

# Adaption to change and coping strategies: New resources for mental health

**Edited by**

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# Adaption to change and coping strategies: New resources for mental health

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# Study Protocol—Coping With the Pandemics: What Works Best to Reduce Anxiety and Depressive Symptoms

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**Background:** The coronavirus disease 2019 (COVID-19) pandemic and lockdown might increase anxiety and depressive symptoms in most individuals. Health bodies recommend several coping behaviors to protect against such symptoms, but evidence on the relationship between these behaviors and symptoms mostly comes from cross-sectional studies in convenience samples. We will conduct a prospective longitudinal study of the associations between coping behaviors and subsequent anxiety and depressive symptoms during the COVID-19 pandemic in a representative sample of the Spanish general adult population.

**Methods:** We will recruit 1,000 adult participants from all autonomous communities of Spain and with sex, age, and urbanicity distributions similar to those of their populations and assess anxiety and depressive symptoms and coping behaviors using fortnightly questionnaires and real-time methods (ecological momentary assessments) for 1 year. The fortnightly questionnaires will inquire about anxiety and depressive symptoms [General Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9)] and the frequency of 10 potential coping behaviors (e.g., follow a routine) during the past 2 weeks.

In addition, we will collect several variables that could confound or moderate these associations. These will include subjective well-being [International Positive and Negative Affect Schedule Short Form (I-PANAS-SF) and Satisfaction with Life Scale (SWLS)], obsessive-compulsive symptoms [Obsessive Compulsive Inventory-Revised (OCI-R)], personality and emotional intelligence [International Personality Item Pool (IPIP) and Trait Emotional Intelligence Questionnaire Short Form (TEIQue-SF)], sociodemographic factors (e.g., work status, housing-built environment), and COVID-19 pandemic-related variables (e.g., hospitalizations or limitations in social gatherings). Finally, to analyze the primary relationship between coping behaviors and subsequent anxiety and depressive symptoms, we will use autoregressive moving average (ARMA) models.

**Discussion:** Based on the study results, we will develop evidence-based, clear, and specific recommendations on coping behaviors during the COVID-19 pandemic and lockdown. Such suggestions might eventually help health bodies or individuals to manage current or future pandemics.

**Keywords:** COVID-19, anxiety, depressive symptoms, coping behaviors, longitudinal study

## INTRODUCTION

Worldwide, the coronavirus disease 2019 (COVID-19) pandemic and subsequent lockdowns might increase anxiety and depressive symptoms. Health bodies provided some recommendations for coping with these symptoms (1). However, most recommendations rely on experiences (e.g., individual prison isolation) that are probably very different from the current situation. The behaviors that may help a prisoner cope with isolation may not aid the general population cope with the pandemic and lockdown. Other recommendations rely on previous research on epidemics, such as the severe acute respiratory syndrome (SARS) epidemic in 2003 or the influenza A pandemic in 2009 (2–5). For instance, Lau and colleagues suggested that positive changes during the SARS epidemic, like spending more time resting, relaxing, or exercising, protected from the negative impacts of the epidemic (3). For other disasters such as terrorist attacks, coping behaviors such as information search and social support have played a role (6). We do not know whether these recommendations apply or could have similar effects in the current context.

Our central hypothesis is that certain “simple” coping behaviors, such as following a healthy diet, or exercise might protect from the adverse psychological effects of the COVID-19 pandemic. Our objective is to find these behaviors, with the final aim to create evidence-based recommendations.

We must note that some research groups have already conducted online surveys to investigate the subject (7). For instance, in April 2020, we conducted a pilot survey of 5,000 Spanish adults 2 weeks after the government established an official lockdown across the country (8). We found that maintaining a healthy/balanced diet and not reading news/updates about COVID-19 very often correlated with lower levels of anxiety and depressive symptoms. Other studies have also found significant associations between certain coping

behaviors and fewer mental health problems during the pandemic (9, 10). One study found that anxiety symptoms may mediate the relationships between the threat of COVID-19 and coping behaviors (11). Other studies have reported negative associations between physical activity and general negative emotions, depression, loneliness, or stress (12, 13). And yet others have reported positive associations between social media exposure and anxiety and depression (14).

There are four general limitations in these previous studies. First, most were cross-sectional, i.e., they mainly “correlated” the frequency of behaviors and the severity of symptoms during the same period. Thus, we cannot rule out reverse causation (mistaking a cause for effect and vice versa). For instance, we found that reading news/updates about COVID-19 correlated with increased anxiety. Still, it is uncertain whether individuals first started reading news very often and afterward got anxious, or the other way round, i.e., they got nervous, and after that, they started reading news very often. Second, most studies investigated a short period of the pandemic course. We cannot discard that the relationships might differ depending on whether the pandemic or the lockdown restrictions endure or change. For instance, a longitudinal study in Wuhan residents found that psychological well-being slightly improved after the lockdown was lifted in early April 2020 (15), although the pandemic was not over. Third, most studies inquired about symptoms retrospectively, which might potentially increase recall bias. Finally, most studies used convenience (and not representative) samples.

To overcome these limitations, we will ask participants to answer fortnightly questionnaires for 1 year using a prospective longitudinal design. We aim to assess the association between coping behaviors and subsequent anxiety and depressive symptoms and whether these associations might change with the COVID-19 pandemic and lockdown conditions. Besides, we will also include ecological momentary assessments (EMA) (16), close in time to experience to minimize recall bias. Finally,

the sample will be more representative of the Spanish general adult population.

## METHODS AND ANALYSIS

### Design

We will conduct an observational prospective, longitudinal study in a sample with a demographic distribution like the Spanish general adult population.

### Recruitment

We will recruit a sample of 1,000 individuals who are willing to answer online questionnaires every 2 weeks and EMA for 1 year. The study's target population will be the Spanish general adult population, probably excluding individuals not fluent in Spanish and individuals not reachable by social networks. Inclusion criteria will be: (a) age  $\geq 18$  years; (b) live in Spain; and (c) have a mobile phone number or email address to receive our notifications. Exclusion criteria will be: (a) fail to answer the preliminary survey or the first online questionnaire; and (b) fail to answer more than eight online questionnaires and/or more than nine EMA during the follow-up.

The sample size estimation relies on the observation that we could detect associations in our pilot study's (8) interim analyses when the sample size was still substantially smaller than 1,000. Thus, while we cannot provide exact sample size/power estimations for the time-series analyses described later, we must note that a sample size of 1,000 would allow the detection of small Pearson correlations ( $r = 0.135$ ) with 90% power after Bonferroni correction for multiple testing (two outcomes  $\times$  10 behaviors).

Recruitment will follow a two-step strategy (Figure 1). First, we will conduct a "pre-recruitment" step to create a pool of potential participants (who will not have the Spanish population's demographic distribution because some groups will be over-represented). Second, we will conduct a "sampling" step in which, separately for different strata (see next paragraph), we will randomly select several participants so that the final sample has a demographic distribution like the Spanish population.

Similar to previous mental health epidemiological research in the Spanish population (17), stratification factors will include age group (18–34, 35–44, 45–54, 55–64,  $\geq 65$ -year-old), gender (binary), region (Spanish autonomous community), and urbanicity. We selected these five age groups because each group corresponds to  $\sim 7.5$  million individuals (18–34 years: 8.6 million; 35–44 years: 7.3 million; 45–54 years: 7.5 million; 55–64 years: 6.3 million;  $\geq 65$  years: 9.3 million). For urbanicity, we will use the municipality size threshold ( $< 10,000$  residents, vs. higher) used in the UK Household Longitudinal Study, which Pierce et al. used to assess the effects of urbanicity on mental health during the pandemic (18).

### Pre-recruitment

We will publicize the study on social networks, inviting everyone to participate in a preliminary survey. To reach heterogeneous society sectors, we will ask close and distant acquaintances from varying ages and professions to invite close and distant acquaintances from varying ages and occupations.

This preliminary survey will only include the informed consent, the questions about the four stratification variables, the 16 anxiety and depression items [General Anxiety Disorder-7 (GAD-7) (19) and Patient Health Questionnaire-9 (PHQ-9) (11)], and the preferred channel to receive communications [via Short Message Service (SMS), email, or both]. We will inform the potential participants that we will randomly select 1,000 individuals and invite them to answer fortnightly questionnaires and EMA for a year, receiving 140€ compensation at the end of the study. We will highlight that only participants included in this second step who complete  $\geq 70\%$  fortnightly questionnaires with  $< 10\%$  missing answers per questionnaire and  $\geq 70\%$  EMAs will receive the compensation.

### Sampling

The number of participants selected from each specific stratum will depend on the stratum's weight and the overall differences between the sample and the population. We have calculated a "stratum-ideal" number of participants for each stratum that ensures that the sample includes individuals from all strata, but at the same time, larger strata in the population are larger in the sample. However, we will recruit up to five more individuals per stratum than this "stratum-ideal" number if their inclusion reduces the statistically significant differences between the overall sample and the population in age, sex, urbanicity, and region (in this order of priority). To calculate the above "stratum-ideal" number, we retrieved the demographic distribution of the Spanish population from the National Statistics Institute (20) and used the following iterative algorithm: (a) we first set the size of each of the 350 sample strata to one participant; (b) we divided the population strata sizes by the sample strata sizes, obtaining the weight that we would apply to each stratum in a weighted analysis; (c) we added one participant to the stratum with the largest weight; (d) we went back to (b). We will exclude those individuals who do not respond correctly to the first questionnaire.

### Follow-Up

We will contact the selected individuals by SMS and email. On Fridays, Mondays, and following Wednesdays, we will either confirm the participants that we have correctly received their responses, inform them that their responses were incomplete ( $\geq 10\%$  missing answers) or potentially inaccurate/inconsistent, or remind them to answer the questionnaire.

We will use two strategies to detect potentially inaccurate/inconsistent responses (i.e., indicators that the participant may have paid low attention). On the one hand, we will look for significant discrepancies between two repeated questions included in each questionnaire (e.g., answering "not at all" and "nearly every day" to the same question). On the other hand, we will detect questionnaires answered in a few seconds, suggesting that the participant did not even read the questions.

Previous research has found that item 9 of PHQ9 (death thoughts) predicts risk for suicide attempts across age groups (21). Therefore, we will send emails/SMS to individuals reporting any frequency on this item advising them to check with their health care provider or, in case of thinking about harming



themselves, to go to an emergency service. That said, we will not exclude any individual based on his/her scores because we aim to represent the whole adult population.

## Online Questionnaires and EMA

We will collect all participants' information through an institutional safe online platform (<https://enquesta.clinic.cat/>). We have created a survey for the "pre-recruitment" step, several questionnaires for the fortnightly follow-up assessments, and a short two-item form for the EMA. Every week, we will send emails and SMS to the participants to answer a questionnaire or an EMA using the platform.

We will not collect any personal information from the participants. Instead, the Uniform Resource Locator (URL) links in the emails and SMS will include a unique random series of letters and numbers to determine which answers correspond to the same participant across the various questionnaires and EMA.

We will present the fortnightly questionnaires every 2 Wednesdays. We understood that Wednesday is neither too close nor too far from the weekend, and thus the answers will not be biased toward weekend or workday memories. The questionnaires will be short to increase the likelihood of response. The first page will include the 16 GAD-/PHQ-9 items, the second page some questions about secondary variables, and the third page the 10 behaviors and the two repeated questions. We will inquire about symptoms first to avoid response order bias (22).

We will prompt the participants to answer the EMA, asked at any random time from Wednesday to Tuesday, from 10 am to 6 pm.

We will make minor modifications to this schedule to avoid special days such as Christmas.

## Main Variables

The study's main dependent variables will be the anxiety and depressive symptoms (GAD-7 and PHQ-9). We will collect them every week: on the first page of the fortnightly questionnaires in even weeks and on the EMA in odd weeks. For the latter, we will only ask one representative item of each scale in the present tense ("Do you feel nervous, anxious, or on edge?" "Do you feel down, depressed, or hopeless?").

The independent variables will be the frequency of these 10 behaviors: follow a routine, talk with relatives/friends not living in the household, physical exercise, follow a healthy/balanced diet, drinking water to hydrate, read news/updates about COVID-19 very often, take the opportunity to pursue hobbies or conduct home tasks such as arranging the wardrobe, stay outdoors or look outside, do relaxing activities, and interact with other individuals of the household (e.g., partner or children) (8). We chose these behaviors based on our previous study (8). We declined the possibility that participants could propose other behaviors because we ask all behaviors in all fortnightly questionnaires, but the participants join the study at different times.

## Secondary Variables

In the fortnightly questionnaires, we will also collect several other variables for their use as covariates, modulators, or alternative outcomes.

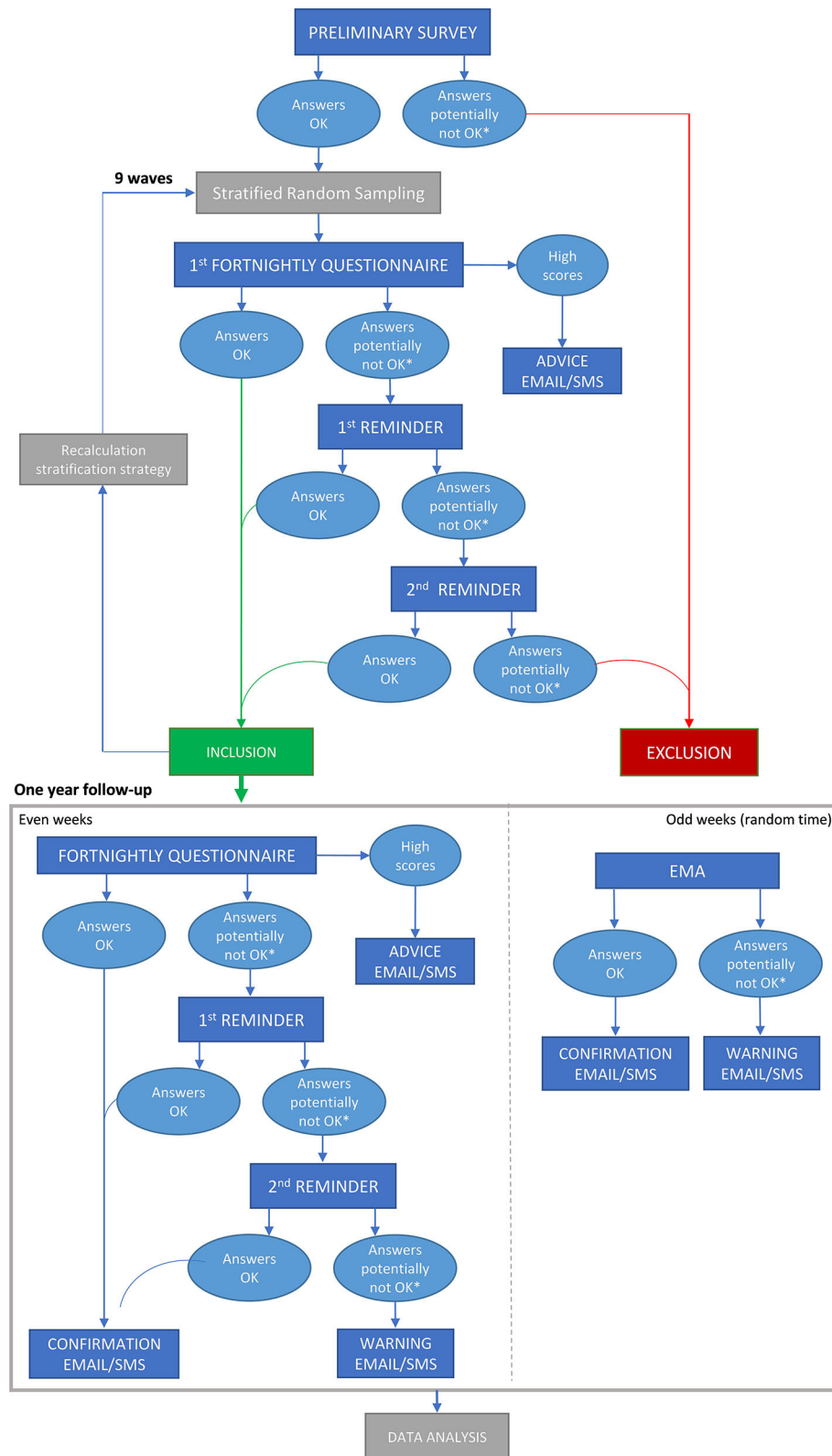
Assessments of psychological well-being other than anxiety and depression will include the 10-item International Positive and Negative Affect Schedule Short Form (I-PANAS-SF) (23), the 5-item Satisfaction with Life Scale (SWLS) (24), and the 18-item Obsessive Compulsive Inventory-Revised (OCI-R) (25). We will present subjective well-being scales (I-PANAS-SF and SWLS) every 6 weeks and the OCI-R twice (with a 6-month difference between the assessments). In the context of the current anti-pandemic frequent hand-washing recommendations, we removed the two contamination/washing questions (items 11 and 17) from the latter. The reason to include the OCI-R is that pandemic contamination/hygienic measures may increase obsessive-compulsive symptoms.

We will also assess personality and emotional intelligence twice (with a 6-month difference between the assessments) with the 50-item International Personality Item Pool (IPIP) (26) and the Trait Emotional Intelligence Questionnaire Short Form (TEIQue-SF) (27). We assume that personality and emotional intelligence may modulate the individual response and adaption to the crisis. Still, pandemic stress and restrictions could also modulate our personality and emotional intelligence.

To estimate the behaviors' baseline frequency, we will ask the participants to think about their everyday life the two last weeks before the pandemic outbreak.

We will also ask some general factors that may have an influence. We will include questions at the beginning of the study and questions about their change for factors that we considered might vary. They will be the work and telework status, having minor or other dependent people in charge, COVID-19 diagnosis/severity/risk in one-self and close relatives, COVID-19 unrelated life events, and having received mental health treatment for more than 3 months. Conversely, we will include questions only once for factors that we considered more stable. They will consist of years of education, housing-built environment, household age composition, stance on vaccination, and COVID-19-related deaths in close relatives and acquaintances (dates asked at the end of the study). To assess the housing built environment, we will use the items used by Amerio et al. (e.g., housing dimension, livable outdoor space, views, indoor quality) to investigate its effects on mental health during COVID-19 lockdown (28).

Finally, we will collect variables related to the effects of the pandemic and lockdown measures, both at the national level and separately for regions. We will download COVID-19 incidence, percentage of positive tests, the instantaneous reproduction number, hospitalizations, intensive care unit (ICU) admissions, and deaths from the Health Alert and Emergency Coordination Center (29). We will standardize (30) the lockdown restrictions (e.g., limitations in social gatherings) from autonomous communities governments (31–52), and we will estimate the number and emotional valence of Spain-originated tweets with relevant keywords (e.g., "coronavirus" or "vaccine") (53).



**FIGURE 1 |** Flowchart of the study. EMA, ecological momentary assessments; SMS, Short Message Service.



We acknowledge that many other factors may have an influence, e.g., the use of alcohol. However, we chose to limit the number of questions to keep the questionnaires short. Besides, the study's main aim is to link coping behaviors with symptom improvement, and these factors are only secondary variables.

## Data Analysis

The primary analysis will estimate the relationship between coping behaviors and subsequent symptoms. We will use low-order autoregressive moving average (ARMA) models, which attempt to answer how past values and moving averages (e.g., the average of the current and past 2 weeks) explain the present symptoms.

Before the analysis, we will do multiple imputations of the missing responses. In addition, we will also analyze the characteristics of missing data (e.g., the relationship with other variables).

We will account for potential confounds, baseline values, and the effect of potentially modulating factors. To assess whether the results might depend on methodological factors, we will conduct the following sensitivity analyses: (a) using GAD-7 and PHQ-9 from fortnightly questionnaires or the following EMA; (b) weighting or not weighting the strata for their population/sample ratio; (c) excluding the questionnaires or participants with highly potentially inaccurate/inconsistent answers.

For the analyses of alternative outcomes (e.g., I-PANAS-SF), we will have fewer measurements of the outcomes than measurements of coping behaviors. To circumvent this problem, we will time-weighted-average the coping behaviors measured since the last measure of the outcome. Besides, fewer assessments might not allow us to fit ARMA models. In this case, we will fit simpler models (e.g., a pre-post repeated-measure linear model). We also plan a series of other secondary analyses, such as the relationship between the symptoms or restrictions and subsequent personality or emotional intelligence changes.

We will correct the primary analyses for multiple comparisons, and we will conduct all analyses with R (54).

## Creation of Recommendations

The results of this longitudinal study will allow us to create evidence-based recommendations. Specifically, we will grade the main results according to their effect size, statistical significance, and variation in the sensitivity analyses. When the modulator analyses show that the effects might be sensibly different depending on a modulator, we will grade the results separately. Finally, we will write the most robust results as recommendations. We will send them to health organizations and providers, and public policymakers, along with a text explaining the study and the grading.

## DISCUSSION

This project aims to study the relationship between a set of simple potential coping behaviors and subsequent anxiety and depressive symptoms in the context of the COVID-19 pandemic and associated lockdown restrictions. To this end, we will recruit a sample with a demographic distribution like the population and

ask the participants to answer fortnightly questionnaires for 1 year and EMA in real-time to estimate the symptoms better.

Based on the study results, we will develop clear and specific recommendations about which coping behaviors may help us mitigate the anxiety and depressive symptoms during the COVID-19 pandemic and lockdown. We will then share these recommendations with health organizations, providers, and public policymakers.

For each of the 20 relationships of interest (i.e., 10 coping behaviors modifying two primary outcomes), the results may draw different scenarios. We will only exemplify the relationship between reading news/updates about COVID-19 and subsequent anxiety symptoms for simplicity. However, we understand that these interpretations would be similar for the other relationships.

A basic scenario could be that we observe that when individuals read news/updates about COVID-19 very often, their anxiety subsequently increases. This finding would support previous interpretations that reading news/updates about COVID-19 increases anxiety (8), and thus the recommendations to decrease the frequency of this behavior (1). However, we could also find that when individuals report high anxiety, they subsequently increase the frequency of reading news/updates about COVID-19. This bidirectional relationship would lead to a vicious circle: anxiety makes individuals read COVID-19 news more often, in turn making them more anxious. Vicious circles are indeed common in anxiety. For instance, anxiety may lead to avoiding feared stimuli, which in turn increases anxiety (55). We should then encourage people to avoid reading news/updates about COVID-19 "too often."

We may alternatively observe that when individuals read news/updates about COVID-19 very often, their anxiety subsequently decreases. This finding would question previous studies, up to the point that we should wonder whether we should recommend reading COVID-19 news often to prevent anxiety. In additional analyses, we could also find that when individuals report high anxiety, they subsequently increase the frequency of reading COVID-19 news, thus suggesting reverse causation. We could speculate that individuals with COVID-19-related anxiety learn that their anxiety decreases after reading COVID-19 news. This amelioration would be the reason why they read COVID-19 news more often.

We may also find that the effect of reading "too often" COVID-19 news is modulated by personality traits, which we also investigate in our study. This result would not be surprising because each Big Five personality is associated with different coping strategies. For example, extraversion and conscientiousness are related to problem-solving and cognitive restructuring. In contrast, neuroticism is related to wishful thinking, withdrawal, and emotion-focused coping (56). Therefore, we could offer more personalized suggestions (i.e., considering coping strategies and personality traits). Another potential modulator of the relationships between coping behaviors and subsequent anxiety or depressive symptoms may be emotional intelligence. A recent study in the context of the COVID-19 pandemic showed indeed that emotional intelligence is related to all coping strategies (57).

GAD-7 and PHQ-9 ask about anxiety and depressive symptoms during the previous 2 weeks. Therefore, we expect that the GAD-7 and PHQ-9 scores will strongly correlate with the anxiety and depression levels measured with the EMA collected during those 2 weeks. However, we cannot give this for granted because there may be some recall bias. For example, a recent study in patients with major depressive disorder found that the severity of suicidal ideation assessed through 1-week EMA correlated with the ideation scores retrospective collected at the end of the week. Still, many participants reporting ideation with EMA denied ideation on the retrospective assessment (58). Thus, the analysis of the relationship between behaviors and EMA scores will yield light on the relevance of this potential recall bias. Suppose the results are similar to those obtained using GAD-7 and PHQ-9. In that case, we will conclude that the potential recall bias has no significant effects on our analyses. Conversely, if the results are substantially different, we will report and interpret both results differently.

We believe that the secondary analyses may also provide interesting guidance. For instance, we may find that some coping behaviors have an only weak relationship with subsequent anxiety symptoms but a strong connection with obsessive-compulsive symptoms. We chose this outcome for its relevance during the pandemic; some studies have indeed observed an increase in obsessive-compulsive symptoms (59). Other interesting alternative outcomes will be subjective well-being, personality, and emotional intelligence. Personality changes little during adulthood (60), but a few studies have found that catastrophic trauma may potentially lead to personality changes (61).

This project has some potential limitations. First, we may face difficulties in recruiting the target sample. The recruitment may seem straightforward if one keeps in mind that we will recruit 1,000 participants in several weeks, while in the pilot study, we recruited 5,000 participants in <2 weeks. However, in the pilot study, we only presented a single survey to a convenience sample. Here, we will conduct a longitudinal study in a sample with a demographic distribution like the population. Second, as in any voluntary study, more altruistic individuals may tend to participate more, although the compensation should reduce this potential participation bias. Third, a common problem of longitudinal studies is the loss of follow-up. To minimize this risk, we have created short questionnaires, and we will

only compensate economically the participants who complete the follow-up. Fourth, we acknowledge the possibility that participants modify their behavior in response to the assessments (i.e., the Hawthorne effect) (62). However, we will not focus on the behavioral changes but on the impact of these changes on anxiety and depressive symptoms. Finally, we must acknowledge that while this study will assess whether coping behaviors precede changes in symptoms, it is only observational. We would need a randomized controlled design to evaluate the “true” efficacy of coping behaviors in reducing anxiety and depressive symptoms.

## ETHICS STATEMENT

The study was reviewed and approved by Comitè d'Ètica de la Investigació amb medicaments, Hospital Clínic de Barcelona (protocol HCB/2020/0890). The participants will provide their electronic informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

JR, MF, LF, AS, JA, CT, CB, DH-M, IG, and EV conceived the study. All authors participated in the redaction of the manuscript including minor or major modifications of the protocol.

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# How Did Awareness, Emotion, and Motivation Shape Behavior Toward COVID-19 in Tunisians?

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This study was conducted to assess the psychological distress in the general population of Tunisia during the pandemic of COVID-19 and examines how awareness of the disease, emotional experience, and motivation shaped the behavior toward this outbreak. The study covers 1492 Tunisian participants. Gender effects and age limits were studied in relation with the seriousness of the disease and lockdown impacts. The data were analyzed and interpreted using the chi-square test, ANOVA, path analysis (PA), and confirmatory factor analysis (CFA). We found a significant effect of gender and age on the awareness of the pandemic dangerousness, the attitude, and the commitment to respect the preventive measures. Women are significantly more aware and committed than men to respect preventive health measures. The 35–45 age group showed more awareness and dedication than the other age groups, while the 20–35 age group showed the most less promise. PA and CFA results showed how awareness, emotion, and motivation shaped behavior toward COVID-19. This study provides practical and relevant information on behavior change during a pandemic crisis, which can orient communication campaigns and help policymakers.

