positive and depressive response toward COVID-19 both directly and indirectly through perceived safety (H4, H5).

Though the scientific understanding of COVID-19 has been advanced over 2 years into the pandemic, the "infodemic" wasn't over. Rumors and misinformation about the virus and vaccine were still widespread across social media (8). In addition, the mental health symptoms were still quite prevalent among public in the "new normal" era (59). Therefore, it's important to examine the mechanism of trust in media sources affect public's wellbeing over time. The path framework we proposed allows the examination of how the key factors affect public's wellbeing both at the early stage of COVID-19 outbreak and post COVID-19 era and also allows to make comparisons of the changes in effects. The developed insights on what has changed over time will inform policy makers to adjust the risk communication strategies accordingly.

2. Materials and methods

2.1. Procedure and participants

National online surveys in China were conducted at the early stage of COVID-19 outbreak and 2 years later. Time 1 survey was

FIGURE 1
An integrative model to predict emotional responses toward the COVID-19.
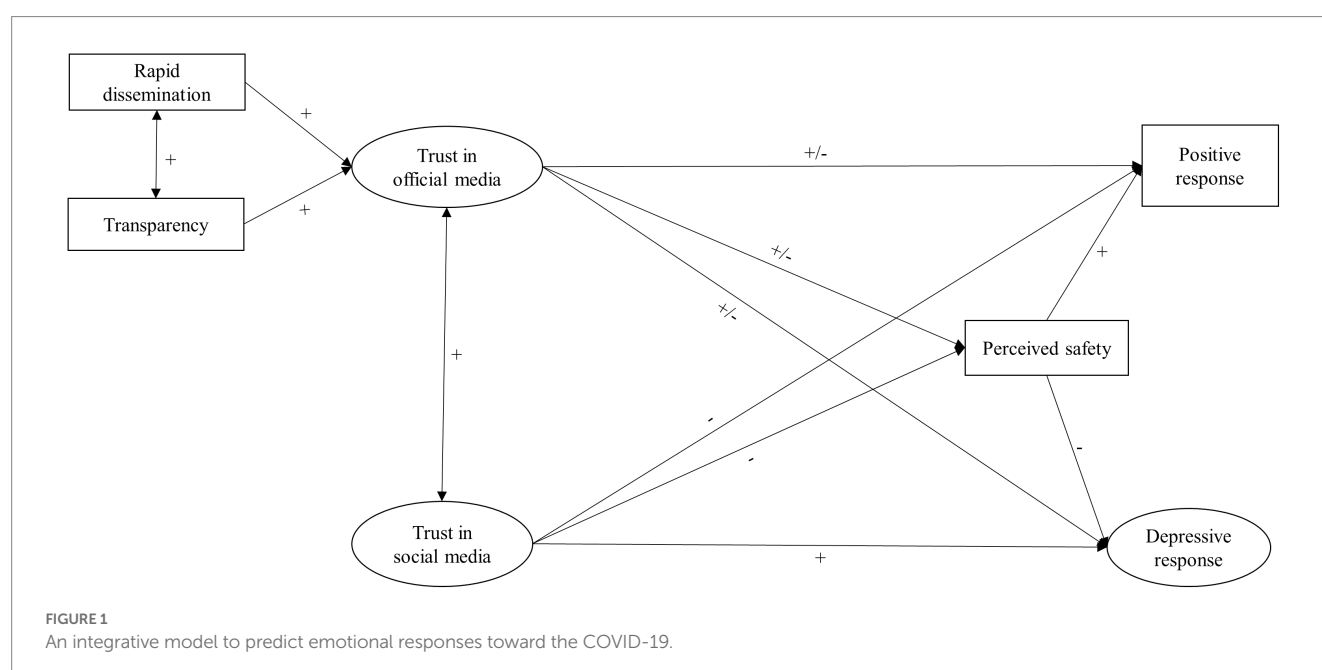
carried out between 24-Jan to 10-Feb, 2020, which was right after China's official announcement of COVID-19 outbreak (on January 20, 2020) and deployed lockdown measures (on January 23, 2020). Time 2 survey was conducted between 21-Apr to 4-May, 2022, when Delta and Omicron variants were widely spread around the world and COVID-zero policy was still in place in China (60). The study was conducted in compliance with the ethical standards specified in the Ethical Principles of Psychologists and Code of Conduct by the American Psychological Association (61) and in 1964 Helsinki declaration and its later amendments (62). Two private research survey companies (Intell-vision for Time 1, ePanel for Time 2) were engaged to recruit participants and conduct data collection through convenance sampling. The survey link was sent to users of the online survey platforms of the two companies. After presenting a brief description of the study, participants were informed that no personal identifiable information would be collected and that their survey results would remain confidential. Participants were further informed that their participation was voluntary and that they could withdraw from the survey at any time without penalty. Participants were asked to click 'I agree' button if they consent to participate in the survey. Participants who completed the survey were paid a small fee for their participation. The collected data was completely anonymous, and the research team was the only party has access to the data.

Table 1 presents participants' demographic information for both Time 1 and Time 2.

2.2. Measures

2.2.1. Trust in official media

At the early stage of COVID-19 outbreak, the official news reached the public largely through television news and it was also available online in China. The TV news report is in the format of news from central government first and followed by news from local government. Hence, at Time 1, trust in official media was measured by asking participants to indicate how trustworthy the information

on the Coronavirus outbreak from central government-owned media and local government-owned media, respectively, on a 4-point scale (1 = not trustworthy at all, 4 = very trustworthy; $\alpha = 0.75$). While 2 years later, community social workers also became important information sources. They conveyed official information on COVID-19 to the public and implemented preventive and control measures at community level. Therefore, at Time 2, trust in official media was measured by asking participants to indicate how trustworthy the information on COVID-19 from central government-owned media, local government-owned media, and community social workers, respectively, on a 5-point scale (1 = not trustworthy at all, 5 = very trustworthy; $\alpha = 0.75$). To compare the change between Time 1 and Time 2, the score of trust in official media at Time 1 was transformed to a 5-point scale by using the following formula (63, 64):

$$X_1 = (4/3)^* \, X - (1/3)$$

Here:

X1: Transformed score of trust in official media (on a 5-point scale).
X: the original score of trust in official media (on a 4-point scale).

2.2.2. Trust in social media

In the beginning of COVID-19 outbreak, Weibo and WeChat were the most popular social media platforms in China for the spread of information about COVID-19. Besides, acquaintances were also important information sources during the pandemic. Hence, at Time 1, trust in social media was measured by asking participants to indicate how trustworthy the information on the Coronavirus outbreak from Weibo influencers, WeChat influencers, and acquaintances, respectively, on a 4-point scale (1 = not trustworthy at all, 4 = very trustworthy; $\alpha = 0.77$). As time passed by, the general netizens became more and more important in information transmission. Therefore, at Time 2, trust in social media was measured by asking participants to indicate how trustworthy the information on COVID-19 from internet influencers, general netizens, and acquaintances, respectively, on a 5-point scale (1 = not trustworthy at all, 5 = very trustworthy; $\alpha = 0.68$). The Cronbach's alpha for trust in social media at Time 2 is a bit lower than the widely considered desirable value of 0.70 (65, 66). However, a low number of items could lead to a low value of Cronbach's alpha (65). Since there were only 3 items in this scale, an alpha value of 0.68 is acceptable (67, 68). To examine the difference between Time 1 and Time 2, the score of trust in social media at Time 1 was also transformed to a 5-point scale by using the formula described above (63, 64).

2.2.3. Rapid dissemination, transparency, and perceived safety

Rapid dissemination was measured with: "So far, do you think the dissemination of information about Coronavirus is rapid?" (1 = very delayed, 4 = very rapid). Transparency was measured with: "So far, how transparent do you think the information on the Coronavirus outbreak is?" (1 = very low, 4 = very high). Perceived safety was measured with: "Thinking about Coronavirus, how safe do you feel from being infected?" (1 = not safe at all, 4 = very safe).

2.2.4. Emotional responses

The measurement of emotional responses toward COVID-19 outbreak was adapted from the Florida Shock Anxiety Scale (69, 70).

TABLE 1 The sample characteristics.

Variables	Values	
	Time 1 (N=22,702)	Time 2 (N=2,901)
Age (years)	28.41 (SD = 9.90/ Range = 18–70)	31.77 (SD = 8.05/ Range = 18–69)
Gender		
Male	10,866 (47.9%)	1,274 (43.9%)
Female	11,836 (52.1%)	1,627 (56.1%)
Education		
Junior high school and below (Year 9 or below)	796 (3.5%)	16 (0.6%)
Senior high school (Year 12)	3,287 (14.5%)	137 (4.7%)
College certificate	3,514 (15.5%)	416 (14.3%)
Bachelor's degree	10,952 (48.2%)	2,115 (72.9%)
Postgraduate	4,153 (18.3%)	217 (7.5%)

The Florida Shock Anxiety Scale (FSAS) was developed to measure patients' psychological distress caused by the threat and fear of potential implantable cardioverter defibrillators (ICD) shock. The COVID-19 pandemic has instilled people with a sense of fear of being infected with the virus. The potential infection may happen but is not certain, which makes people feel worried, scared, and angry. This psychological distress is very similar to that elicited from the anticipation of experiencing ICD shock. Hence, we adapted this scale to measure the emotional responses toward COVID-19. Participants were asked to rate their feelings toward COVID-19 outbreak using a 5-point scale (1 = not at all, 5 = very much) on the adjectives describing positive response (optimistic) and depressive response (worried, scared, sad, and angry; $\alpha = 0.80$ at Time 1, $\alpha = 0.81$ at Time 2).

2.3. Data analysis

SPSS version 22.0 with AMOS version 24.0 was used for the data analysis. Descriptive statistical analysis, independent samples t-test, and Pearson correlations were conducted first. To examine the hypothesized model (Figure 1), A two-stage structural equation modeling approach was conducted (71–77). The analyses for the model at both Time 1 and Time 2 utilized a covariance matrix as input and used maximum likelihood estimation. The goodness of fit of the model was assessed using the comparative fit index (CFI), the Non-Normed Fit Index (NNFI), Goodness-of-fit statistic (GFI), and root mean square error of approximation (RMSEA). A satisfactory fit is suggested by CFI > 0.90, NNFI > 0.90, GFI > 0.90, and Standardized RMSEA < 0.08 (72).

3. Results

3.1. Changes in measured variables over time

Table 2 presents the means and standard deviations of measured variables at both survey times and independent samples t-test results between the two time points. On average, participants displayed sound trust in official media both at Time 1 ($M = 3.94$, SD = 0.84) and Time 2 ($M = 4.17$, SD = 0.67), which were significantly higher than trust in social media at both times (Time 1, $M = 3.07$, SD = 0.86, Time 2, $M = 3.04$,

SD = 0.67); t (22701) = 131.58, $p < 0.001$ and t (2900) = 72.87, $p < 0.001$, respectively. Moreover, trust in official media at Time 2 was significantly higher than Time 1 [t (4161.46) = −17.18, $p < 0.001$], while trust in social media at Time 2 was significantly lower than Time 1 [t (4225.96) = 2.50, $p < 0.05$]. The results indicated that trust in official media largely increased over time, while trust in social media decreased over time.

The dissemination of information about the Coronavirus was regarded on average less rapid ($M = 2.75$, SD = 0.87) and transparent ($M = 2.75$, SD = 0.78) at Time 1. However, both measures were significantly improved at Time 2 (rapid dissemination: $M = 3.19$, SD = 0.64, transparency: $M = 3.08$, SD = 0.71); Rapid dissemination: t (4394.35) = −33.40, $p < 0.001$; Transparency: t (3866.79) = −23.31, $p < 0.001$. Perceived safety from being infected with the Coronavirus also enhanced from Time 1 ($M = 2.80$, SD = 0.68) to Time 2 ($M = 2.89$, SD = 0.65), t (3760.10) = −7.22, $p < 0.001$. At last, positive emotional response toward COVID-19 increased over time (Time 1, $M = 3.07$, SD = 1.27, Time 2, $M = 3.33$, SD = 0.94); t (4405.12) = −13.41, $p < 0.001$, while depressive response decreased over time (Time 1, $M = 3.22$, SD = 1.00, Time 2, $M = 3.09$, SD = 0.87); t (3951.96) = 7.41, $p < 0.001$.

Table 3 presents Pearson correlations between the measured variables at both survey times. Positive response was positively related to trust in official media and social media as well as rapid dissemination, transparency, and perceived safety both at Time 1 and Time 2, while depressive response was negatively associated with these variables (except for trust in social media at Time 1, which was not significantly correlated to depressive response). In addition, trust in official media and social media, rapid dissemination, transparency, and perceived safety were positively correlated to each other at both survey times (except for trust in social media and perceived safety at Time 2, which was not significantly correlated). Finally, positive response and depressive response was negatively related at both survey times.

3.2. The relationship among information dissemination, trust in media sources, perceived safety, and emotional responses over time

A two-stage structural equation modeling approach was conducted (71–77) to examine the hypothesized model. In this approach, the measurement model, which specifies the relationships

TABLE 2 Descriptive statistics and independent samples t-test results for measured variables.

	M (SD)		t	df	Cohen' d
	Time 1 (N=22,702)	Time 2 (N=2,901)			
Trust in official media	3.94 (0.84)	4.17 (0.67)	−17.18***	4161.46	−0.28
Trust in social media	3.07 (0.86)	3.04 (0.67)	2.50*	4225.96	0.04
Rapid dissemination	2.75 (0.87)	3.19 (0.64)	−33.40***	4394.35	−0.52
Transparency	2.75 (0.78)	3.08 (0.71)	−23.31***	3866.79	−0.43
Perceived safety	2.80 (0.68)	2.89 (0.65)	−7.22***	3760.10	−0.13
Positive response	3.07 (1.27)	3.33 (0.94)	−13.41***	4405.12	−0.21
Depressive response	3.22 (1.00)	3.09 (0.87)	7.41***	3951.96	0.13

***p < 0.001, *p < 0.05. Trust in official media and trust in social media were measured on a 5-point scale (1 = not trustworthy at all, 5 = very trustworthy). Rapid dissemination was measured on a 4-point scale (1 = very delayed, 4 = very rapid). Transparency was measured on a 4-point scale (1 = very low, 4 = very high). Perceived safety was measured on a 4-point scale (1 = not safe at all, 4 = very safe). Positive response and depressive response were measured on a 5-point scale (1 = not at all, 5 = very much).

TABLE 3 Pearson correlations between the measured variables at Time 1 and Time 2.

Variables	1		2		3		4		5		6	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
1. Trust in official media	1.00	1.00										
2. Trust in social media	0.33***	0.22***	1.00	1.00								
3. Rapid dissemination	0.46***	0.48***	0.26***	0.12***	1.00	1.00						
4. Transparency	0.49***	0.52***	0.28***	0.16***	0.69***	0.68***	1.00	1.00				
5. Perceived safety	0.31***	0.14***	0.22***	0.03	0.35***	0.14***	0.37***	0.16***	1.00	1.00		
6. Positive response	0.28***	0.26***	0.18***	0.12***	0.36***	0.22***	0.36***	0.27***	0.31***	0.23***	1.00	1.00
7. Depressive response	−0.18***	−0.19***	0.01	−0.04*	−0.24***	−0.21***	−0.23***	−0.24***	−0.28***	−0.25***	−0.20***	−0.38***

***$p < 0.001$, *$p < 0.05$. Trust in official media and trust in social media were measured on a 5-point scale (1 = not trustworthy at all, 5 = very trustworthy). Rapid dissemination was measured on a 4-point scale (1 = very delayed, 4 = very rapid). Transparency was measured on a 4-point scale (1 = very low, 4 = very high). Perceived safety was measured on a 4-point scale (1 = not safe at all, 4 = very safe). Positive response and depressive response were measured on a 5-point scale (1 = not at all, 5 = very much).

between the latent constructs and the observed measures, was tested first *via* confirmatory factor analysis (CFA); followed by the structural model, which specifies the relationships among independent, dependent, and mediating variables. In addition, the bias-corrected bootstrap method was carried out to test the indirect effects. 5,000 bootstrapped samples were generated to approximate the confidence interval (CI) of the indirect effects both at Time 1 and Time 2. A 95% CI without zero indicates statistical significance. Furthermore, following the practice of previous studies (78, 79), the structural model was tested for robustness by changing the sample range.

3.2.1. Confirmatory factor analysis (CFA) for the measurement model

Confirmatory factor analysis (CFA) was conducted to examine the measurement model both at Time 1 and Time 2. The measurement model was supported by the model fit indexes at both survey times: Time 1, CFI = 0.97, NNFI = 0.96, GFI = 0.98, and RMSEA = 0.06; Time 2, CFI = 0.93, NNFI = 0.90, GFI = 0.96, and RMSEA = 0.08.

Furthermore, the convergent and discriminant validity of the measurement model were assessed at both times. The convergent validity was evaluated by using standardized factor loadings, composite reliability (CR) and the average variance extracted (AVE) (see Table 4). All items loaded significantly on their respective constructs, with the standardized factor loadings ranging from 0.50 to 0.85, reaching the criterion of 0.50 or above (74). The CR values ranged from 0.68 to 0.81, meeting an acceptable criterion of 0.60 (74). The AVE values ranged from 0.42 to 0.68, reaching the criterion of 0.36 or above (77). These results provided evidence of satisfactory convergent validity. Discriminant validity was assessed by comparing AVE with the squared correlation between constructs. The squared correlations between constructs at both times ranged from 0.00 to 0.20, which were all much lower than AVE values, indicating that the measurement model has satisfactory discriminant validity (73–75).

These results suggested that the measurement model is of sufficient quality to examine the structural model.

3.2.2. Pathway analysis for the structural model

Our hypothesized model (Figure 1) specified rapid dissemination and transparency of information as exogenous predictors of trust in official media, both trust in official media and social media as exogenous predictors of perceived safety. Perceived safety, in turn, was identified as a predictor of positive response and depressive response. Moreover, trust in official media and trust in social media also served as exogenous predictors of positive response and depressive response. In this model, trust in official media, trust in social media, and depressive response were latent variables presented using ellipses, while rapid dissemination, transparency, positive response (optimistic) and perceived safety were observed variables presented using rectangles.

The model fit indices suggest that the model provided good fit for the data at both times: Time 1, CFI = 0.94, NNFI = 0.92, GFI = 0.96, and RMSEA = 0.07; Time 2, CFI = 0.92, NNFI = 0.90, GFI = 0.95, and RMSEA = 0.07.

Figure 2 presents the standardized parameter estimates for the model at both Time 1 (T1) and Time 2 (T2). Table 5 presents the direct, indirect, and total effects of trust in media sources on public's wellbeing at both Time 1 (T1) and Time 2 (T2).

First, trust in social media was negatively related to positive response at Time 1 ($\beta = -0.16$, $p < 0.001$) and positively associated with depressive response both at Time 1($\beta = 0.30$, $p < 0.001$) and Time 2 ($\beta = 0.08$, $p < 0.001$), such that the more people trusted the information about the Coronavirus received in social media, the less they felt optimistic and the more they felt depressive toward the pandemic, especially in the beginning of COVID-19 outbreak. Since trust in social media was no longer significantly related to positive response at Time 2 ($\beta = 0.01$, $p = 0.684$), Hypothesis 1 was fully supported at Time 1 and was partially supported at Time 2. Moreover, Trust in social media was negatively associated with perceived safety at Time 1 ($\beta = -0.10$, $p < 0.001$), but not significantly associated with perceived safety at Time 2 ($\beta = -0.04$, $p = 0.096$). In turn, perceived safety was positively related to positive response (Time 1, $\beta = 0.11$, $p < 0.001$; Time 2, $\beta = 0.16$, $p < 0.001$) and negatively linked to depressive response (Time 1,

TABLE 4 The standardized factor loadings, composite reliability (CR), and average variance extracted (AVE) of each construct in measurement model at Time 1 and Time 2.

Construct	Time 1				Time 2			
	Item	Standardized factor loading	CR	AVE	Item	Standardized factor loading	CR	AVE
Trust in official media	Central government-owned media	0.60	0.80	0.68	Central government-owned media	0.74	0.76	0.52
	Local government-owned media	1.00			Local government-owned media	0.84		
					Community social workers	0.56		
Trust in social media	WeChat influencers	0.82	0.79	0.56	Internet influencers	0.73	0.68	0.42
	Weibo influencers	0.85			General netizens	0.70		
	Acquaintances	0.54			Acquaintances	0.50		
Depressive response	Worried	0.62	0.80	0.51	Worried	0.66	0.81	0.52
	Scared	0.77			Scared	0.75		
	Sad	0.79			Sad	0.79		
	Angry	0.66			Angry	0.68		

CR: Composite reliability, AVE: Average variance extracted.

FIGURE 2
The relationship among information dissemination, trust in media sources, perceived safety, and emotional responses over time.
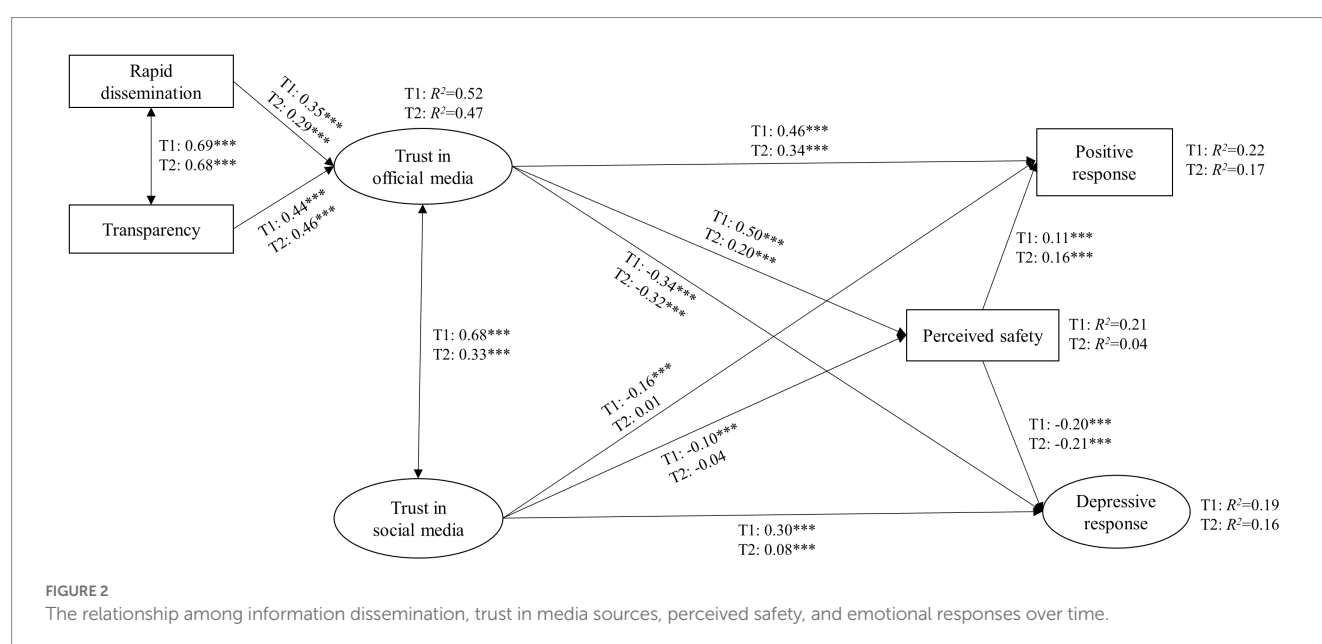
$\beta = -0.20$, $p < 0.001$; Time 2, $\beta = -0.21$, $p < 0.001$) at both survey times, suggesting that the safer people felt, the more they were optimistic and the less they were depressed. These results indicated that perceived safety served as a mediator between trust in social media and emotional responses toward COVID-19 at Time 1 but not at Time 2. Thus, Hypothesis 2 was only supported at Time 1.

Second, trust in official media was strongly associated with rapid dissemination (Time 1, $\beta = 0.35$, $p < 0.001$; Time 2, $\beta = 0.29$, $p < 0.001$) and transparency (Time 1, $\beta = 0.44$, $p < 0.001$; Time 2, $\beta = 0.46$, $p < 0.001$) over time, such that the more people believed information dissemination as rapid and transparent, the more they trusted official media both at the early stage of COVID-19 outbreak and 2 years later. Thus, Hypothesis 3 was supported at both survey times.

Third, trust in official media was positively related to positive response (Time 1, $\beta = 0.46$, $p < 0.001$; Time 2, $\beta = 0.34$, $p < 0.001$) and was negatively associated with depressive response (Time 1, $\beta = -0.34$, $p < 0.001$; Time 2, $\beta = -0.32$, $p < 0.001$) over time, such that the more people trusted the information about the Coronavirus given by official media, the more they responded optimistically and the less they felt depressively toward the pandemic. Hence, the results provided support for a positive relationship between trust in official media and public's wellbeing of Hypothesis 4 at both survey times. Furthermore, trust in official media was positively associated with perceived safety at both times (Time 1, $\beta = 0.50$, $p < 0.001$; Time 2, $\beta = 0.20$, $p < 0.001$), such that the more people trusted the information about the Coronavirus given by official media, the more they felt safe from being

TABLE 5　The direct, indirect, and total effects of trust in media sources on public's wellbeing at Time 1 and Time 2.

Paths	Time 1		Time 2	
	Standardized effect	95% CI	Standardized effect	95% CI
Direct effects				
Trust in official media → positive response	0.46***	(0.436, 0.479)	0.34***	(0.289, 0.396)
Trust in official media → depressive response	−0.34***	(−0.360, −0.312)	−0.32***	(−0.373, −0.255)
Trust in social media → positive response	−0.16***	(−0.181, −0.133)	0.01	(−0.046, 0.065)
Trust in social media → depressive response	0.30***	(0.281, 0.328)	0.08**	(0.020, 0.150)
Indirect effects				
Trust in official media → perceived safety → positive response	0.06***	(0.048, 0.063)	0.03***	(0.023, 0.044)
Trust in official media → perceived safety → depressive response	−0.10***	(−0.109, −0.092)	−0.04***	(−0.057, −0.032)
Trust in social media → perceived safety → positive response	−0.01***	(−0.015, −0.008)	−0.01	(−0.015, 0.002)
Trust in social media → perceived safety → depressive response	0.02***	(0.016, 0.026)	0.01	(−0.003, 0.019)
Total effects				
Trust in official media → positive response	0.51***	(0.494, 0.532)	0.38***	(0.321, 0.427)
Trust in official media → depressive response	−0.44***	(−0.458, −0.415)	−0.36***	(−0.414, −0.298)
Trust in social media → positive response	−0.17***	(−0.194, −0.143)	0.00	(−0.054, 0.061)
Trust in social media → depressive response	0.33***	(0.300, 0.350)	0.09**	(0.026, 0.160)

***$p < 0.001$, **$p < 0.01$.

infected. In turn, the safer people felt, the more they felt optimistic and the less they felt depressed. That is, perceived safety mediated the relationship between trust in official media and emotional responses toward COVID-19 both at Time 1 and Time 2. Thus, Hypothesis 5 was supported by a positive mediating effect of perceived safety between trust in official media and public's wellbeing at both survey times.

The robustness of the structural model was tested by changing the sample range ([78], [79]). To examine if the structural model only held due to high trust in media sources, we removed a portion of the sample with high trust scores (> 4 out of a possible 5) either in official media or social media. The structural model still held after changing the sample range. And all significant coefficients in the structural model remain significant in robustness check. These results suggest that our findings are relatively robust.

4. Discussion

The present research applied a longitudinal approach to examine how trust in media sources affect public's wellbeing through perceived safety and how the dissemination of information contributes to increased public trust in official media during the course of COVID-19 pandemic.

The results of the present study suggest that the public had more trust in the information about COVID-19 from the official media outlets than from the social media both at the early stage of the pandemic outbreak and 2 years later. The comparatively higher trust in official media is likely due to that the official media represents the voice of the government and is regarded as highly reliable during a pandemic ([80], [81]). In addition, trust in official media was significantly increased over a two-year period, which is opposite to research findings from Europe and the USA showing trust in official media decreased both in short-term ([82]) and in long-term ([83], [84]) during

the COVID-19 pandemic. In contrast, trust in social media was slightly decreased two years after COVID-19 outbreak.

Public perceptions of rapid dissemination and transparency regarding information about the Coronavirus also increased over time, which is likely due to the open and transparent risk communication implemented by governments. During COVID-19 pandemic, the Chinese government disclosed real-time data in detail on confirmed, suspected, and cured cases, as well as deaths across the country. It also issued national action plans and released authoritative interpretations of the coronavirus to mitigate public panic and doubts ([85]). Moreover, public's wellbeing was significantly improved over the 2 years period, which is in line with research findings from UK ([86]) and the USA ([59]).

While the social media were flooded with information and sensational news about COVID-19, public's trust in them was low. However, trust in social media played a dominant role in contributing to increased depressive symptoms in the early stage of COVID pandemic. The negative impact of trust in social media was largely reduced over time. In contrast, trust in the information from official media was higher, and it played an influential role in contributing to enhanced positive response and decreased depressive symptoms both at the beginning of the pandemic and over 2 years later. While existing literature points to both positive and negative directions regarding how trust in official media would affect mental wellbeing during COVID-19 pandemic ([51]–[58]), the present study provides evidence for a positive effect of trust in COVID-19-related information from official media on public's wellbeing in Chinese context over time. The findings suggest that enhancing public trust in information from official media will be an effective approach to fight against the so called COVID-19 infodemic and protect public's wellbeing. This has significant implications for public health measures to combat the pandemic of social media panic. To effectively minimize the negative impact of social media on public mental health, health authorities

need to rapidly detect and respond to misinformation and rumors in social media.

The present research demonstrated that trust in official media was positively correlated with rapid dissemination and transparency of the information about COVID-19 over time. Hence, fostering and maintaining public's trust requires rapid dissemination and transparency of information. The trust-building function of transparency revealed in the present study is in line with literature on the general relationship between transparency and public trust (43, 48, 87, 88). Research on infectious disease found that public trust in government and public health authorities as information source influences public perceived risk and their responses to the threat (47, 88–91). The present study further shows that rapid dissemination of information and transparency works hand in hand. These findings suggest that government and health authorities need to rapidly disseminate information and update the outbreak through various platforms including their social media accounts to accommodate all segments of the population. The information needs to be transparent, even though communicating uncertainty and a lack of knowledge in the case of the novel COVID-19 can be unsettling. Otherwise, the absence of official information creates a rich breeding ground for misinformation and rumors in social media, which can further exacerbate the fear caused by the objectively life-threatening nature of the coronavirus. A trusted official media based on transparency and rapid dissemination of COVID-19-related information can keep the public informed and enable them to develop a sense of agency through knowing how to manage the risks.

While the present study has shed light on the negative impacts of trust in social media sources on wellbeing, future research needs to unpack the complexity of social media. The information in social media is diverse and sometimes contradicting. In addition, the information may come from a wide range of sources including people sharing information acquired from official sources (48). Thus, how trust in social media affect public's wellbeing may depend on the contents and sources. For example, a literature review has shown that viewing stressful content about COVID-19 outbreak on social media was linked to poor psychological outcomes, while viewing motivational and heroic speech, knowledge of COVID-19, and entertaining contents was related to positive psychological wellbeing (45). To unpack the complexity of trust in social media, future research needs to tease apart the information source and contents on social media. The insights will help policy makers and health authorities develop targeted strategy to harness the benefits of social media and mitigate the negative impacts. Moreover, to fully utilize the protective role of trust in official media, an in-depth examination of what key aspects of pandemic related information important for the public is needed. Such insights would inform a more targeted strategy for rapid dissemination. Noticeably, though trust in official media can protect public's wellbeing against COVID-19 infodemic, this does not mean all the information given by official media is the absolute truth. Scientific understanding of COVID-19 is evolving constantly, such that what qualifies as misinformation might be subjective to new scientific discoveries (6). In addition, fear-based communication strategies may raise public adherence to health recommendations for COVID-19, but such strategies might negatively affect public's wellbeing (51, 53, 55, 92–94). Future research can unpack the contents and approaches adopted by official media to identify effective communication strategies in conveying information efficiently while protecting public's wellbeing. At

last, although the current study took a longitudinal approach (95), it's not a follow-up study with the same participants. Future research needs to follow up the same participant sample to further verify the impact of trust in media sources on public's wellbeing over time.

In summary, the present study has empirically and longitudinally demonstrated that the COVID-19 infodemic can have serious consequence for public's wellbeing. Especially, trust in the information about COVID-19 in social media was associated with stronger depressive response at the beginning of pandemic. However, trust in official media can mitigate this negative impact. More importantly, the rapid dissemination and transparency of information regarding the virus can enhance public trust in the information from official media outlets. The findings highlight that, to protect public's wellbeing against COVID-19 infodemic, government and health authorities need to rapidly disseminate information and be transparent even though communicating uncertainty and unknowns can be unsettling. Otherwise, the absence of official information creates a rich breeding ground for misinformation and rumors in social media, which has huge consequence for public's wellbeing, especially at the early stage of the pandemic.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by The Academic Committee of Institute of Sociology, Chinese Academy of Social Sciences (CASS). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

JW, YiZ, and AZ conceived and designed the study. JW, XL, and XT contributed to data collection. YiZ analyzed the data. YiZ, AZ, RM, XT, and XL wrote the first draft of the manuscript. YiZ, AZ, and YaZ revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Effects of risk exposure on emotional distress among Chinese adults during the COVID-19 pandemic: The moderating role of disruption of life and perceived controllability

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Background: COVID-19 affects not only the physical health of individuals but also their mental health and different types of risk exposures are believed to have different effects on individual emotional distress.