**Keywords:** COVID-19, psychological distress, mental health, awareness, emotion, cognition, behavior change, AB-Survey

## INTRODUCTION

The Coronavirus Disease 2019 (COVID-19 or SARS-CoV-2) outbreak began in Wuhan, China (1), and quickly spread through the country and then around the world, causing the World Health Organization (WHO) to announce COVID-19 a pandemic on March 11, 2020 (2). Together with severe physical issues, the COVID-19 pandemic has caused intense anxiety and panic in most societies (3) and feelings of boredom, isolation, and frustration among those who have been isolated (4). Consequently, and as with previous epidemics and pandemics, the COVID-19 pandemic has triggered a wide variety of negative psychological responses in the general population, involving anxiety and depression (5–8).

Therefore, this study was conducted to assess the psychological distress in the general population of Tunisia during the COVID-19 outbreak and examine how awareness of the disease, emotional experience, and motivation shaped the behavior toward COVID-19 (9–12). Results will give some valuable insights to policymakers and interveners in the field. First, the general pandemic context in Tunisia and over the world is described. Then, the mental health challenges and emotional issues are analyzed. Next, the central role of perception and awareness is discussed. Afterwards, the gender effect and the risky aversion attitude are analyzed. Finally, the age effect and attitude toward the pandemic are discussed.

Early March saw the first cases of COVID-19 recorded in Tunisia. To combat the pandemic, which was wreaking havoc on the vulnerable health system, the government took security steps. The state of emergency was declared, accompanied by the closing of the border, limiting population movement to necessities such as grocery shopping and finding emergency medical services. Health messages were provided to Tunisian citizens regularly, emphasizing the importance of staying at home, wearing a face mask when outside, hand washing, and social distancing (13, 14). The effectiveness of governments' attempts to reduce the spread of the virus is influenced by public opinion. Several studies have been found to determine the public's attitude toward safety measures and the attitudes of particular occupational groups. In Saudi Arabia, the general population has a moderate attitude toward regulation and prevention measures. Respondents said that social distancing, handwashing, staying at home, and the following department of health guidelines would aid in controlling COVID-19's spread in their country (15). The Chinese government was confident in its ability to control the transmission of the COVID-19 pandemic and win the war against it (16). Malaysian government employees expressed optimism about the government's ability to control the COVID-19 pandemic. They were optimistic that COVID-19 would be contained and that since their government handles health problems so well, their country would be able to resolve them (17). Up to April 24, 2021, 12:50 GMT, Coronavirus Cases attain 146,348,573, with 3,102,348 deaths and 124,170,337 recovered cases. The world sanitary crisis continues to threaten lives, and its effective management needs to be informed on important psychological variables as awareness, emotion, motivation, and behavior change toward the pandemic.

From an epidemiological standpoint, widespread implementation of health-protective behavior, such as enhanced personal hygiene or social distancing, is typically successful in minimizing or slowing the spread of contagious respiratory diseases (18). However, when avoidance behaviors result in prejudice against subgroups of people or a lack of essential needs like food or prescription goods, they may have severe social and economic consequences (19). The question of whether the discovery of the coronavirus sparked a panic reaction, i.e., excessive public risk expectations and emotion-driven behaviors in light of available epidemiological evidence, prompted somewhat conflicting statements from prominent experts in the early stages of the COVID-19 epidemic. Dr. Michelle Dusart, the physician in the Saint-Pierre Hospital, strongly condemned the public's exaggerated paranoia and panic about the possibility of coronavirus infection. At the same time, Prof. Didier Raoult and Prof. Nassim Nicholas Taleb claimed that people's fear of such an emerging health danger was understandable. However, since the media tends to emphasize unusual behavior and knows so little about what people think about the hazard of coronavirus infection, it is impossible to say if they are excessively positive or cynical about the COVID-19 epidemic's long-term effects on public health.

COVID-19's unpredictability and ambiguity endanger not only people's physical health but also their mental wellbeing, especially in terms of emotions and comprehension, according

to several studies. Disasters such as pandemics are said to trigger depression and complexity, which occurs because we may not be equipped to cope with such epidemics and their emotional consequences (20). In the nations, healthcare regulators and policymakers have enforced crises and shutdowns, which has had a negative impact on people's mental health, leading to an increase in anxiety, depression, and other mental illnesses. The COVID-19 crisis has raised fear and uncertainty, placing a strain on our scarce resources (20).

In such situations, people are more likely to experience negative emotions [e.g., irrational fear, anxiety, etc.; (21, 22)] and negative cognitive appraisal (23, 24) for self-protection, according to the Behavioral Immune System (BIS) theory (25). People develop avoidance habits [e.g., To avoid communication with people that have pneumonia-like signs; (26)] and strictly follow social standards (e.g., compliance) when they are faced with a possible disease danger. According to stress theory (27), public health crises and perceived danger theory induce more negative emotions and affect cognitive evaluation. When it comes to illness, these negative feelings hold people away from possible pathogens. The intensified anxiety and fear caused by the COVID-19 crisis put a strain on people's internal capacities. Decision-making issues, confusion, and nervous fatigue are among the consequences (20).

Lockdown also had a profound effect on the mental health of people. The sudden shutdown of the world economy left people jobless with nothing to do other than to stay locked up at home. This left people in an array of sadness and anxiety. Not being able to meet your loved ones and friends was already a big shock to people, but not setting foot out of the house left everyone in depression. Previous research has found that people under lockdown are more likely to develop stress, depression, emotional exhaustion, insomnia, and post-traumatic anxiety symptoms (28). Gender has been shown as a determinant factor in the way people cope with the lockdown (29).

On the other hand, long-term negative emotions can impair people's immunity and disrupt the balance of their usual biological systems (30). We can track psychological changes over time using emotional (e.g., negative emotions and positive emotions) and cognitive measures because psychological changes triggered by public health crises can be directly mirrored in emotions and cognitions [(22–24); e.g., social risk judgment and life satisfaction]. Meanwhile, individuals can retaliate to any disease if officials provide insufficient guidance, resulting in excessive avoidance and blind compliance (31). As a result, it is important to grasp the potential psychological effects of COVID-19 immediately.

Similarly, fear also plays a vital role in the psychological point of view of the individuals. A major psychological reaction to a health crisis is fear of a pandemic. Some recent research has concentrated on the negative effects of the global epidemic and social exclusion on mental health and psychological well-being at both the global and regional scales (32, 33). In these effects, the fear expresses itself in emotions, attitudes, actions, and on a psychological level can be illustrated, as it is activated both by the powerful proximity of the phobic stimuli and by the expectation of this future touch (34). Fear may have various outcomes, such as

certain people doing desired acts due to their fear, while others do not. Another implication is that when people are afraid, they can respond in highly inappropriate forms (35). Fear is necessary for human survival because it is a component of the adaptive defense system for triggering behaviors to potentially dangerous events, rather than being a pathology in and of itself.

On the other hand, fear can raise anxiety and stress in healthy people during serious events like pandemics and escalate symptoms in people who already have mental disabilities, generating short to long-term psychological repercussions (36, 37). Broche-Pérez and his team (38) specified in their study that women are more likely to feel fear and anxiety and succumb to depression than men.

In addition to emotions' impact on behaviors and behavior change, perception and awareness play a central role. Generally speaking, risk perception and the awareness of the behaviors to be adopted and implemented shape behavior change and the attitude toward rules and measures. This was confirmed in smoking behavior (11), and in the protective behaviors against COVID-19 spread and similar future pandemics. A significant risk perception and awareness can lead to positive attitudes which are necessary to beat the pandemic. Nevertheless, Xu and Peng stated that the links between behavior and risk perception are unstable, and that "the evolving patterns of risk perception and responsive behavior over the course of an influenza pandemic are sensitive to how risk and behavior are defined and scoped" [(39), p. 1].

In addition, all the psychological traits have a strong connection with risk perception and the awareness about the important measures to be taken, compared to the ambiguity perception that does not affect the psychological traits. There is also a profound relationship between risk, benefits, and judgments. For instance, if an object is judged approvingly, then overall, it will be evaluated positively instead of negative evaluation. A recent study by Qian and his team (40) indicated that psychological and behavioral reactions were influenced by perceptions of morbidity, mortality, severity, and knowledge reliability. It was also found that a strong association exists between self-confidence and optimism among people and the lower risk of epidemic. The results indicate that irrespective of quarantine status, anxiety levels and preventative practices shifted quickly and significantly during the early stages of the outbreak (41, 42).

Regarding the relationship between gender and risk-aversion, our analysis confirms findings from previous literature that women are more risk-averse than men. From the research, it has been found that the hazard's quality has a significant impact on the perception of risk either exposure to the hazard is voluntary or in control, or its results are whether catastrophic, or its advantages are distributed fairly among those who can bear the risks. The studies suggest that men, compared to women, are usually found to be perceived the more eager to take risks (11, 43–45). A study recommended that the known risks are placed on higher-value by people than the unknown ones, i.e., uncertainty (46). It can be termed as ambiguity aversion. Its main function is to rationalize the equity-premium puzzle, also to analyze the different actions taken by different people in difficult

circumstances. Women usually show higher ambiguity-aversion than men, but if the ambiguity increases, so then both men and women respond high (46, 47).

Regarding age effect on awareness and attitudes toward the pandemic, some studies have shown that the older the respondents, the better their attitude toward the disease (48). However, as the pandemic progressed older people tended to adopt mitigating personal behavioral changes more than younger people (49). Thus, two months after the pandemic started, older people showed more compliance with suggested measures and regulations including practicing quarantining, social distancing, and better hygiene. After the beginning of the pandemic, older people were less likely than younger people to adopt risky behaviors. In their study, Kim and Crimmins observed that "the change in risky behavior over time did not differ by age; but both younger and older people were more likely to engage in risky behaviors after two months" [(49), p. 1].

This study supposes that women are more risk-averse, more aware and adopt less risky behaviors than men. They are supposed to show more compliance to preventive measures and more commitment than men. The 35–45 aged people are supposed to be more aware of the pandemic's seriousness than the youngest people and, consequently, more committed to respecting the preventive measures. Awareness and emotion are supposed to determine the specific committed behaviors and shape the general commitment.

## METHOD

### Participants

For this study, ethical approval has not been necessary since the data are properly anonymized and informed consent was obtained at the time of original data collection. The study was conducted in the Tunisian population. It was administrated from March 14 to March 25, 2020. It covered 1492 Tunisian participants aged 16 to 92 years old who could connect to the Internet and who were residents in Tunisia. Three hundred and twenty one men (21.52%) participated to the study with an average age of 34,31 ( $SD = 12,35$ ), and 1,155 women (78.48%) participated with an average age of 31,32 ( $SD = 10,16$ ). All participants were asked to check a dedicated box to confirm their consent to participate in the study. They have been informed that participation is completely anonymous, apart from certain demographic data.

The sample size was determined and constrained by the persons available to participate voluntarily in the study through the provided form on the web and through the government Covid-19 website.

### Measure: AB-SURVEY

The study was based on the administration of the AB-SURVEY (Attitude-Behavior Survey) tool online (see **Supplementary Material**). This tool was specially conceived for the study and structured in five sections as follows: (1) Demographic section (five items), (2) Awareness/Perception section (two items), (3) Commitment/Behavior section (five items), (4) Emotion section (seven items), (5)



**TABLE 1** | Reliability of the different components of the AB-SURVEY.

Perception/Awareness		Behavior (Specific Commitment)			Motivation/General Commitment		
Evaluation of gravity	Evaluation of Speed of Spread	Hand Cleaning	No Touch	Social Distancing	Commitment	Behavioral Change	Optimism
Alpha Cronbach = 0.71		Alpha Cronbach = 0.713			Alpha Cronbach = 0.715		
Alpha Cronbach = 0.7							

**TABLE 2** | The goodness of fit statistics for AB-SURVEY.

Absolute Fit indices				Relative Fit Indices		
CMIN/DF	RMSEA	GFI	AGFI	CFI	NFI	TLI
9.155	0.096	0.91	0.86	0.87	0.86	0.882

Motivation/General Commitment section (three items). All the questions were formulated in French and Arabic since Tunisians are bilingual, and as we did not want the language to be a barrier. We used four different scales to get answers, according to the questions: Scale one (Very little, Little, Often, Always); Scale two (Very little, Little, A lot, Totally); Scale three (Yes, No); and Scale four (from 1 to 4, to measure the degree of emotions).

## Procedure

The AB-SURVEY form is distributed through the social media network and the government's official website, using the governmental information platform related to COVID-19. All participants were informed via the introduction of the form before starting that the participation is completely anonymous. They have to check the box confirming their consent to participate. Answering the questionnaire lasts no more than 7 min.

## Statistical Analysis

After receiving 1560 responses and after cleaning the data set (eliminating 60 participants for missing data and eight participants for providing inconsistent data such as an inconsistent age (e.g., 2 years), or a tendency to give the same answer to all the questions), we kept 1492 for analysis. SPSS Package V20 was used to perform Chi-square and ANOVA analysis, while LISREL V8.72 was used to make Path Analysis (PA) and Confirmatory Factor Analysis (CFA).

## RESULTS

### Reliability of the AB-SURVEY

As shown in **Table 1**, the overall alpha Cronbach of the tool was 0.7. With acceptable alpha coefficient values for perception/awareness, behavior (specific commitment), and general commitment, this tool shows a good reliability.

## Confirmatory Factor Analysis

Confirmatory factor analysis was performed using maximum likelihood approximation with four factors (50) to see whether the latent model is confirmed or not. Several statistics were used to investigate the model's goodness of fit: Overall  $\chi^2$  root means the square error of approximation (RMSEA), Akaike's information criterion (AIC), and comparative fit index (CFI). The AB-SURVEY CFA shows acceptable absolute and relative indices for the goodness of fit (**Table 2**). This allows us to consider with good confidence the confirmed model. The results show that the model presented an acceptable fit, with RMSEA ranging between 0.096 and 0.10.

The model graph in **Figures 1, 2** shows the estimated values between the four factors and their respective components.

## Path Analysis Out of the Different Models

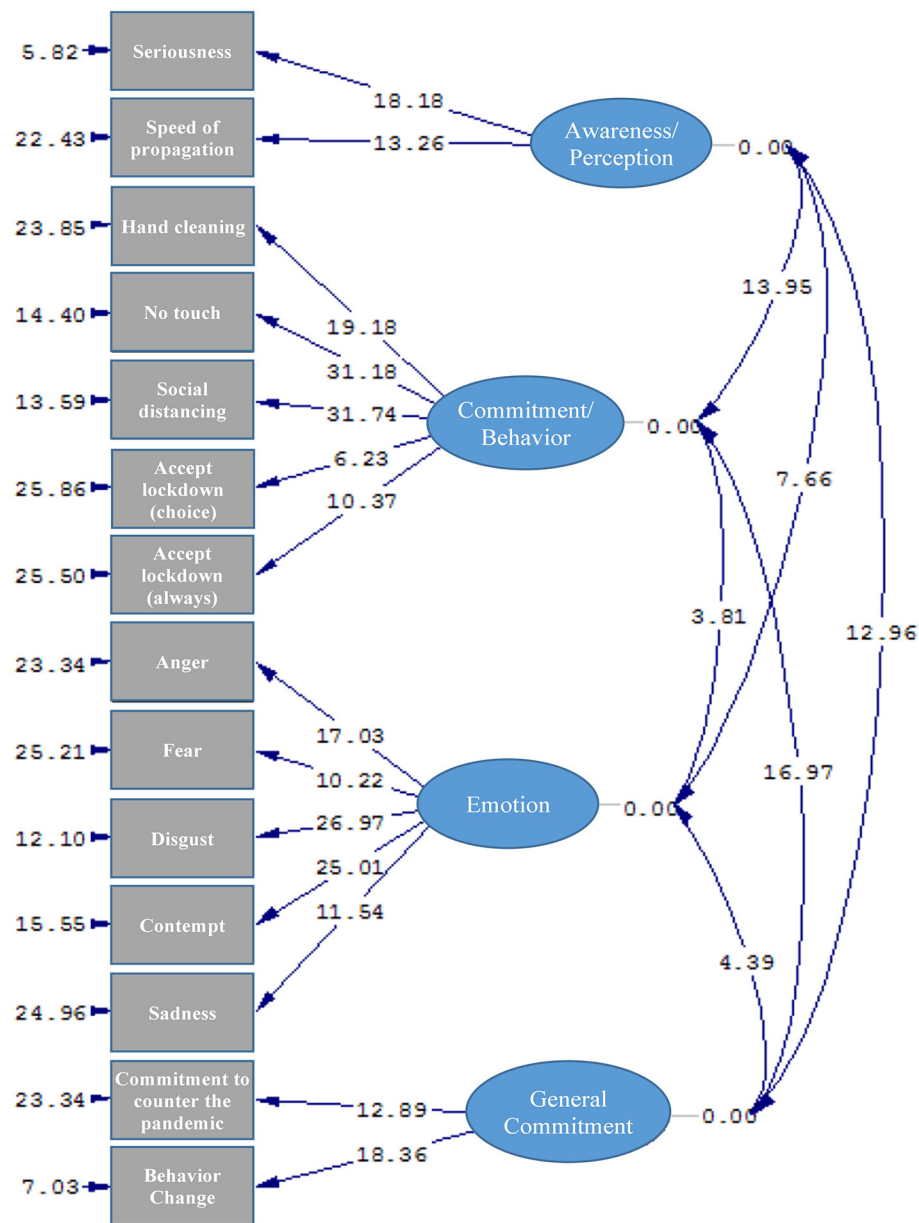
Path analysis is an extension of the regression model, used to test the fit of the correlation matrix against two or more causal models compared by the researcher (51). Our hypotheses represented in the 6-path model are tested using SEM with Maximum Likelihood Estimation. results show that models 3 and 6 were supported while models 1, 2, 4, and 5 were not supported (**Table 3**). The RMSEA, CFI, GFI, and AGFI values showed that the path model had a somewhat good fit for the observed data for models 3 and 6.

The path graphs (**Figure 3**) show how models 3 and 6 represent respectively the relationships between emotion, perception, and commitment (precautious behaviors), and emotion, perception and general commitment. Thus, emotion has an impact on commitment and general commitment through the modulation effect of perception. This would be a strong basis and justification for the importance to change perception to increase engagement. This could be achieved through communication and evidence-based information.

## Gender Effect: Women Are More Aware and Committed

The chi-square test of independence showed a significant relationship between gender and awareness of the necessity of the lockdown. Women are significantly more convinced about lockdown in any case:  $\chi^2 (1, 1492) = 3.97, p = 0.047$ ; and about Lockdown in case of doubt about own infection:  $\chi^2 (1, 1492) = 5.94, p = 0.014$ .

The chi-square test of independence also showed a significant relationship between gender and awareness of the pandemic's



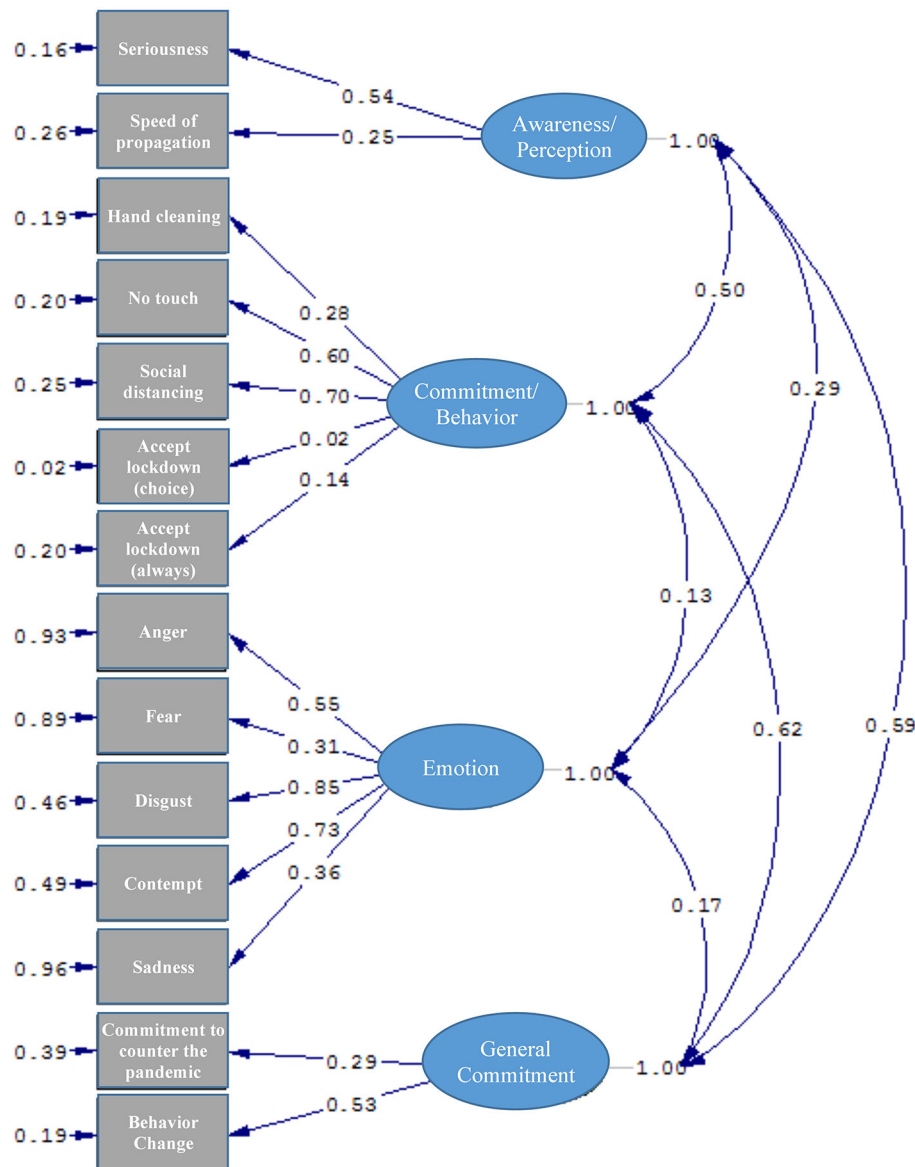
**FIGURE 1 |** The resulting model (T-Values) from the CFA analysis ( $\chi^2 = 968.69$ ;  $df = 71$ ;  $p < 0.001$ ; RMSEA = 0.096).

dangerousness. Women are more aware of the dangerousness of the pandemic:  $\chi^2 (3, 1492) = 26.56$ ,  $p = 0.007$ .

Seemingly, the chi-square test of independence was performed to examine the relationship between gender and the extent to which the preventive health measures were respected. Hand cleaning, touching other persons and social distancing are significantly related to gender, respectively  $\chi^2 (3, 1492) = 24.63$ ,  $p = 0.02$ ;  $\chi^2 (3, 1492) = 22.21$ ,  $p = 0.05$ ;  $\chi^2 (3, 1492) = 10.25$ ,  $p = 0.02$ . The preventive health measures (hand cleaning, social distancing, and mask-wearing) are accomplished to minimize coronavirus transmission and are more respected by women than men.

## Emotion, Motivation, and Commitment According to Gender

A chi-square test of independence was performed to examine the relationship between gender and the extent to which the basic emotions were felt at the beginning of the lockdown. The relationship between these variables was significant, Fear:  $\chi^2 (3, 1492) = 66.576$ ,  $p < 0.001$ ; Sadness:  $\chi^2 (3, 1492) = 41.635$ ,  $p < 0.001$ ; Joy:  $\chi^2 (3, 1492) = 18.758$ ,  $p < 0.001$ ; Serenity:  $\chi^2 (3, 1492) = 34.435$ ,  $p < 0.001$ . Women were more likely than men to feel fear and sadness and less than men to feel joy and serenity (Table 4).



**FIGURE 2 |** The resulting model (Estimates) from the CFA analysis ( $\chi^2 = 968.69$ ;  $df = 71$ ;  $p < 0.001$ ; RMSEA = 0.096).

When we considered the four-degree scale of emotions as an interval variable, the mean comparison between women and men led to significant differences regarding fear [ $t_{(1492)} = -6.931$ ,  $p < 0.001$ ], sadness [ $t_{(1492)} = -6.874$ ,  $p < 0.001$ ], joy [ $t_{(1492)} = 1.825$ ,  $p < 0.003$ ], and serenity [ $t_{(1492)} = 4.964$ ,  $p < 0.001$ ], as seen in.

Moreover, although men are more optimistic, they are less committed to countering the pandemic than women through preventive measures. The chi-square test showed a significant relationship between optimism and gender, and between commitment and gender, respectively  $\chi^2(3, 1492) = 22.7$ ,  $p < 0.001$  and  $\chi^2(3, 1492) = 23.885$ ,  $p < 0.001$ .

An ANOVA was achieved to check if men and women are significantly different regarding their optimism and commitment. Optimism, gender, and their interaction had a

significant effect on commitment, respectively,  $F_{(3,1489)} = 9.427$ ,  $p < 0.001$ ,  $\eta^2 = 0.19$ ;  $F_{(1,1491)} = 11.939$ ,  $p < 0.001$ ,  $\eta^2 = 0.18$ ;  $F_{(3,1489)} = 3.341$ ,  $p < 0.02$ ,  $\eta^2 = 0.17$  (Figure 4).

### Age Effect: Elders and 35–45 Years Old Age Group Are More Aware and Prudent

The perception and evaluation of the dangerousness of the pandemic depend on the age of the respondent, since the older the respondent, the closer his evaluation is to reality:  $\chi^2(6, 1492) = 23.435$ ,  $p < 0.001$ .

The most careful age group regarding the preventive behavior “do not touch others” and “keep the safety distance of one m” is 35–45 years, respectively  $\chi^2(9, 1492) = 57.337$ ,  $p < 0.001$ , and  $\chi^2(9, 1492) = 56.024$ ,  $p < 0.001$ .

Although the 35–45 age group is the most cautious and the most committed to countering the pandemic, it is the one who especially feels fear,  $\chi^2(9, 1492) = 32.445, p < 0.0001$ .

The 20–35 and 35–45 age groups are the age groups who especially expressed sadness,  $\chi^2(9, 1492) = 25.843, p < 0.003$ .

The youngest age group (<20 years) is the most optimistic group,  $\chi^2(9, 1492) = 17.602, p < 0.05$ .

## Interconnections Between Awareness, Attitude, and Behavior

Respondents who described the pandemic as very dangerous responded better to “lockdown in case of doubt” and seemed to take the necessary preventive behaviors (hand cleaning, keeping the social distancing) and are more committed to countering the pandemic and to changing their behaviors. Indeed, the chi-square test of independence showed a significant relationship between

the perception of the pandemic dangerousness and the lockdown acceptance in case of doubt:  $\chi^2(3, 1492) = 45.59, p < 0.001$ .

The lockdown acceptance in case of doubt was positively related to the preventive behaviors, “cleaning hands” [ $\chi^2(3, 1492) = 108.08, p < 0.0001$ ], “Do not touching others” [ $\chi^2(3, 1492) = 43.031, p < 0.0001$ ], “Social distancing” [ $\chi^2(3, 1492) = 54.01, p < 0.0001$ ].

The relationship between the awareness of the dangerousness of the pandemic and the commitment to counter the pandemic is significant:  $\chi^2(3, 1492) = 37.399, p < 0.0001$ .