Objective: This study explores the relationships between risk exposure, disruption of life, perceived controllability, and emotional distress among Chinese adults during the COVID-19 outbreak.

Methods: This study is based on an online survey conducted during the COVID-19 pandemic, from 1 to 10 February 2020, with a total of 2,993 Chinese respondents recruited through convenience and snowball sampling. Multiple linear regression analysis were used to examine the relationships among risk exposure, disruption of life, perceived controllability, and emotional distress.

Results: This study found that all types of risk exposures were significantly associated with emotional distress. Individuals with neighborhood infection, family member infection/close contact, and self-infection/close contact had higher levels of emotional distress ($B=0.551$, 95% CI: -0.019, 1.121; $B=2.161$, 95% CI: 1.067, 3.255; $B=3.240$, 95% CI: 2.351, 4.129) than those without exposure. The highest levels of emotional distress occurred among individuals experiencing self-infection/close contact, while the lowest levels of emotional distress occurred among individuals experiencing neighborhood infection and the moderate levels of emotional distress occurred among individuals experiencing family member infection (Beta=0.137; Beta=0.073; Beta=0.036). Notably, the disruption of life aggravated the effect of self-infection/close contact on emotional distress and family member infection/close contact on emotional distress ($B=0.217$, 95% CI: 0.036, 0.398; $B=0.205$, 95% CI: 0.017, 0.393). More importantly, perceived controllability lowered the strength of the association between self-infection/close contact and emotional distress, as well as family member infection/close contact and emotional distress ($B=-0.180$, 95% CI: -0.362, 0.002; $B=-0.187$, 95% CI: -0.404, 0.030).

Conclusion: These findings shed light on mental health interventions for people exposed to or infected with COVID-19 near the beginning of the pandemic, particularly those who themselves had COVID or had family members with

COVID-19 risk exposure, including being infected/having close contact with an infected person. We call for appropriate measures to screen out individuals or families whose lives were, or remain, more severely affected by COVID-19. We advocate providing individuals with material support and online mindfulness-based interventions to help them cope with the after-effects of COVID-19. It is also essential to enhance the public's perception of controllability with the help of online psychological intervention strategies, such as mindfulness-based stress reduction programs and mindfulness-oriented meditation training programs.

1. Introduction

Coronavirus disease-2019 (COVID-19) not only threatens people's physical health but also has a huge impact on their psychological well-being (1). Emotional distress during the COVID-19 pandemic could be affected by environmental (e.g., media) and individual-level factors.

For one thing, the widespread media attention in the face of this novel virus created an 'information epidemic' (2), which might have enhanced individuals' public health compliance in the COVID-19 pandemic (3) and led to positive attitudes and behavioral changes to respond to the risk (4), but might also have led to some consequences (e.g., lack of individual control) (5). This is because frequent media exposure may amplify individuals' perceptions of COVID-19 risk and thus lead to negative emotional responses (6). Also, individuals may become information overloaded by frequent exposure to pandemic-related information (2), leading to a sharp increase in short-term stress, which may increase their attention to external stimuli and impair their cognitive responses (7).

For another, after the initial outbreak of COVID-19, 31 provinces in mainland China implemented lockdown measures to control the spread of the outbreak, including home quarantine, closing public places, following social distancing, and working from home online. These sudden changes, along with the fear of infection and the increasing uncertainty and uncontrollability of the epidemic, triggered virus-related stress in individuals (8, 9), which led to further psychological reactions. Consequently, individuals were prone to suffer from various emotional problems, such as panic, anxiety, feelings of emptiness, anger, etc. (10–13). Also, in particular, people with COVID-19 risk exposure tended to have higher levels of anxiety, fear, anger, and other adverse emotional reactions (13–16). Research has shown that emotional distress problems in the population have increased dramatically throughout the COVID-19 pandemic (17).

1.1. Risk exposure and emotional distress

As noted by the stress process model, stressors are environments and experiences that are difficult to adjust to. Exposure to stressors can deleteriously affect emotions, cognitions, behavior, etc. (18). The COVID-19 pandemic itself is a stressor that exposes people to the risk of illness and death (19). Therefore, exposure to COVID-19 is a major risk factor for psychological problems. Individuals' higher levels of direct exposure, or other experiences associated with the pandemic, might have a particularly strong impact on an individual's psycho-emotional reactions, including suffering from anxiety, fear, depression, and anger. Exposure experiences might include oneself being infected with COVID-19 (16), having close contact with people diagnosed with COVID-19 or showing symptoms of COVID-19 (20), working in high-risk locations or settings (21), the presence of confirmed cases in the community (13, 14), and having family members or friends diagnosed with COVID-19 (15). For instance, studies have shown that individuals who have been in contact with suspected COVID-19 cases or infected objects have higher levels of anxiety symptoms (22). Also, one study showed that people who lost a loved one to COVID-19 were more likely to feel anger than those who did not (23). Another study pointed out that, compared to those people living geographically near, living in, or traveling to Wuhan, those persons who had a direct exposure experience exhibited stronger predictors of depression and other psychological problems (24). Exposure experiences might include being infected, being at high risk of infection, or having a close relationship with an infected individual or an individual at high risk of infection—perhaps a family member, a friend, or a neighbor. Thus, more attention needs to be paid to the impact of these various experiences on individuals' mental wellbeing, whether the pandemic impacted them personally or a person close to them.

Another study found that people with infected acquaintances had significantly higher levels of depression and also experienced higher levels of anxiety when a family member was infected (25). Almost simultaneously, another study found that higher degrees of anger were experienced by infected individuals, although this anger did not carry over when loved ones were infected (26). Although these studies differentiated between acquaintances and family members on measures, they did not include other types of close social connections, such as neighbors or people one might know who had not been exposed, nor did they compare differences in the strength of the effects of exposure from members of different relational intimacy on individual emotional distress. Therefore, to better understand the

relationship between risk exposure and emotional distress during COVID-19, we focus on classifying the direct exposure risk specifically to explore the impact of the exposure risk of different types of members on an individual's emotional distress and attempt to obtain descriptive results (9) on the differences in the intensity of their effects.

1.2. Disruption of life and perceived controllability as moderators

Disruption of life and perceived controllability may also play a moderating role in the relationship between risk exposure and emotional distress. While COVID-19 risk exposure is a greater stressor for individuals, some individuals appear to be more vulnerable to it. As a result, some people suffer more emotional distress despite being exposed to the same level of COVID-19 risk.

1.2.1. Disruption of life as a moderator

1.2.1.1. Disruption of life and emotional distress

In addition to putting people at risk of infection, the COVID-19 pandemic also caused varying degrees of disruption to people's normal life activities, which led to psychological distress (27). The pandemic exposed people to a range of certain social risks, such as social isolation, economic loss, job insecurity, health insecurity, etc., which increased the uncertainty of life, and could have a serious impact on people's mental health (27–29). A related study showed that job-related changes caused by COVID-19, such as changes in workload and reductions in income, lead to higher levels of general life dissatisfaction and anxiety among individuals (27). Also, another study indicated that disruptions to daily life were predictors of higher levels of depression, such as poor access to basic supplies (e.g., medicine, food, and toilet paper), having to move unexpectedly, having to cancel a trip or experiencing a major disruption in travel plans, or having to cancel or postpone important events (28). Furthermore, patients with chronic diseases and their family members suffered from higher levels of depression, anxiety, and stress, as healthcare facilities mainly treated COVID-19 patients and public transport was suspended, which significantly affected routine treatment and care for chronic diseases (29, 30). As mentioned above, the pandemic's disruption of an individual's life should be considered when examining emotional distress during the COVID-19 pandemic.

1.2.1.2. The moderating role of disruption of life

According to cumulative risk models, exposure to multiple COVID-19 risk factors tends to be associated with more severe mental health outcomes than experiencing a single risk exposure (31), which was supported by empirical research (32). Thus, it can be speculated that cumulative risk sources associated with the COVID-19 pandemic, such as COVID-19 exposure risk and disruption of life, may lead to excessive negative emotions. Therefore, the interaction between risk exposure and life disruption in predicting individual emotional distress should be considered. Furthermore, as noted by the life-change model, the impact of the COVID-19 pandemic on individual lives increased individuals' emotional vulnerability in general, making it difficult for people to

cope with additional, non-COVID trauma exposure, so people whose lives were highly disrupted by the pandemic would suffer more and various risk exposure effects (33). A previous study of victims of workplace bullying showed that exposure to other negative life events besides bullying may increase PTSD symptoms (34), and the same emotional response may be true for individuals affected by COVID-19. In contrast, the facilitator model (33) suggests that life disruption of the pandemic may help people to acquire experiences in coping with stress, which may benefit them in coping with COVID-19 exposure and reduces their psychological distress. That is, the potential role of COVID-19 pandemic disruption to life between individual risk exposure status and emotional distress is unclear, and more empirical evidence is needed. Surprisingly, few current studies on the effects of COVID-19 on mental health discuss the interaction effects of risk exposure and disruption of life.

1.2.2. Perceived controllability as a moderator

1.2.2.1. Perceived controllability and emotional distress

Perceived controllability related to COVID-19 is a situational controllability that refers to the belief in one's ability to exert influence on the external environment (35, 36). According to Lazarus and Folkman (37), controllability is related to an individual's evaluation of whether the resources available can help the individual cope with a threat. Individuals who assess more controllability in stressful situations may develop more positive beliefs and behaviors (38, 39), such as optimism, confidence, and protective behavior, leading to better mental health outcomes. Conversely, lower levels of feelings of controllability, such as overgeneralizing the danger of the event and exaggerating the possibility of further catastrophic events, may generate situational fear and lead to lasting stress disorders (40, 41). Previous studies have shown that belief of controllability was linked to public motions and psychological symptoms during public health emergencies. For example, studies of emotional psychological distress during COVID-19 had shown that perceived controllability was a significant negative predictor of depression, anxiety, and stress (42), and conversely, individuals who perceived risk as uncontrollable experienced more depression and posttraumatic stress disorder (9). However, it has also been argued that the adaptive value of controllability does not always work; strong control beliefs in environments with low opportunities for control have instead led to a decline in individuals' psychological well-being (43). For example, when unemployed victims had higher control beliefs before they lost their jobs, they experienced more distress after job loss (44). Thus, there is no consensus on the relationship between perceived controllability and emotional distress during acutely stressful events, and more evidence is needed.

1.2.2.2. The moderating role of perceived controllability

According to stress and coping theory, stress results from the interaction between the individual and the environment (45). In stressful situations, people make a primary appraisal of the threat and severity of stressors and a secondary appraisal of their coping resources (46). The appraisal is the subjective perception of whether an individual believes an event is controllable. Specifically, applied to
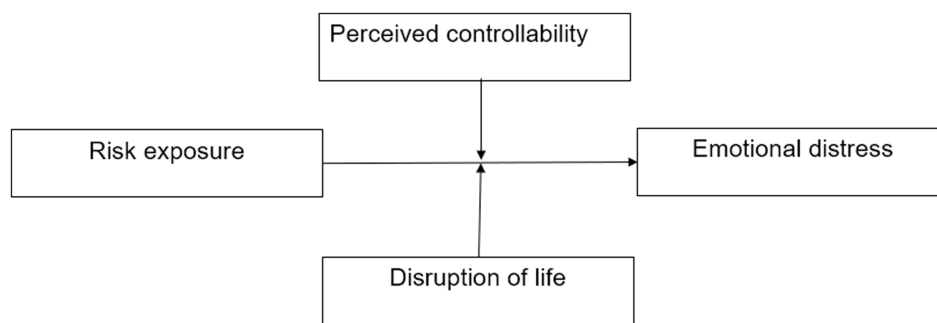
The analytical framework of risk exposure affecting emotional distress.

the COVID-19 pandemic, the pandemic was recognized as a stressor affecting mental health in all countries (47), which was an objective experience in individuals' lives; however, individuals could take the initiative to cope with COVID-related stressors in their environments. Therefore, in the face of the comparable risk exposure situation, not all individuals exposed to it may have the same level of stress reaction (18), and individuals with higher perceived controllability were more likely to be less affected by COVID-19 exposure (48).

The self-efficacy mechanism also suggests that the controllability and predictability of risk can help people enhance their sense of self-efficacy (49). Conversely, beliefs of uncontrollability reduce people's self-efficacy and confidence when exposed to stress, leading to an increase in people's experience of stress and thus increasing their emotional distress (50, 51). In brief, perceived controllability should be considered as an interactive factor that may reduce individuals' emotional distress. A previous study has discussed the interaction of COVID-19-related exposure and perceived uncontrollability on psychological outcomes, but researchers have mainly focused on exploring the mediating role of perceived uncontrollability between media exposure (which was indirect exposure) (6) and psychological outcomes, without giving attention to the effect of perceived uncontrollability (or controllability) between direct exposure and psychological outcomes. In addition, insufficient attention has been paid to the moderating role of perceived uncontrollability (or controllability) in the above relationships. Hence, the present study sought to explore the moderating role of perceived controllability between direct risk exposure and emotional distress.

1.3. Objectives and hypotheses

This study aims to examine the association between types of risk exposures and emotional distress among Chinese adults during the COVID-19 pandemic, utilizing perceptions of the disruption of life and perceived controllability as moderators (see Figure 1).

Correspondingly, we propose the following hypotheses. The first hypothesis (*H1*) focuses on risk exposure. We hypothesize that respondents who had higher levels of COVID-19 risk exposure would have higher emotional distress. Further, we try to propose an

exploratory question: different types of risk exposure may be differentially associated with emotional distress in individuals, with neighborhood infection likely to have the weakest association and self-infection/close contact the strongest. The second hypothesis (*H2*) relates to the moderation effect of risk exposure and disruption of life. We hypothesize that the pandemic's disruption to life may strengthen the relationship between risk exposure and emotional distress. Last, the third hypothesis (*H3*) pertains to the moderating effect of perceived controllability. We hypothesize that perceived controllability would mitigate the impact of risk exposure on emotional distress during the COVID-19 pandemic.

2. Materials and methods

2.1. Study design

The data for this study were obtained from the Novel Coronavirus Epidemic Psychosocial Survey conducted online[1] from 1 to 10 February 2020. Convenience sampling and snowball sampling were used to recruit participants. The respondents were Chinese citizens aged 18 or older. The recruitment process consisted of two parts: first, researchers designated several key contacts according to occupation, age, gender, and province; second, the designated contacts were asked to share the survey link to their WeChat groups (an instant messaging software widely used in China). People in the WeChat groups were encouraged to forward the survey link to their WeChat friends. Finally, due to the shortage of medical staff during the outbreak, which may have led to a lag in COVID-19 diagnoses, survey recruits might not have had time to complete the questionnaire. Considering the sample representativeness, a supplementary sample was taken from medical staff. When participants clicked on the survey link, they received informed consent information about confidential negotiations and privacy protection. Recruits could decide to agree and continue to participate or disagree and close the survey.

Participants usually completed the questionnaire in 10–20 min and were asked to answer one question before they could move on to the next question until they completed all questions.

The sample size is calculated by the following formula (52):

$$N = \frac{\left(\frac{Z_\alpha}{2}\right)^2 \times p(1-p)}{d^2}$$, where $\frac{Z_\alpha}{2}$ is the standard normal variate

[at 5% of type 1 error ($p < 0.05$) is 1.96, and researchers usually set $\frac{Z_\alpha}{2}$

at 1.96 (53)]; p is the expected prevalence proportion of emotional distress. The study showed that the prevalence of emotional distress such as anxiety and depression in the Chinese population during the COVID-19 pandemic was around 8.3–35.1% and 14.6–48.3% (47), respectively, but to maximize the value of p(1-p) and thus maximize the sample size, we take $p = 0.5$ into the calculation; d is absolute error or precision (when p is between 10 and 90%, d is recommended to be set to 0.05) (53). Based on the above value settings, the minimum sample size for this study was calculated to be 384. In view of the possible invalid responses, we decided to collect a larger sample. Finally, a total of 2,993 respondents in mainland China were recruited, from medical workers, social service providers, teachers, students, the unemployed, farmers, workers, and other occupations.

Among participants, medical workers working on the front line of the pandemic were at the highest risk of COVID-19 infection. Community workers also had an elevated risk of COVID-19 exposure because they undertook major service tasks such as community group purchasing, food delivery, community screening of potentially infected persons, and assisting in transporting infected persons for medical treatment. Samples younger than 18 years ($n = 135$) or poor quality samples (such as logical confusion, missing information on key variables, etc.) were excluded, and 2,774 samples were finally included in this study (flowchart see Figure 2).

2.2. Measurements

2.2.1. Outcome variable

2.2.1.1. Emotional distress

The measurement of emotional distress was adapted from the Discrete Emotions Questionnaire (DEQ) (54), which was measured using four specific emotions: panic, worry, anger, and emptiness, respectively, representing the four dimensions of the original Discrete Emotions Questionnaire. Each emotion was assessed with a 5-point Likert scale ranging from 1 (never) to 5 (all the time). Respondents reported the frequency of each item according to their emotional state over the last month, then summed all items to get a score ranging from 4 to 20. The higher the score, the more severe the respondent's emotional distress. The Cronbach's alpha of this scale was 0.776. To assess the fitness of the scale, confirmatory factor analysis was used to explore the validity of the scale in this study, and the results showed that all the items met the measurement requirements (results after linking errors of anger and emptiness according to modification indices: $\chi^2/df = 8.413$, $p < 0.05$; RMSEA $= 0.052$, CFI $= 0.998$, SRMR $= 0.009$).

2.2.2. Moderating variables

2.2.2.1. Disruption of life

Disruption of life refers to the extent to which Chinese adults perceived their lives to be disrupted by the COVID-19 pandemic. Based on studies related to the disruption of people's lives by the COVID-19 pandemic and SARS pandemic (28, 55–57), seven items were used to evaluate the COVID-19 pandemic's disruption of individuals' lives, organized under four dimensions: work, finances, daily life, and health. Items examined included overtime work, economic loss, travel changes, being stranded, loss of livelihood, delayed medical care, and lack of supplies. Each item was rated on a 4-point Likert scale ranging from 1 (no impact) to 4 (a very large impact), and the seven items were then added up to get a total score ranging from 7 to 28, with higher scores indicating greater disruption

FIGURE 2
Flow chart of the study design.
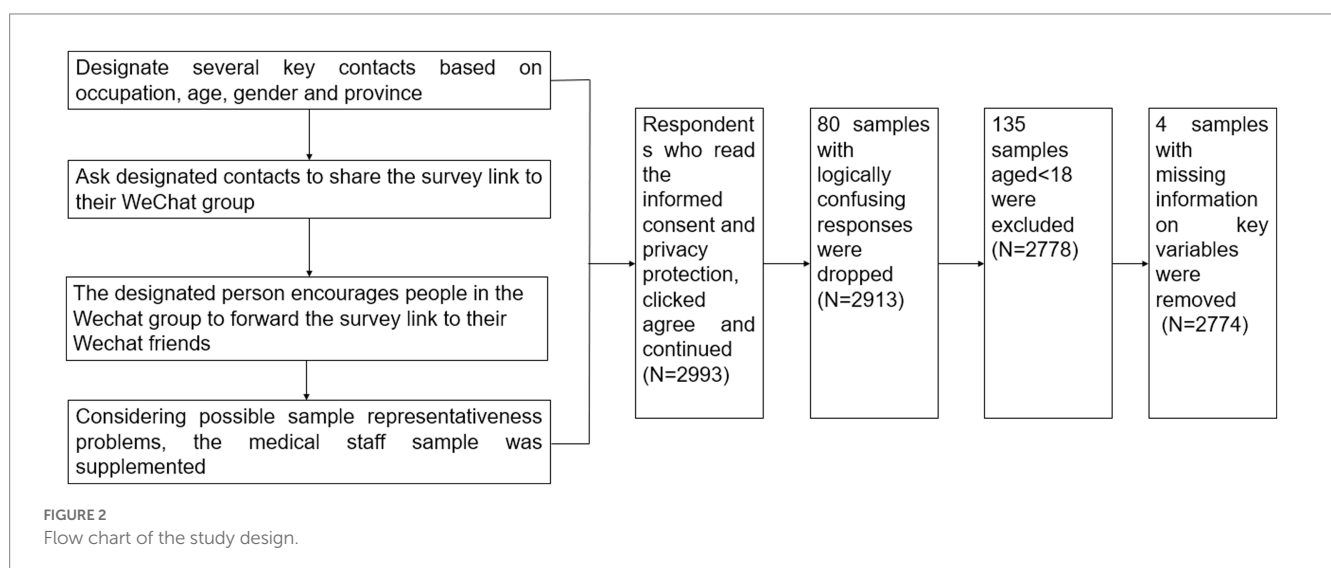
to an individual's life. This scale showed good internal consistency and test–retest reliability. The Cronbach's alpha was 0.865 in this study. Confirmatory factor analysis was performed to assess the fit of these seven items, and the results implied that one factor contributed to the correlation structure of these seven underlying item factors (χ^2/df = 51.586, p < 0.000; RMSEA = 0.135, CFI = 0.914, SRMR = 0.049).

2.2.2.2. Perceived controllability

Referring to research on perceived risk controllability of COVID-19 and SARS (6, 9, 58), five items were used to measure an individual's perceived controllability of COVID-19, including the controllable degree of society over COVID-19 (uncontrollable to controllable), the avoidable degree of individuals over COVID-19 (avoidable to inevitable), the familiarity with COVID-19 knowledge (familiar to unfamiliar), the possibility of the general public contracting COVID-19 (possible to impossible), and the degree of impact of COVID-19 on society (small to large). We used a seven-point Likert score for each item and reverse-coded all items, with a total score ranging from 5 to 35 when all items were added up. Accordingly, the higher the score, the higher the level of perceived controllability. A confirmatory factor analysis on these three latent variables indicated that the model fit well (results after linking errors of the likelihood of COVID-19 infection in the general population and the impact of COVID-19 on society according to modification indices: χ^2/df = 7.501, p < 0.000; RMSEA = 0.048, CFI = 0.987, SRMR = 0.019). The Cronbach's alpha was 0.64 in the current study.

2.2.3. Independent variable

2.2.3.1. Risk exposure

Due to the extreme infectivity and hidden transmission of COVID-19, the exposure risk level of close contact with infected persons was also high. Thus, personal infection status and a history of close contact with an infected person were combined. Then, the final comprehensive risk exposure variable was constructed, which could be divided into four dimensions according to the relational closeness: "no risk exposure, neighborhood infection, family member infection/having close contact with an infected person, and self-infection/having close contact with an infected person" were assigned a score of 1 to 4: the higher the score, the higher the risk exposure level. If participants had any two or more categories of COVID-19 risk exposure among themselves, family members, and neighbors, only the answer with the highest score was used in the analysis. Additionally, risk exposure was a categorical variable in the current study.

2.2.4. Confounding variables

As in previous studies on mental health during COVID-19 (9, 24), the confounding variables in this study mainly included three aspects: demographic characteristics, socioeconomic characteristics, and geographical location variables. Demographic characteristics variables included gender (male, female), age (18–40, 41–60, over 60), educational attainment (middle school or below, high school/technical school, junior college or above), ethnicity (Han, ethnic minorities), marital status (yes, no), and religious beliefs (yes, no). Socioeconomic status variables included job (frontline high-exposure workers, including healthcare workers, aid workers, and community workers; second-line service providers for epidemic prevention and control,

including civil servants and social workers; and others), member of the Communist Party of China (CPC) (yes, no), and household income (below average, average, above average). The geographical location variable refers to specific provinces (Hubei Province, other provinces in mainland China).

2.3. Statistical analysis

Descriptive analysis was applied to describe the characteristics of the sample. For categorical variables, such as risk exposure, gender, ethnicity, age, member of CPC, religious beliefs, marital status, education, job, geographic location, and household income, frequencies and their percentages were calculated. For continuous variables, such as emotional distress, disruption of life, and risk perception, the mean value, and standard deviation were calculated.

The main analysis was divided into three steps, and the same covariates were used in each step: gender, age, education, ethnicity, marital status, religious beliefs, job, member of CPC, and geographic location. First, since emotional distress was a continuous variable, multiple linear regression models were used to examine the relationship between risk exposure and emotional distress symptoms. Second, based on the above model, the interaction effect of risk exposure and disruption of life on emotional distress was examined by adding the interaction variable (risk exposure × disruption of life). Last, we introduced the interaction variable (risk exposure × perceived controllability) to explore the moderating effect of perceived controllability in the relationship between risk exposure and emotional distress based on the first model. Stata 13.0 was used to conduct all analysis.

3. Results

3.1. Descriptive analysis

Table 1 presents the descriptive characteristics of the sample. Among the 2,774 adult respondents, almost 96% were Han ethnicity, only a small number of respondents (n = 266, 9.59%) had religious beliefs, about a quarter were members of the Communist Party of China (n = 703, 25.34%), and female (n = 1,483, 53.46%) and married (n = 1,168, 60.13%) accounted for more than half. Most respondents were aged 18–40 years old (n = 2,169, 78.19%). A small portion of the respondents were workers with high exposure at the frontline of the epidemic (n = 455, 16.4%), compared to a lower proportion of civil servants and social workers who indirectly served during the epidemic (n = 178, 6.42%), and the remaining respondents were employees almost unrelated to the epidemic (n = 2,141, 77.18%). In addition, most respondents considered their household income to be at the average level of the population (n = 2,388, 86.09%), while a minority considered it to be above average (n = 67, 2.42%). Regarding educational attainment, most of the respondents had a junior college degree or above (n = 2,137, 77.04%), and only 9.34% (n = 259) had a middle school education or below.

In terms of risk exposure, 90.66% (n = 2,515) of the respondents had no risk exposure, 5.7% (n = 158) of the respondents reported neighborhood infection, and very few of the respondents had family members who were infected or had close contact with the

TABLE 1 Descriptive analysis of sample characteristics.

	N	%
Gender		
Male	1,291	46.54
Female	1,483	53.46
Ethnicity		
Han	2,656	95.75
Ethnic minorities	118	4.25
Age		
18–40	2,169	78.19
41–60	521	18.78
>60	84	3.03
Religious beliefs		
Yes	266	9.59
No	2,508	90.41
Member of CPC		
Yes	703	25.34
No	2,071	74.66
Marital status		
Yes	1,668	60.13
No	1,106	39.87
Educational attainment		
Middle school or below	259	9.34
High school/technical school	378	13.63
Junior college or above	2,137	77.04
Job		
Frontline high-exposure workers	455	16.4
Second-line service providers for epidemic	178	6.42
Others	2,141	77.18
Geographic location		
Other provinces in mainland China	2,344	84.50
Hubei province	430	15.50
Household income		
Below average	319	11.50
Average	2,388	86.09
Above average	67	2.42
Risk exposure		
No risk exposure	2,515	90.66
Neighborhood infection	158	5.70
Family member infection/close contact	39	1.41
Self-infection/close contact	62	2.24
	Mean	**SD**
Emotional distress	9.16	3.5
Disruption of life	18.62	5.44
perceived controllability	18.98	5.04

SD, standard deviation.

TABLE 2 Multiple linear regression analysis of the relationship between risk exposure, disruption of life, perceived controllability, and emotional distress.

	Model 1-emotional distress			Model 2-emotional distress		
	B	(95%CI)	Beta	B	(95%CI)	Beta
Risk exposure (ref: no risk exposure)						
Neighborhood infection	**0.551**	(−0.019, 1.121)	**0.036***	0.537	(0.014, 1.061)	**0.036****
Family member infection/ close contact	**2.161**	(1.067, 3.255)	**0.073*****	1.808	(0.802, 2.814)	**0.061*****
Self-infection/close contact	**3.240**	(2.351, 4.129)	**0.137*****	2.345	(1.525, 3.166)	**0.099*****
Disruption of life				**0.107**	(0.084, 0.129)	**0.166*****
Perceived controllability				**−0.222**	(−0.246, −0.197)	**−0.319*****
R-squared	0.045			0.195		
N	2,774			2,774		

*p < 0.1, **p < 0.05, ***p < 0.001. B, the nonstandardized coefficients. Beta, standardized coefficients. 95% confidence intervals in brackets. All confounding variables (gender, ethnicity, age, religious beliefs, member of CPC, marital status, educational attainment, job, geographic location, and household income) were controlled in the above models. The bold numbers indicate statistically significant confidence coefficients.

infected (n = 39, 1.41%), with only 2.24% (n = 62) of the respondents reporting being infected or having close contact with an infected person. The average scores for disruption of life and perceived controllability among respondents were 18.62 (range 7–28, SD = 5.44) and 18.98 (range 5–35, SD = 5.035) respectively, indicating that the disruption to people's lives caused by COVID-19 pandemic and people's perceived controllability were both at medium levels. Regarding the emotional distress variable, the mean value for emotional distress was 9.16 (range 4–20, SD = 3.5). Finally, 430 respondents (15.5%) were from Hubei Province, the worst-hit area in mainland China at that time, and 2,344 respondents (84.5%) were from other provinces in China.

3.2. The association between risk exposure and emotional distress

Table 2 presents the multiple linear regression analysis results for the relationship between risk exposure, disruption of life, perceived controllability, and emotional distress among Chinese adults. After controlling for the relevant variables, Model 1 indicated that all types of risk exposures were strongly associated with higher degrees of emotional distress (B = 0.551, 95% CI: −0.019, 1.121; B = 2.161, 95% CI: 1.067, 3.255; B = 3.240, 95% CI: 2.351, 4.129). In detail, compared with unexposed individuals, individuals who were infected or had close contact with infected individuals seemed to have the highest level of emotional distress (Beta = 0.137), followed by individuals with infected family members/close contact (Beta = 0.073), and individuals with neighborhood infection seemed to have the lowest emotional distress (Beta = 0.036). Regarding the COVID-19 disruption of life, model 2 in Table 2 suggested that the COVID-19 disruption of life was strongly related to greater emotional distress (B = 0.107, 95%CI: 0.084, 0.129). Finally, model 2 in Table 2 also showed that perceived controllability was negatively significantly associated with emotional distress (B = −0.222, 95%CI: −0.246, −0.197).
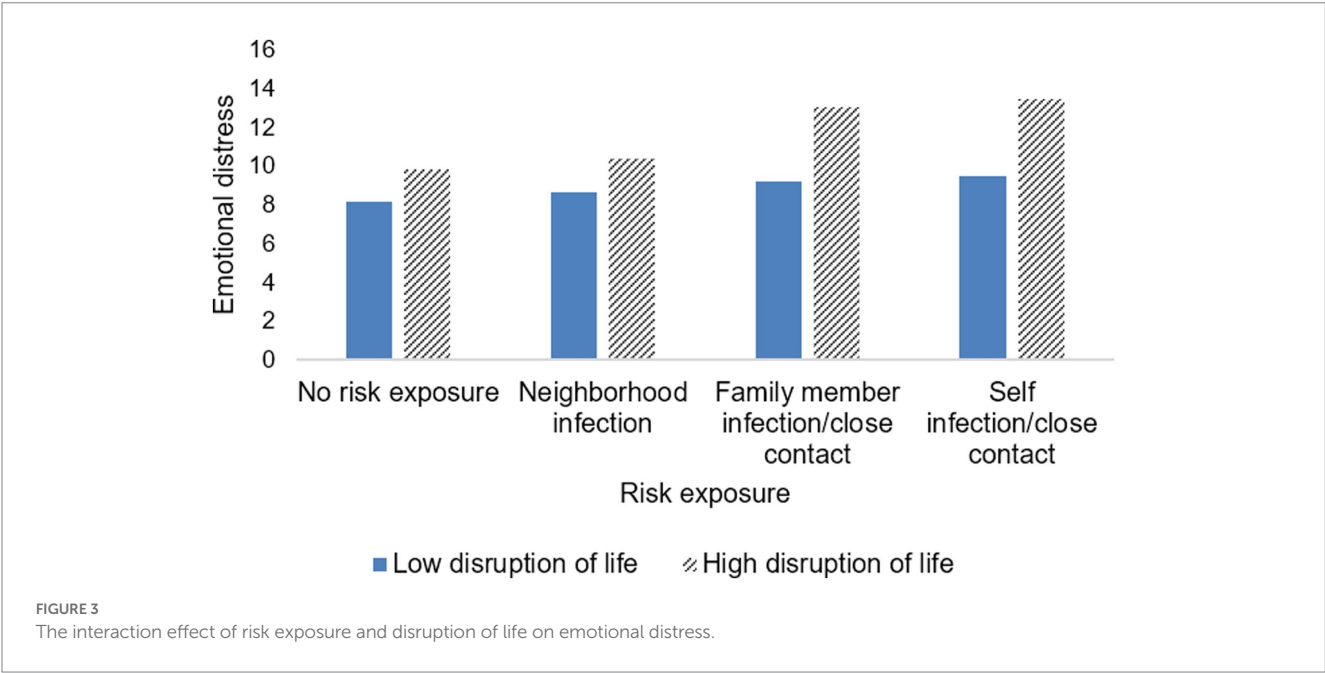
3.3. The moderating effect of disruption of life and perceived controllability

Table 3 and Figures 3, 4 show the interaction effect of risk exposure and disruption of life, as well as risk exposure and perceived controllability on emotional distress. Regarding emotional distress symptoms, models 1 and 2 in Table 3 indicated that both the disruption of life and perceived controllability had a significant interaction effect on the association between self-infection/having close contact and emotional distress and family member infection/ having close contact and emotional distress (see below). However, no significant interaction effects of either life disruption or perceived controllability on the relationship between neighborhood infection and emotional distress were observed (see below). Notably, the direction of the moderating effects of life disruption and perceived controllability were different (see below). Specifically, the more an individual's life was disrupted by the pandemic, the greater the emotional distress for individuals who were infected/having close contact, and the same result for individuals whose family members were infected/having close contact (see Figure 3); that is, disruption of life enhanced the relationship between family member infection/ close contact and emotional distress, as well as between self-infection/ close contact and emotional distress (B = 0.205, 95%CI: 0.017, 0.393; B = 0.217, 95%CI: 0.036, 0.398). Furthermore, the interaction effect of self-infection/having close contact and disruption of life (Beta = 0.196) on emotional distress appeared to be stronger than that of family member infection/having close contact and disruption of life (Beta = 0.136). In contrast to the role of disruption of life, the higher the perceived controllability level, the lower the emotional distress of both self-infection/close contact and family member infection/close contact (see Figure 4). Perceived controllability reduced emotional distress in individuals who were infected/closely exposed themselves, or whose family members were infected/closely exposed (B = −0.180, 95%CI: −0.362, 0.002; B = −0.187, 95%CI: −0.404, 0.030), and the effect of the former seemed to be greater than that of the latter (Beta = −0.123; Beta = −0.115).