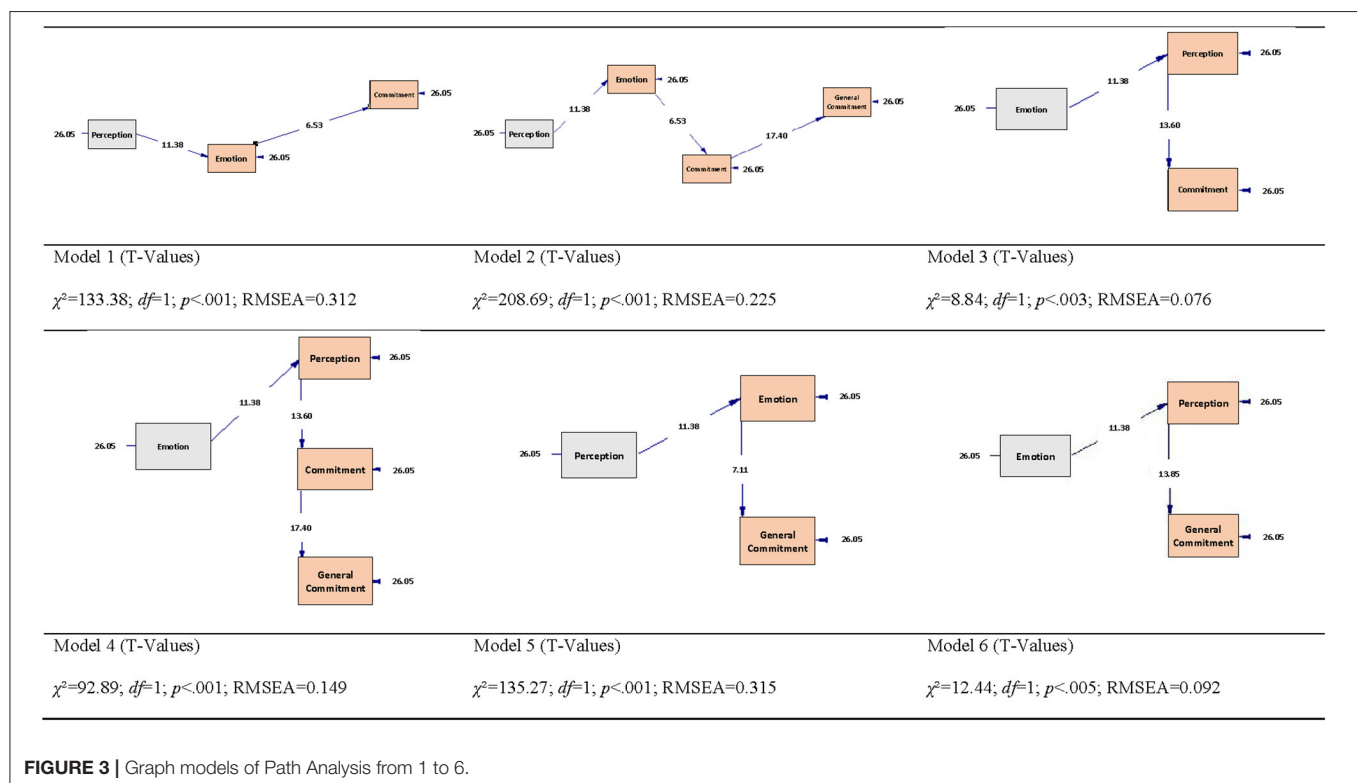
In the same vein, the lockdown acceptance in all cases depends significantly on the awareness of the dangerousness of the pandemic [ $\chi^2(3, 1492) = 53.017, p < 0.0001$ ], and the evaluation/awareness of its speed of spread [ $\chi^2(3, 1492) = 15.862, p < 0.001$ ].

Accepting lockdown in all cases was positively related to the preventive behaviors: “Hand cleaning” [ $\chi^2(3, 1492) = 44.604, p < 0.0001$ ], “do not touching others” [ $\chi^2(3, 1492) = 64.56, p < 0.0001$ ], and social distancing [ $\chi^2(3, 1492) = 107.95, p < 0.0001$ ].

In fact, the more the respondent is aware of the dangerousness of the pandemic and its speed of spread, the more he is prepared to accept lockdown and to take the necessary precautions behaviors (cleaning hands, keeping social distancing, do not touch the others); he is also more willing to counter the pandemic and to change his behavior. The positive relationship between the awareness of the dangerousness of the pandemic and the readiness to change behavior was significant:  $\chi^2(9, 1492) = 273.752, p < 0.0001$ .

**TABLE 3** | The goodness of fit statistics for the Path Analysis.

	RMSEA	CFI	GFI	AGFI
Model 1	0.31	0.56	0.94	0.63
Model 2	0.22	0.71	0.93	0.76
Model 3	0.076	0.98	1	0.97
Model 4	0.15	0.88	0.97	0.89
Model 5	0.31	0.57	0.94	0.63
Model 6	0.092	0.97	0.99	0.96

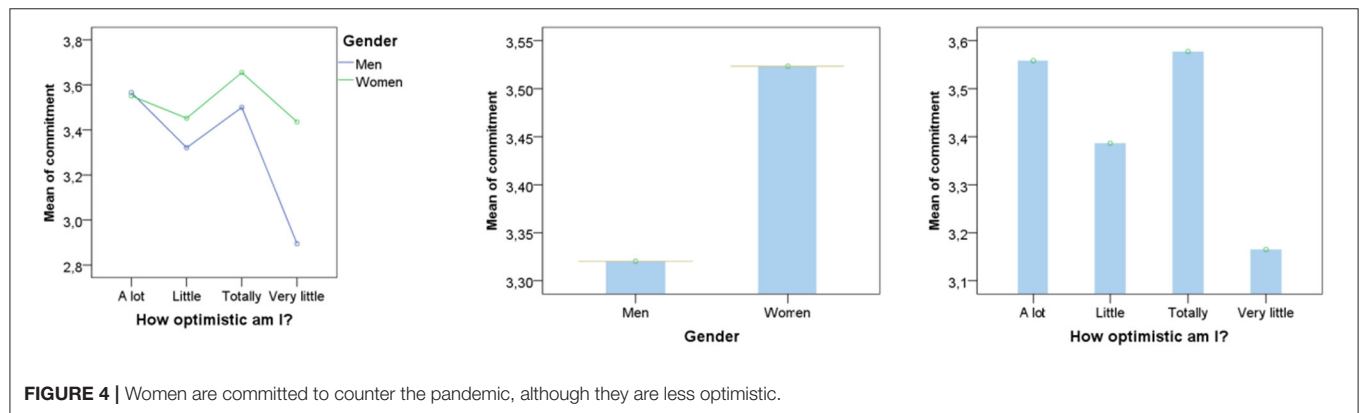


**FIGURE 3** | Graph models of Path Analysis from 1 to 6.

**TABLE 4** | Percentages of women and men regarding the four degrees of fear, sadness, joy, and serenity (percentages).

Degree	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Fear				Sadness				Joy				Serenity			
Women	9.9	21.0	36.1	33.1	11.2	20.3	29.8	38.7	90.2	5.3	2.0	2.5	64.9	17.1	10.8	7.3
Men	18.6	35.1	30.8	15.5	22.0	24.4	30.5	23.2	82.3	11.6	2.1	4.0	48.1	21.7	21.1	9.1
Together	11.8	24.1	34.9	29.2	13.5	21.2	30.0	35.3	88.5	6.7	2.0	2.8	60.9	18.2	13.2	7.7

Dark color means high degree and clear color means low degree.

**FIGURE 4** | Women are committed to counter the pandemic, although they are less optimistic.

## DISCUSSION

Public health issues, such as the COVID-19 pandemic, have been shown in studies to trigger psychological issues in people, with symptoms including anger, fear, anxiety, hopelessness, and boredom (5, 7, 8). This survey-based study was conducted during the outbreak of the COVID-19 pandemic and had 1,492 participants; we examined public awareness, emotion, and motivation toward COVID-19 and evaluated the influence of these factors on the commitment and behavior of people.

This study aimed to find the relationship between covid-19 and the people's psychological effects, emotions, and behavior, crossed with the influence of age and gender. We found a significant relationship between gender and acceptance of the lockdown. Women are significantly more convinced about Lockdown and Lockdown in case of doubt about their infection than men. This finding corroborates the results obtained by Brooks and his team (28) in their study of people's behavior and reaction to the quarantine.

It can also be observed that women are more aware of the dangerousness of the pandemic as a significant relationship between gender and awareness of the dangerousness of the pandemic was observed. The results also showed that women, in comparison to men, are more cautious when interacting with the world. Women follow more precautions in handwashing, social distancing, and mask-wearing to minimize the transmission of the coronavirus. Gender has a significant impact on perceiving the risks and coping strategies (29).

It has been found that men are more likely to be affected by the COVID-19 outbreak in terms of mortality rate compared to women since the men's and women's chromosomes, genes, and

hormones are released to show different responses against viral infections. It has been observed that women are showing more severe responses against COVID-19 and complying with the restraining measures. From the research, it has been suggested that both men and women were initially at normal status. However, then women were paying more attention and suffering from high anxiety levels compared to men. They started to wear hand gloves and surgical masks. Women experienced more psychological problems during the pandemic than men, which highly affected their performance and health conditions (47).

When the effect of COVID-19 was seen regarding emotion, motivation, and commitment according to gender, most female respondents were seen to be more mentally exhausted and more likely than men to feel fear and sadness. This finding corresponds to results obtained by Broche-Pérez and his team (38), who looked at gender differences in COVID-19 fear and concluded that women became more psychologically vulnerable during the epidemic and that gender was a major predictor of COVID-19 fear. The WHO had previously stated that the pandemic should be viewed from a gender perspective because it affects men and women differently. Women tend to be the most affected by the current pandemic, with rates of gender-based violence increasing during quarantine (34). Although men are more optimistic, they are less committed to countering the pandemic than women through preventive measures. It can be perceived that men and women are considerably different regarding their optimism and commitment. This study demonstrated that women are committed to counter the pandemic, although they are less optimistic (47, 52). The severity perception of the pandemic was divided among the respondent's age group. When the respondents were divided according to age group, it can be



observed that the older participants were closer to reality than the younger people. The results displayed that the most cautious regarding “keeping the distance with others of one meter” and “no touching rule” was 35–45 years old. Even though this age group is the most careful, it is most committed to countering the pandemic and the one who feels mostly fear. In terms of sadness, the 20–35 and 35–45 age groups are the most age groups who expressed dismay and lack of positive emotions, while the youngest age group (<20) was the most optimistic regarding the whole COVID-19 situation. When it comes to controlling both risky behaviors in implementing precautionary measures and broad individual reactions to COVID-19 contexts, optimism’s defensive position opens up intriguing possibilities for counterbalancing positively and negatively affect (53).

Our imagination may not be reliable when drawing assumptions about the future, especially when it comes to health issues, which is why health-related interaction must be explicit about the risks, but a positive attitude may be adaptive in overcoming hardships. Indeed, positive messages reverberated worldwide: All will be fine, then everything will be fine (53–56).

The results prove a direct relationship between perception and general commitment; however, the indirect effect of perception on the general commitment can also be seen. Perception affects commitment which in turn affects the general commitment. Also, there is another indirect relationship as the perception affects the commitment that affects the emotion and directly affects the general commitment. Perception also has a direct connection with emotion and commitment. So, it can be deduced that perception plays a vital role in determining and involving the other variables.

Furthermore, there was a direct effect of perception on the two variables (evaluation and speed). At the same time, emotion had a direct relationship with the five emotional variables (as anger, fear, disgust, contempt, and sadness), which shows that they had a positive association with each other. The general commitment is directly associated with people’s communication and behavior, proving that the lower level of public commitment affects the poor behavior and communication among people amid this pandemic. At the same time, the commitment had a direct association with the hand cleaning, no-touch, and the social behavior of people.

Higher potential risk and severity of transmitting the novel coronavirus, higher perceived comparative susceptibility and harm to the body from SARS, and more uncertainty about knowledge reliability, according to the study, were all significantly and positively correlated with recorded medium risk and intensity of catching the novel coronavirus. On the other hand, strong self-confidence was positively linked to a lower risk during the epidemic (40).

## CONCLUSION

In this study, we compared the effect of COVID-19 on the awareness, emotion, and motivation of the Tunisians. We found that gender disparity can be seen in how COVID-19 risk

perception can be observed. Women, in general, are more cautious about the coronavirus when interacting with the world. Higher precautions are taken by women in hand cleaning, social distancing, and covering face with the mask. Women’s psychological and emotional state is more toward the sadness and pessimistic side than men who are more carefree about the whole situation. Compared with the age, the older age group is more serious about the Covid-19 pandemic in countering it. The younger age group seems to be more optimistic about the situation. The more the respondent is aware of the seriousness of the pandemic and its speed of spread, the more he is prepared to accept lockdown and to take the necessary precautions (cleaning hands, keeping social distancing, do not touch the others) and more his emotions of fear, contempt, disgust, sadness are strong. He is also more willing to counter the pandemic and to change his behavior. The younger age group has a lower mortality rate compared to the adults. Seeking effective coping mechanisms is imperative.

An effective communication system must be achieved during COVID-19 (i.e., content, method, people, and partners). Content is considered phased and situation-specific, ensuring the communication precedes and monitors the operational and community response during the outbreak. In the process, different platforms should be included. For instance, blogs, call centers, webinars, conference calls, online health group videos, digital news media are the means to ensure communication. First, it is highly recommended to make a gender-sensitive communication that appeases their negative emotions and transform their commitment into a powerful mean to engage the overall society and to increase the men’s commitment. It is also recommended to help youngers positively so that they can express their feelings. On the other hand, engage older adults in other safe things (as they become more aggressive and emotionally depressed) that will make them feel relaxed, loving daily exercise, regular sleep schedules, and eating nutritious food is all recommended. Emotions play an important role when dealing with any crisis. In the time of the pandemic, it is highly recommended to stay positive and optimistic. The WHO and its agencies in the different countries should be the leader of the psychological management of the pandemic crisis, based on studies like the present one. Social media is the biggest platform for any awareness program. Hence, awareness of the sanitary methods in the people can be done through various social media platforms. Finally, policymakers should be more aware and practical regarding the psychological management of the pandemic and any kind of new health crisis.

## DATA AVAILABILITY STATEMENT

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

## ETHICS STATEMENT

For this study, ethical approval has not been necessary since the data are properly anonymized and informed consent was obtained at the time of original data collection.

## AUTHOR CONTRIBUTIONS

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

## SUPPLEMENTARY MATERIAL

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# Implementing Introductory Training in Trauma-Informed Care Into Mental Health Rehabilitation Services: A Mixed Methods Evaluation

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**Objective:** This paper describes the implementation of training in trauma-informed care (TIC) across a mental health rehabilitation service.

**Method:** A mixed-methods approach was applied incorporating baseline measures of staff attitudes toward TIC, quantitative description of staff training participation, and semi-structured interviews of Team Leaders' views on the implementation of TIC.

**Results:** Fifty-five of 123 staff responded to the Organizational Change Readiness Assessment (OCRA) survey (44.7%). Training completion varied considerably between the eight rehabilitation teams (4.8–78%). Analysis of the Team Leader interviews identified four broad themes: The need to respect the person's life journey including the risk of re-traumatization; the importance of considering the context of implementing TIC training; TIC being an essential part of mental health care; and staff may also have trauma histories.

**Conclusions:** Staff working in mental health rehabilitation are supportive of the need for TIC. The variable training uptake did not reflect the staff comments about the importance of TIC. The burden of adjusting mental health care delivery to COVID-19 restrictions was reported as a major influence on the uptake of training. Systematically implementing training in TIC is required but needs to be complemented by a structured organizational approach to aid embedding this approach into daily mental healthcare delivery.

**Keywords:** trauma-informed care, training, recovery orientated mental health rehabilitation, implementation, competency framework

## INTRODUCTION

A history of experiencing trauma is common in people seeking help from mental health services (1, 2). The pervasiveness of trauma and its impact on the development; presentation; and management of people experiencing mental illness is well established. The Australian National Framework for Recovery-Oriented Mental Health Services (3) was endorsed in 2013 and emphasizes the importance of Trauma-Informed Care (TIC).

There are multiple definitions of trauma. The Substance Abuse and Mental Health Services Administration (SAMHSA) reviewed the definitions and developed the following concept:

“Individual trauma results from an event, series of events, or set of circumstances that is experienced by an individual as physically or emotionally harmful or life threatening and that has lasting adverse effects on the individual’s functioning and mental, physical, social, emotional, or spiritual well-being” (4). Trauma can follow acute single events or result from accumulative traumas over a lifetime. Interpersonal trauma is particularly common in people seeking or requiring mental health care. Sometimes trauma is not the presenting mental health complaint, and it can often be missed. The secondary manifestations of trauma may be the primary focus of care (e.g., substance misuse, interpersonal difficulties, paranoia) and the link to a trauma history can go unrecognized. Principles of TIC have been developed emphasizing the importance of safety, trustworthiness, choice, collaboration and empowerment (4). These principles can provide a universal practice framework for mental healthcare professionals and help to ensure services/professionals are sensitive to the heterogeneous manifestations of trauma and adapt their practice to reduce the risk of re-traumatization (5).

TIC involves a systems approach and staff awareness rather than a sole focus on providing a specific group or individual trauma therapy (6). Transitioning toward TIC requires organizational change within mental health services and staff training and support (5, 7). The literature recommends a multi-level (trauma informed, trauma skills, trauma enhanced, and trauma specialist) competency-based training structure (4). The fundamental competency level is being trauma informed which is relevant to all staff (4, 8, 9).

Training alone is unlikely to lead to the change in practice required to embed TIC into standard care (10, 11). There is also a need for an organizational response that has TIC as part of routine clinical practice and organizational governance systems (12). Recent commentaries have emphasized the challenges of implementing TIC, especially in public mental health services (7, 12). Barriers to implementing TIC within mental health services include resourcing, organizational culture, the dominance of the bio-medical model, and clinician misconceptions (13). Isobel notes there can be a lack of staff clarity of what is meant by trauma and issues in sustaining attempts at implementing TIC (7). Despite the recognized need there is limited evidence to guide the effective implementation of Trauma Informed Care (11).

Specialized mental health rehabilitation services aim to provide environments that facilitates recovery. However, the manifestations of trauma can influence therapeutic engagement and become a limiting factor in optimal personal recovery (2, 14). This study evaluates a quality improvement activity of implementing introductory, online trauma-informed training across the eight rehabilitation teams of an Australian mental health service. The training aims to increase knowledge and awareness of trauma and the impact of trauma on individuals.

## OBJECTIVES

The primary objective was to evaluate the organizational goal to have all staff working in the rehabilitation teams trained in TIC.

In addition, Team Leaders views on the integration of TIC into routine clinical care was explored.

## METHODS

### Study Design

A mixed-methods approach was applied, this incorporated baseline measures of staff attitudes toward TIC, quantitative description of staff training participation, and semi-structured interviews of Team Leaders’ views on the implementation of TIC.

The study and its findings were reported considering the COREQ checklist (15) (see **Supplementary Material**). All participation was based on voluntary informed consent, and ethics approval was obtained before study commencement (Metro South Human Ethics Committee ethical clearance HREC/2019/QMS/52067).

### Study Population

The study population included clinicians (occupational therapists, psychologists, social workers, psychiatrists, psychiatrists in training, nursing staff), rehabilitation therapy aids, and peer workers of the eight rehabilitation teams of a large metropolitan public mental health service ( $n = 123$ ) (**Table 1**) and Team Leaders ( $n = 8$ ) at these services who are responsible for operational management of the teams and operational supervision of staff.

### Study Setting

The study was undertaken in a large metropolitan public mental health service in Queensland (Australia) whose catchment area includes over 1.1 million people. An extensive range of mental health services are provided, including eight rehabilitation teams. The rehabilitation teams include a team supporting

**TABLE 1 |** Rehabilitation team descriptions and training completion rates.

Rehabilitation service component	Team site	Staff (N)	Training completion	
			n	%
Early Psychosis team <sup>a</sup>	PAH	9	1	11%
Extended treatment and rehabilitation <sup>b</sup>	Bayside	17	9	53%
Community Care Unit <sup>c</sup>	Bayside	24	6	25%
	Coorparoo	16	1	6.3%
	Logan	21	1	4.8%
Mobile Intensive Rehabilitation Team <sup>d</sup>	Logan	13	1	6.3%
	PAH	14	2	14.3%
Transitional Housing Team <sup>e</sup>	PAH	9	7	78%

<sup>a</sup>Intensive community-based support to 18–25-year-olds within 2 years of the first onset of psychotic symptoms (16).

<sup>b</sup>Sub-acute medium-term mental health inpatient mental health rehabilitation for adults aged 18–65 years (17).

<sup>c</sup>Community-based recovery-oriented residential mental health rehabilitation support focusing on living skills development and community integration (18).

<sup>d</sup>Community-based intensive mental health rehabilitation support based on an adaptation of the Assertive Community Treatment model (23).

<sup>e</sup>Provides transitional accommodation in community-based independent living units, and intensive domestic and community support to consumers for up to 6 months.

### MSAMHS INTRODUCTION TO TRAUMA: BECOMING TRAUMA INFORMED.

This is an introductory course for clinical, administrative and peer workforce. It explains what trauma is and how it affects people. It will increase knowledge and awareness of trauma and how it affects people. It will increase knowledge and awareness of trauma which is the first step on your journey to becoming a trauma informed staff member.

Traumatic Experiences involve situations where we:

- Are harmed, either real or perceived
- Are threatened with harm
- See someone else being harmed

#### Course Outline

1. Introduction
2. Complex trauma and the ripple effect
3. Secondary and vicarious trauma considerations
4. Trauma informed care in action
5. TIC consideration: Indigenous and Cultures and Languages Diverse people
6. Resources

#### Course objectives

1. Explain why it is important to become trauma informed
2. Recognise the signs and symptoms of trauma stress
3. Name the five principles and state the associated strategies of TIC
4. State the different types of traumatic responses and the impacts of complex trauma

**FIGURE 1 |** MSAMHS introduction to trauma: becoming trauma informed. Metro south addiction and mental health services (2020). MSHLearn (birchlp.com.au).

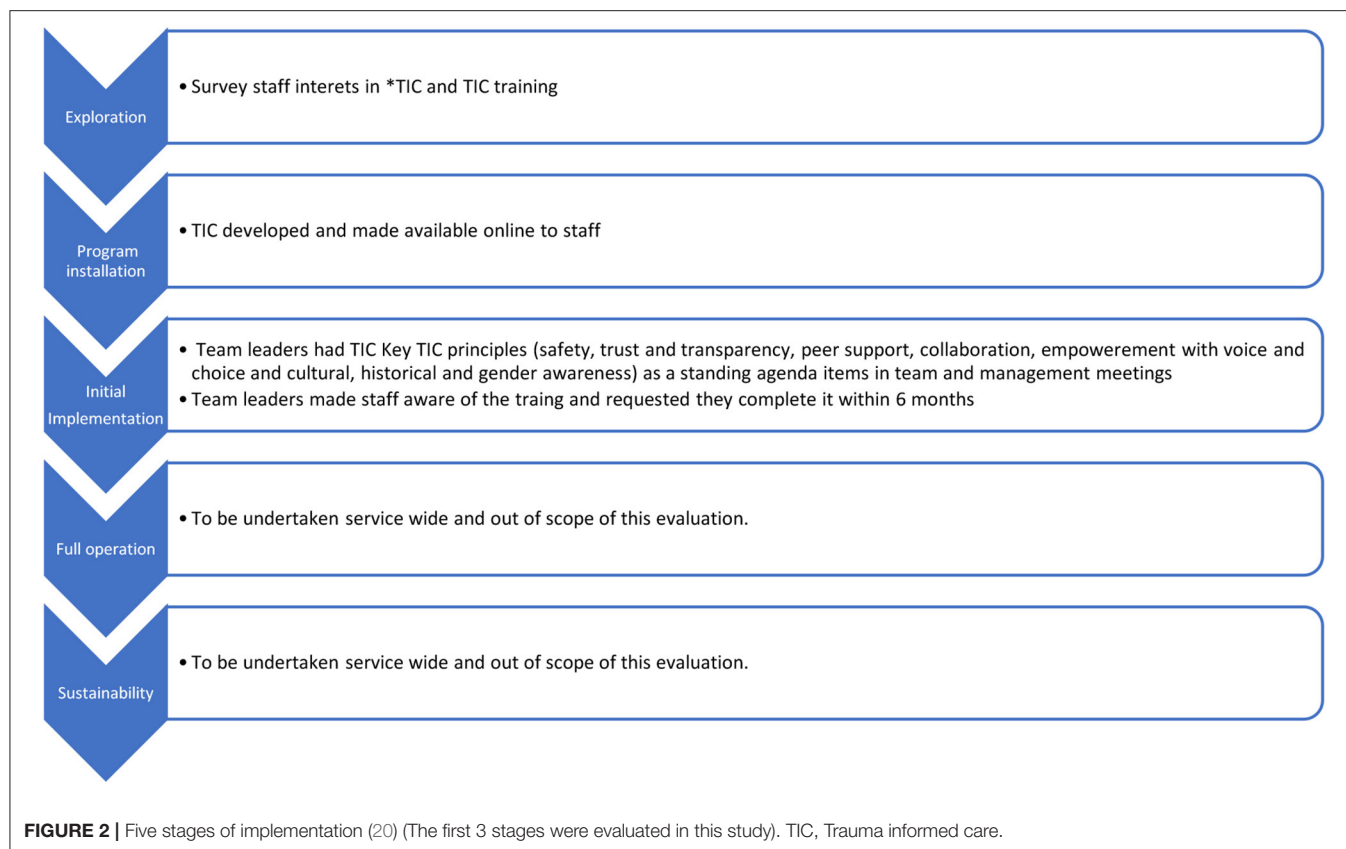
people with a history of homelessness (Transitional Housing Team), two community-based outreach teams (Mobile Intensive Rehabilitation Teams), an Early Psychosis team and three residential rehabilitation units (Community Care Units) (see **Table 1**). The senior leadership across the rehabilitation service identified the implementation of TIC as a quality improvement activity. The implementation experience reported in this paper covered the period 15/11/2019 to 2/4/2021. This period was inclusive of unanticipated disruptions in service activity due to COVID-19 commencing in March 2020.

## TIC Online Training

The service's multi-professional Psychological Trauma Steering Committee developed the introductory online staff training (19). **Figure 1** outlines the focus and content of the online training.

## Implementation Plan

The implementation plan focused on the first three stages of the five stages of implementation as described by Fixsen et al. (13) (**Figure 2**). In the exploration phase, staff were surveyed to ascertain their perception of the organizational readiness to introduce TIC training. The survey results influenced the initial implementation phase, which focused on staff training and incorporating the TIC principles into multidisciplinary team meetings and staff supervision. Team Leaders audited training completion within their teams. Key TIC principles (**Figure 2**) were made a standing item within professional and operational supervision in the rehabilitation teams to facilitate applying the training to practice. After 6 months, Team Leaders were interviewed via phone or teleconference to ascertain their views on implementing the TIC training into clinical practice. The implementation stages 4 (full implementation), and stages 5 (sustainability) were out of scope of this study.



## MEASURES

### Organizational Change Readiness Assessment

There are many organizational change measures available often with limited evaluation of their psychometric properties (20). The reliability and validity of instruments is context dependent. In this study we aimed to find an instrument that: (1) could be adapted for the public rehabilitation service context, (2) that was short to encourage completion, and (3) that focused on staff perceptions of the planned implementation of TIC. The instrument was developed in Canada (21) and designed to provide a quick overview of factors potentially inhibiting or facilitating change that may need to be addressed in a change process.