TABLE 3 Multiple linear regression analysis for interaction effects of risk exposure and disruption of life on emotional distress and risk exposure and perceived controllability on emotional distress.

	Model 1-emotional distress			Model 2-emotional distress		
	B	(95%CI)	Beta	B	(95%CI)	Beta
Risk exposure×disruption of life (ref: no risk exposure)						
Neighborhood infection×disruption of life	0.010	(−0.094, 0.114)	0.013			
Family member infection/close contact×disruption of life	**0.205**	(0.017, 0.393)	**0.136****			
Self-infection/close contact×disruption of life	**0.217**	(0.036, 0.398)	**0.196****			
Risk exposure × perceived controllability (ref: no risk exposure)						
Neighborhood infection×perceived controllability				0.021	(−0.077, 0.119)	0.027
Family member infection/close contact × perceived controllability				**−0.187**	(−0.404, 0.030)	**−0.115***
Self-infection/close contact × perceived controllability				**−0.180**	(−0.362, 0.002)	**−0.123***
R-squared	0.106			0.172		
N	2,774			2,774		

*$p < 0.1$, **$p < 0.05$, ***$p < 0.001$. B, the nonstandardized coefficients. Beta, standardized coefficients. 95% confidence intervals in brackets. All confounding variables (gender, ethnicity, age, religious beliefs, member of CPC, marital status, educational attainment, job, geographic location, and household income) were controlled in the above models. The bold numbers indicate statistically significant confidence coefficients.
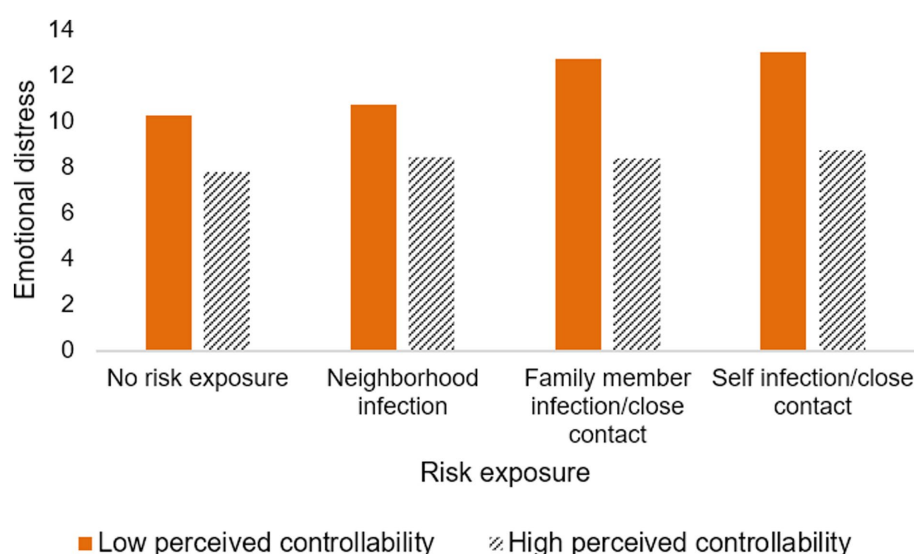

FIGURE 3
The interaction effect of risk exposure and disruption of life on emotional distress.

FIGURE 4
The interaction effect of risk exposure and perceived controllability on emotional distress.

4. Discussion

This study investigates the relationship between COVID-19 risk exposure and emotional distress, with disruption of life and perceived controllability as the moderators. Consistent with our hypothesis 1, we found that all types of risk exposure were significantly associated with higher reported emotional distress, controlling for all covariates. In addition, our results showed that both disruption of life and perceived controllability played a moderating role in the link between some types of risk exposures and emotional distress, partially supporting hypotheses 2 and 3 proposed above. Specifically, when exposed to the same level of COVID-19 risk, individuals whose lives were more disrupted by the pandemic might have experienced a higher level of emotional distress symptoms. Meanwhile, our results also suggested that perceived controllability buffered the effects of self-infection/close contact on emotional distress and family member infection/close contact on emotional distress. Overall, our results may provide empirical evidence for mental health intervention strategies applicable during the COVID-19 pandemic, such as digital health technologies, and online intervention techniques based on online mindfulness and meditation (59–61). Utilizing online platforms, these low-cost and easily accessible interventions (61) can benefit individuals who are in emotional distress.

In line with the previous studies (15, 16, 20), risk exposures were associated with higher levels of emotional distress. However, the strength of the associations appeared to vary by the relationship of the exposed to the individual, i.e., emotional distress was highest for self-infection/close contact, followed by family member infection/close contact, and finally, neighbor infection. This may be partly attributed to sociocultural differences and could be explained by individuals' perceptions of relationship closeness. According to the theory of the "differentiated mode of association"

(chaxugeju) (62), Chinese society is organized by concentric relationship circles, with the family as the core and extending outward to relatives, neighbors, friends, strangers, etc. (63). Not all personal relationships are equal, but they are differentiated according to the degree of closeness or distance from the self (64), resulting in different attitudes toward family members, relatives, and friends (63). Compared with Western populations, family is a more important object of social and emotional support for Chinese adults (9, 65). While such affective interaction has been proven to help individuals cope with adverse psychological symptoms caused by the pandemic (9), it could also trigger some negative effects, as talking about traumatic experiences may mean additional trauma exposure in emergencies (66). If someone in the family was infected or at risk of contracting COVID-19, with continuous intimate interaction and emotional sharing, it would bring a sharp increase in the stress psychological response. This is due to the following reasons: individuals inevitably have deep emotional interaction with their relatives, witness the tragic situation of their relatives closely, feel the painful experience, and empathize with their emotions, thus producing "empathy pain" (67). Furthermore, as the stress process model suggests (18), exposure to stressors can trigger a variety of psychological and physiologic responses (68). COVID-19 can be viewed as a stress event that can trigger related negative emotions (23). More importantly, direct exposure to COVID-19 (20), such as a family member contracting COVID-19 (69), can increase the risk of infection in oneself or other family members, leading to more psychological distress in individuals. In the context of the COVID-19 pandemic lockdown, people were advised to stay home to prevent the spread of the virus (70), objectively putting themselves or their family members at potential risk of infection while being relatively less affected by their neighbors. Therefore, the emotional distress of someone in the household who was infected or at high risk of infection was more

serious than neighbor's infection. Last, another explanation could be that the risk of infection within the family may make individuals more stressed, resulting in negative emotions or psychological reactions (71). Given the infectivity and long latency of COVID-19, many people may fear that they could unknowingly become infected and spread it to family members (72). Given the critical role of risk exposure on emotional distress, it is necessary for the government to use Internet-based platforms to provide material support and psychological support to protect the mental health of individuals with COVID-19 risk exposure, especially those who are infected or at high risk of infection themselves, or who have family members at high risk of infection. First, spatial epidemiological analysis methods (mainly combining big data processing techniques such as machine learning and natural language processing with spatiotemporal data analysis) are used to identify key regions and key populations where mental health problems increase over time (73, 74). For example, sentiment content posted on popular social media platforms by users in areas with a high concentration of COVID-19 cases is analyzed to identify and monitor users' emotional states (73). Second, provide the public with various online psychoeducational interventions such as mindfulness stress reduction, positive meditation, cognitive behavioral therapy, cognitive restructuring, emotional freedom techniques, narrative exposure therapy, and stress management techniques (59, 75); Third, use location or multiple sources of epidemic data (e.g., hospital visit data, population health platform data, government health department data, etc.) to predict epidemic transmission trends, thereby concentrating medical resources in high-risk exposure areas and dynamically visualizing (medical resource mapping) regional medical resources to provide easy healthcare access to individuals with COVID-19 risk exposure (76). Finally, develop a self-service intelligent service system to help people understand COVID-19-related trends and knowledge with the help of AI.

More importantly, the life disruption caused by COVID-19 acted as a moderator between self-infection/close contact and emotional distress, and between family member infection/close contact and emotional distress. Specifically, the disruption of life potentially exacerbated emotional distress in individuals who were infected/had close contact with infected persons or whose family members were infected/had close contact with infected persons, and the emotional distress appeared to be greater in the former than in the latter. This could be understood within the framework of the cumulative risk model (31), which implies that experiencing multiple stressors associated with COVID-19 may lead to worse psycho-emotional responses. Life disruptions caused by the pandemic, such as school suspensions and unemployment, had led to anxiety and other negative psychological outcomes (27, 77). Moreover, previous research has also established that someone in the family (perhaps an individual him- or herself or a family member) infected or at high risk of infection (e.g., having close contact) tended to have more negative emotions (23, 24). According to the cumulative risk model (31), these negative emotions would be more severe for those whose lives were disrupted by COVID-19. In addition, another explanation may be that the life disruptions of COVID-19, such as livelihood shocks and job losses, reduced the potential resilience of households or individuals to other stresses beyond their control (78). For example, respondents with reduced

household income were forced to save less, leading to greater vulnerability to future shocks, such as health risks from pandemics (78). The last explanation related to exposure bias, whereby individuals whose lives were vulnerable to shocks, such as suffering unemployment and being stranded outside the home, were inherently more exposed to risk. A previous study showed that immigrants stranded at the North American border because of travel restrictions had a higher risk of contracting COVID-19 (79), while concerns about health risks were associated with immigrants' distress and fear (80). Given the above, we believe that public health interventions that screen out people whose lives are most affected by COVID-19 and provide them with material support measures such as livelihood assistance and online psychoeducational interventions including mindfulness techniques and meditation techniques (59) are critical for mental health protection during the pandemic.

Moreover, this study found that perceived controllability mitigated the effects of self-infection/close contact on emotional distress and family member infection/close contact on emotional distress, with perceived controllability appearing to have a stronger effect on the former than the latter. As noted by the stress and coping model (37), COVID-19-related emotional distress was the result of the interaction between objective real risk and individual subjective appraisal, and perceived controllability is a key secondary appraisal factor in the stress-coping process. According to the compensatory effects hypothesis in the risk-resilience model (81), some protective factors can buffer the negative emotional responses to adversity, and these include both internal and external resources. Perceived controllability was considered a positive psychological resource that implies individual self-efficacy and optimistic belief in the face of threat (82) and was a protective factor that not only buffered the effects of the COVID-19 pandemic on adverse psychological outcomes but also promoted psychological well-being (e.g., life satisfaction) during the pandemic (48, 83). Perceived controllability, as a positive psychological belief, acts similarly to confidence in society: individuals who perceive COVID-19 risk to be at a controllable level may hold higher expectations of themselves and society as being able to cope with the threat of COVID-19 (51), thereby reducing the anxiety and stress associated with infection or possible infection. Also, another explanation may relate to the fact that risk controllability predicts higher perceived effectiveness of social distance and more preventive behaviors (38). That is, individuals with high perceived controllability may have a more fact-based understanding of COVID-19. Therefore, when they or their family members are infected or at risk of infection, they may adopt more active coping styles, such as maintaining safe social distancing at home, wearing masks, washing hands frequently, and communicating online, which not only ensures the close connection between family members but also reduces the psychological stress of being infected or potentially infecting their family members. In summary, we should learn from these results and improve the public's perceived controllability through public health education and psychological interventions, such as effective communication with the public, online psychological interventions (including the use of cognitive–behavioral techniques, Mindfulness-Based Stress Reduction and meditation techniques group training programs) (59–61), and guide the public to improve controllability in stressful situations.

4.1. Limitations and implications

This study has several limitations. First, the cross-sectional study design makes it difficult to accurately identify causality in the relationship between risk exposure and individual emotional distress outcomes. Future studies can use experimental designs and longitudinal data to further clarify causal relationships. Second, network sampling technology was convenient and safe during the pandemic but also causes sample selection bias. Some groups with relatively poor internet access (such as low-educated people, the elderly, and rural people) were excluded, making the relationship between risk exposure and emotional distress inappropriately assessed due to the differences in risk exposure among the population. Previous studies showed that people with low education were at higher risk of exposure to COVID-19 due to their occupation (84). As the number of COVID-19 infections in urban areas was much higher than that in rural areas, the risk exposure of rural populations was overestimated. Third, we could not show the trend of the relationship between risk exposure and emotional distress symptoms over time. Our data were collected during the early stages of the COVID-19 outbreak, when a vaccine was not yet available to protect against the virus in all countries. As time goes by, scientific research has not only led to the clinical use of the COVID-19 vaccine in most countries, but also an increasingly comprehensive understanding of COVID-19 among the general public, so that the impact of risk exposure on individual emotional distress may not be as strong as in the early years. Thus, it is prudent to consider potential time changes in interpreting our findings, especially in the post-epidemic era after mass vaccination with the COVID-19 vaccine; Also, future studies could examine changes in this relationship over time, particularly now that the COVID-19 vaccine has been mass vaccinated in most countries, and make longitudinal comparisons with findings from the earliest days of the COVID-19 outbreak. Fourth, our data were collected at the beginning of the COVID-19 pandemic, when most countries (85, 86) were experimenting with various lockdown strategies and policies to control the spread of the pandemic as much as possible in the face of this novel virus. Therefore, our data do not measure perceptions of media information or government policies. For that reason, it would be best to cautiously generalize the findings of this research and consider potential changes in policy or societal perceptions related to COVID-19 over time. As countries around the world shift their policies toward the COVID-19 pandemic, future research could consider incorporating these macroenvironmental factors and comparing findings with studies from the beginning of the pandemic to understand how emotional distress changes over time and circumstances during the pandemic. Finally, the generalization of the research conclusions is best placed in a similar geographical and cultural context. Our sample was collected in mainland China, influenced by the collective culture prevalent in East Asia, where people's subjective understanding of risk exposure may differ from that in western countries, resulting in different levels of emotional distress. Future studies can complement comparative studies from the perspective of cultural differences.

Notwithstanding the above limitations, this study still has some important implications. First, we found that risk exposure strongly predicts higher levels of emotional distress, especially among individuals who were infected/had close contact and whose family members were infected/had close contact, suggesting that targeted psychoeducational interventions should be more family oriented. Furthermore, the study showed that the life disruption of COVID-19 enhances the relationship between self-infection/having close contact and emotional distress, as well as the relationship between family members' infection/having close contact and emotional distress. Therefore, the government should adopt appropriate measures (such as questionnaires and telephone contacts) to identify families or individuals whose lives are greatly affected by the COVID-19 pandemic and provide them with effective support. Third, given the buffering effect of perceived controllability between risk exposure and emotional distress, the government should implement appropriate mental health interventions to enhance individuals' perceived controllability and reduce their pandemic-related stress. For example, the government provides systematic psychological care for individuals, including online video courses or apps such as Mindfulness-Based Stress Reduction training (MBSR) and meditation exercises, to promote individuals' mental flexibility skills, thereby improving their subjective perceptions of risk and alleviating their emotions (60).

5. Conclusion

This study indicates that individuals with self-infection/close contact, family member infection/ close contact, and neighborhood infection have higher degrees of emotional distress than individuals without risk exposure, and that the level of emotional distress seems to decrease progressively among these four risk exposures. Moreover, the disruption of life by COVID-19 is found to enhance the effects of emotional distress in individuals who were infected themselves/were in close contact with an infected person or had a family member infected/family members in close contact with an infected person. Additionally, perceived controllability buffers the impact of the effects of self-infection/ close contact on emotional distress and family infection/close contact on emotional distress. These findings provide important implications for the government in crisis management of similar epidemics in the future; that is, they should not only prevent the spread of epidemics scientifically but also pay attention to the mental health problems of the public and provide them with online health interventions (e.g., mindfulness-based stress reduction programs and mindfulness meditation programs) (59) using videoconferencing, websites, or mobile apps to guide them to effectively adjust their negative emotional reactions.