The OCRA (21) profiles an organization's "change readiness" from the perspective of staff using 29 questions. It can be adapted to focus on a particular initiative. The instrument provides a profile of service direction, operations and support system levers that facilitate change or may hinder change (Table 2). Each lever has a number of subcategories rated from 1 (most supportive) to 5 (most inhibitory). Ratings 1–3 indicate there is a likelihood that these levers and subcategories are likely to support change and rating of 4 or 5 are likely to inhibit change (Table 2). No psychometric data is available on this instrument.

**TABLE 2 |** Organizational change readiness assessment profile.

		Scoring <sup>a</sup>				
		1	2	3	4	5
Lever	Questions	Likely to support			Likely to hinder	
Service direction	a. External environment			X		
	b. Leadership			X		
	c. Strategic direction				X	
Operations	d. Organization structure, tasks, work processes				X	
	e. Management processes and communication				X	
Support systems	f. Culture, norms, morale			X		
	g. Human resource systems				X	
	h. Employees' personal goals and competencies				X	
	i. Information processes				X	

<sup>a</sup> 1 = most supportive of change, 5 = most inhibitory of change.

### Team Leader Interview Questions

The interview comprised eight open-ended questions developed by the authors and designed to capture information about Team leaders' views on the implementation of TIC into practice (Figure 3). Due to COVID restrictions all interviews were



### Semi Structured Interview Questions

1. Firstly, in your own opinion what would you say the key principles of Trauma Informed Care are.
2. How well do you think the training prepared you to supervise staff in Trauma Informed Care?
3. Where there any areas of the training that you do not think was covered adequately. If so, please elaborate.
4. Without mentioning specific names, could you give examples of you staff using information from the TIC training in their day to day work.
5. Have there been an adverse or unexpected negative effect of the training. Please given anonymous examples
6. What are some examples of the ways you attempt to ensure TIC is included in care plans? Please given examples
7. How is awareness of trauma included in case communications and discussions.
8. Is there anything else that we have not covered today that you think may be important for us to know about the TIC training and its implementation.

**FIGURE 3 |** Team Leader interview questions.

conducted either by telephone or videoconferencing with notes taken by the interviewer. Participants were given the option of having the interview conducted by an independent research assistant or the Director of the Rehabilitation services; all chose the Director.

### Analysis

The OCRA scoring scheme (21) was applied in profiling the survey results. The de-identified Team Leader interview transcripts were analyzed from an inductive thematic approach following the steps of Braun and Clarke (22) using the NVIVO12 program. These steps were not linear but provide elements of a recursive analysis of the data. Two authors were the main data coders who familiarized themselves with the data before coding each item and collating the codes and data extracts. The themes were reviewed with reflection on representing and synthesizing the data identified in the analysis. Two authors completed this thematic analysis independently and then worked collaboratively with another author to get consensus on the final themes and illustrative transcript extracts. Participants did not provide feedback on the findings.

## RESULTS

### Organizational Change Readiness Assessment

Fifty-five of the 123 staff (44.7%) completed the survey. The service profile indicated that possible barriers to

implementation were in the lever categories of Service Direction (Strategic direction); Operation (organizational structure, management processes and communication) and Support Systems (human resource systems and employees' personal goals and competencies) (Table 2). The initial implementation plan addressed the identified barriers via the TIC training and Team Leaders prioritizing TIC in management processes. There was a relative strength in the lever categories Service Direction (external environment, and leadership) and Support system levers (service culture, norms, and morale).

### Training Completion Rates

Training completion rates varied between the eight rehabilitation teams (6.3–78%, Table 1). Teams with the highest training uptake had one or more of the authors as program champions working in the team.

### Thematic Analysis of Team Leader Interviews

All eight Team Leaders within the rehabilitation service were interviewed. Below are the themes that emerged through the analysis (Table 3 and Figure 3).

#### Theme 1: The Need for to Respect the Person's Life Journey and the Risk of Re-traumatization

Patients referred to specialized mental health rehabilitation teams have ongoing functional impairment related to their mental illness that has not responded to general mental health care. Team Leaders emphasized the need to take an

**TABLE 3 |** Break down of the thematic analysis of the semi structured interviews of the Team Leaders.

Theme	Examples/meaning units
Theme 1. The need for to respect the person's life journey and the risk of retraumatization	<ul style="list-style-type: none"> <li>• Aware of the long-lasting impact and influence of historical trauma</li> <li>• Reframe person as an individual rather than diagnosis</li> <li>• What happens to you rather than what is wrong</li> <li>• More holistic</li> <li>• Look longitudinally rather than cross sectionally</li> <li>• It is important we don't repeat traumas inadvertently</li> <li>• Experience trauma from mental health care</li> <li>• Even though you wouldn't know it if (you) break trust even in a little way. Easy to take it for granted. Promised tea before meeting got caught up and forgot. Later apologized</li> </ul>
Theme 2. The context of implementing TIC training is important	<ul style="list-style-type: none"> <li>• (due to) COVID.... (TIC training) had slipped my mind.'</li> <li>• I found myself getting frustrated with staff and residents.</li> <li>• Timely given the year we have had.</li> <li>• Reflect on how your stress has impacted on work. can get brusque.</li> <li>• Don't implement TIC training before a pandemic.</li> <li>• The supervisions and TIC follow up got interrupted by COVID.</li> <li>• Change fatigue esp. in general COVID climate</li> <li>• Staff shortages and change capacity to invest in TIC.</li> <li>• Psychologist won't do sessions in residents' unit if trauma issues may come up</li> </ul>
Theme 3. (TIC) is an essential part of mental health care	<ul style="list-style-type: none"> <li>• TIC part of our philosophy of practice</li> <li>• It is why we do what we do</li> <li>• The principles are that we work with all clients from a care that recognizes trauma in multiple ways, individual, not formulaic.</li> <li>• Without the training and background knowledge easy to be judgemental</li> <li>• TIC helps make services cater and avoid re-traumatization...</li> <li>• Integrate with other work e.g. sensory</li> <li>• Latched onto the similarities with sensory work</li> <li>• Focus on sensory work</li> <li>• Increased request for trauma therapy</li> </ul>
Theme 4. Staff may also have trauma histories	<ul style="list-style-type: none"> <li>• Understand staff may have traumas or have experienced trauma in the workplace</li> <li>• Appreciate staff who have experienced trauma.</li> <li>• Help support staff</li> <li>• The training did not cover the issue of clinicians who themselves maybe traumatized</li> </ul>

individualized, longitudinal, and holistic perspective with each patient. For example, understanding a person's history and trauma background would allow staff to work collaboratively with the individual to tailor treatments.

*In one case with a male with a history of sexual abuse we ceased the depot because of a concern it could be retraumatizing. (Participant 3)*

*..... you wouldn't know it if you break trust even in a little way. Easy to take it for granted (Participant 6).*

*Our work needs to account for traumas they have suffered and impact on how they look and behave. It is important we don't repeat traumas or inadvertently they experience trauma from mental health care (Participant 1).*

*Awareness of consumer journey. ....TIC is overarching significance. .... e.g. .... person who left school early got involved in the correctional system. Need to understand why they respond in circumstances (Participant 2).*

*...Aware of the long-lasting impact and influence of historical trauma (Participant 4).*

## Theme 2: The Context of Implementing TIC Training Is Important

Soon after commencing the implementation of TIC training, the impact of the health response to COVID 19 took effect. Team Leaders were central to the COVID 19 response within each team.

While Team Leaders recognized the importance of TIC, this was difficult to prioritize given the effects of COVID 19.

*Change fatigue especially in the general COVID climate.... Bombarded by emails... Staff shortages and change capacity to invest in TIC. (Participant 4).*

*Don't implement TIC training before a pandemic. The supervision and TIC follow up got interrupted by COVID (Participant 1).*

## Theme 3: TIC Is an Essential Part of Mental Health Care

There was an awareness and acceptance of the high rates of trauma in the life histories of people with mental illness. Team Leaders viewed trauma as common and believed staff needed to be supported to recognize how trauma can manifest and best assist the person.

*(The Early Psychosis) team uses a trauma perspective as part of core business. Especially relevant as team sees refugee and people from low socioeconomic (groups). Need to differentiate trauma from other processes leading to psychosis (Participant5)*

*The principles are that we work with all clients from a care that recognizes trauma in multiple ways, individual, not formulaic. (Participant 1)*

*TIC is part of our philosophy of practice. ...It is why we do what we do (Participant 8).*



Staff commented that TIC complemented other mental health care delivered within the rehabilitation setting.

*(TIC) is integrated with other work e.g., sensory. Sensory to deal with functional disabilities (of trauma) (Participant 1).*

#### Theme 4: “Staff May Have Traumas...”

Team Leaders commented that completing the TIC training may be triggering for staff. Equally, they viewed working in mental health may inadvertently retrigger staffs’ own past traumas.

*Also, try to understand staff may have traumas or have experienced trauma in the workplace (Participant 1).*

*Appreciate staff who have experienced trauma. ....Help support staff (Participant 8).*

#### Minor Themes

There were comments arising from four team leaders’ interviews that despite not being frequently endorsed were considered to represent themes worthy of inclusion. The rehabilitation teams have a significant proportion of non-clinical staff who may have differing needs in relation to TIC training and practice.

*Differing abilities... depending on whether clinical or non-clinical (Participant 1).*

*There was some fear from the peer workers that they would be expected to do trauma therapy (Participant 2).*

The team leaders are usually senior staff who have extensive clinical experience. The TIC training did not expand their knowledge base and there was a recognition of the need for the development of further training.

*The training ignited existing knowledge. I have been working for several years ...I will apply my knowledge in professional supervision and do further reading (Participant 2).*

*I was already aware of the importance of trauma. the TIC training didn’t make a lot of personal difference...not new for me (Participant 3).*

*As a psychologist nothing new in the training as TIC is part of our training. More in depth training as a psychologist. ... (TIC training) is good basic training, sufficient at this level...need for follow-up training especially for clinicians. In general, we are not meeting the need (for specific trauma therapy) (Participant 4).*

## DISCUSSION

The association of trauma and mental illness is well recognized (1, 2). This study evaluated aspects of the implementation of introductory TIC training into the rehabilitation curriculum of teams within a rehabilitation service of a large public mental health service. Despite the recognition of the importance of trauma this study found variable uptake of TIC training and the initial objectives of implementation were not met.

The OCRA survey results were encouraging regarding organizational readiness and validated the initial implementation plan focusing on staff training and supporting practice change using existing team management structures. However,

this instrument measures a point in time and cannot predict emergent issues, particularly external events like the global pandemic.

There was wide variability in the uptake of the training. Teams where the authors worked had the highest levels of training completion. This highlights the influence of program champions in successful change implementation (16). The implementation literature also refers to the influence of timing on successful implementation and the concept of absorptive capacity on how much change an organization can accommodate (16). The Team Leader interviews referred to this issue as they noted the role of staff fatigue due to the demands of the response to COVID-19. Making TIC training mandatory would be an organizational solution that would be congruent with the importance of trauma in mental health.

The minor themes were consistent with the limitations of entry level training that focusses on the fundamentals of TIC but does not meet the needs of a diverse workforce. In addition, there is an identified gap in training staff in other levels of competency e.g., trauma skilled, trauma enhanced and trauma specialist. The current limited ability for this public mental health service to meet the need for specific trauma therapy was seen as a gap in care provision. It is necessary to have a whole of service structured competency framework to address this need. This study investigated the basic level of trauma competency within a section of a large public mental health service. The findings in this study add support for further organizational support and investment to build broad based, multilevel competency levels in staff that is congruent with their roles. This would involve fundamental TIC training for all staff, as well as training to develop staff specialists in specific trauma therapy. A comprehensive organizational response would also include provision for staff supervision and for ongoing training.

Leadership is core to any successful change implementation (16). Team Leaders are critical in facilitating behavioral change in the staff they manage and supervise. The key themes emerging from the qualitative analysis of the Team Leader interviews foregrounded how awareness of trauma is integral to mental health care. Having a trauma lens can influence clinical decisions with the recognition that vigilance is needed to minimize re-traumatization. Taking a person-centered approach was seen as a way to ensure that care especially in relation to trauma is individualized and the uniqueness of the person’s experience is appreciated (17).

## LIMITATIONS

The authors recognize the need for larger, more methodologically rigorous studies of the effectiveness of strategies for the implementation of TIC. This study examined a service improvement initiative of the rehabilitation teams of a large public mental health service, in the absence of a service wide comprehensive implementation plan. Despite this qualification this study is an example of how services within large organizations can begin to take responsibility for quality activities.

The authors also acknowledge the limitation of the measures (OCRA and the Team Leader questions) not being validated but context specific. The survey response (44.7%) did not represent the views of all staff or staff in all teams. To minimize the potential influence of participant researchers, discipline-specific data on who completed the training was not collected. This meant the authors were unable to comment about training differences between disciplines. Optimal data saturation (18) was not reached for the thematic analysis due to the fixed population of Team Leaders ( $n = 8$ ). Another limitation to this study was the derailment that occurred following COVID-19 with regards both to the response rate from the survey as well as the actual implementation of the training. In this research staff opinions were collected rather than exploring factors other than COVID-19 that impacted on training uptake.

This evaluation does not involve the complete implementation of TIC training which would require endorsement at a senior executive level of the service but focused on the initial stages and will inform ongoing TIC implementation in the service.

## CONCLUSIONS

Introductory training in a trauma-informed approach was considered necessary but not sufficient to embed TIC into routine care. Staff also emphasized that an overall organizational commitment is required for meaningful implementation of TIC (9). The need to have a systematic approach that incorporates all strands of TIC and uses a structured competency framework to build a comprehensive response to trauma is needed for effective implementation.

## RECOMMENDATIONS

- To better integrate TIC into everyday practice it should be a prioritization in both operational and professional supervision.
- Training in TIC should become mandatory training for all mental health staff to ensure expressed importance of trauma in mental healthcare is reflected in the training provided.
- A systematic approach to TIC is required that incorporates staff training, organizations' policy and procedures, environmental considerations, and staff well-being.

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- A competency framework should be used to inform staff training with all staff being expected to be trauma informed and additional competencies toward being trauma skilled, trauma enhanced or trauma specialist, depending on the staff member's role in the organization. This requires organizations to prioritize and invest in becoming trauma responsive.
- Future research on the implementation of TIC into routine practice should involve codesign and participation of all disciplines including people with lived experience and peer workers.

## DATA AVAILABILITY STATEMENT

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

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Metro South Addiction and Mental Health Human Ethics Committee HREC/2019/QMS/52067. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MS, KP, TN, MM, and FD conceived the study. FD, LN, MS, KP, MM, and NS designed the study. FD and LN did the initial thematic analysis and SP reviewed the analysis. FD supervised the whole project. SP was supervisor and consultant on the thematic analysis. All authors were involved in writing the paper.

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## SUPPLEMENTARY MATERIAL

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# American Older Adults in COVID-19 Times: Vulnerability Types, Aging Attitudes, and Emotional Responses

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The Coronavirus Disease (COVID) pandemic has aroused challenges to emotional well-being of the individuals. With 1,582 respondents from the Health and Retirement Survey (HRS), this study investigates the heterogeneity in older adults' vulnerability and examines the relationship between vulnerability types, aging attitudes, and emotional responses. International Positive and Negative Affect Schedule Short-form (I-PANAS-SF) and Attitudes toward own aging (ATOT) were used to assess the emotional experiences and aging attitudes, and 14 kinds of pandemic-related deprivations evaluated vulnerability of individuals. Latent class analysis (LCA) was used to explore the vulnerability types, and weighted linear regressions examined the relationship between vulnerability, aging attitudes, and emotional responses. The results showed that the proportion for individuals with mild vulnerability (MV), healthcare use vulnerability (HV), and dual vulnerability in healthcare use and financial sustainment (DVs) was 67, 22, and 11%, respectively. Older adults aged below 65, Hispanics and non-Hispanic Blacks, and those not eligible for Medicaid were more likely to have HV or DVs. The relationship between vulnerability and positive emotions (PAs) was non-significant, yet individuals with HV (beta = 0.10, standard error [SE] = 0.16) or DVs (beta = 0.09, SE = 0.28) were likely to have more negative emotions (NAs) than their mildly vulnerable counterparts. Furthermore, aging attitudes moderated the relationship between vulnerability and emotions. The salutary effect of positive aging attitudes on emotional well-being was more significant among people with DVs than those with MV (beta = 0.20, SE = 0.04 for positive responses; beta = -0.15, SE = 0.04 for negative responses). Thus, we urge more attention for vulnerable older adults in a pandemic context. Meanwhile, encouraging positive aging attitudes might be helpful for older adults to have better emotional well-being, especially for those with DVs.

**Keywords:** vulnerability, aging attitudes, emotion, older adults, COVID-19



## INTRODUCTION

The Coronavirus Disease (COVID-19) pandemic brought substantial mental health impacts besides direct threats to the physical health of individuals. With the influences of pandemic threats, changes in routine, worries about financial loss, and loneliness during this public health upheaval, people faced multiple challenges to emotional well-being (1). Prevailing evidence indicated that emotional distress was increased in several countries (2). According to the Strength and Vulnerability Integration Model, older adults have strength in regulating emotions with a better use of attentional strategies, appraisals, and behaviors, yet with vulnerability in modulating the high and sustained levels of physiological arousal (3). Despite older adults generally having higher levels of emotional health, they might experience heightened negative emotions (NAs) when faced with acute stresses, such as the outbreak of Severe Acute Respiratory Syndrome (SARS) (4). About one-half of older adults in the hard-hit United States reported stress related to the disease, while a quarter developed negative mental health responses (5). As emotions have a great potential in affecting life satisfaction and coping strategies, a growing body of research studies tried to explore the risk and protective factors of emotional well-being in the COVID-19 context (6, 7). Individual characteristics, such as gender, age, race, the level of education, marital status, economic status, the ability of daily activities, and self-perceived health status had been intensively examined (6, 8). However, based on our information, a few studies have examined the association between emotional well-being and vulnerability among older adults.

Vulnerability is the result of a set of risks in threat exposure, threat materialization, and lack of defense to cope with the threat (9). In previous studies, the vulnerability could be evaluated either by models targeting individuals' deficiencies in the face of hazards or by models focusing on the outcomes of these risks (10). Referring to existing studies (11–14), we measure the vulnerability during COVID-19 with the risks in pandemic-related deprivations, which are rooted in older adults' deficiencies in disease prevention, healthcare utilization, financial resilience, and housekeeping capability. More detailed, in the face of highly infectious disease, declining immune function among older adults, and defective preventive strategies of their families may put individuals at increased risk of infection (11). Besides, existing studies suggest that older adults are more likely to have inadequate healthcare use and financial hardships than their younger counterparts in emergent circumstances (15–18). Moreover, they might have to deal with overwhelming chores during the pandemic because of austere hygiene challenges and disruption in housekeeping

service (19). However, the vulnerability of older adults might be heterogeneous due to differential types and volumes of resources that individuals possess. People may have different levels of risk to experience the pandemic-related deprivations and might be distinguished as having single-dimensional or multiple-dimensional vulnerability. However, most existing COVID-19-related studies treated the vulnerability of older adults homogeneously (7, 20); to date, none of them have revealed the heterogeneity in the vulnerability of the older adult population.

Previous studies proposed that vulnerability during adverse events might arouse negative emotional responses (4, 21). However, researchers have reached no consensus regarding the association between vulnerability and positive emotional responses. In some studies, positive emotions (PAs) were decreased when the person had a severer vulnerability (22, 23). By contrast, other studies found no significant reduction in PAs despite the vulnerability of older adults (24, 25). Besides differences in trauma types, variation in the affective profiles of the respondents also contributed to this inconsistency. The affective profile is a psychological trait with an orthogonal structure describing individuals prone to PAs and NAs in the face of life challenges (26). Accordingly, affective profile of an individual may involve four main types: self-fulfilling, low-affective, high affective, and self-destructive. People with a self-fulfilling profile are often more energetic and optimistic and perform better in maintaining emotional well-being than the other three affective types in stressful situations (27). In addition, emotional responses during an adverse event are linked with the rumination on pandemic-related deprivations, as the Cognitive Appraisal Theory of Emotion was noted (28). In unintentional situations, positive internal schema and PAs would sustain when older adults attribute their vulnerability to external factors. Alternatively, considering the vulnerability as a result of personal inability may lead to self-depreciation and expel PAs. Nevertheless, during the COVID-19 pandemic, how older adults conceive their vulnerability may be differential across populations (14). Thus, in the current study, we examine the relationship of vulnerability with positive and negative emotional responses, thereby evaluating the emotional well-being of older adults amidst the COVID-19 threats.

Moreover, aging attitude as a cognitive pattern might moderate the relationship between vulnerability and emotional responses. The Cognitive Vulnerability-Stress Model suggests that older adults with positive aging attitudes would have better subjective well-being during adverse events (29). When confronted with risks in pandemic-related deprivations, positive aging attitudes would improve the emotional well-being *via* emotional and informational processing. On the one hand, self-esteem from positive aging attitudes serves as a shield against initial negative reactions, which is helpful to restrain stress-diathesis and have better use of emotion regulation strategies (30). On the other hand, positive aging attitudes would help individuals to effectively select the pandemic-related information (31). People with positive views on aging are less likely to be impacted by discriminative information against older adults, thereby conducting fewer negative ruminations (32). However, whether the association between positive aging

**Abbreviations:** COVID-19, Coronavirus Disease; HRS, Health and Retirement Survey; I-PANAS-SF, International Positive and Negative Affect Schedule Short-form; ATOT, Attitudes toward own aging; PGC, Philadelphia Geriatric Center; PA, Positive Affect; NA, Negative Affect; LCA, Latent Class Analysis; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; ssaBIC, sample size-adjusted BIC; LMRT, Lo-Mendell-Rueben Test (LMRT); MV, Mild vulnerability; HV, Healthcare use vulnerability; DVs, Dual vulnerability in healthcare use and financial sustainment.



attitudes and emotional responses vary between vulnerability types remains unclear. Theoretically, older adults experiencing fewer dimensions of insecurities may have greater self-esteem and confidence to overcome the pandemic after comparisons with their multiple-dimensional damaged counterparts (33). Such a sense of capability is intrinsically inherent with positive aging attitudes and might amplify their salutary effects on the emotional well-being. Alternatively, positive aging attitudes might also be more important for populations with multiple-dimensional vulnerability, helping to maintain positive self-images under substantial pandemic-related deprivations (34). Given the debates above, this study tries to examine the interactive effect of vulnerability and aging attitudes on the emotional well-being of older adults.

## Aims and Hypotheses

This study investigates the latent vulnerability types among American older adults and examines the relationship between vulnerability type, aging attitudes, and emotional responses in COVID-19 settings. Our first hypothesis concerns the latent vulnerability types with an investigation on disease infection, delayed healthcare use, financial hardships, and overwhelming chores. This hypothesis is exploratory, assuming older adults might be distinct as having a single-dimensional or multiple-dimensional vulnerability due to differential types and volumes of resources they possess. Moreover, the socioeconomic and health characteristics of vulnerability groups would be different. Secondly, we propose that multiple-dimensional vulnerability is associated with higher levels of negative emotional responses. In contrast, the relationship between vulnerability and positive emotional responses might be negative or non-significant. Lastly, we assume that older adults with positive aging attitudes would have more positive and fewer negative emotional responses. Meanwhile, positive aging attitudes might moderate the relationship between vulnerability and emotional responses. The salutary effect of positive aging attitudes on emotional well-being might be more significant for individuals being either single- or multiple-dimensional vulnerable in the pandemic.

## MATERIALS AND METHODS

### Study Design and Data Collection

Health and Retirement Survey (HRS) is a national longitudinal study of older Americans' health and economic situation (<https://hrsonline.isr.umich.edu/>). Data in this study were used from the 2020 HRS COVID-19 Project (Early, version 1.0). The COVID-19 module administrated 50% random subsample of households initially assigned to enhance the interviewing. This 50% random subsample was further split into two random samples: the first one was released to fieldwork on June 11, 2020, while the second one was on September 24, 2020. Information in this study was gained from the first random sample of 3,266 respondents, accounting for ~25% of the original HRS sample. Due to lockdowns in the pandemic, the COVID-19 Project was conducted via telephone, with a response rate of 62%. Detailed information on sampling design, survey content, and sample weights of HRS can be found elsewhere (35).

After excluding persons below age 60 and who did not report emotional responses, this study included a total of 1,582 cases. All regressions were weighted using inverse probability weights to adjust for selections and non-response in the data.

The Institutional Review Board (IRB) of the University of Michigan approved the HRS survey, while the IRB of Yale University provided approval for this study. All methods were performed in accordance with the Declaration of Helsinki. As some of the older adults could not write, all respondents provided verbal consent to this survey.

## Measures

### Outcome Variable

Emotional responses in this study were measured with the International Positive and Negative Affect Schedule Short-form (I-PANAS-SF) (36), which includes 10 items and estimates the degree of PAs and NAs that individuals experienced in the past month. Five positive emotional responses involved active, determined, attentive, inspired, and alert, whereas five negative responses included afraid, nervous, upset, hostile, and ashamed. Older adults were invited to rate these emotional responses on a 5-point scale according to the extent to which they have felt, while higher scores referred to more intensive affectivities. The I-PANAS-SF is psychometrically acceptable across cultures (37). In the current study, the internal consistency coefficient (Cronbach's  $\alpha$ ) for PAs and NAs was 0.811, 0.776, respectively, indicating acceptable reliability of the measurement.

### Independent Variables

The vulnerability was assessed with 14 items of pandemic-related deprivations rooted in older adults' deficiencies in disease prevention, healthcare utilization, financial resilience, and housekeeping capability. With references from the Sensitivity and Resilience Model and related empirical studies (11–14), this study made use of the most typical symptoms for each dimension. Disease infection of individuals and their family members exhibited older adults' vulnerability in disease prevention. Delay for surgery, prescription filling, doctor visits, dental care, and other services expressed vulnerability in healthcare utilization. Experiences of income deduction, spending growth, food shortage, missing financial dues, asking help with bills, and other hardships showed vulnerability of the individuals in financial resilience. Then, asking for help to do chores represented a vulnerability in housekeeping capacity. We invited older adults to report if they had experienced each of the 14 items during the pandemic (since April 2020), with 0 refers to no and 1 for yes. The vulnerability was calculated as a categorical variable after latent class analyses (LCA), with 0 for mild vulnerability (MV), 1 for healthcare use vulnerability (HV), and 2 for dual vulnerability in healthcare use and financial sustainment (DVs).

Aging attitudes were examined with a brief five-item unidimensional measure that compromises the Expansion: Attitudes towards own aging (ATOA) dimensions of the Philadelphia Geriatric Center (PGC) Morale Scale (38). Items from the ATOA measure included: "I have much pep as I did last year," "I am as happy now as when I was younger," "Things keep getting worse as I get older," "The older I get, the more useless I

feel,” and “As I get older, things are better than I thought they would be.” A 6-point response scale was used to evaluate the degree of each item. When negative items were reverse-scored, this scale captured older adults’ global positive evaluation of their aging process (39). The Cronbach’s  $\alpha$  for the scale was 0.773 in this study.