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.

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The relationship between faculty interactions, sense of belonging, and academic stress: a comparative study of the post-COVID-19 college life of Korean and international graduate students in South Korea

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Objective: Rapid changes in post-COVID-19 higher education have increased students' academic stress. This study focused on graduate students' academic stress in South Korea and compared the results for Korean graduate students and those for international graduate students.

Method: Using the online survey results, the study verified the relationships between faculty interactions, a sense of belonging, and academic stress among Korean and international graduate students using a mediating effects analysis and a multigroup path analysis.

Results: The results were as follows. First, Korean students experienced greater academic stress, faculty interactions, and a sense of belonging, but no statistically significant difference was observed. Second, a sense of belonging had a mediating effect on the relationship between faculty interactions and academic stress. Unlike in previous studies, all paths were found to be statistically significant. Faculty interactions had a negative effect on academic stress and a positive effect on a sense of belonging. A sense of belonging had a negative effect on academic stress. Third, the comparison of Korean and international graduate students showed that international students had a greater effect of faculty interactions on academic stress.

Conclusion: Through these results, we explored the post-COVID-19 academic lives of Korean and international graduate students in South Korea and built grounds for effective interventions for alleviating academic stress.

KEYWORDS

COVID-19, college life, academic stress, faculty interactions, sense of belonging, graduate students

1. Introduction

Since March 2020, educational institutions worldwide have experienced rapid changes because of the COVID-19 pandemic. Students began to participate in classes by using online and remote learning tools, which do not require school attendance (1). Higher educational

institutions were also affected by the COVID-19 pandemic situation. It changed the traditionally utilized education environment and methods. As online and remote education progressed after COVID-19, college instructors recognized that human encounters had decreased, and negative academic behaviors had increased (2). Students in higher education institutions experienced relief and curiosity as online education began, compared to the education situation before the initial lockdown; however, they also experienced disappointments and perceived certain deficiencies due to the decrease in interactions (3).

Furthermore, this rapid change in higher education environments and practices has increased academic stress (4). For example, college students in China experienced stress because of increased academic burdens and their separation from school after the COVID-19 pandemic (5). Similarly, students in the United States underwent a crisis regarding their academic future, and approximately 30% of students expressed their intention to unregister themselves from their classes or take fewer classes if remote learning and lockdown were to continue (6). These phenomena were similar to those observed in South Korea (henceforth Korea). The stress of college life before and after COVID-19 was qualitatively different as classes and education environments changed fundamentally. Previously, the learning process itself caused academic stress; however, after COVID-19, participating in online learning caused academic stress (7). Students began to feel stressed out because of the lack of differentiation between living spaces and learning spaces, since they were now taking their classes at home. Such academic stress showed a different pattern compared to previous ones in that it was caused by changes in the environment. Preceding studies have confirmed that the academic stress occurring after COVID-19 has been different from previous stress experiences (8); therefore, we must consider ways to deal with this new type of academic stress.

Proper intervention is especially important for dealing with stress because chronic stress negatively affects cognition and causes mental health vulnerabilities (9). As discussed earlier, after the COVID-19 pandemic, students began to experience a new type of academic stress. Moreover, researchers suggest that returning to pre-COVID-19 education is unlikely (10, 11). In other words, non-face-to-face lectures and real-time online lectures may still be maintained, and even without the pandemic, students may still experience different types of academic stress compared to pre-COVID-19. To this end, we verified the variables that could affect academic stress both positively and negatively during the pandemic in higher education institutions. The details on the current research are as follows.

First, the current research was conducted only on graduate students. Graduate students were more susceptible to academic stress during pandemics. For example, students who lived with their children experienced stress because of a decrease in their studying time after the pandemic; furthermore, because of the increase in their economic responsibilities and difficulties, they tended to worry about academic continuation (12). It was also found that graduate students experienced greater stress compared to undergraduate students because of their diversified roles and strengthened responsibilities, even when they were not facing a pandemic situation (13). As such, the Graduate Student Stress Scale is largely divided into academic stress, environmental stress, and stress caused by family and financial responsibilities (14).

Second, among graduate students, the current research focuses on the different experiences between Korean and international graduate

students in Korea. The culture of Korean graduate schools tends to exhibit hierarchical and authoritarian relationships (15). Moreover, the teaching style in Korean graduate schools often involves self-directed learning through discussions and presentations (16), and there exists a difference in multicultural sensitivity development between professors with and without experience in studying abroad or supervising international students (17). Consequently, international graduate students who are unfamiliar with Korean culture may experience qualitatively different academic stress, sense of belonging, and faculty interaction compared to Korean graduate students. Especially since the COVID-19, stress and anxiety increased in universities among students who did not move to their homes after the shutdown (18). The Pandemic has made it difficult for international students to return to their home countries, and it is possible that such difficulties have exacerbated these differences. Thus, this study aims to examine experiences related to academic stress after the pandemic among graduate students, while also comparing Korean and international students.

Third, we focused on the role of a sense of belonging and faculty interactions in this regard. Sense of belonging refers to a sense of connection and relationship to people, spaces, places, and so on; it is a concept that includes social place, identity, emotional attachment, and ethical-political values (19). The sense of belonging embodies space and place, and students feel a sense of belonging to the higher education institutions. This sense of belonging felt by university students encompasses judgment on how well they fit into the new school environment, the degree to which they fit in with the values and support promoted within the environment, and the degree to which they integrate themselves with the system (20). Students are influenced by factors such as the memberships they maintain in school and the amount of social support they have (21, 22). Such a sense of belonging can affect their satisfaction, commitment, immersion, and well-being; a low sense of belonging can influence dropout decisions (20, 23). In particular, among graduate students, such sense of belonging has been found to have fundamental differences between PhD students completing their degrees and those who are not (24); furthermore, a sense of belonging to a graduate schools had a positive effect on academic self-concept and commitment to study (25). Thus, in previous studies, a sense of belonging has been found to play the role of a protective factor. Moreover, the strengthened role of a sense of belonging as a protective factor against academic stress after COVID-19 has been confirmed (26).

Faculty interactions affect both students' sense of belonging and their studies. The instructor variable has a significant effect on students' learning and motivation, and it also influenced international students' academic paths. It was confirmed that faculty interactions could affect both academic stress and sense of belonging and that it was an appropriate variable for examining differences between international and domestic students (27). However, there were mixed results from previous studies on the differences between international and domestic students. Kim (28) suggested that in Korea, daily communication with instructors in classes is often conducted in the Korean language, and international students may thus find interactions with instructors more difficult than Korean students because of language barriers. However, in other research, international students perceived higher support from their instructors (29).

Thus, in this study we focused on the graduate students' experience on academic stress, sense of belonging, and faculty

interactions during the COVID-19 pandemic in Korea, and compared the experience between Korean and international students. By focusing on these variables we expected to broaden the previous studies in new scenes and times because of national differences in Korea and the COVID-19 pandemic. In sum, the relationships between the variables were verified as follows. First, we examined whether there were any differences between the experiences of Korean and international graduate students in terms of academic stress, sense of belonging, and faculty interactions. Furthermore, this current study examined the relationships among the three variables. The research problems and models were as follows (Figure 1):

RQ1. Is there a difference in academic stress, sense of belonging, and faculty interactions between Korean and international graduate students?

RQ2. Does a sense of belonging mediate the relationship between faculty interaction and academic stress?

RQ3. Does the relationship between academic stress, sense of belonging, and faculty interaction differ between Korean graduate students and international graduate students?

2. Methods

2.1. Participants

The survey participants attended graduate school at S University. The online survey was conducted by the S University Counseling Center for about 1 month (December 21, 2021–January 22, 2022). The counseling center conducted the entire survey utilizing S University's survey system. In December, the lists of currently enrolled graduate school students were extracted from the survey system, and online questionnaires were delivered to all graduate students via email. Due to the use of secondary data from the S university counseling center, our research was not reviewed by the Institutional Review Board (IRB).

The total number of participants was 2,087. One hundred twenty-three responded data were eliminated from the total participants because of missing values for all items on at least one scale. Regression imputation methods then estimated the remaining missing values using Amos 22.0. The research participants ($n = 2,087$) comprised 1,075 (51.50%) male and 1,012 (48.49%) female participants. The distribution of nationality was as follows: 1,968 (94.30%) Korean students and 119 (5.70%) international students. In terms of degree levels, 1,075 (51.50%) had a master's degree, 452 (21.66%) had a doctoral degree, and 560 (26.83%) had an integrated Ph.D. Thus, a

graduate student referred to the person who has pursued degrees of master, doctoral, and integrated doctoral studies in S university, Korea.

2.2. Instruments

2.2.1. Faculty interactions

To measure interactions with the faculty, we used 4 items that were assessed using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher item scores indicated that the participants interacted with faculty members more frequently. Each item measured student-faculty interactions regarding academic problems, personal problems, career problems, and the appropriateness of the academic faculty-student ratio. Examples of faculty interaction items were as follows: "Students discuss academic issues (academic plan, fitness of the major, grade, and so on) with faculty members," "students discuss personal issues in college (economic difficulties, interpersonal problems) with faculty members," and "My graduate school has an appropriate academic advisor-student ratio." In this scale, Cronbach's alpha was 0.83.

2.2.2. A sense of belonging

To measure a sense of belonging, we assessed 9 items using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher item scores indicated that the participants perceived a greater sense of belonging. Each item measured subjective perceptions of the available educational opportunities in the relevant college and intimacy with college members. Item 5 was a reversed item. Examples of faculty interaction items were as follows: "I feel my college satisfies my educational goals," "I feel my college provides me with sufficient opportunities to learn," and "I feel my college members (cohorts, friends, juniors-seniors) have close enough relationships with me." In this scale, Cronbach's alpha was 0.86.

2.2.3. Academic stress

To measure academic stress, we assessed 2 items using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher item scores indicated that the participants perceived higher levels of academic stress. Each item measured academic satisfaction and academic problems. Item 1 was a reversed item. Examples of the academic stress items were "the degree of satisfaction with academic and grade management" and "how difficult it has been to deal with academic problems for the past year." In this scale, Cronbach's alpha was 0.46 the insufficient level of consistency can be corroborated by the number of the scales. Cronbach's alpha of 2-item scale can underestimate the true internal consistency (30).

2.3. Data analysis

Several steps were taken for conducting data analysis using SPSS 23.0 and Amos 22.0. First, we used descriptive statistics and t-tests to identify the demographic results of the participants, and the mean differences between Korean and international graduate students. Second, a mediating effects analysis was implemented in order to determine the role of a sense of belonging in the relationships between faculty interactions and academic stress. Third, multigroup confirmatory factor analysis was conducted to validate the

FIGURE 1
Model figure.
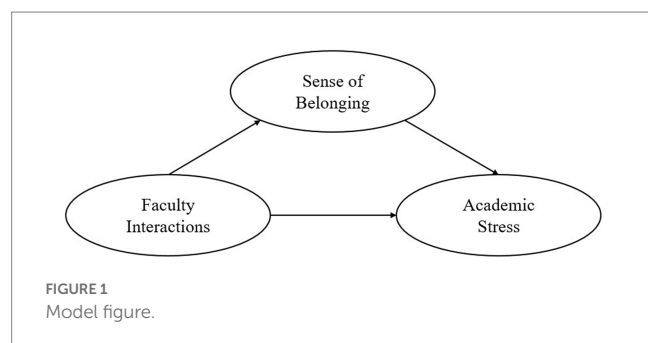
measurement models for further analysis. Fourth, two multigroup path analyses were conducted to examine the group differences in the structural paths of the tested models." As the difference between Korean and international graduate students was considered to be the main presenting group difference, our study did not include any confounding factor in subsequent analyses.

3. Results

3.1. Descriptive statistics

Before conducting the multigroup analysis, the normality of the data and the characteristics of the participants were reviewed. There were 1968 Korean students and 119 international students, and more than half of the students were master students (Korean 51.1%; international 58.8%). The nationalities of the international students ($N = 119$) were as follows: 69 (57.5%) from China, 8 (6.7%) from the United States, 5 (4.2%) from Vietnam, 4 (3.3%) from Taiwan, and 4 (3.3%) from Mongolia.

Before assessing the multigroup path analysis, the normality of the data was reviewed through descriptive statistics. Skewness and kurtosis ranged from −2 to 2, satisfying the assumption of normality. Furthermore, the correlation coefficients did not exceed 0.9 (−0.327 to −0.477), which was acceptable for the multicollinearity test requirements. Finally, a mean difference analysis was performed to compare the scores of each variable based on nationality. There were no significant nationality-based differences in academic stress, faculty interactions, and sense of belonging among graduate students ($p > 0.05$) (see Tables 1–3).

3.2. Mediating effect

The structural equation model fit was examined in order to identify the structural models related to a sense of belonging, faculty interactions, and academic stress, and the model fit was as follows: $\chi^2 = 3336.207$ (df = 87), CFI = 0.814, NFI = 0.810, IFI = 0.813, and RMSEA = 0.134. Though the study reported poor fit of RMSEA, the model fit could be marginally accepted due to the other fit values such as CFI ≥ 0.8 and IFI ≥ 0.8 (31, 32) The path coefficients were statistically significant ($p < 0.001$) (Table 2). Faculty interactions had a negative effect on academic stress ($\beta = -0.185$) and a positive effect on a sense of belonging ($\beta = 0.548$). A sense of belonging had a negative effect on academic stress ($\beta = -0.509$). The indirect effect of a sense of belonging was statistically significant ($\beta = -0.279$, $p < 0.01$) (Table 3).

3.3. Multigroup confirmatory factor analysis (multigroup CFA)

Multigroup CFA was conducted between the data of Korean and international graduate students in order to assess measurement invariance. First, an unconstrained model ($\chi^2 = 3406.996$ ($p < 0.001$), TLI = 0.743, CFI = 0.814, IFI = 0.815, RMSEA = 0.094) demonstrated an acceptable model fit as CFI, IFI, and RMSEA scores could be acceptable even if these are at the marginal. Thus the study proceeded to the measurement invariance for further steps. Following that, the difference tests comparing between the unconstrained and constrained models revealed that constrained models 1 (factor loadings invariance model) and 2 (covariance invariance model) were not significantly different at the significance levels of 0.05 ($p > 0.05$). The multigroup model was satisfied with configural measurement, factor loadings, and covariance invariance models, which allowed for multigroup path analyses. However, the constrained 3 (factor loadings and covariance invariance model) and 4 (factor loadings and Covariance and error invariance model) were significantly different from each other ($p < 0.001$).

3.4. Multigroup path analysis

All paths between faculty interactions, academic stress, and sense of belonging were statistically significant, but group differences were only significant in the path between faculty interactions and academic stress (Table 4). In the Korean student group, interactions with faculty negatively impacted academic stress ($\beta = -0.167$, $p < 0.001$). Furthermore, the faculty interactions of international students also had a negatively significant effect on academic stress ($\beta = -0.556$, $p < 0.01$); however, the data of international students had a greater standardized coefficient value than that of Korean students. Therefore, significant differences were noted between the groups in the path of faculty interactions and academic stress ($p < 0.05$).

4. Discussion

First, a comparison of the experiences of international graduate students and Korean graduate students revealed that the latter had more academic stress, faculty interactions, and a sense of belonging; nonetheless, no statistically significant difference between both student groups was found. This result differed from that of previous studies. Except for a sense of belonging the present study reported contrasting outcomes in terms of academic stress and faculty

TABLE 1 Descriptive results.

Nationality		N	Mean	SD	Skewness	Kurtosis
Korean	Academic stress	1968	2.8402	0.73461	0.110	0.264
	Faculty interactions	1968	3.2305	0.91531	−0.077	−0.421
	Sense of belonging	1968	3.6267	0.65237	−0.508	0.521
International	Academic stress	119	2.7941	0.72314	0.154	0.333
	Faculty interactions	119	3.2278	0.98660	0.022	−0.551
	Sense of belonging	119	3.5427	0.59178	0.022	−0.010

SD = Standard deviation.

TABLE 2 Results of path coefficients between structural model variables.

Path	B	S.E	β	t
Faculty interactions → Academic stress	−0.121***	0.023	−0.185***	−5.200
Faculty interactions → Sense of belonging	0.698***	0.040	0.548***	17.424
Sense of belonging → Academic stress	−0.260***	0.028	−0.509***	−9.346

S.E = standard error.
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

TABLE 3 Indirect effects in structural model.