### Covariates

Affective profile was determined by the mean scores of positive affections and negative affections, reported throughout 2002–2018 HRS waves. In line with previous studies (26, 40), we adopted a cutoff point at 53.2% for PAs and 48.9% for NAs to identify the orthogonal structure of individuals’ affections: self-fulfilling profile (high scores in PAs but low scores in NAs); low affective profile (low scores both in PAs and NAs); high affective profile (high scores both in PAs and NAs); and self-destructive profile (low scores in PAs but high scores in NAs). Other covariates in the current study comprised sex (male/female), age (below 65/65 and older), race (Hispanic/non-Hispanic White/non-Hispanic Black/others), marital status (married or partnered/uncoupled), educational level (less than high school/high school or above), household wealth (relatively poor/mid-level/rich), Medicaid eligibility (eligible/not eligible), difficulty in daily activities (none/one and more, i.e., 9 items, such as dressing, bathing, preparing hot meals, shopping for groceries, and so on), and self-reported health status (relatively poor/relatively good). These variables have been examined to associate with the emotional well-being of older adults in the United States (6, 8, 41).

### Statistical Analyses

Descriptive analyses were conducted for the outcome variable, independent variables, and covariates. We used Mplus Version 7 to conduct LCA to identify unobserved clusters of individuals that respond to measured vulnerability items with a similar pattern. In this stage, robust maximum likelihood (MLR) estimators were adopted. Indicators, such as Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), sample size-adjusted BIC (ssaBIC), entropy, values of the Lo-Mendell-Rueben Test (LMRT), and the Bootstrap Likelihood Ratio Test (BLRT) were used for model selection. Meanwhile, we conducted bivariate analyses between the vulnerability type and socioeconomic/health variables while considering uncertainty in membership assignment (42). In the next step, class membership was assigned to each individual based on the probability and was treated as an observed variable. We used multinomial logit regressions to examine the factors associated with the vulnerability type, of which the relative risk ratio (RRR) and 95% CI were reported. In addition, Linear regressions were conducted to examine the association between the vulnerability type, aging attitudes, and emotional responses, after adjusting for a broad spectrum of covariates, such as affective profile, sex, age, race, marital status, education, household wealth, Medicaid eligibility, difficulty in daily activities, and self-reported health. Here, standardized and unstandardized coefficients, robust SE, and 95% CI were reported. All regressions were weighted using inverse probability weights, with sample weights that have

corrections for emotion non-response. List-wise deletion was used to handle missing data, and all regressions were conducted in Stata Version.

## RESULTS

**Table 1** presents the descriptive characteristics of variables in this study. Among 1,582 respondents, women ( $N = 919$ , 58.20%) and persons aged 65 years and older ( $N = 1,129$ , 71.50%) were accounted for the majority. Additionally, more than half of the respondents were non-Hispanic Whites ( $N = 1,085$ , 68.71%), married or partnered ( $N = 971$ , 61.50%), and had a high school degree or above ( $N = 1,327$ , 83.98%). Although 64.91% ( $N = 1,025$ ) of the elderly had difficulty in daily activities, the proportion for self-reported poor health was only 38.53% ( $N = 608$ ). In line with the high proportion of the self-fulfilling affective profile ( $N = 1,197$ , 81.93%), older adults in this study reported a relatively high level of PAs (mean = 12.60, SD = 4.21, range 0–20). By contrast, the mean score for NAs was only 3.09 (SD = 2.90, range 0–20). With regard to vulnerability items, over 20% of respondents ( $N = 336$ , 21.24%) lived with stressful chores and had to ask for help. Meanwhile, the prevalence for a delayed doctor visit and inadequate dental care was 16.31% ( $N = 258$ ) and 20.35% ( $N = 322$ ), respectively. Noteworthy, the most prevalent financial insecurities among older adults were income deduction ( $N = 214$ , 13.53%), spending growth ( $N = 277$ , 17.51%), and asking others to pay the bills ( $N = 304$ , 19.22%). Details are shown in **Table 1**.

**Table 2** compares the fit indices of four LCA models, from the 1-class model to the 4-class model, and decides on the 3-class model as the best. Based on the estimated probability of respondents from each latent class answering yes to vulnerability items, we further summarized the pattern of detected types as MV (including 67% respondents), HV (22% respondents), and DVs (11% respondents).

As shown in **Figure 1**, the probability of individuals with MV to endorse pandemic-related deprivations is almost zero except 12% for income deduction, 14% for spending growth, 19% for requesting help with bills, and 20% for requesting help with chores. Distinct from mildly vulnerable persons, older adults with HV were with significantly higher risks in delayed healthcare utilization, whose probability of experiencing delayed doctor visits and dental care were both over 60%. However, the chance for individuals from the HV group to have financial hardships was all below 10%. Meanwhile, the DVs group simultaneously demonstrated significant risks in healthcare use and financial sustainment. Apart from a 22–54% chance of having items of financial hardship, older adults with DVs had a 44% chance for delayed doctor visits and a 37% chance for delayed dental care.

**Supplementary Table S1**, **Table 3** further examine the association between the vulnerability type and socioeconomic and health factors. While considering the uncertainty of membership assignment, bivariate regressions indicate that sex, marital status, age, difficulty in daily activities, affective profile, and race were significantly associated with older adults’ vulnerability type (see **Supplementary Table S1** for more

**TABLE 1** | Descriptive analysis of the sample ( $N = 1,582$ ).

Characteristics	Mean ( <i>N</i> )	SD (%)	Range
<b>Emotional responses</b>			
Positive emotions	12.60	4.21	[0,20]
Negative emotions	3.09	2.90	[0,20]
<b>Aging attitudes</b>	19.92	5.40	[5,30]
<b>Affective profile</b>			
Self-fulfilling	1,197	81.93	
High-affective	13	0.89	
Low-affective	232	15.88	
Self-destructive	19	1.30	
<b>Sex</b>			
Male	660	41.80	
Female	919	58.20	
<b>Age</b>			
<65	450	28.50	
≥65	1,129	71.50	
<b>Race</b>			
Hispanic	183	11.59	
Non-Hispanic White	1,085	68.71	
Non-Hispanic Black	261	16.53	
Others	90	3.17	
<b>Marital status</b>			
Married or partnered	971	61.50	
Uncoupled	608	38.50	
<b>Education level</b>			
Less than high school	255	16.12	
High school or above	1327	83.98	
<b>Household wealth</b>			
Relatively poor	777	49.24	
Medium level	486	30.80	
Relatively rich	315	19.96	
<b>Medicaid eligibility</b>			
Not eligible	1,431	90.46	
Eligible	151	9.54	
<b>Difficulty in daily activities</b>			
None	554	35.09	
One or more	1,025	64.91	
<b>Self-rated health status</b>			
Relatively poor	608	38.53	
Relatively good	970	61.47	
<b>Vulnerability items</b>			
Diagnosed with the COVID-19	22	1.39	
HH member diagnosed	23	1.45	
Delayed surgery	63	3.98	
Delayed prescription filling	19	1.20	
Delayed doctor visit	258	16.31	
Delayed dental care	322	20.35	
Other delayed health services	102	6.45	
Income deduction	214	13.53	
Spending growth	277	17.51	
Food shortage due to financial hardships	74	4.68	
Missed financial dues	80	5.06	

(Continued)

**TABLE 1** | Continued

Characteristics	Mean ( <i>N</i> )	SD (%)	Range
Other financial hardships	82	5.18	
Ask sb outsides HH to help with bills	304	19.22	
Ask sb outsides HH to help with chores	336	21.24	

SD, Standard Deviation; HH, Household.

information). With weighted multinomial regression, **Table 3** demonstrates that individuals aged below 65 were more likely to have HV (RRR = 1.51, 95% CI: 1.07, 2.11) or DVs (RRR = 1.95, 95% CI: 1.05, 3.61) during the pandemic. Compared with those not eligible for Medicaid, older adults with Medicaid were less likely to have HV (RRR = 0.49, 95% CI: 0.26, 0.93). Meanwhile, Hispanics (RRR = 3.99, 95% CI: 1.89, 8.41) and non-Hispanic Blacks (RRR = 2.06, 95% CI: 1.07, 3.98) had a significantly higher risk of developing DVs. Details are presented in **Table 3**.

In **Table 4**, the relationships between vulnerability type, aging attitudes, and positive emotional responses during the COVID-19 pandemic are presented. With covariates controlled, positive attitudes toward aging were associated with a higher level of positive emotional responses among older adults ( $B = 0.26$ ,  $\beta = 0.35$ , 95% CI: 0.22, 0.31). Despite that Model 2 suggests no significant difference in PAs across three vulnerability groups, we found the association between positive aging attitudes and greater PAs was more significant among individuals with DVs than their mildly vulnerable counterparts ( $B = 0.09$ ,  $\beta = 0.20$ , 95% CI: 0.01, 0.18).

**Table 5** focuses on the negative emotional responses among older adults, investigating its relationship with aging attitudes and the vulnerability type. After adjusting for covariates, positive aging attitudes were associated with fewer negative emotional responses ( $B = -0.20$ ,  $\beta = -0.36$ , 95% CI =  $-0.23$ ,  $-0.17$ ). Compared with mildly vulnerable older adults, persons with HV ( $B = 0.74$ ,  $\beta = 0.10$ , 95% CI = 0.43, 1.06) or DVs ( $B = 1.05$ ,  $\beta = 0.09$ , 95% CI = 0.50, 1.59) were more likely to develop NAs. Moreover, the salutary effect of positive aging attitudes in reducing negative emotional responses was significantly stronger for older adults with DVs than those with MV ( $B = -0.10$ ,  $\beta = -0.15$ , 95% CI =  $-0.19$ ,  $-0.01$ ).

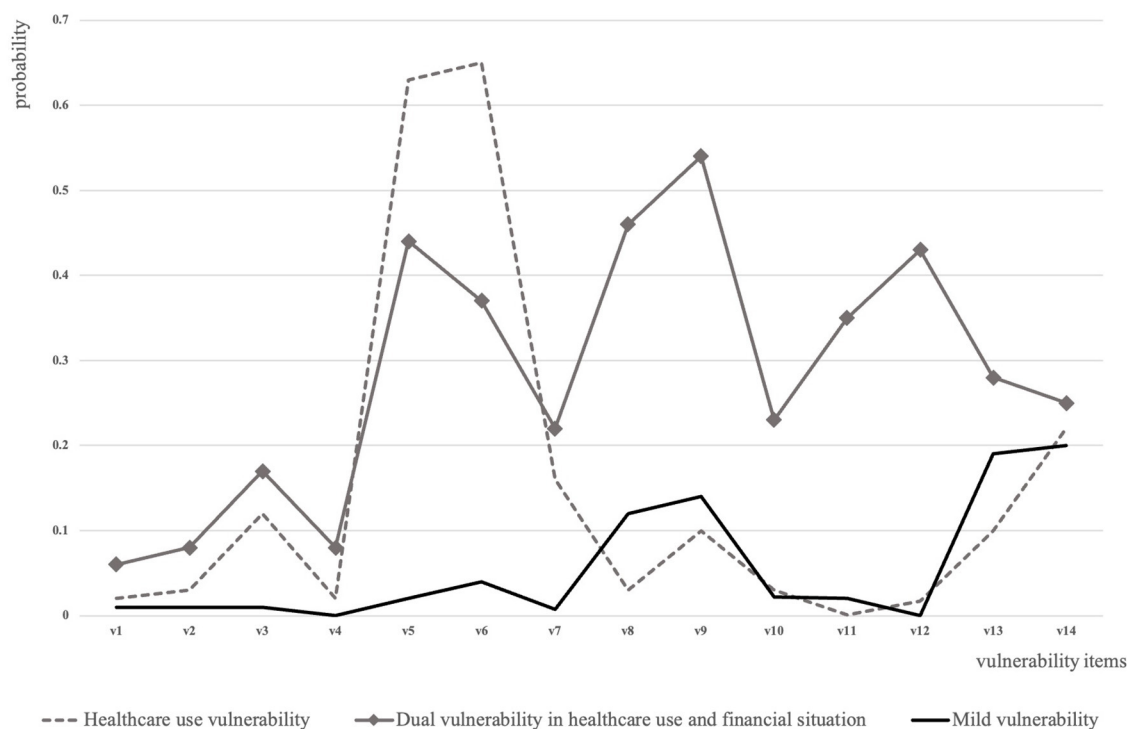
## DISCUSSION

The COVID-19 pandemic has put older adults at increased risk of pandemic-related deprivations and negative emotional responses. This study reveals that older adults demonstrated three vulnerability types in the face of COVID-19 threats. The proportion of individuals with MV, HV, and DVs was 67, 22, and 11%, respectively. We found no significant difference in PAs between vulnerability types, after controlling for a broad spectrum of covariates, such as affective profile, sex, marital status, age, education, race, difficulty in daily activities, self-rated health, eligibility for Medicaid, and household wealth. However, older adults with HV or dual vulnerability were likely to have more NAs than their mildly vulnerable counterparts. In addition,

**TABLE 2 |** Comparing models with different latent classes: fit indices (no. of Obs = 1,582).

No. of groups	loglikelihood	AIC	BIC	ssaBIC	Entropy	LMR		BLRT		Proportion in class			
						2LL	P	2LL	P	1	2	3	4
1	−4915.313	9872.627	9976.953	9910.253									
2	−4645.753	9377.505	9591.125	9454.550	0.80	535.627	<0.001	539.121	<0.001	0.24	0.76		
3	−4587.773	9305.545	9528.459	9422.008	0.80	115.208	0.034	115.960	<0.001	0.22	0.11	0.67	
4	−4557.761	9289.523	9721.731	9445.404	0.69	59.634	0.089	60.023	0.083	0.68	0.02	0.08	0.22

Notes: Selection Criteria: Model selection starts from one latent class and should stop if (a) the AIC/BIC/ssaBIC begins to grow with another new group added; or (b) the p for LMR/BLRT turned non-significant with another new group added ( $p > 0.05$ ). A model with an entropy of 0.8 or over is acceptable. ssaBIC, sample-size adjusted BIC; LMR, Lo-Mendell-Rubin test; BLRT, bootstrapped likelihood ratio test.



**FIGURE 1 |** Vulnerability groups detected among older adults in the United States during the COVID-19 pandemic. Notes: The vulnerability type was determined by the estimated probability of respondents from each latent class answering yes to vulnerability items. The solid black line refers to the group with mild vulnerability; the dotted line refers to the group with healthcare use vulnerability; and the solid line with square marks refers to the group with dual vulnerability in healthcare use and financial sustenance. Vulnerability items are as follows: v1: had been diagnosed with the COVID-19; v2: had a household member been diagnosed with COVID-19; v3: had delayed surgery; v4: had delayed prescription filling; v5: had delayed doctor visit; v6: had delayed dental care; v7: had other delayed health services; v8: had income deduction; v9: had spending growth; v10: had food shortage due to financial hardships; v11: had missed financial dues; v12: had other financial hardships; v13: had to ask someone outside household to help with bills; and v14: had to ask someone outside household to help with chores.

positive aging attitudes were associated with better emotional well-being among older adults, and this salutary effect was more significant for individuals with dual vulnerability. Several findings of this study warrant further discussion.

First, we propose that older adults in the United States demonstrated three distinct vulnerability types during the COVID-19 pandemic. Even for people with MV, there was still a certain probability of asking for help with bills and chores. Consistent with one previous study (19), older adults with inadequate housekeeping capacity are likely to experience

disrupted housekeeping services during the pandemic, thus having to request help from others with chores. Also, the risk of requesting help with bills is understandable. A previous study suggested that the compensation of employees and social benefits from the government were severely affected by COVID-19-induced restrictions (43), which are two of the most important income contributors for older adults (44). Besides the risk of stressful chores, individuals with HV demonstrated a significantly higher risk of endorsing delayed healthcare services. Theoretically, individuals with HV are more likely from states



**TABLE 3 |** Multinomial logit regression examining differences in risk factors across three detected latent vulnerability groups (reference group: MV,  $N = 1,539$ ).

	HV		DVs	
	RRR	95%CI	RRR	95%CI
<b>Age</b> (ref: $\geq 65$ )				
<65	1.51*	(1.07, 2.11)	1.95*	(1.05, 3.61)
<b>Race</b> (ref: non-Hispanic White)				
Hispanic	0.70	(0.36, 1.36)	3.99***	(1.89, 8.41)
Non-Hispanic Black	0.68	(0.43, 1.10)	2.06*	(1.07, 3.98)
Others	0.48	(0.21, 1.09)	3.12	(0.84, 11.60)
<b>Medicaid eligibility</b> (ref: not eligible)				
Eligible	0.49*	(0.26, 0.93)	1.04	(0.48, 2.26)

Notes: Regressions were weighted, with sample weights that have corrections for emotion non-response using inverse probability weights. Non-significant characteristics, such as affective profile, gender, marital status, education, household wealth, difficulty in daily activities, and self-rated health were not presented due to space limits.

MV, mild vulnerability; HV, healthcare use vulnerability; DVs, dual vulnerability in healthcare use and financial sustainability; RRR, relative-risk ratio; CI, confidence interval; ADL, activities of daily living;  $p < 0.05^*$ ,  $p < 0.001^{***}$ .

and counties endorsing the stay-at-home order, which restricts interpersonal contacts and suggests cancellation of elective care (14). Especially in hard-hit areas where health resources are massively reassigned for pandemic control, it becomes even more challenging for older adults to access non-infectious healthcare (45). Moreover, more than one in ten older adults had DVs. Possibly, individuals with dual vulnerability are those with lower socioeconomic status. On the one hand, one prior study noted that about half of the disadvantaged older adults in the United States are living without emergency savings, thereby with a significantly higher chance of experiencing financial hardships during recessions (46). Moreover, they are more likely to have increased expenditure as many of the mechanisms for navigating life on a limited budget became difficult during the pandemic (47). On the other hand, disadvantaged older adults are more likely to depend on public transportation to get healthcare services, which is at least inconvenient under the pandemic restrictions (48). Thus, we urge local governments and communities to keep a watchful eye on older adults during crises. Noteworthy, the vulnerability is more likely to be heterogeneous rather than homogenous, and a careful evaluation for older adults of their risks in trauma-related deprivations is critical before social services are conducted.

In addition, we suggest that older adults under 65 years were less likely to be mildly vulnerable, while those not eligible for Medicaid were more likely to have healthcare vulnerability, and Hispanics/non-Hispanic Blacks were prone to have dual vulnerability. In contrast with previous studies suggesting age as a risk factor of vulnerability (12, 13), we suggest that individuals aged 60–65 years were more likely to have financial hardships and inadequate healthcare services than their older counterparts. Two explanations rationalize this finding. Firstly, older adults below 65 years are more likely to be active in the labor market before the pandemic. However, they would find it difficult to reenter the workforce during the post-pandemic recession, thereby having

a greater chance to experience financial hardships (1). Secondly, it is possible that individuals of older ages would ignore their physical discomforts and require lesser care and services, as they tend to have better subjective well-being and be more satisfied with life (49). Moreover, an existing study suggested that adults aged over 65 years conduct more telemedicine visits than their 55–65 years counterparts, thus at a lower risk of delaying healthcare (50). Apart from age, we also found that individuals not eligible for Medicaid are more likely to have healthcare vulnerability, as Medicaid promotes healthcare access during the pandemic (51). Furthermore, we found Hispanics and non-Hispanic Blacks are more likely to have dual vulnerability than their Whites counterparts. One recent review suggested that Hispanics and non-Hispanic Blacks experienced higher rates of infection, hospitalization, and mortality in the pandemic (52). According to Blumenshine's model (48), Hispanics and non-Hispanic Blacks depend largely on public transportation and have limited capacity to work at home, thus becoming harder to access healthcare services and sustain income during the pandemic. In a vicious cycle, they have a greater risk of infection to get a job or seek healthcare services, which intensifies the probability of inadequate healthcare use and financial hardships once individuals become infected. In a nutshell, we propose that older adults below 65 years, being Hispanics or non-Hispanic Blacks, and not eligible for Medicaid are more likely to have healthcare vulnerability or dual vulnerability during the pandemic, which is worthy of more care and services.

Third, this study reveals that the vulnerability type of older adults presented no significant relationship with PAs but was significantly associated with NAs during the pandemic. Previous evidence claimed that severe vulnerability would lead to stress and a ruined sense of self-continuity, thus reducing PAs in young adults (53). However, this study found no significant difference in PAs between older adults from different vulnerability groups. Possibly, intrinsic motivation for emotionally meaningful goals among older adults could rationalize this finding, which is examined to be helpful to sustain PAs under challenging situations (54). Often, older adults are prone to pay attention to positive stimuli over negative information during stressful events, thus being easier to develop PAs (55). However, emotional regulation strategies are harder to work on negative arousals under prolonged stress (56). With the introduction of the sense of relative deprivation (57), people with healthcare vulnerability or dual vulnerability are understandable to have a higher level of NAs. Individuals in traumatic events are prone to compare their vulnerability with others. Nevertheless, compared with mildly vulnerable counterparts, older adults with healthcare or dual vulnerability might have a sense of unfairness, which is likely to activate negative responses such as hostility and anger (58). Thus, although older adults are often more resilient in emotional well-being, their NAs should also be noted and timely intervened when individuals demonstrate healthcare or dual vulnerability in crises.

Lastly, we propose that positive aging attitudes benefited older adults' emotional well-being in the COVID-19 context, especially for individuals with DVs. As noted by prior studies,



**TABLE 4 |** Weighted linear regressions of the relationship between aging attitudes, vulnerability type, and positive emotional responses among older adults ( $N = 1,539$ ).

Variables	Model 1			Model 2			Model 3		
	B (Robust S.E.)	95%CI	Beta	B (Robust S.E.)	95%CI	Beta	B (Robust S.E.)	95%CI	Beta
<b>Aging attitudes</b>	0.26 (0.02)	(0.22, 0.31)	0.35***	0.27 (0.02)	(0.22, 0.31)	0.36***	0.25 (0.02)	(0.20, 0.29)	0.33***
<b>Vulnerability (ref: MV)</b>									
HV				−0.01 (0.25)	(−0.48, 0.48)	−0.01	−1.85 (0.95)	(−3.72, 0.02)	−0.19
DVs				0.56 (0.44)	(−0.34, 1.46)	0.03	0.54 (1.26)	(−1.94, 3.02)	0.03
<b>Interaction (ref: AA * MV)</b>									
AA * HV							−0.01 (0.07)	(−0.14, 0.13)	−0.02
AA * DVs							0.09 (0.04)	(0.01, 0.18)	0.20*
Constant	10.53 (1.04)	(8.50, 12.57)		10.51 (1.04)	(8.48, 12.55)		10.83 (1.04)	(8.79, 12.87)	
Covariates		Yes			Yes			Yes	

Notes: Linear regressions were conducted with positive emotional responses as the outcome variable. All regression models controlled for affective profile, sex, marital status, age, education, race, difficulty in daily activities, self-rated health status, eligibility for Medicaid, and household wealth. Regressions were weighted, with sample weights that have corrections for emotion non-response using inverse probability weights.

MV, mild vulnerability; HV, healthcare use vulnerability; DVs, dual vulnerability in healthcare use and financial sustainment; AA, aging attitudes; B, coefficient; S.E., standard error; CI, confidence interval, \* $p < 0.05$ ; \*\*\* $p < 0.001$ .

**TABLE 5 |** Weighted linear regressions of the relationship between aging attitudes, vulnerability type, and negative emotional responses among older adults ( $N = 1,539$ ).

Variables	Model 1			Model 2			Model 3		
	B (Robust S.E.)	95%CI	Beta	B (Robust S.E.)	95%CI	Beta	B (Robust S.E.)	95%CI	Beta
<b>Aging attitudes</b>	−0.20 (0.01)	(−0.23, −0.17)	−0.36***	−0.19 (0.01)	(−0.22, −0.17)	−0.35***	−0.19 (0.02)	(−0.22, −0.15)	−0.33***
<b>Vulnerability (ref: MV)</b>									
HV				0.74 (0.16)	(0.43, 1.06)	0.10***	0.88 (0.63)	(−0.35, 2.11)	0.12
DVs				1.05 (0.28)	(0.50, 1.59)	0.09***	2.83 (0.85)	(1.15, 4.50)	0.23***
<b>Interaction (ref: AA * MV)</b>									
AA * HV							−0.01 (0.03)	(−0.07, 0.05)	−0.02
AA * DVs							−0.10 (0.04)	(−0.19, −0.01)	−0.15*
Constant	11.30 (0.68)	(9.96, 12.64)		10.78 (0.69)	(9.43, 12.12)		10.40 (0.72)	(8.99, 11.81)	
Covariates		Yes			Yes			Yes	

Notes: Linear regressions were conducted with negative emotional responses as the outcome variable. Both regression models controlled for affective profile, sex, marital status, age, education, race, difficulty in daily activities, self-rated health status, eligibility for Medicaid, and household wealth. Regressions were weighted, with sample weights that have corrections for emotion non-response using inverse probability weights.

MV, mild vulnerability; HV, healthcare use vulnerability; DVs, dual vulnerability in healthcare use and financial sustainment; AA, aging attitudes; B, coefficient; S.E., standard error; CI, confidence interval, \* $p < 0.05$ ; \*\*\* $p < 0.001$ .

older adults have endured prevalent discrimination during the pandemic, as some young adults may blame the dramatic response of COVID-19 as an “old people problem” (59, 60). Tags, such as #BoomerRemover#, are prevalently endorsed to express the hostility toward the elderly, exacerbating social discrimination toward older adults in the pandemic settings. Often, old persons may have emotional exhaustion under ageism discrimination, yet positive aging attitudes help to promote self-appreciation and thus against negative ruminations (61). In particular, positive attitudes toward aging might be even more critical for older adults with dual vulnerability. As noted by the attribution theory (62), older adults with multiple-dimensional vulnerability are more likely to make internal attributions for their pandemic-related deprivations. Often, self-blame is associated with greater internal ageism (i.e., people feeling ashamed for their age) and more negative

affections among older adults (63). However, positive aging attitudes might alleviate such internal ageism via informational and behavioral processing. On the one hand, positive aging attitudes help individuals avoid ageism information and conduct fewer negative ruminations on that (64). Also, older adults with positive aging attitudes are less likely to consider their vulnerability during the pandemic as a threat to future lives, which might lower prospective fear and worries (65). On the other hand, people with positive aging attitudes are more likely to conduct adaptative behaviors to cope with their vulnerability during the pandemic, which establishes a better sense of self-efficacy and would mitigate the internal ageism (66). Therefore, we suggest that encouraging positive aging attitudes might be a critical approach for social services to promote emotional well-being for older adults, especially those with dual vulnerability.

## Strengths and Limitations

This study is among the first to explore the heterogeneity in vulnerability of the older adults during the COVID-19 pandemic. We provided novel evidence to reveal three latent groups of vulnerability and the relationship between vulnerability type, aging attitudes, and emotional responses. However, some limitations of this study should be acknowledged. First, this study reports that 1.39% of respondents were diagnosed. The lack of COVID-19 tests, especially at the beginning of the pandemic, and the potential stigma associated with the infection may contribute to the underestimation of the infection rate in this sample. Given the overstretched healthcare system and financial needs (before Medicare coverage) among infected older adults, the proportion of people with dual vulnerability might be higher in the U.S. population. Hence, it is of interest for future studies to use multiple sources of data to better represent populations who were infected with the disease. Second, based on cross-sectional data, this study cannot infer causality, although it seems plausible in the temporal sequence vulnerability and aging attitudes first, and emotional responses being the outcome. Third, there might be some confounding that was not controlled. For instance, we assumed that differences in political responses of states, territories, and counties contribute to the heterogeneity in inadequate healthcare utilization. However, residence information was lacking in this data. Lastly, the uncertainty in membership assignment was not considered in weighted regressions, despite bivariate analyses using a 3-step procedure supporting these findings.

## CONCLUSION

This study suggests that adults aged over 60 years presented three distinct patterns of vulnerability during the pandemic. About 67% of individuals were mildly vulnerable, and more than 30% of respondents had HV or DVs. Besides, individuals not eligible for Medicaid were more likely to have healthcare vulnerability, and Hispanics and non-Hispanic Blacks were more likely to have dual vulnerability. Meanwhile, adults below 65 years were prone to have healthcare vulnerability or dual vulnerability other than MV. While older adults from different vulnerability types had no significant difference in PAs, those with HV or dual vulnerability were likely to have more NAs. Besides, positive aging attitudes were associated with more positive and fewer NAs, and this salutary effect is more significant for individuals with dual vulnerability. Thus, we urge local governments and communities to keep a watchful eye on older adults during crises,

with individuals having healthcare or dual vulnerability being prioritized. In addition, encouraging positive aging attitudes might be a critical approach for social services to promote the emotional well-being of older adults, especially those with dual vulnerability.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Yale University Institutional Review Board. The patients/participants provided their verbal informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MF carried out the statistical analysis and drafted the manuscript. JG assisted with writing the article. XC critically reviewed this article. BH, FA, and MS participated in the revision of this manuscript. QZ designed the study and revised the manuscript. All authors have read and approved the manuscript.

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# Associations Among Workplace Bullying, Resilience, Insomnia Severity, and Subjective Wellbeing in Chinese Resident Doctors

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**Background:** Although workplace bullying is common among medical workers, its associations with insomnia severity and subjective wellbeing are still unclear. Our study aimed to investigate these associations among resident doctors who are more vulnerable to both workplace bullying and insomnia.

**Methods:** We conducted a cross-sectional survey of 1,877 resident doctors from 12 hospitals across 7 administrative regions in China. Workplace bullying, resilience, insomnia severity, and subjective wellbeing were evaluated by the Negative Acts Questionnaire-Revised (NAQ-R), the Chinese version of the Connor-Davidson Resilience Scale-10-item (CD-RISC-10), the Insomnia Severity Index, and the Index of Wellbeing, respectively. Further, a logistic regression analysis was used to analyze factors associated with insomnia. In addition, structural equation modeling (SEM) was applied to examine the associations among workplace bullying, resilience, insomnia severity, and subjective wellbeing.

**Results:** In the present study, the rates of workplace bullying and insomnia were 51.4 and 33.2%, respectively. Workplace bullying (OR = 1.056,  $p < 0.001$ ) and poor resilience (OR = 0.957,  $p < 0.001$ ) were the factors associated with insomnia after controlling the confounding variables. Further, SEM of the present study revealed a direct relationship between workplace bullying and subjective wellbeing (std- $\beta$  = -0.223,  $p < 0.001$ ). In addition, insomnia severity (std- $\beta$  = -0.071,  $p < 0.001$ ) and resilience (std- $\beta$  = -0.092,  $p < 0.001$ ) can individually or collectively (std- $\beta$  = -0.008,  $p < 0.001$ ) mediate the indirect associations between workplace bullying and subjective wellbeing. However, resilience was found to act as a moderator only in the direct association between workplace bullying and subjective wellbeing.

**Conclusions:** Workplace bullying and poor resilience were the factors associated with insomnia. Further, greater resilience acted as a buffer in the direct association



between workplace bullying and subjective wellbeing, whereas both insomnia severity and resilience were critical mediators in the indirect associations between them.

**Keywords:** workplace bullying, insomnia, resilience, subjective wellbeing, Chinese resident doctor, questionnaire survey

## INTRODUCTION

Sleep problems due to various causes are prevalent among resident doctors (1). Several previous studies have reported that nearly one in two medical students and resident doctors have poor quality of sleep which is strongly associated with workplace bullying (2, 3). Workplace bullying is common among trainees in many medical fields, including surgery (4), psychiatry (5), internal medicine, and family medicine (6). Resident doctors are often occupied with intensive work and study and hence are more vulnerable to workplace bullying and insomnia. This may worsen their wellbeing and performance during clinical tasks (7, 8). Insomnia is strongly associated with cardiovascular diseases (9) and deterioration in cognitive performance (10), memory (11), and emotional function (12, 13). A previous meta-analysis of 17 studies involving 115,988 participants in China showed that the pooled prevalence of insomnia was 15.0% (14), and younger adults were more likely to suffer from insomnia. Therefore, it is important to focus on the association between workplace bullying and insomnia disorders among young doctors in China.

Workplace bullying refers to situations in which people are repeatedly subjected to negative behavior or mistreatment by others in their organization of work (15). Previous studies have found that negative workplace behavior is an occupational hazard in the healthcare sector (16). The prevalence of bullying varies among studies depending on the research design and assessment methods. According to a study involving Australian surgeons in 2016, 47% of the surgeons were victims of workplace bullying, and 68% witnessed workplace bullying (4). In the US, 37% of junior doctors have experienced bullying during their training (15). But in China, workplace bullying among resident doctors is overlooked. Some studies have suggested that workplace bullying is closely related to insomnia and the association is significantly closer for individuals with the miR-146a GG genotype (3, 17, 18). However, few studies have focused on mediating and moderating variables as well as the mechanisms underlying the association between workplace bullying and insomnia.

Resilience is the ability to mentally and emotionally cope with a crisis and help individuals recover, maintain or improve their mental health when challenged by risk factors (19, 20). Previous studies have shown that resilient characteristics are associated with lower anxiety and depression levels as well as reduced risk of suicidal ideation (21). When facing workplace bullying, individuals with poor resilience are prone to stronger emotional dysregulation than those with greater resilience (22). However, there is a paucity of research evaluating the mediating and moderating effects of resilience among workplace bullying, insomnia severity, and subjective wellbeing.

Subjective wellbeing is a self-reported measure of wellbeing. A tripartite model of subjective wellbeing developed by Ed Diener describes how people experience the quality of their lives (23). It comprises both reflective cognitive judgments, such as the satisfaction of life, and emotional reactions to life in terms of positive emotions vs. negative emotions (24). Subjective wellbeing not only reflects concerns of people and feelings regarding their quality of life (25) but also is closely associated with many important mental health indicators, such as anxiety, depression (26, 27), and insomnia (28). Insomnia has been shown to be detrimental to wellbeing of an individual and thus alleviation of sleep disorders is an effective way to improve subjective wellbeing (29, 30). However, few studies have assessed the associations between workplace bullying and subjective wellbeing.

The present study aimed to explore the associations among workplace bullying, resilience, insomnia severity, and subjective wellbeing in Chinese resident doctors. The hypotheses were: ① workplace bullying and resilience were the factors associated with insomnia; ② insomnia severity might be a mediator in the association between workplace bullying and subjective wellbeing, and the presence of resilience might act as a moderator.

## MATERIALS AND METHODS

### Recruitment Procedure

A cross-sectional study was conducted through an online survey from January to April 2021. The participants of this study were recruited via WeChat network platform. The sampling of resident doctors was conducted from 12 hospitals across 7 administrative regions in China using convenience sampling strategy.

All resident doctors in hospitals possessed their own WeChat groups. An applet “Questionnaire Star” with an anonymous questionnaire was sent to the WeChat groups to invite resident doctors to participate in the survey. At the start of the questionnaire, all resident doctors were informed of the purpose of the present study and were requested whether they had a previous diagnosis of mental illness, such as schizophrenia, bipolar disorder, depression, anxiety, and obsessive-compulsive disorder. The study enrolled resident doctors who spent at least 6 months in the standardized residency training program at hospital. Those who had a previous diagnosis of mental illness or spent less than 6 months in the residency program were excluded from the present study. The present study was approved by the Research Ethics Board of Shantou University Medical College.

A total of 2,154 resident doctors completed the survey, and a total of 1,877 valid questionnaires were collected, yielding an effective rate of 87.1%.

## Questionnaires

### Demographic Characteristics

The collected general demographics of the resident doctors included their gender, age, marital status, education level, resident grade, specialty, salary per month, and number of night shifts per month.

### Workplace Bullying

Globally, the Negative Acts Questionnaire-Revised (NAQ-R) is constantly used to evaluate the prevalence of workplace bullying (31). The NAQ-R contains 22 types of negative behaviors, such as physical injury, verbal aggression, and social exclusion. The participants were required to select how often they were bullied by others in the workplace. Scores of between 1 and 5 for each question represent “never,” “now and then,” “monthly,” “weekly,” and “daily.” The overall score ranged from a minimum of 22 to a maximum of 110, and the higher scores indicated greater experiences of workplace bullying. A person with a total NAQ-R score  $\geq 33$  is usually identified as a victim of workplace bullying (32). Further, the Cronbach's alpha of the NAQ-R, which indicates the internal consistency of scales, was found to be quite satisfactory at 0.95.

### Resilience

In the present study, resilience was evaluated using the Connor-Davidson Resilience Scale-10-item (CD-RISC-10) (33, 34). The CD-RISC-10 had a high internal consistency (Cronbach's alpha  $> 0.85$ ) (34–36). It captures the core features of resilience over the preceding month. Further, the CD-RISC-10 comprises a total of 10 items that measure resilience on a five-point Likert scale. The participants were asked to rate the extent of their agreement (0, never; 1, few; 2, sometimes; 3, often; and 4, all the time). The rating score ranged from 0 to 40, and a lower score indicated poor resilience (36).

### Sleeping Problems Assessment

In order to assess the sleeping problems of resident doctors, the insomnia severity index (ISI) was used in the present study. It comprises of seven items assessing (a) sleep-onset severity, (b) the maintenance of sleep, (c) problems of early morning awakening, (d) satisfaction with current sleep pattern, (e) interference with daily functioning, (f) noticeability of impairment due to sleep problems, and (g) level of distress caused by sleep problems. The respondents were requested to rate each item on a five-point Likert scale (0, none; 1, mild; 2, moderate; 3, severe; and 4, extremely severe). Items were summed. An overall score  $> 8$  suggests the presence of insomnia, and higher scores indicated more severe sleeping problems (37). The internal consistency of scales is great (Cronbach's alpha = 0.86) (38).

### Subjective Wellbeing

The subjective wellbeing has been widely assessed using the index of wellbeing. This scale is composed of the following

two sections: ① an index of general affect; and ② a life satisfaction questionnaire. This scale contains nine items measuring subjective wellbeing on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The overall subjective wellbeing index score is the weighted sum of the scores of the above two sections. Further, a lower score indicates poor subjective wellbeing. In a latest study, it has been reported that the internal consistency of this scale was ideal (Cronbach's alpha = 0.90) (39).

## Statistical Analysis

In the present study, Chi-squared tests were applied to perform comparisons of the categorical variables between the insomnia group and non-insomnia group. Student *t*-test and Mann-Whitney test were used to compare differences between two groups for the normally and non-normally distributed continuous variables, respectively. A binary logistic regression analysis was also used to analyze the factors associated with insomnia, using workplace bullying and resilience as explanatory variables and controlling for potential confounding factors. The correlation analyses of normally and non-normally distributed continuous variables were tested through Pearson and Spearman correlation analyses, respectively.

Structural equation modeling (SEM) was performed using Mplus 8.3 to conduct path tests and examine the mediating effects of insomnia severity between workplace bullying and subjective wellbeing, as well as to evaluate the moderating effects of resilience among workplace bullying, insomnia severity, and subjective wellbeing. The significance of the mediating and moderating effects was examined using the bootstrap method. The 95% confidence intervals (95% CIs) were calculated using percentile and bias-corrected bootstrap methods with 5,000 iterations. Further, the mediating and moderating effects were significant if the 95% CI did not include a zero. The statistical significance of difference was set at  $P < 0.05$ . In addition, a simple slope analysis was performed to depict the moderating effects of resilience.

## RESULTS

### Characteristics of Participants

The demographic characteristics of the resident doctors were displayed in **Table 1**. The mean age of the 1,877 resident doctors was  $24.65 \pm 1.47$  years, 61.8% were female, 55.8% were single, 37.1% were in a relationship, and 7.1% were married. Further, the resident doctors in the first, second, and third years accounted for 39, 36.4, and 24.6% of all participants, respectively. In addition, among all resident doctors, 49.4% specialized in internal medicine, 22.3% specialized in surgery, 7.2% specialized in gynecology, and 16.2% specialized in other specialties. A total of 623 resident doctors had varying degrees of insomnia, yielding an insomnia rate of 33.2%.

Results of analyses of the difference between insomnia and non-insomnia groups revealed that males ( $p = 0.001$ ), higher age ( $p = 0.017$ ), higher resident grade ( $p = 0.001$ ), lower salary ( $p = 0.002$ ), more night shifts ( $p = 0.006$ ), greater experience of

**TABLE 1** | Characteristics of the resident doctors in the insomnia group and non-insomnia group.

	Total (n = 1,877)	Non-insomnia (n = 1,254)	Insomnia (n = 623)	P-values
Gender, % (n)				<b>0.001**</b>
Male	38.2 (717)	35.6 (446)	43.5 (271)	
Female	61.8 (1,160)	64.4 (808)	56.5 (352)	
Age, years (M ± SD)	24.65 ± 1.471	24.596 ± 1.457	24.767 ± 1.496	<b>0.017**</b>
Marital status, % (n)				0.46
Single/Divorced	55.8 (1047)	56.8 (712)	53.8 (335)	
Relationship	37.1 (697)	36.4 (456)	38.7 (241)	
Married	7.1 (133)	6.8 (86)	7.5 (47)	
Education level, % (n)				0.638
Junior college	1.3 (24)	1.1 (14)	1.6 (10)	
Bachelor	34.5 (647)	34.2 (429)	35 (218)	
Master	63.7 (1,196)	64 (803)	63.1 (393)	
Ph.D.	0.5 (10)	0.7 (8)	0.3 (2)	
Resident grade, % (n)				<b>0.001**</b>
First-year	39 (732)	41.6 (521)	33.9 (211)	
Second-year	36.4 (683)	36 (452)	37.1 (231)	
Third-year	24.6 (462)	22.4 (281)	29 (181)	
Specialty, % (n)				0.209
Internal medicine	49.4 (927)	50.1 (628)	48 (299)	
Surgery	22.3 (419)	21.6 (271)	23.7 (148)	
Gynecology	7.2 (136)	7.8 (98)	6.1 (38)	
Pediatrics	4.9 (92)	5.3 (66)	4.2 (26)	
Others	16.2 (303)	15.2 (191)	18 (112)	
Salary per month, % (n)				<b>0.002**</b>
<1,000 yuan	28.5 (536)	26.6 (334)	32.4 (202)	
1,001–3,000 yuan	39.2 (735)	40.8 (512)	35.8 (223)	
3,001–5,000 yuan	18.5 (347)	17.4 (218)	20.7 (129)	
>5,000 yuan	13.8 (259)	15.2 (190)	11.1 (69)	
Number of night shifts per month, % (n)				<b>0.006**</b>
0	10.8 (202)	11.9 (149)	8.5 (53)	
1–2	17.8 (335)	18.7 (235)	16.1 (100)	
3–5	51.9 (974)	51.7 (648)	52.3 (326)	
>5	19.5 (366)	17.7 (222)	23.1 (144)	
Workplace bullying, M ± SD	36.02±12.969	32.84±10.047	42.4±15.581	<b>0.000**</b>
Person-related bullying	13.32±5.169	12.09±3.889	15.77±6.409	<b>0.000**</b>
Work-related bullying	13.76±5.236	12.56±3.829	16.17±6.666	<b>0.000**</b>
Organizational injustice	8.94±3.834	8.18±3.49	10.46±4.041	<b>0.000**</b>
Resilience	23.24±9.267	24.76±9.486	20.19±7.984	<b>0.000**</b>

M ± SD, mean ± standard deviation.

\*\**p* < 0.01.All bold values are statistically significant (*p* < 0.05).

workplace bullying (*p* < 0.001), and poor resilience (*p* < 0.001) were more significant in insomnia group.

## The Factors Associated With Insomnia

Results of binary logistic regression analyses were shown in **Table 2**. The males (OR = 1.251, *p* = 0.043) and status of a senior resident doctor (second-year vs. first-year: OR = 1.23, *p* = 0.123; third-year vs. first-year: OR = 1.588, *p* = 0.004) were both more likely to suffer from insomnia. Notably, resident doctors who had greater experience of workplace bullying (OR = 1.056, *p* < 0.001) and poor resilience (OR = 0.957, *p* < 0.001) were

identified as the factors associated with insomnia after controlling for the confounding variables (gender, age, resident grade, salary, and number of night shifts).

## Correlations of Variables

The results of the correlation analyses in the current study showed that all variables were correlated (**Table 3**). Expectedly, insomnia severity was positively associated with workplace bullying but negatively associated with resilience. Further, subjective wellbeing was negatively associated with both

**TABLE 2 |** Binary logistic regression analysis of insomnia.

	$\beta$	OR	95%CI	P-values
Male	0.224	1.251	(1.007, 1.553)	<b>0.043*</b>
Age	0.034	1.035	(0.951, 1.126)	0.425
Resident grade				<b>0.017*</b>
First-year (Reference)	/	1	/	/
Second-year	0.207	1.23	(0.945, 1.601)	0.123
Third-year	0.463	1.588	(1.157, 2.18)	<b>0.004**</b>
Salary per month				0.364
<1,000 yuan (Reference)	/	1	/	/
1,001–3,000 yuan	−0.101	0.904	(0.697, 1.172)	0.444
3,001–5,000 yuan	0.083	1.086	(0.796, 1.483)	0.602
>5,000 yuan	−0.228	0.796	(0.556, 1.139)	0.212
Number of night shifts per month				0.602
0 (Reference)	/	1	/	/
1–2	0.109	1.115	(0.734, 1.694)	0.61
3–5	0.201	1.223	(0.848, 1.764)	0.282
>5	0.259	1.296	(0.856, 1.962)	0.22
Workplace bullying	0.055	1.056	(1.046, 1.066)	<b>0.000**</b>
Resilience	−0.044	0.957	(0.946, 0.968)	<b>0.000**</b>

Gender, age, resident grade, salary, and number of night shifts were controlled for in the analyses of workplace bullying and resilience.

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

All bold values are statistically significant ( $p < 0.05$ ).

**TABLE 3 |** Correlation analyses of all variables.

	1	2	3	4	5	6	7	8	9
1 Workplace bullying	1								
2 Person-related bullying	0.928**	1							
3 Work-related bullying	0.924**	0.855**	1						
4 Organizational injustice	0.869**	0.693**	0.686**	1					
5 Resilience	−0.302**	−0.290**	−0.278**	−0.244**	1				
6 Insomnia severity	0.410**	0.403**	0.378**	0.388**	−0.330**	1			
7 Subjective wellbeing	−0.437**	−0.383**	−0.387**	−0.423**	0.547**	−0.409**	1		
8 General affect	−0.425**	−0.372**	−0.373**	−0.415**	0.549**	−0.402**	0.962**	1	
9 Life satisfaction	−0.417**	−0.365**	−0.371**	−0.402**	0.500**	−0.389**	0.947**	0.834**	1

\*\* $p < 0.01$ .

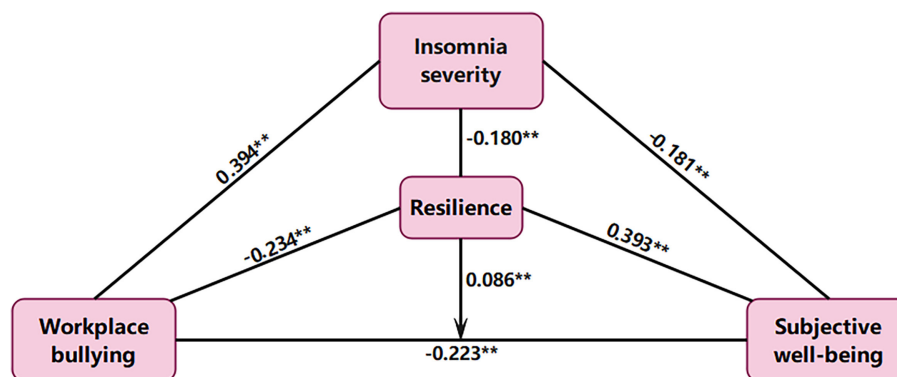
workplace bullying and insomnia severity but positively associated with resilience.

## Structural Equation Model

The SEM was performed in the present study to test the study hypotheses (Figure 1). The indices of the model fit were ideal (SRMR = 0.008, CFI = 0.998, TLI = 0.986, RMSEA = 0.035, and RMSEA  $p$ -value < 0.05). In addition, the tests of single paths were all statistically significant ( $p < 0.001$ ) and their coefficients [standardized  $\beta$  (std- $\beta$ )] were displayed in Figure 1 and Table 4.

According to the bootstrap results of the current study, a direct association was found between workplace

bullying and subjective wellbeing (std- $\beta$  = −0.223, S.E. = 0.024,  $p < 0.001$ ). This indicates a direct effect between workplace bullying and subjective wellbeing. Further, the moderating effects of resilience were identified only on this direct association (std- $\beta$  = 0.086, S.E. = 0.020,  $p < 0.001$ ). Therefore, greater resilience would attenuate this direct association. In addition, results of the present study identified insomnia severity as a significant mediator between workplace bullying and subjective wellbeing. Besides, the bootstrap results showed that resilience was also a mediator among workplace bullying, insomnia severity, and subjective wellbeing.



**FIGURE 1 |** Structural equation model describing the indirect associations between workplace bullying and subjective wellbeing via insomnia severity and resilience. The direct association between workplace bullying and subjective wellbeing moderated by resilience is also shown. Standardized  $\beta$  are reported. \*\* $p < 0.01$ .

**TABLE 4 |** Tests of single path.

Single path	Std- $\beta$	S.E.	P-values
Workplace bullying $\rightarrow$ Insomnia severity	0.394	0.026	<b>0.000**</b>
Workplace bullying $\rightarrow$ Resilience	-0.234	0.025	<b>0.000**</b>
Workplace bullying $\rightarrow$ Subjective wellbeing	-0.223	0.024	<b>0.000**</b>
Insomnia severity $\rightarrow$ Subjective wellbeing	-0.181	0.025	<b>0.000**</b>
Resilience $\rightarrow$ Subjective wellbeing	0.393	0.024	<b>0.000**</b>
Resilience $\rightarrow$ Insomnia severity	-0.180	0.022	<b>0.000**</b>
Workplace bullying $\times$ Resilience $\rightarrow$ Subjective wellbeing	0.086	0.020	<b>0.000**</b>

Std- $\beta$ , standardized  $\beta$ ; S.E., standard error.

\*\* $p < 0.01$ .

All bold values are statistically significant ( $p < 0.05$ ).

## Mediation Analysis

A detailed results of bootstrap in the present study was as presented in **Table 5**. With an exception of for the direct effect between workplace bullying and subjective wellbeing [Path 1, std- $\beta = -0.223$ , S.E. = 0.024, percentile 95% CI (-0.270, -0.177),  $p < 0.001$ ], the rest four other indirect paths were also confirmed. Specifically, and in consistence with the hypotheses of the current study, insomnia severity was identified as a significant mediator between workplace bullying and subjective wellbeing [Path 2, std- $\beta = -0.071$ , S.E. = 0.011, percentile 95% CI (-0.093, -0.050);  $p < 0.001$ ]. Moreover, resilience had significant mediating effects on the association between workplace bullying and insomnia severity [Path 3, std- $\beta = 0.042$ , S.E. = 0.007, percentile 95% CI (0.029, 0.057),  $p < 0.001$ ], as well as on the association between workplace bullying and subjective wellbeing [Path 4, std- $\beta = -0.092$ , S.E. = 0.012, percentile 95% CI (-0.117, -0.069),  $p < 0.001$ ]. Besides, both resilience and insomnia severity mediated the relationship between workplace bullying and subjective wellbeing [Path 5, std- $\beta = -0.008$ , S.E. = 0.002, percentile 95% CI (-0.011, -0.005),  $p < 0.001$ ].

## Moderation Analysis

Results of the current study indicated that the direct association between workplace bullying and subjective wellbeing was statistically significant. In addition, resilience was identified

as a moderator only on this direct association (std- $\beta = 0.086$ , S.E. = 0.020,  $p < 0.001$ ). Based on the described findings, a moderation model was tested to obtain more details and to determine whether the direct association between workplace bullying and subjective wellbeing varied as a function of resilience.

The results of bootstrap on the moderating effects of resilience were demonstrated in **Table 6**. The coefficients of the moderating effects of resilience were all negative at high, medium, and low levels of resilience [High resilience:  $\beta = -0.029$ , S.E. = 0.006, percentile 95% CI (-0.042, -0.017); Medium resilience:  $\beta = -0.044$ , S.E. = 0.005, percentile 95% CI (-0.054, -0.035); low resilience:  $\beta = -0.059$ , S.E. = 0.006, percentile 95% CI (-0.070, -0.048)]. However, the pairwise comparison among the three levels of resilience were all positive and statistically significant [High-Low:  $\beta = 0.029$ , S.E. = 0.007, percentile 95% CI (0.016, 0.045); High-Mean:  $\beta = 0.015$ , S.E. = 0.004, percentile 95% CI (0.008, 0.022); Mean-Low:  $\beta = 0.015$ , S.E. = 0.004, percentile 95% CI (0.008, 0.022)].

Thus, the moderating effects of resilience on the direct association between workplace bullying and subjective wellbeing were significantly different among the three levels of resilience. Poor resilience would strengthen the direct association between workplace bullying and subjective wellbeing. Furthermore, simple slope analysis of the moderating effects of resilience,



**TABLE 5 |** Bootstrap results of direct and indirect effects between workplace bullying and subjective wellbeing.

Effect and path	Std-β	S.E.	Percentile 95%CI			Bias-corrected 95%CI		
			Lower	Upper	P-value	Lower	Upper	P-value
Direct effect								
Path 1	−0.223	0.024	−0.270	−0.177	0.000**	−0.269	−0.175	0.000**
Indirect effect								
Path 2	−0.071	0.011	−0.093	−0.050	0.000**	−0.095	−0.051	0.000**
Path 3	0.042	0.007	0.029	0.057	0.000**	0.029	0.058	0.000**
Path 4	−0.092	0.012	−0.117	−0.069	0.000**	−0.117	−0.069	0.000**
Path 5	−0.008	0.002	−0.011	−0.005	0.000**	−0.011	−0.005	0.000**

Path 1, workplace bullying  $\rightarrow$  subjective wellbeing; Path 2, workplace bullying  $\rightarrow$  insomnia severity  $\rightarrow$  subjective wellbeing; Path 3, workplace bullying  $\rightarrow$  resilience  $\rightarrow$  insomnia severity; Path 4, workplace bullying  $\rightarrow$  resilience  $\rightarrow$  subjective wellbeing; Path 5, workplace bullying  $\rightarrow$  resilience  $\rightarrow$  insomnia severity  $\rightarrow$  subjective wellbeing; Std- $\beta$ , standardized  $\beta$ ; S.E., standard error.

\*\* $p < 0.01$ .

All bold values are statistically significant ( $p < 0.05$ ).

**TABLE 6 |** Bootstrap results of the moderating effects of resilience on the direct association between workplace bullying and subjective wellbeing.