Path	Indirect effect (β)	Bias-corrected
Faculty interactions → Sense of belonging → Academic stress	−0.279	−0.333 ~ −0.237**

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

interactions (29). The interpretations of the results were as follows. Academic stress may stem from the strong passion and emphasis on higher education in Korea. According to a study conducted in Korea, the academic stress scores of college students were in the high-risk stress levels within the top 30% of the normative range (33). Considering previous research indicating that graduate students experience higher levels of academic stress compared to undergraduate students (12, 34), it can be expected that graduate students in Korea also experience significantly high levels of academic stress. In short, overly high expectations and enthusiasm for higher education in Korea might have led to higher scores of academic stress for Korean students than those for international students.

Furthermore, in terms of faculty interactions, Korean laboratory's hierarchical culture and the composition of instructors may have influenced the results (15). In a previous study on school adaption of international graduate students, "scary advisor" and "rules in laboratory community life that they have not experienced in their home countries" were identified as social stressors (35). In other words, international students may have perceived their professors as more unapproachable due to the distinctive culture of Korean graduate school laboratories; thus, such cultural differences may have led them to decrease interactions with their faculties. Korean graduate students have also suggested that a neglectful culture and unfriendly and insincere education are parts of the features of Korean graduate schools (36). Also, differences in faculty interactions may have resulted from the experience and composition of the instructors. A study on Korean instructors' multicultural sensitivity toward international graduate students discovered that instructors' experiences influenced their teaching of international graduate students (17). Instructors who have never studied abroad or taught international students are still in the early stages of development. Based on these prior studies in Korea, it can be predicted that the current study's findings would differ from those of previous studies in the United States due to the different atmosphere and instructors at Korean graduate schools.

Second, unlike previous studies, all paths were found to be significant in the relationship between academic stress, faculty interactions, and a sense of belonging experienced by international students. The relationship between a sense of belonging and academic stress was found to be generally consistent with previous studies. Although no prior studies have directly revealed the relationship between sense of belonging and academic stress

experienced by international graduate students, previous studies have revealed that college student's sense of belonging is negatively related to stress (37), and positively related to academic motivation, academic endurance and persistence, and academic value (38). Levett-Jones and Lathlean (39) stated that the unfulfilled desire to belong can increase academic stress or anxiety, making it hard for international students to fully focus on their studies or exert their academic competence. In particular, international students in college need psychological stability because they not only face stress as a result of other students' negative perceptions on their special admissions (40) but also their sense of belonging (or lack thereof) (41). According to Chen and Zhou (42), cultural influence, information accessibility, language barriers, and various other factors can influence international students' academic performance, causing academic stress to rise during the adaptation process. Therefore, in a challenging academic environment, it is critical for students to have the experience of being accepted and having their psychological needs met by others around them; this can reduce their academic stress.

The prior research showed findings of both directions between the relationship between a sense of belonging and faculty interactions (43, 44). Kim et al. (44) proved that a sense of belonging can significantly affect faculty interactions because a higher sense of belonging could lead to development of positive feelings and prosocial behaviors. On the other hand, faculty interactions can also influence students' sense of belonging (43). Faculty interactions are essential human resources for educational purposes; the level of proactive interactions is considered a key aspect in maintaining academic relationships (45). In other words, frequent faculty interactions in a graduate setting can promote a greater sense of belonging. Graduate students tend to identify current positions throughout their graduate programs; hence, faculty interactions can play a positive role in students' adaptation process. Furthermore, with the growing interest in informal interactions such as personal interactions and counseling (46), as well as academic interactions such as assignments, exams, and grades, various and active interactions with professors (45) are helpful for international graduate students to experience enough sense of belonging and reduce their academic stress in a graduate setting.

Third, significant differential effects of faculty interactions on academic stress have been revealed between Korean and international graduate students. Both groups reported that faculty interactions had a negative effect on academic stress, but this effect was significantly greater among international students. This finding is consistent with previous studies (27, 47–50). Rice et al. (50) concluded that a relationship with the instructor is a significant factor to relieve academic stress among international students. Although moderating effects between

TABLE 4 Results of multigroup path analysis.

Path	Korean students			International students			Diff
	B	β	S.E	B	β	S.E	
Faculty interactions → Sense of belonging	0.707***	0.545***	0.042	0.611***	0.580***	0.127	−0.714
Faculty interactions → Academic stress	−0.108***	−0.167***	0.023	−0.388**	−0.556**	0.129	−2.134*
Sense of belonging → Academic stress	−0.265***	−0.512***	0.029	−0.225*	−0.338*	0.106	0.283

S.E = standard error.

Korean and international students were not revealed, there is convincing evidence that international students are more vulnerable to a lack of respects from their instructors compared to Korean students (50). Furthermore, the role of the instructor has been proven as the most influential factor for international students to decide whether they continue their academic studies (27). Similarly, the Chinese international students in Korea, satisfaction with their interactions with professors reduced stress in adaptation to classes [Cho and Jeon, 2009; (49)] or increased participation in the class (47). Therefore, as a university-level policy, appropriate plans or programs should be considered as ways of strengthening interactions between instructors and students to alleviate the academic stress among international graduate students. Increased faculty interactions can contribute to international students' successful acculturation and academic achievement.

The significance and further directions of this study are as follows. First, only a handful of previous studies have examined the academic stress experienced by Korean graduate students. Most prior research looked at the stress issue with narrow scope to medical graduate students (51). Further research must be conducted to explore diverse majors or general graduate students encompassing their academic stress issues. Second, this current research is essential for finding ways to deal with their mental health considering the higher stress levels of graduate students than undergraduates. In particular, the COVID-19 pandemic situation shed light on the importance of examining the stress issues of Korean graduate students. This is because the pandemic situation has posed serious mental health issues and required timely and appropriate mental health interventions (52). Thus, current study can be a primary source to suggest and organize useful interventions for aiding mental health and college adaptation interventions. The limitations of this study are as follows. First, the external validity issue might be threatened because participants were collected only in S University graduate students in Seoul, Korea. Thus, the study findings may not be fully representative of graduate students. Second, there was a considerable gap in the ratio of Korean to foreign students. The number of recruited international students in this study was smaller than the actual percentage of international students in the University. Therefore, future research should prepare appropriate measures to increase international graduate participants as well as diverse universities to generalize research findings to the population.

Data availability statement

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

Author contributions

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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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Humanistic care relieves mental distress of inpatients in the shelter hospital during COVID-19 pandemic in Shanghai: a cross-sectional observational study

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Objective: The prevalence of mental distress has been noted in shelter hospitals set up for COVID-19. Potential risk demographic and hospitalization factors were screened. We also aimed to determine whether humanistic care established in the shelter hospital was effective in ameliorating mental distress.

Methods: A cross-sectional observational survey-based single-centered study was conducted from 28th April to 5th May 2022 during the COVID-19 pandemic in Shanghai. Asymptomatic adult inpatients and those with mild symptoms were recruited for this study, and humanistic care measures were carried out by the administrative office according to the Work Program on Psychological Assistance and Social Work Services at the Shelter Hospital launched on 5th March 2020. Symptoms of mental distress, such as reported stress, anxiety, depression, and insomnia were measured using the Chinese Stress Response Questionnaire-28, the Chinese version of Generalized Anxiety Disorder-7, Patient Health Questionnaire-9, and Insomnia Severity Index-7, respectively.

Results: In total, 1,246 out of 9,519 inpatients, including 565 (45.35%) women and 681 (54.65%) men, with a median age of 36 years responded to the survey. The overall prevalence of stress, anxiety, depression, and insomnia in inpatients was 94 (7.54%), 109 (8.75%), 141 (11.32%), and 144 (11.56%), respectively. Mental distress was aggravated by COVID-19-related symptoms, comorbidities, and prolonged hospital stays. A stable internet connection was the most effective measure to reduce stress and depression. Offering inpatient with study or work facilitations, and mental health education help to ameliorate anxiety and depression. Organizing volunteering was a potential protective factor against stress.

Conclusion: Humanistic care is crucial and effective for protecting against mental distress, which should be emphasized in shelter hospitals.

KEYWORDS

COVID-19, mental distress, shelter hospital, inpatients, humanistic care

1. Introduction

The coronavirus disease 2019 (COVID-19) continues to spread around the world. According to World Health Organization COVID-19 epidemiological updates, as of 10th June 2022, over 532 million confirmed cases and over six million deaths have been reported globally. In late February of 2022, a wave of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) clustered into the BA.2.2 sub-lineage raged unexpectedly in Shanghai, China (1). There have been 58,052 confirmed cases and 588 deaths in this wave of the pandemic in Shanghai from 26th February to 10th June 2022 according to the Shanghai Municipal Health Commission.

Based on the experiences of the COVID-19 pandemic in Wuhan in 2019, the use of shelter hospitals in quarantining infected and suspected cases of COVID-19, without symptoms or with mild symptoms, is a crucial step for public health. It is a social measure to control the spread of the disease, in addition to locking down districts with severe outbreaks, large-scale viral nucleic acid and antigen screenings, quarantining patients with close contact in hotels, and transferring special infected cases to designated hospitals. Accumulating research has established that mental distress is ubiquitous during unanticipated pandemics. This is certain to be echoed in the populations affected by the COVID-19 pandemic in Shanghai, especially inpatients quarantined in shelter hospitals (2). The potential causes of mental distress pertinent to shelter hospitals include physical distance from family, unemployment and consequent financial burden, and interference in aspects of daily life that can have significant implications for the long term such as interference in education.

In such cases, humanistic care plays a crucial role in screening for psychopathology, psychoeducation, psychosocial support, and addressing adverse psychosocial outcomes in addition to medical care. Neglected humanistic care is not only unethical but may also translate into a range of emotional reactions, unhealthy behaviors, non-compliance with shelter hospital directives, and even impairment to physical well-being among inpatients. However, evidence-based evaluations of humanistic care for the mental health of inpatients in shelter hospitals are relatively scarce. Consequently, this study conducts a retrospective, cross-sectional, observational, single-centered study validating the association of humanistic care measures with alleviating mental disorders and reducing potential risk factors among shelter hospital inpatients.

2. Materials and methods

2.1. Study design

This cross-sectional observational study conducted a hospital-based survey during the COVID-19 pandemic from 28th April to 5th May 2022

at the Shelter Hospital of Shanghai New International Expo Center (SNIEC) in Shanghai, China. This shelter hospital, established on 31st March 2022, consisted of 4,339 healthcare workers and hospitalized 9,519 inpatients. Accumulatively, by April 28th 2022, 36,147 patients had been hospitalized here. Humanistic care measures towards inpatients were carried out by the administrative office according to the Work Program on Psychological Assistance and Social Work Services launched on 5th March 2020 during the Wuhan COVID-19 pandemic. The specific humanistic care measures included active encouragement by healthcare workers, stable Internet signal offered by local telecommunication supply, study or work facilitations provided by the logistics department, online COVID-19 and mental health education offered by related specialists, and organized graffiti and emotional drawing, regular recreational activity, volunteering, and physical exercise.

The survey was conducted through online self-reported questionnaires. The primary outcome was the validation of the protective effects of humanistic care on mental distress. The secondary outcome was the occurrence rate of mental distress and potential risk factors.

This study was approved and supervised by the clinical research ethics committee of Ren Ji Hospital, School of medicine, Shanghai Jiao Tong University (No. KY2022-082-B), which is responsible for the administration of the shelter hospital. Additionally, it follows the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement for cross-sectional studies. All participants were fully informed about this study and provided electronic informed consent prior to their enrollment. They were allowed to terminate the survey at any time and confidentiality of their information was guaranteed.

2.2. Participants

Participants eligible for this study included asymptomatic inpatients who had nucleic acid testing-validated SARS-CoV-2 infections and those with mild symptoms. The following patients were excluded: patients with a previous history of or diagnosed with psychological diseases by psychiatrists, with moderate or severe symptoms of COVID-19 or other unstable morbidities to be transferred out to designated hospitals, and those unable or unwilling to fill out the questionnaires. Inpatients under 18 years old were not included in this study. The family cabin in the SNIEC shelter hospital is designed for SARS-Cov-2 infected children taken care of by their parents or assigned guardians.

The sample size of patients was calculated at a 3% margin of error with a 95% confidence level.[1] The population size of inpatients was set as 10,000. The required sample size of inpatients was calculated to be 965.

2.3. Data sources and measurement

Demographic, domestic, and occupational characteristics were self-reported by patients, including age, gender, marital status, children number, dependents in need of care, and hospitalization characteristics. Data on whether they were living in the family cabin was taken from the hospital management system. Participants indicated whether they were receiving a humanistic care intervention through the self-report questionnaire. This was validated by the authors.

2.3.1. Questionnaires

The stress, anxiety, depression, and insomnia in inpatients were measured by the Chinese Stress Response Questionnaire-28 (SRQ-28), the Chinese version of Generalized Anxiety Disorder-7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9), and Insomnia Severity Index-7 (ISI-7), respectively. All questionnaires have been granted permission for this study.

The Chinese SRQ-28 is a 28-item questionnaire whereby participants rate their responses on a 5-point Likert scale to indicate their stress response. The total score of SRQ-28 is 140, and higher scores indicate higher levels of the stress response (3). While there is no official cut-off, the moderate level of ≥ 84 is set as the cut-off value.

GAD-7 and its Chinese version is a 7-item questionnaire wherein participants rate their responses on a 4-point Likert scale. It is treated as a reliable and valid measure of anxiety response in the general population (2). The total score of GAD-7 is 21, and higher scores indicate a higher level of anxiety response. The cut-off of GAD-7 is set as ≥ 10 for moderate anxiety (4).

PHQ-9 is a 9-item questionnaire that measures depression through a 4-point Likert scale. It has a total score of 27 and the cut-off score for moderate depression is ≥ 10, with higher scores indicating higher levels of depression response (5). The Chinese version has been proven to be valid and reliable, and the optimal cut-off point to detect depression in Chinese outpatients is also 10 for PHQ-9 (sensitivity = 0.77, specificity = 0.76) (6).

Insomnia is assessed via the ISI, a 7-item self-report index assessing the severity of initial, middle, and late insomnia. Scores ≥ 15 indicate that moderate insomnia is present (7). Its Chinese version has been validated (8).

2.4. Statistical methods

Data analysis was performed using SPSS statistical software version 27.0.1 (IBM Corporation, Armonk, NY, United States). The significance level was set at $\alpha = 0.05$, and all tests were 2-tailed. The ranked data, which were derived from the counts of each level for symptoms of stress, anxiety, depression, and insomnia are presented as numbers and percentages. Quantitative variables that were not normally distributed were presented as medians with an interquartile range (IQR). The nonparametric Mann–Whitney U test and Kruskal-Wallis test were applied to compare the severity of each symptom between two or more groups. To determine the effects of humanistic care for symptoms of stress, anxiety, depression, and insomnia, multivariable logistic regression analysis was performed, and the associations between risk factors and outcomes are presented as odds ratios (ORs) and 95% confidential intervals (CIs), after adjustment for

recognized significant confounders. All respondents were required to complete the questionnaires, otherwise were excluded from the survey.

3. Results

In total, 1,246 out of 9,519 inpatients (response rate 13.09%) responded to the survey (Table 1). The median age with IQR of total inpatients, outside, and inside the family cabin was 36.00 [29.00, 47.00], 36.00 [28.00, 48.00], and 38.00 [33.00, 42.00], respectively. There were 565 (45.35%) females and 681 (54.65%) males in total. In the family cabin, there were more married female with children ($p < 0.001$). Additionally, inpatients in the family cabin had more dependents in need of care outside the hospital ($p = 0.003$). Education levels inside the family cabin were higher (51.95%) than outside (31.53% above K12, $p < 0.001$); however, the employment rate was comparable.

Inpatients in both groups presented similar rates of SARS-Cov-2-related symptoms, comorbidities, and long-term medication and received traditional Chinese medicine without significant differences. Inpatients were administered SARS-Cov-2 nucleic acid test on the third day after hospitalization. The median nucleic acid test times and hospital length of stay with IQR was 4.00 [2.00, 7.00] and 6.00 [3.00, 9.00] days overall, 3.00 [1.00, 5.00] and 5.00 [3.00, 7.00] days in the family cabin, and 5.00 [2.00, 7.00] and 6.00 [4.00, 9.00] days outside the family cabin, respectively ($p < 0.001$).