	$\beta$	S.E.	Percentile 95%CI			Bias-corrected 95%CI		
			Lower	Upper	P-value	Lower	Upper	P-value
High resilience	-0.029	0.006	-0.042	-0.017	<b>0.000**</b>	-0.042	-0.017	<b>0.000**</b>
Mean resilience	-0.044	0.005	-0.054	-0.035	<b>0.000**</b>	-0.054	-0.035	<b>0.000**</b>
Low resilience	-0.059	0.006	-0.070	-0.048	<b>0.000**</b>	-0.070	-0.047	<b>0.000**</b>
High-Low	0.029	0.007	0.016	0.045	<b>0.000**</b>	0.016	0.045	<b>0.000**</b>
High-Mean	0.015	0.004	0.008	0.022	<b>0.000**</b>	0.008	0.022	<b>0.000**</b>
Mean-Low	0.015	0.004	0.008	0.022	<b>0.000**</b>	0.008	0.022	<b>0.000**</b>

High = mean + standard deviation; Low = mean - SD; S.E., standard error.

\*\* $p < 0.01$ .

All bold values are statistically significant ( $p < 0.05$ ).

presented in **Figure 2**, showed that when exposed to equal levels of workplace bullying, the resident doctors with poor resilience had poor subjective wellbeing. Meanwhile, greater resilience would attenuate direct association between workplace bullying and subjective wellbeing.

## DISCUSSION

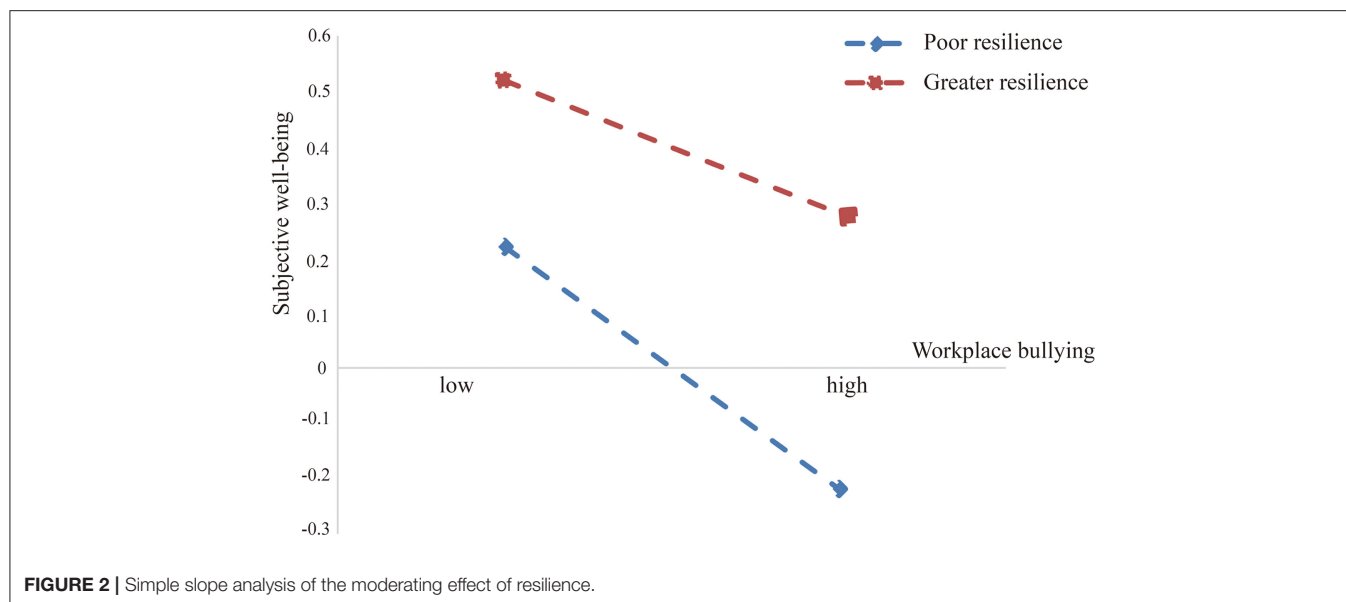
Insomnia is a common disorder and according to a meta-analysis involving 17 studies with 115,988 participants, the pooled prevalence of insomnia in China has been reported to be 15.0% (14). However, the present study reported a much higher rate of insomnia (33.2%) among Chinese resident doctors, which is statistically similar to a study involving Chinese healthcare workers during the COVID-19 epidemic (38.4%) (40).

Previous meta-analysis revealed that at least 15% of workers experience workplace bullying (41). However, in the current study, the prevalence of workplace bullying among Chinese resident doctors was 51.4%, which is as high as the rate in Australia (47%) (4, 41). In addition, reports of previous studies have identified a much higher rate of workplace bullying in the healthcare sector, particularly among resident doctors. The reported rates of workplace bullying among resident doctors range from 30% in Ireland to 89% in India (8).

Further, workplace bullying and poor resilience were the factors associated with insomnia and the SEM of the study revealed close relationships among workplace bullying, resilience, and insomnia severity. Workplace bullying is a considerable environmental stressor that can increase sleep problems. Therefore, individuals with experiences of workplace bullying are more likely to suffer from insomnia (42–44) and have a higher use of sleep-inducing drugs and sedatives (45). Results of a recent meta-analysis showed that bullied workers have 2.13 higher odds of sleep problems than non-bullied workers (3). Further, inflammation may have effects on stress-induced insomnia among people exposed to workplace bullying (17).

Currently, there is limited research on mediating and moderating variables as well as mechanisms underlying the association between workplace bullying and insomnia severity. The results of the present study found that resilience, as a mediator, played a critical role in the association between workplace bullying and insomnia severity. This suggested that resilience may have a significant mediating effect rather than a moderating effect in the relationship between workplace bullying and insomnia severity.

Similarly, a study by Hansen found that workplace bullying is related to development of subsequent sleep problems and although physical activity has been shown to be beneficial for



resilience, the association is not moderated by leisure-time physical activity (46–48).

In the present study, males had a higher rate of insomnia than females (37.8 vs. 30.3%), indicating that males and senior residence status were more likely to develop insomnia. The noted gender difference in the present study is different from those reported in previous studies. The rate of insomnia in females has been approximated to be 1.5 times higher than that in males (49). However, several studies have found that females have a better quality of objective sleep (50, 51). The studies highlighted that females may not objectively sleep worse than males in the general population. The likely reason for the finding might be that male resident doctors face more life stress than their female counterparts during the standardized residency training program in the hospital. In addition, some male resident doctors spend more night-time playing games to relax when they feel stressful and thus the reduced sleep time led to poor sleep quality and daily functioning (52). Moreover, in the present study, third-year resident doctors appeared to have a higher insomnia rate than the rest of the counterparts. This could be due to the senior residence status, accompanied by heavier burdens of studies, clinical tasks, and examinations.

The present study not only identified moderating role of resilience in the association between workplace and subjective wellbeing among Chinese resident doctors, but also found the mediating effects of insomnia severity and resilience between them. Although a previous study has provided evidence that workplace bullying increases insomnia, resulting in reduced life satisfaction of employee (18), there was still a paucity of research evaluating the mediating and moderating variables in the association between workplace bullying and subjective wellbeing.

Some studies reported different kinds of bullying and their adverse effects on subjective health complaints or life satisfaction (18, 53). A study conducted in 2017 reported a close relationship

between workplace bullying and subjective wellbeing, with personality playing a moderating effect between them (54). In 2019, the data from the second wave of the Children's Worlds Survey revealed that the combined impact of physical and psychological bullying significantly contributed to subjective wellbeing across different age groups and geographical regions (55). Until 2020, another relevant study revealed the moderating effect of resilience on the relationship between poly-bullying victimization and subjective wellbeing (56).

The roles of insomnia severity and resilience in the association between workplace bullying and subjective wellbeing provide an in-depth understanding of the mechanisms. Insomnia severity played a mediating role whereas resilience played both moderating and mediating roles. The current study indicated that resilience may be pivotal among workplace bullying, insomnia severity, and subjective wellbeing. On the other hand, insomnia severity acts as a critical mediator between workplace bullying and subjective wellbeing. Therefore, great resilience is a virtuous circle. According to resilience framework theory, people with positive psychological resilience can promote the reintegration of resilience, hence enabling the individuals to subsequently reach greater resilience (57). Further, resilience is an important component of psychological capital, which is considered as a stable and lasting predictor for subjective wellbeing of an individual (58). Therefore, improving the workplace environment is the first measure that needs to be adopted in the healthcare sector. It is hence important to enhance resilience of resident doctors and reduce their insomnia severity.

Strengths in the present study include large sample size and examination of multiple psychological variables, which provide an in-depth understanding of associations among workplace bullying, resilience, insomnia severity, and subjective wellbeing. In addition, some limitations should be considered in future

studies. For example, the present cross-sectional study could not clearly confirm the causality between the variables. In addition, the results in the present study cannot be extrapolated to those with mental disorders.

## CONCLUSION

The current study found a remarkably high rate of workplace bullying accompanied by a high prevalence of insomnia among the Chinese resident doctors. Further, workplace bullying and poor resilience were the factors associated with insomnia. The present study further validated the mediating effect of insomnia severity on the association between workplace bullying and subjective wellbeing, as well as the moderating and mediating effects of resilience between them. Therefore, resilience may be pivotal in workplace bullying, insomnia severity and subjective wellbeing. Further, insomnia severity acts as a critical mediator between workplace bullying and subjective wellbeing.

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## DATA AVAILABILITY STATEMENT

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

## AUTHOR CONTRIBUTIONS

SZ and JC contributed to conception and design of the study. SZ, JC, and HL organized the research and collected the data. SZ, JC, and YY performed the statistical analysis. JC wrote the first draft of the manuscript. SZ and HL wrote sections of the manuscript. All authors carried out the research. All authors contributed to manuscript revision, read, and approved the submitted version.

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# Prediction of Online Psychological Help-Seeking Behavior During the COVID-19 Pandemic: An Interpretable Machine Learning Method

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Online mental health service (OMHS) has been named as the best psychological assistance measure during the COVID-19 pandemic. An interpretable, accurate, and early prediction for the demand of OMHS is crucial to local governments and organizations which need to allocate and make the decision in mental health resources. The present study aimed to investigate the influence of the COVID-19 pandemic on the online psychological help-seeking (OPHS) behavior in the OMHS, then propose a machine learning model to predict and interpret the OPHS number in advance. The data was crawled from two Chinese OMHS platforms. Linguistic inquiry and word count (LIWC), neural embedding-based topic modeling, and time series analysis were utilized to build time series feature sets with lagging one, three, seven, and 14 days. Correlation analysis was used to examine the impact of COVID-19 on OPHS behaviors across different OMHS platforms. Machine learning algorithms and Shapley additive explanation (SHAP) were used to build the prediction. The result showed that the massive growth of OPHS behavior during the COVID-19 pandemic was a common phenomenon. The predictive model based on random forest (RF) and feature sets containing temporal features of the OPHS number, mental health topics, LIWC, and COVID-19 cases achieved the best performance. Temporal features of the OPHS number showed the biggest positive and negative predictive power. The topic features had incremental effects on performance of the prediction across different lag days and were more suitable for OPHS prediction compared to the LIWC features. The interpretable model showed that the increase in the OPHS behaviors was impacted by the cumulative confirmed cases and cumulative deaths, while it was not sensitive in the new confirmed cases or new deaths. The present study was the first to predict the demand for OMHS using machine learning during the COVID-19 pandemic. This study suggests an interpretable machine learning method that can facilitate quick, early, and interpretable



prediction of the OPHS behavior and to support the operational decision-making; it also demonstrated the power of utilizing the OMHS platforms as an always-on data source to obtain a high-resolution timeline and real-time prediction of the psychological response of the online public.

**Keywords:** prediction, online mental health service, COVID-19, online psychological help-seeking, interpretable machine learning

## INTRODUCTION

Throughout the world, people are affected by mental health disorders at staggering rates (1). In many cases, people who lack appropriate treatment or have mental health conditions may experience severe human rights violations, discrimination, and stigma (2). COVID-19 has direct and indirect impacts on mental health conditions, while traditional mental health systems around the world are challenged during the pandemic, resulting in the disruption of their essential services. Online mental health service (OMHS) has been named as the best psychological assistance measure provided in the lockdown during the COVID-19 pandemic. The OMHS is conducive to saving time. More importantly, it has the advantage of avoiding face-to-face contact between patients and practitioners, which is critical to curb the spread of the COVID-19 successfully (3).

During the COVID-19 pandemic, previous studies found that the pooled prevalence of psychological stress, anxiety, depression, and posttraumatic stress symptoms among the general population were 29.6, 31.9, 33.7, and 23.9%, respectively, till the end of May 2020 (4). Similarly, high prevalence rates of acute stress, fear, anxiety, and depression symptoms were also observed in China (5). Compared to the prevalence rates of psychological diseases before the pandemic, the prevalence rates during the pandemic increased sharply among the general population in China (6). Therefore, it is reasonable to suspect that the demand for OMHS would increase during the COVID-19 pandemic due to the increased prevalence rates of psychological problems.

Considering the continuing influence of the COVID-19 pandemic on the mental status of the public, building an interpretable, accurate, and early prediction for the demand of OMHS is crucial for local governments and organizations which need to allocate and make decisions in mental health resources. Machine learning techniques have been widely applied in mental healthcare to facilitate the automatic detection of psychiatric diagnoses, such as suicide risks (7, 8), depression (9, 10), and to monitor system trends to predict the outbreak of psychological crisis (11, 12). Despite the successes, machine learning has its own limitations and drawbacks. The most significant one is the lack of transparency behind their behaviors (13), which leaves users with little understanding of how particular decisions are made by these models.

The interpretability gives machine learning the ability to explain or to present their behaviors in understandable terms to humans (14), which would be an effective tool to mitigate these problems in the prediction of OPHS. From the perspective

of taking immediate crisis response, using the machine learning method may provide more accurate predicted values of OPHS behavior, which enables governments and OMHS platforms to rationally organize and allocate valuable counselors based on the help-seeking trends. From the perspective of psychological intervention, interpretable machine learning methods can identify the underlying risk factors of the OPHS [e.g., the surge in COVID-19 cases, the massive unemployment (15), and decreased access to mental health services (16) etc.], which offers policy suggestions for governments to undertake the follow-up of psychological intervention strategies.

In this study, we used the daily OPHS number as an indicator of public demand for the OMHS. Therefore, the question concerned in the present study was which variables (i.e., features) can be utilized to predict and explain the OPHS behavior of the public in the context of the COVID-19 pandemic in China. According to previous studies, COVID-19 cases, mental health topics related to the OPHS behavior, linguistic features, and temporal features were expected to correlate with the OPHS behavior in the context of the COVID-19 pandemic (17–19).

More specifically, the first type of variable is the COVID-19 cases, which include cumulative confirmed cases, cumulative deaths, new confirmed cases, and new deaths. Previous studies found that the COVID-19 cases would affect the investment and trust behavior, and the physical activity of the public (20–22). The OPHS behavior affected by the COVID-19 cases was also investigated among the public workers and college students (23, 24). However, how the OPHS behavior of the Chinese public was affected by the COVID-19 cases has not yet been understood. That is, no previous study has investigated the OPHS behavior affected by the number of COVID-19 cases from the perspective of the Chinese public with psychological problems.

The second type of variable considered in the present study is the mental health topics related to OPHS behavior. According to the five stages of grief proposed by Kubler-Ross, people who experience grief would go through a series of five emotions, which include denial, anger, bargaining, depression, and acceptance (25). Supported by this model, people may experience these emotions sequentially and have psychological problems associated with these emotions during different stages of the COVID-19 pandemic.

Moreover, linguistic features were also considered in the present study when predicting the OPHS number during the COVID-19 pandemic. Previous studies found that depressed and anxious people expressed themselves differently in the language (26). If the online psychological help-seekers would seek help due to different psychological problems during the different

stages of the COVID-19 pandemic, their expression and texts would change accordingly, which indicates that the linguistic features may be important predictive variables for predicting the OPHS number.

Last but not the least, temporal features of the OPHS number are considered in the present study to predict the OPHS number. Time-series analysis techniques have been used in the prediction of COVID-19 cases. It is reasonable to believe that the temporal features of the OPHS number extracted by time series analysis would be a strong predictive variable for the OPHS number during the COVID-19 pandemic.

The purpose of the present study was to build a predictive model for the OPHS behavior, then identify and investigate the influences of the above factors, which must meet the following two requirements. First, motivated by the considerations of practical applications, this model must predict the OPHS number in a relatively long term (one or 2 weeks) rather than in a short term (e.g., the same day or the next day) (27). Second, the present model would integrate an innovative method to provide some possible explanations for the predictive performance and to investigate how the LIWC and the mental health topics expressed in the OPHS, the COVID-19 cases, and the temporal features of OPHS number, influence the model. Overall, the present study aimed to build an interpretable machine learning model that could predict the OPHS behavior in long lag days during the COVID-19 pandemic. Besides, the importance and influence of the predictive variables were investigated for interpreting the model.

## MATERIALS AND METHODS

### Data Crawling

The first data source is one of the largest Chinese OMHS platforms, “One Psychology Community” (28), through which about 20 million people have asked for mental health services. People could anonymously post their psychological problems and seek psychological help and support from the psychological counselors in the platform of Q&A community. The question post could include the following optional components: the title of the question, age and gender of the help-seeker, course of the psychological problem, inner feelings, duration of the problem, and the label (i.e., occupation, marriage, romantic relationship, family, etc.). We utilized “Bazhuayu” (29), a web scraping software, to crawl 54,797 psychological help-seeking questions ranging from January 31, 2018, to January 08, 2021, of which 3,263 posts referred to the COVID-19 pandemic. The average daily OPHS numbers per day was 29.93. Each post contained three sections, i.e., the description of the title, the description of the psychological problem, and the asking time. The report conducted by a famous Chinese online counseling platform, “JianDanXinLi” (30) in 2020 showed that among the visitors of OMHS users, the female visitors were more, who were three times more than the male visitors, and visitors in the early adulthood (21–35 years old) accounted for 77.57%.

The second data source is the official website of the National Health Commission (31) through which search could be done on the COVID-19 cases in China including cumulative

confirmed cases, cumulative deaths, new confirmed cases, and new deaths (32).

The third data source is the MOE-CCNU mental health service platform (the MOE-CCNU OMHS platform) (33), through which the time-series data on the daily OPHS number could be collected. Since January 31, 2020, the platform has been opened to psychological help-seekers *via* WeChat, which is the most popular social network app in China. Time-series data on the number of daily OPHS behaviors were collected from January 31, 2020, to January 08, 2021, with a total number of 37,698 OPHS behaviors.

## Data Analysis

### Neural Embedding-Based Topic Modeling

Neural embedding is a family of techniques for obtaining a compact, dense, and continuous vector-space representations of entities that can efficiently encode multifaceted relationships among those entities (34), which has become a core ingredient in modern machine learning (35), and has recently offered novel opportunities and solutions to challenging problems, e.g., language evolution, gender, and stereotypes (36–39). In our study, for analyzing psycholinguistic clues (i.e., psychological problems and influential factors) in the OPHS behavior, we proposed a neural embedding method named, Word2vec (40) to learn dense and compact vector-space representations of mental health-related words in the OPHS question text.

Specifically, first, we constructed a predefined lexicon regarding the psychological problems and the influential factors of mental problems. Two Ph.D. candidates in Psychology extracted and categorized two types of seed words from sources that are directly related to mental health, e.g., Kessler 10 and Patient Health Questionnaire (41), the emotional vocabulary of Dalian Institute of Technology (42), and the question tag system of One Psychology (43).

Second, we constructed the domain lexicons of the OMHS community. We cut the texts of mental health questions and deleted stop words by using the Jieba tool (i.e., a Python segmentation package for Chinese) and the Baidu stop-word list. According to the word embedding algorithm, the texts were used as the training corpus. The word vector technology of Word2vecin Gensim software (44) was used to construct the vector model of mental health pretraining words for obtaining domain lexicons of psychological problems and related influential factors. Based on the word vector, we calculated the cosine similarity between the words in the vector model and the predefined vocabulary, to build the domain lexicons of psychological problems and influential factors. Specifically, the mental health lexicons contain two parts: (1) about 2,567 words related to the psychological problems of the OPHS. The semantic similarity between these words and the predefined seed words are  $>0.3260$ ; (2) about 1,077 words related to the influencing factors of the OPHS. The semantic similarity between these words and the predefined seed words are  $>0.3556$ .

Third, we obtained the topics of the psychological problems and the influential factors of the help-seekers. We recruited two graduate students to set the cosine similarity thresholds to remove words in the OPHS texts which were irrelevant to

the lexicons of the psychological problems or influential factors. The thresholds can improve the accuracy and interpretability of the topic detection, through which the formation of mutual interference between these two types of semantics could be avoided. Word vector representations of psychological problems and influential factors were obtained by using the average word embedding method (45). Based on these text vector representations, we used the k-means clustering algorithm (Python implement of K-Means method in scikit-learn) and its evaluation index (i.e., silhouette coefficient), to obtain and evaluate the clustering performance with different numbers of clustering centers (46). We tried 4–20 numbers of clustering centers. We finally selected the best k-mean clustering model with 7 cluster centers for the detection of topics. The number of clusters under the optimal silhouette coefficient was selected to construct the cluster of psychological problems and influential factors; refer to **Supplementary Figure 1** for the details of models with different clusters and its silhouette coefficient. The values of the silhouette coefficient range from  $-1$  to  $1$ . A higher value represents a better clustering performance. Then, we recruited two Ph.D. candidates to classify similar topics of psychological problems and influential factors according to high-frequency keywords related to several clusters, and to determine the content and number of topics regarding the psychological problems and the influential factors of the help-seekers.

### Time Series Analysis

Predicting the future trends is one of the most challenging but valuable tasks for scientists in the field of machine learning. We used the time series analysis method named, Prophet to identify the temporal features of OPHS behavior during the COVID-19 pandemic. Prophet is an advanced classical time series analysis method based on the generalized additive model developed by Facebook (47). It is capable of generating forecasts of a reasonable quality at scale. According to Taylor and Letham, Prophet always performs better than other classical approaches (47), and through which we can identify the trend of OPHS time series, such as yearly, weekly, etc. On this basis, we used the Pearson's correlation coefficient to quantify the relationships between daily OPHS numbers in OMHS platforms of MOE-CCNU and that in the OnePsychology during the COVID-19 pandemic.

### Interpretable Machine Learning

We took the daily time series of the OPHS behavior in the Q&A section in the OMHS community as the dependent variable. We also took the frequency of the OPHS topics, the language clues in LIWC, the temporal features of the daily time series of the OPHS behavior, and the daily time series of the COVID-19 cases as independent variables. We utilized the regression method of machine learning to build the OPHS number predictive model with lagging one, three, seven, and 14 days and used the Shapley additive explanation (SHAP) method to investigate the predictive power of the features. The regression algorithms utilized in the present study included linear regression (LR), ridge regression (RR), least absolute shrinkage and selection operator (LASSO), support vector regression (SVR), and random forest (RF). The Prophet prediction method was used as a baseline of the classical

time series prediction method. The result of 10-fold cross-validation related to RF is shown in **Supplementary Table 1**.

Interpretability is one of the key approaches in which the time series prediction method can be used to facilitate decision support. *Post-hoc* interpretable models are developed to interpret trained predictions, helping to identify important features or examples without modifying the original weights. Specifically, The SHAP method was considered as one of the two techniques for *post-hoc* interpretability in time series forecasting with machine or deep learning (48). The SHAP is a widely used approach based on the cooperative game theory, which comes with desirable properties. The SHAP represents responsibility of a feature for a change in the model output, which has at least two advantages (49). The first advantage of SHAP is the global predictability, i.e., it can show how much each variable contributes, either positively or negatively, to the target outcome. The second advantage is the local observability, i.e., each observation gets its SHAP value. Traditional machine learning interpretation only showed the results across the entire population but not in each case, while the local predictability of SHAP enables us to pinpoint and contrast the impacts of factors (13). The SHAP value greatly increases the transparency of machine learning and has been implemented in many studies and industry scenarios (48, 50).

Therefore, the RF regression and the SHAP value based on the interpretable machine learning framework were used to select the efficient features from the four predefined feature sets (i.e., topic, LIWC, temporal features of the OPHS number, and the COVID-19 cases; refer to **Supplementary Table 2** for the details of these features). The mean absolute error (MAE) and Pearson correlation coefficient (Pearson Coef) was used to evaluate the performance of the predictive models. Then, we calculated the SHAP value for each feature and feature set in the best performance predictive model to investigate the ways through which the features contribute to the model.

We used accumulative SHAP values to quantify the positive and negative influence of the four feature sets on the OPHS number. If counting by days, the length of the time series is  $M$ . If the feature number of feature set  $F$  is  $\{1, 2, \dots, P\}$ , the SHAP values of the included features are

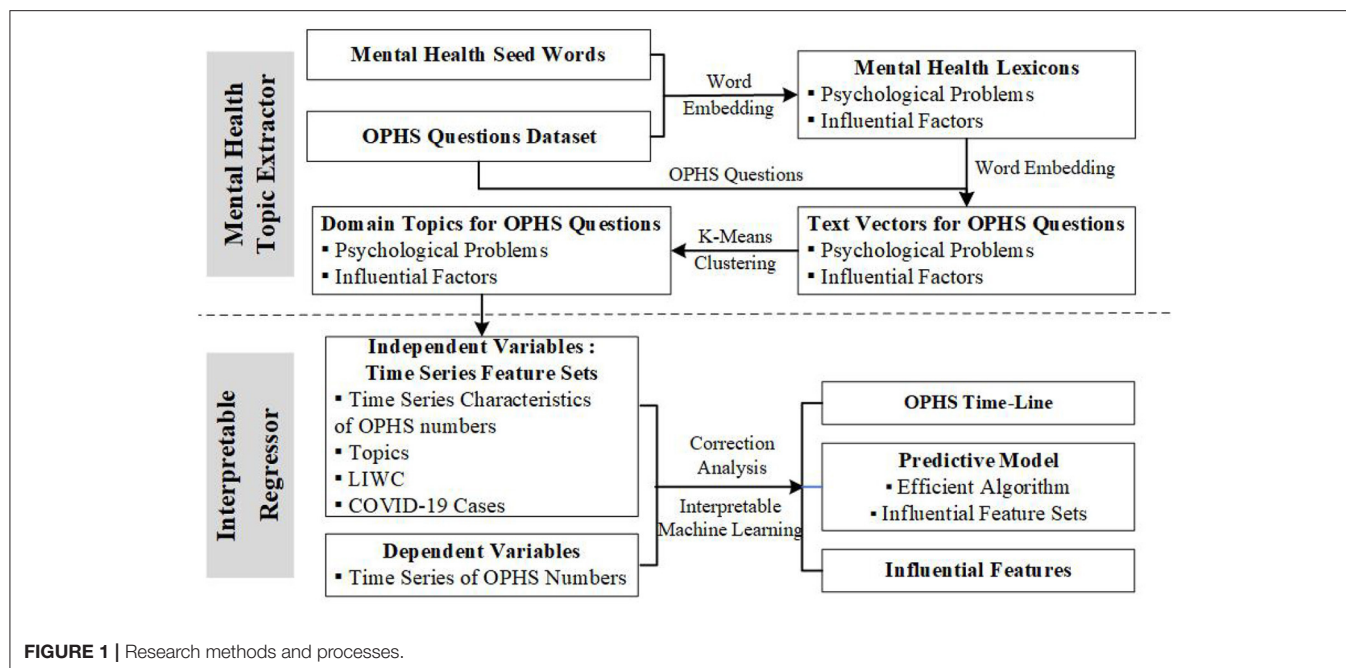
$$\begin{bmatrix} SHAP_{1,1} & \cdots & SHAP_{1,P} \\ \vdots & \ddots & \vdots \\ SHAP_{M,1} & \cdots & SHAP_{M,P} \end{bmatrix},$$

Therefore, the positive SHAP value of the feature set  $F$  is:

$$SHAP_F^+ = \sum_{i=1}^P \frac{(\sum_{j=1}^M SHAP_{i,j}^+)}{X_i}, SHAP_i^+ > 0, X_i \in [X_1, X_2, \dots, X_P],$$

$X_i$  is the total number of positive SHAP values for an feature  $i$ . We calculated the positive SHAP value in the same way.