The overall prevalence of stress, anxiety, depression, and insomnia of inpatients was 94 (7.54%), 109 (8.75%), 141 (11.32%), and 144 (11.56%), respectively (Table 2). In our sample, females were prone to anxiety (57.80% vs. 44.15%, $p = 0.008$) and depression (55.32% vs. 44.07%, $p = 0.015$) in comparison with males. Inpatients with children were reportedly more resistant to insomnia (59.72% vs. 68.42%, $p = 0.045$). Additionally, having more dependents in need of care, a higher level of education and longer hospital stays were strongly associated with an increased risk of anxiety, depression, and insomnia. Unemployment was also a potential risk factor for depression ($p = 0.022$), while SARS-COV-2-related symptoms were strongly related to depression and insomnia (both $p < 0.001$). Inpatients with comorbidities were more likely to experience anxiety ($p = 0.024$) and insomnia ($p = 0.005$). The comorbidities included diabetes, hypertension, cardiovascular disease, and other specific chronic diseases.

Among humanistic care towards inpatients, a stable internet connection appeared to be the most effective means to reduce stress [OR = 0.385, CI (0.235, 0.631), $p < 0.001$], anxiety [OR = 0.491, (0.294, 0.818), $p = 0.006$], and depression [OR = 0.575, CI (0.350, 0.944), $p = 0.029$], but not insomnia (Table 3). Offering inpatients study or work facilities and mental health education helped to ameliorate anxiety [OR = 0.637, CI (0.414, 0.980), $p = 0.040$ and OR = 0.598, CI (0.360, 0.995), $p = 0.048$] and depression [OR = 0.478, CI (0.322, 0.710), $p < 0.001$ and OR = 0.546, CI (0.344, 0.866), $p = 0.010$]. Organizing volunteering activities by cabin administrators regularly was a potential protective factor against stress [OR = 0.578, CI (0.346, 0.968), $p = 0.037$].

4. Discussion

To avoid quarantining children alone, results indicate that being placed in a family cabin is by all means very necessary in the SNIEC shelter hospital. In addition, hospitalization in the family cabin was

TABLE 1 Basis demographic and hospitalization characteristics of inpatients.

Characteristics	Overall N = 1,246 (100%)	Inside family cabin N = 231 (18.54%)	Outside family cabin N = 1,015 (81.46%)	p
Age, year	36.00 [29.00, 47.00]	38.00 [33.00, 42.00]	36.00 [28.00, 48.00]	0.048
Gender				**<0.001**
Female	565 (45.35)	136 (58.87)	429 (42.27)	
Male	681 (54.65)	95 (41.13)	586 (57.73)	
Marital status				**<0.001**
Unmarried	368 (29.53)	16 (6.93)	352 (34.68)	
Married	878 (70.47)	215 (93.07)	663 (65.32)	
Children number				**<0.001**
0	406 (32.58)	19 (8.23)	387 (38.13)	
≥1	840 (67.42)	212 (91.77)	628 (61.87)	
Dependents in of need care				**0.030**
No	895 (71.83)	152 (65.80)	743 (73.20)	
Yes	351 (28.17)	79 (34.20)	272 (26.80)	
Education level				**<0.001**
K12 and under	806 (64.69)	111 (48.05)	695 (68.47)	
Above K12	440 (35.31)	120 (51.95)	320 (31.53)	
Employment				0.186
Employed	1,027 (82.42)	183 (79.22)	844 (83.15)	
Unemployed	219 (17.58)	48 (20.78)	171 (16.85)	
SARS-Cov-2-related symptoms				0.758
No	380 (30.50)	68 (29.44)	312 (30.74)	
Mild	866 (69.50)	163 (70.56)	703 (69.26)	
Comorbidity				0.304
No	1,077 (86.44)	205 (88.74)	872 (85.91)	
Yes	169 (13.56)	26 (11.26)	143 (14.09)	
Long-term medication				0.354
No	1,097 (88.04)	208 (90.04)	889 (87.59)	
Yes	149 (11.96)	23 (9.96)	126 (12.41)	
Traditional Chinese medicine				0.864
No	570 (45.75)	104 (45.02)	466 (45.91)	
Yes	676 (54.25)	127 (54.98)	549 (54.09)	
Nucleic acid test, times	4.00 [2.00, 7.00]	3.00 [1.00, 5.00]	5.00 [2.00, 7.00]	**<0.001**
Hospital length of stay, day	6.00 [3.00, 9.00]	5.00 [3.00, 7.00]	6.00 [4.00, 9.00]	**<0.001**

Bold values mean the p-value is significant.

found to be significantly related to shorter hospital length of stay, although it is not associated with relief of mental disorders and SARS-COV-2 symptoms. The family cabin is both beneficial to inpatients and their family members. The physical presence of the caregiver in the rehabilitation setting of family glass cabin was reported to not only increases acute brain injury patients' functional recovery, but also reduces caregivers' anxiety and emotional burden (9).

Major reported stressors of inpatients included concerns about finances, occupation, children's education, family issues (Figure 1). These findings are in line with existing research. For instance, Pierce et al. identified predictive factors for deteriorating mental health, which

included infection with SARS-CoV-2, local lockdown, and financial difficulties. They compared their findings with pre-pandemic data from the United Kingdom's adult population (10). Inpatients with SARS-COV-2-related symptoms, comorbidities, and prolonged hospital length of stay are more susceptible to mental disorders. Obesity and a wide range of comorbidities are risk factors for long COVID (11). These inpatients warrant special attention in treatments and nursing care that is tailored to their symptoms and comorbidities. Inpatients with moderate symptoms or above, and unstable comorbidities are screened before hospitalization, diagnosed during hospitalization, and transferred out of the shelter hospital to designated hospitals with sophisticated

TABLE 2 The prevalence of mental disorders among inpatients.

Characteristics	SRQ Normal mild N = 1,152 (92.46%)	SRQ Moderate severe N = 94 (7.54%)	p	GAD Normal mild N = 1,137 (91.25%)	GAD Moderate severe N = 109 (8.75%)	p	PHQ Norma mild N = 1,105 (88.68%)	PHQ Moderate severe N = 141 (11.32%)	p	ISI Normal mild N = 1,102 (88.44%)	ISI Moderate severe N = 144 (11.56%)	p
Age, year	36.00 [29.00, 47.00]	35.00 [28.00, 44.00]	0.546	36.00 [29.00, 47.00]	36.00 [30.00, 41.00]	0.593	36.00 [29.00, 47.00]	37.00 [29.00, 43.00]	0.462	36.00 [29.00, 47.00]	35.00 [28.00, 41.25]	0.124
Gender												
Female	516 (45.70)	49 (41.88)	0.488	502 (44.15)	63 (57.80)	**0.008**	487 (44.07)	78 (55.32)	**0.015**	492 (44.65)	73 (50.69)	0.200
Male	613 (54.30)	68 (58.12)		635 (55.85)	46 (42.20)		618 (55.93)	63 (44.68)		610 (55.35)	71 (49.31)	
Marital status												
Unmarried	335 (29.67)	33 (28.21)	0.822	341 (29.99)	27 (24.77)	0.302	328 (29.68)	40 (28.37)	0.823	318 (28.86)	50 (34.72)	0.176
Married	794 (70.33)	84 (71.79)		796 (70.01)	82 (75.23)		777 (70.32)	101 (71.63)		784 (71.14)	94 (65.28)	
Children number												
0	368 (32.60)	38 (32.48)	1.000	375 (32.98)	31 (28.44)	0.390	358 (32.40)	48 (34.04)	0.767	348 (31.58)	58 (40.28)	**0.045**
≥1	761 (67.40)	79 (67.52)		762 (67.02)	78 (71.56)		747 (67.60)	93 (65.96)		754 (68.42)	86 (59.72)	
Dependents in need of care												
No	819 (72.54)	76 (64.96)	0.103	848 (74.58)	47 (43.12)	**<0.001**	829 (75.02)	66 (46.81)	**<0.001**	823 (74.68)	72 (50.00)	**<0.001**
Yes	310 (27.46)	41 (35.04)		289 (25.42)	62 (56.88)		276 (24.98)	75 (53.19)		279 (25.32)	72 (50.00)	
Education level												
K12 and under	732 (64.84)	74 (63.25)	0.810	756 (66.49)	50 (45.87)	**<0.001**	737 (66.70)	69 (48.94)	**<0.001**	738 (66.97)	68 (47.22)	**<0.001**
Above K12	397 (35.16)	43 (36.75)		381 (33.51)	59 (54.13)		368 (33.30)	72 (51.06)		364 (33.03)	76 (52.78)	
Employment												
Employed	935 (82.82)	92 (78.63)	0.315	945 (83.11)	82 (75.23)	0.053	921 (83.35)	106 (75.18)	**0.022**	915 (83.03)	112 (77.78)	0.150
Unemployed	194 (17.18)	25 (21.37)		192 (16.89)	27 (24.77)		184 (16.65)	35 (24.82)		187 (16.97)	32 (22.22)	
Family cabin												
No	917 (81.22)	98 (83.76)	0.584	930 (81.79)	85 (77.98)	0.396	903 (81.72)	112 (79.43)	0.587	896 (81.31)	119 (82.64)	0.785
Yes	212 (18.78)	19 (16.24)		207 (18.21)	24 (22.02)		202 (18.28)	29 (20.57)		206 (18.69)	25 (17.36)	
SARS-COV-2-related symptoms												
No	344 (30.47)	36 (30.77)	1.000	355 (31.22)	25 (22.94)	0.092	360 (32.58)	20 (14.18)	**<0.001**	356 (32.30)	24 (16.67)	**<0.001**
Mild	785 (69.53)	81 (69.23)		782 (68.78)	84 (77.06)		745 (67.42)	121 (85.82)		746 (67.70)	120 (83.33)	
Comorbidity												
No	976 (86.45)	101 (86.32)	1.000	991 (87.16)	86 (78.90)	**0.024**	963 (87.15)	114 (80.85)	0.054	964 (87.48)	113 (78.47)	**0.005**
Yes	153 (13.55)	16 (13.68)		146 (12.84)	23 (21.10)		142 (12.85)	27 (19.15)		138 (12.52)	31 (21.53)	

(Continued)

TABLE 2 (Continued)

Characteristics	SRQ Normal mild N = 1,152 (92.46%)	Moderate severe N = 94 (7.54%)	p	GAD Normal mild N = 1,137 (91.25%)	Moderate severe N = 109 (8.75%)	p	PHQ Norma mild N = 1,105 (88.68%)	Moderate severe N = 141 (11.32%)	p	ISI Normal mild N = 1,102 (88.44%)	Moderate severe N = 144 (11.56%)	p
Long-term medication												
No	997 (88.31)	100 (85.47)	0.453	1,006 (88.48)	91 (83.49)	0.168	978 (88.51)	119 (84.40)	0.201	976 (88.57)	121 (84.03)	0.149
Yes	132 (11.69)	17 (14.53)		131 (11.52)	18 (16.51)		127 (11.49)	22 (15.60)		126 (11.43)	23 (15.97)	
Traditional Chinese Medicine												
No	514 (45.53)	56 (47.86)	0.700	516 (45.38)	54 (49.54)	0.464	508 (45.97)	62 (43.97)	0.719	506 (45.92)	64 (44.44)	0.807
Yes	615 (54.47)	61 (52.14)		621 (54.62)	55 (50.46)		597 (54.03)	79 (56.03)		596 (54.08)	80 (55.56)	
Nucleic acid test times, times	4.00 [2.00, 7.00]	4.00 [2.00, 7.00]	0.929	4.00 [2.00, 7.00]	5.00 [2.00, 7.00]	0.376	4.00 [2.00, 7.00]	5.00 [3.00, 7.00]	0.258	4.00 [2.00, 7.00]	5.00 [2.00, 7.00]	0.237
Hospital length of stay, day	6.00 [3.00, 9.00]	6.00 [3.00, 9.00]	0.558	6.00 [3.00, 9.00]	7.00 [4.00, 10.00]	**0.019**	6.00 [3.00, 9.00]	7.00 [4.00, 10.00]	**0.004**	6.00 [3.00, 9.00]	7.00 [4.00, 10.00]	**0.030**

Bold values mean the p-value is significant.

FIGURE 1
Word cloud of the major stressors among inpatients. Major stressors are presented as a word cloud. Font size is positively correlated with proportion.

medical equipment. Moreover, dependents in need of care outside the shelter hospital are at strong risk of mental distress. Collaborations between the government, the shelter hospital, and community social workers have been established to ensure they are not unattended; particularly, women and those with higher levels of education and unemployment are screened as they have higher risks of mental distress.

We also found that inpatients with children were less vulnerable to insomnia. This may be explained by previous experiences of interrupted sleep at night when looking after children. However, a national longitudinal cohort study in the United Kingdom elaborated that greater increases in mental disorders are observed in young adults, especially women (< 35 years), and those living with preschool children (< 5 years) (12). Additionally, having a stable internet connection was a strong protective factor for reducing stress, anxiety, and depression. This facilitates online research based on patients' generated data, as well as popularizing knowledge of COVID-19 (13). Mental health education was established by watching the relevant online recorded video. These were demonstrated to be linked with reduced anxiety and depression. A similar effect was noted in offering study or work facilities, such as power supply, desks, and pens. Volunteering activities were also organized by cabin administrators to help healthcare workers in goods transportation and distribution, order maintenance, garbage clearance, and other logistical roles—these were determined to relieve anxiety. Similarly, Chan et al. also demonstrated that volunteering among Chinese older adults during COVID-19 was related to fewer depressive and anxiety symptoms and higher self-esteem (14).

4.1. Limitations

This study has several limitations. Firstly, this single-center study has a limited sample size of 1,246 inpatients, which limits the generalizability of the findings to other regions. Secondly, humanistic care was defined and measured as a binary variable of whether care

TABLE 3 Humanistic care effects on mental disorders among inpatients.

	SRQ OR	CI		p	GAD OR	CI		p	PHQ OR	CI		p	ISI OR	CI		p
Active encouragement																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	1.170	0.725	1.888	0.520	0.789	0.491	1.268	0.328	0.705	0.450	1.104	0.126	0.827	0.531	1.288	0.401
Graffiti and emotional drawing																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.867	0.542	1.388	0.552	1.171	0.712	1.927	0.534	1.321	0.816	2.138	0.257	1.177	0.742	1.866	0.489
Stable Internet signal																
No	1[Reference]				1[Reference]				1[Reference]				1[Reference]			
Yes	0.385	0.235	0.631	**<0.001**	0.491	0.294	0.818	**0.006**	0.575	0.350	0.944	**0.029**	0.641	0.393	1.046	0.075
Study or work facilitations																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.996	0.659	1.506	0.986	0.637	0.414	0.980	**0.040**	0.478	0.322	0.710	**<0.001**	0.828	0.563	1.217	0.336
COVID-19 education																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.980	0.536	1.792	0.947	0.828	0.464	1.477	0.522	1.735	0.957	3.144	0.070	0.935	0.534	1.638	0.816
Mental health education																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.901	0.555	1.464	0.674	0.598	0.360	0.995	**0.048**	0.546	0.344	0.866	**0.010**	0.807	0.517	1.257	0.342
Regular recreational activity																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.732	0.439	1.221	0.232	0.912	0.530	1.569	0.740	1.137	0.693	1.865	0.612	0.788	0.481	1.290	0.344
Organizing volunteering																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.578	0.346	0.968	**0.037**	1.043	0.639	1.701	0.868	0.895	0.566	1.414	0.634	0.952	0.610	1.484	0.827
Organizing physical exercise																
No	1 [Reference]				1 [Reference]				1 [Reference]				1 [Reference]			
Yes	0.866	0.553	1.356	0.529	0.844	0.531	1.340	0.471	0.892	0.585	1.361	0.596	0.878	0.583	1.323	0.535

Patient's characteristics with $p < 0.05$ in the univariable analysis (Table 2) were adjusted in respective logistic regression models. SRQ had no statistically significant factors in univariate analysis. GAD was adjusted for gender, dependents in need of care, education level, comorbidity and hospital length of stay. PHQ was adjusted for gender, dependents in need of care, education level, employment, SARS-COV-2-related symptoms and hospital length of stay. ISI was adjusted for children number, dependents in need of care, education level, SARS-COV-2-related symptoms, comorbidity and hospital length of stay.
Bold values mean the p-value is significant.

was received or not. In-depth quantification and standardization of measuring humanistic care are warranted for future studies. Thirdly, the observational period of this cross-sectional observational study was 8 days, which was relatively short; the long-term manifestation of inpatients' mental disorders is worth further investigation.

5. Conclusion

Symptoms of mental disorders were prevalent among inpatients in the shelter hospital. They are aggravated by COVID-19-related symptoms, comorbidities, and prolonged hospital stays. After screening and adjusting for potential risk factors, humanistic care is crucial in ameliorating mental distress.

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 Shanghai Jiaotong University School of Medicine, Renji Hospital Ethics Committee. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

DX and MC conducted the interview. JQ, YL, and JZ designed the study as supervisors. HH and JY recorded the interview data for JW

to analyze. WZ and MJC translated and designed the questionnaires. WF, YZ, and ZF completed the application to ethics committee. YS, ZY, and CS wrote this 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.

The reviewer LH declared a shared affiliation with the authors to the handling editor at the time of review.

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