The research methods and processes are shown in **Figure 1**. In summary, first, we obtained the OPHS behavior data of public



by a web crawler named, “Bazhuayu,” mentioned earlier, from the OMHS community and the MOE-CCNU OMHS platform. Second, we used the existing knowledge related to psychological problems to construct domain lexicons by the neural embedding method. Then, we used the domain lexicons to remove words that were irrelevant to psychological problems in the OPHS texts, and obtained the vector representation of OPHS questions from every visitor, by neural embedding. We further used the k-means algorithm to cluster the vector representation of the OPHS questions of all visitors. The best clusters and related high-frequency words were validated manually. Third, we built the time series feature sets as the independent variables that contain the temporal features of the OPHS number, the COVID-19 cases, and mental health topics and LIWC features. We made the time series of the OPHS number as dependent variables. Finally, we built an interpretable machine learning model for predicting and interpreting the OPHS number, got the most effective algorithm and feature sets, and investigated the ways those features contributed to the performance of the predictive models.

## RESULTS

### Analysis of the Timeline of OPHS Behavior and Related Psychological Problems and Influential Factors During the COVID-19 Pandemic

To validate the influence of the COVID-19 pandemic on the OPHS number, we utilized two OMHS platforms related to OPHS time-series data to recognize the trends of daily OPHS numbers in COVID-19. The OPHS trends of the two OMHS platforms with different lag days are shown in **Figure 2**. The result shows the OPHS behaviors in the OMHS community or

the MOE-CCNU OMHS platform that increased sharply after the beginning of the COVID-19 pandemic. Specifically, compared to the OPHS behavior in the MOE-CCNU OMHS platform that peaked in mid-March, the OPHS behavior in the OMHS community peaked in early March. Further, as shown in **Table 1**, the correlation between the time series of the OPHS number in the OMHS community and platform was calculated. The OPHS number in the MOE-CCNU OMHS platform had the strongest correlation with that of the OMHS community with a lead time of 13 days, reaching 0.585 ( $N = 343$ ,  $p < 0.05$ ). The relationship between daily OPHS numbers in two OMHS platforms during the COVID-19 pandemic is shown in **Table 1**. The trends between the two daily OPHS numbers had a strong correlation as well, peaking at 0.911 with a lead time of 13 days ( $N = 343$ ,  $p < 0.05$ ).

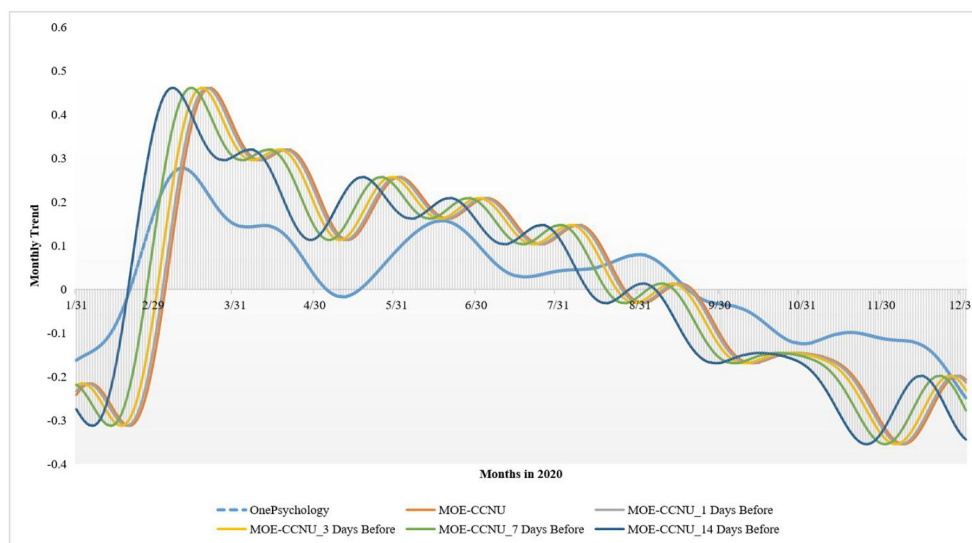
By the topic modeling of the OPHS texts, we extracted seven psychological problems, seven influential factors, and the corresponding keywords (refer to **Table 2**). The topics of the psychological problems included depression and anxiety, suffering, social phobia, lack of interest, suicidal tendency, worry (afraid), and anger. The topics of influential factors involved love, marriage, psychotherapy, work, interpersonal relationship, personal characteristics, and family.

### Predictive Model for the Daily OPHS Number

For predicting the OPHS number in different lag days and investigating the importance of different features and feature sets, we tried to get a regression model with the best performance based on the refined feature sets.

As shown in **Table 3**, the RF achieved the best performance when lagging 3 days, and the ratio of MAE to the average OPHS number was 20.03% ( $5.99/29.93 \times 100\%$ ). The SVR (a linear





**FIGURE 2 |** The trends of daily online psychological help-seeking (OPHS) numbers between online mental health service (OMHS) platforms of MOE-CCNU (MHSP) and the OnePsychology (OMHC) during the COVID-19 pandemic.

**TABLE 1 |** The correlations between the time series of the online psychological help-seeking (OPHS) number in the online mental health service (OMHS) community and platform.

Lag days of OMHS platform	Correlations of time series of the OPHS number in OMHS platform and community	Correlations of the trends of the OPHS number in OMHS platform and community
0	0.456**	0.794**
1	0.396**	0.811**
3	0.361**	0.841**
5	0.374**	0.868**
7	0.357**	0.889**
9	0.357**	0.904**
11	0.560**	0.911**
13	0.585**	0.911**
14	0.475**	0.908**

\*\*  $p < 0.001$ .

kernel function) achieved the best performance when lagging 1 day, 7 days, and 14 days. The ratios of MAE to the average OPHS number were 20.11, 21.14, and 22.84%, respectively. Overall, the RF and SVR performed better than other typical regression algorithms.

Then, we compared the performances of different combinations of the four feature sets based on the RF regressor. As shown in **Table 4**, as for the performance of the single feature set in the prediction, the temporal features of the OPHS number performed better than the others. Notably, as lag days increased, the performance of the single feature set decreased. The combination of all the four feature sets showed a better performance than any single feature set with any lag days. However, the combination of four feature sets did not show the

best performance at all the time, e.g., although the combination of the four feature sets achieved the best performance when lagging 14 days, it did not perform better than the combination of topic, time series, and COVID-19 cases when lagging 1 day, 3 days, and 7 days. Moreover, compared to the advanced time series forecasting method named, Prophet, the predictive model with the four feature sets achieved a better performance when lagging 3 and 7 days. In addition, there are similarities in the results between the correlation coefficient and the MAE. We can see that the prediction with a long lead time has a high correlation between its predicted and true values, although their MAEs are high.

## Influential Factors of the Psychological Help-Seeking Behavior

To investigate the influence of the feature sets on the OPHS number, we calculated the cumulative SHAP values for different feature sets, as shown in **Table 5**. The result shows that the temporal feature set of the OPHS number is the largest positive and negative predictive power. The predictive power of LIWC was larger than that of the overall topic. The predictive power of the COVID-19 cases was larger than that of the topics but smaller than that of LIWC, but its positive and negative predictive power was stronger than both LIWC and topic feature sets when lagging 14 days.

To quantify the cumulative contribution of different features in different predictions, we calculated the cumulative SHAP values of the top-20 features in the predictive model with lag days of 1, 3, 7, and 14 days, as shown in **Figure 3**. The top-20 features contributed more than 90% to the prediction with any lag days. The top-7 features contributed ~80% to the prediction with any lag days. **Table 6** shows the top-20 features in predictions with different lag days. Among these features, temporal features of In



**TABLE 2 |** The mental health topics related to the OPHS behavior.

Type of topics	Topics	High-frequency word (ranking in order)
Psychological problems	Depression and anxiety	depression, anxiety, insomnia, obsessive-compulsive disorder, depressive symptoms, diagnosis, bipolar, despair, violence, shadows, trauma, extreme, headaches, waking up, staying up, dreaming
	Suffering	unhappy, sad, uncomfortable, wronged, embarrassed
	Social phobia	communication, self-abasement, introversion, sensitivity, lack of self-confidence, dissocial, cowardice, dependence, eye contact, avoidance, conversation
	Lack of interest	no interest, no drive, no confidence, no enthusiasm, no desire
	Suicidal tendency	suicide, self-harm, tendency, breakdown, fear of pain, despair, escape, regret, torture, bad
	Worried, afraid	fear, worry, tension, doubt, struggle, avoidance, rejection, nausea
	Angry	anger, dislike, tantrums, bullying, grievance, disgust, blame, rejection, excess, ugliness, grumpiness, dissatisfaction, selfishness, trust, respect
Influential factors	Love	love, boyfriend, relationship, girlfriend, heterosexual, confession, break up, good feeling, gay, single, Ex, meet, ex-boyfriend, reunion, first love, ex-girlfriend, Cold War, entanglement, long-distance relationship
	Marriage	marriage, divorce, children, pregnancy, wife, man, mother-in-law, husband, married, sex, birth, in-laws
	Psychotherapy	treatment, diagnosis, pandemic, anxiety, disorder, medication, mental illness, withdrawal, bipolar, character, cognition, character disorder, schizophrenia
	Work	job, graduation, resignation, income, economy, pressure, development, unemployment, job-hopping, career, boss
	Interpersonal relationship	communication, character, contact, friend, speech, relationship, conversation, eye contact, dealing, indifference, impression, avoidance
	Personal characteristics	character, emotion, life, growth, cognition, conflict, obstacle, age, communication, impression, shadow, avoidance, dominance, character disorder
	Family	parents, mother, family, mom, father, dad, brother, grandmother, sister, daughter, grandparents

**TABLE 3 |** Mean predictive performance of different algorithms for the OPHS number.

Algorithms/ lag days (day)/ MAE	1	3	7	14
LR	25.945	36.300	33.814	24.655
Ridge	6.440	6.717	6.781	7.014
LASSO	8.307	8.453	8.763	9.491
SVR	6.018	6.152	6.328	6.836
RF	6.280	5.995	6.398	7.790

The average daily OPHS number is 29.929.

OPHS numbers (i.e., trend, additive terms, year, yhat; Refer to **Supplementary Table 2** for details, the same below.), COVID-19 cases-related features (i.e., people positive cases count and people death count) were included in the top-20 features of all the four models with different lag days. The LIWC feature (i.e., love) was included in the top-20 features in all the models with all four lag days except for 1 day. Other top-20 features in different lag days included some features in the LIWC features, e.g., personal pronouns (i.e., I, She, He, and They), number, informal language (i.e., swear), time orientations (i.e., TenseM, FutureM), social processes (i.e., friend and humans), Affective processes (i.e., NegEmo, Anx, and Sad), cognitive processes (i.e., certain, inhibition, inclusive, and exclusive), perceptual processes (i.e., see, hear, and bio), biological processes (i.e., body, sexual, and ingest), relative processes (i.e., relative and motion), personal concerns (i.e., work), drives (i.e., achieve), personal concerns (i.e.,

leisure, home, death, and love), and time orientations (i.e., tPast and tNow). Some features in the psychological problems and influential factors in the mental health topics are also the top-20 features in a model of the specific lag days, e.g., depression and anxiety, suffering, social phobia, lack of interest, suicidal tendency, love, work, social interaction, personal characteristic, and family.

To understand how the ways features contribute to the performance of the predictions, we summarized the influential ways of top-20 features on the OPHS number, as shown in **Figure 4**. The figure shows the adjustment to the predicted x-axis for each of the top-20 features. Each plot is made up of thousands of individual points from the predictive dataset. As the higher value is redder, the lower value is bluer. This is depicted by the feature value bar on the right of each plot. Besides, if the dots on one side of the central line are increasingly red or blue, it suggests the increasing values or declining values, prospectively. For instance, lower “Trend” values (blue dots) are associated with a relatively lower OPHS number.

The result showed that the temporal features of daily OPHS numbers (i.e., trend and yhat) positively predicted the OPHS number in all lag days. The LIWC features (i.e., love) positively predicted the OPHS number when this feature was at a lower level, while negatively predicted the number when it was at a higher level with lagging 3, 7, and 14 days. The additive terms, the yearly trend in the temporal features of the OPHS number, the COVID-19 cases (i.e., people positive cases count and people death count), the number, biological processes (i.e., body and ingest), time orientations (i.e., tNow), personal concerns (i.e., death), cognitive processes (i.e., certain),

**TABLE 4 |** Predictive performance of the combinations of feature sets.

LeadTime (day)/ feature sets	Metrics	LIWC	Topic	Temporal features of the OPHS	COVID-19 cases	The combination of all four feature sets	Optimal features combination	Performance of the optimal combination	Prophet
1	MAE	7.758	7.392	6.550	11.882	6.265	Topic & Timeseries & Covid19 pandemic	6.211	5.93
	Pearson Coef	0.731**	0.781**	0.798**	0.822**	0.884**		0.898**	0.923**
3	MAE	8.149	7.705	6.214	13.396	5.929	Topic & timeseries	5.780	5.96
	Pearson Coef	0.876**	0.898**	0.885**	0.906**	0.911**		0.932**	0.911**
7	MAE	8.258	8.343	6.470	11.947	6.400	Topic & timeseries	6.223	6.34
	Pearson Coef	0.916**	0.876**	0.913**	0.913**	0.924**		0.940**	0.908**
14	MAE	9.258	8.881	8.416	12.953	7.779	LIWC & topic & Timeseries & Covid-19 pandemic	7.779	5.92
	Pearson Coef	0.928**	0.93**	0.931**	0.901**	0.942**		0.942**	0.903**

\*\* $p < 0.001$ .**TABLE 5 |** The impact of different feature sets on the OPHS behavior with different lag days.

FeatureTypes/ SHAP values/ lag days(day)	Cumulative SHAP values (positive)				Cumulative SHAP values (negative)				Sum of absolute value of both – and +
	1	3	7	14	1	3	7	14	
LIWC	10.998	7.344	9.093	4.768	–4.502	–3.300	–4.476	–3.010	47.490
Topic	6.306	8.045	1.615	3.199	–0.865	–1.003	–1.158	–0.929	23.120
Temporal features of the OPHS	48.097	56.710	52.345	48.286	–7.960	–15.160	–17.096	–9.848	255.503
Covid19_Pandemic	8.810	3.726	2.534	10.942	–3.834	–0.536	–1.422	–5.154	36.956

perceptual processes (hear), relative processes (motion), time orientations (i.e., FutureM), social processes (i.e., Humans), affective processes (i.e., Anx, NegEmo), perceptual processes (i.e., Bio) in the LIWC features, and suffering, depression and anxiety; social phobia in the topic features positively predicted the OPHS number when these features were at high levels, while negatively predicted the number when they were at low levels.

## DISCUSSION

### Principal Results

The present study built four types of feature sets (i.e., LIWC, mental health topics, temporal features of the OPHS number, and the COVID-19 cases), and used the machine learning method (i.e., LR, RR, LASSO, SVR, and RF) to predict and interpret the daily OPHS number during the COVID-19 pandemic. We found several interesting findings as follows.

First, after the beginning of the COVID-19 pandemic, the daily OPHS number in both the OMHS community and the MOE-CCNU OMHS platform increased significantly, and the

number of help-seekers in the OMHS community reached the peak at 13 days earlier than that in the OMHS platform. Moreover, a strong and positive relationship between daily OPHS numbers in the OMHS platforms of MOE-CCNU and that in the OnePsychology, indicated that the dynamic changes of the OPHS behavior of the online public was not an exception.

Second, for the performance of predictions with different feature sets, we found that the model with feature sets containing temporal features of the OPHS number, mental health topics, LIWC, and COVID-19 cases under RF or SVR regression achieved the best performance. (1) Although the feature set containing all the four types of features performed overall better than any single feature set, it cannot always perform the best. For example, when predicting the OPHS number with a lagging of 14 days, the best performance was obtained by using all four types of features. Nevertheless, when predicting the OPHS number with lagging 3 or 7 days, the best performance was obtained by using only two types of features (i.e., topic and temporal features). This finding can be supported by the principle of feature selection, i.e., more features do not necessarily lead to better performance

**TABLE 6 |** Top-20 features in predictions with different lag days.

Top rank features	Lag days (day)			
	1 day	3 days	7 days	14 days
Top 1	trend	yhat	trend	trend
Top 2	yhat	trend	yhat	Additive terms
Top 3	PEOPLE_DEATH_COUNT	yearly	yearly	yearly
Top 4	PEOPLE_POSITIVE_CASES_COUNT	Love	Additive terms	PEOPLE_POSITIVE_NEW_CASES_COUNT
Top 5	yearly	Additive terms	tNow	yhat
Top 6	Additive terms	Work	PEOPLE_DEATH_COUNT	PEOPLE_POSITIVE_CASES_COUNT
Top 7	Social phobia	Suffering	Love	Personal characteristics
Top 8	Exclusive	PEOPLE_POSITIVE_NEW_CASES_COUNT	They	PEOPLE_DEATH_COUNT
Top 9	In Love	Ingest	PastM	See
Top 10	Bio	PEOPLE_DEATH_COUNT	Humans	Sad
Top 11	Body	Suicidal tendency	Hear	FutureM
Top 12	Depression and anxiety	PEOPLE_DEATH_NEW_COUNT	Inclusive	Interpersonal relationship
Top 13	Achieve	Home	I	Death
Top 14	Work	PEOPLE_POSITIVE_CASES_COUNT	Motion	TenseM
Top 15	Anx	Family	SheHe	Swear
Top 16	Lack of interest	Interpersonal relationship	covid19_pandemic	Number
Top 17	NegEmo	FutureM	Psychotherapy	SheHe
Top 18	Boyfriend or girlfriend	Sexual	Friend	Love
Top 19	Relative	Work	PEOPLE_POSITIVE_NEW_CASES_COUNT	Inhibition
Top 20	Leisure	Personal characteristics	PEOPLE_POSITIVE_CASES_COUNT	Certain

because of redundancy and the irrelevance of features (51). (2) The present study found that the temporal features of the OPHS number have an advantage over other features in the prediction. For example, the models with lagging 1, 3, and 14 days show that the trend of daily OPHS numbers might be the most important feature, followed by predicting values and yearly trend generated by the Prophet. A possible explanation is that the temporal features contain more information, such as the cyclical and trend changes affected by the environment and events (47). (3) Compared to LIWC, the topic features we proposed were more important and had incremental effects on the overall performance of models with different lag days, which indicated that mental health-related linguistic features were more targeted to OPHS behavior prediction. It could be supported by a previous study which found that the LIWC model performs better in the document with approximately 22 sentences while the topic model performs better in the document with about two sentences (52). The help-seeking posts are usually short and express their psychological problems, which implies that the topic model performs reasonably better.

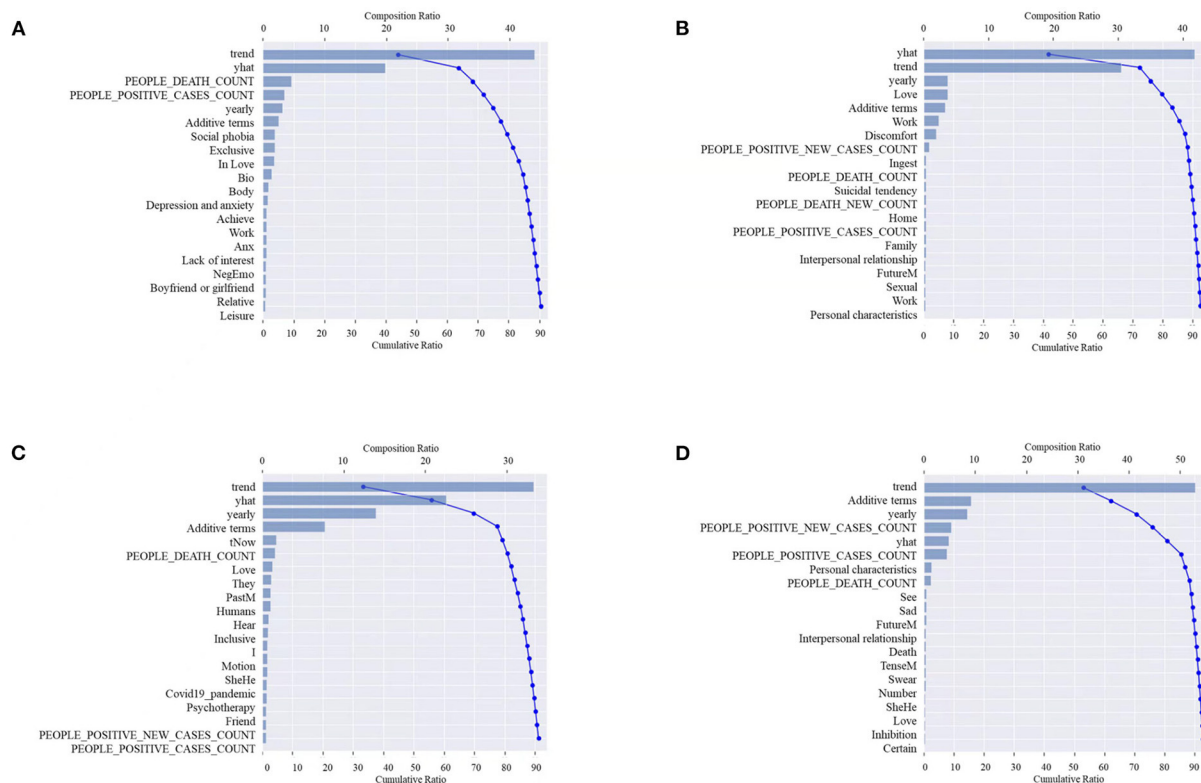
Third, for the performance of predictions with different lag days, our models were predictive for the number of OPHS with lag days up to 2 weeks. Compared to an advanced classical forecasting method named, Prophet, the present model has

advantages when lagging 3 and 7 days and has interpretability that the Prophet does not have. The present predictive model may help to facilitate early, fast, and accurate prediction and interpretation for the daily OPHS number in the context of a major public health emergency. Meanwhile, it can help the government and platform managers to arrange the number of psychological consultants on duty reasonably, and to take targeted interventions and public policy to prevent potential psychological crises of the online public.

In particular, with respect to the explanation of the model built in the present study, we found some meaningful results.

First, we found that the top-20 features included trend, additive terms, yearly, yhat in temporal features of the OPHS number, people positive cases count, and people death count in COVID-19 cases among all the four models, which indicated that these features might be the most important ones for predicting the OPHS number.

Second, the results from the SHAP values provided possible explanations for the black-box models, which broke the stereotype that machine learning methods were difficult to interpret and understand. It is crucial to gain a better understanding of the ways the features contribute to the performance of the predictive model. For example, in the cumulative confirmed cases, the cumulative deaths positively

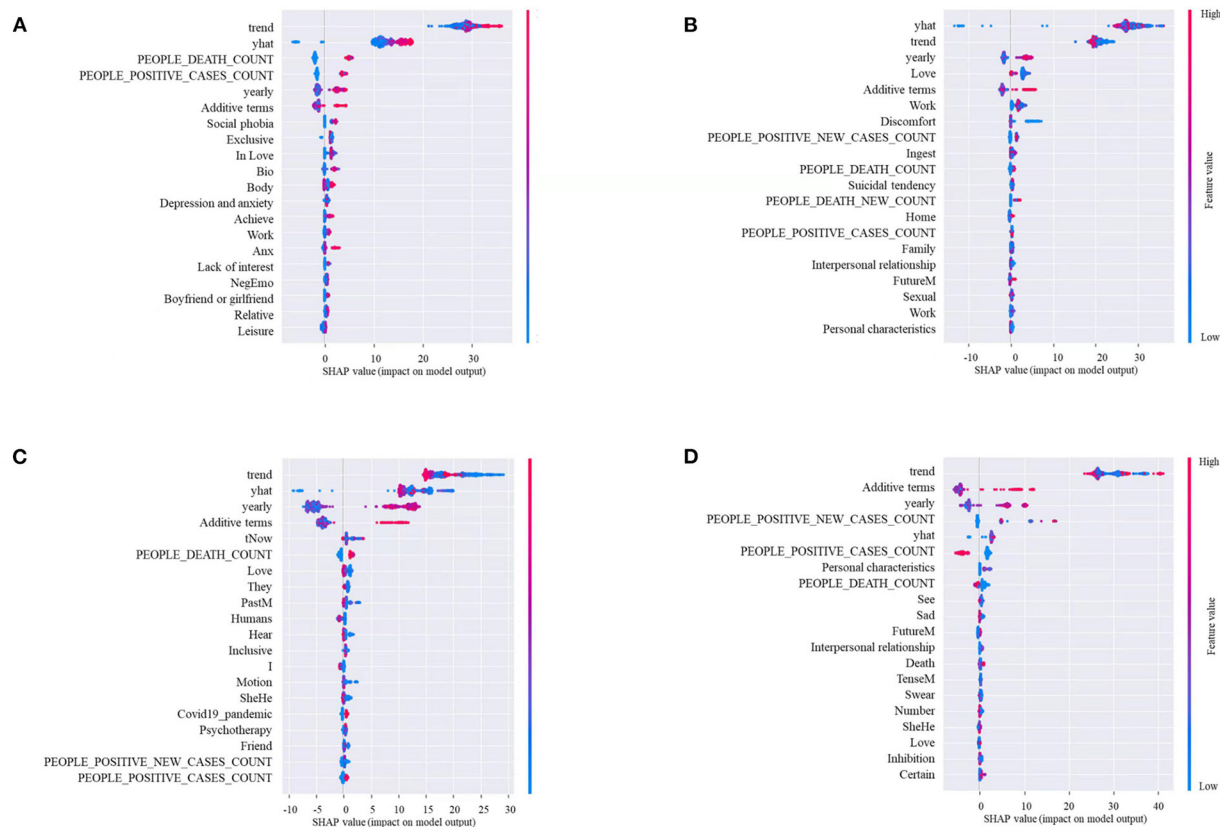


**FIGURE 3 |** Top-20 features of predictions with lagging one (A), three (B), seven (C), and 14 days (D).

predicted the OPHS number when these features were at high levels, while negatively predicted the OPHS number when they were at low levels, which indicated that the increase in the OPHS number was affected by the cumulative confirmed cases and cumulative deaths, while it was not sensitive to the new confirmed cases or new deaths. The effect sizes of these two COVID-19-related features got larger when predicting the OPHS number with longer lag days. Considering the individual mental health status that changes continuously, sporadic new confirmed cases or new deaths of the COVID-19 may not have a great impact on the OPHS behavior of the public. However, the impact of major changes in the social environment on the mental health of the public is profound and lasting (53). The present study indicates that this phenomenon is also reflected in the growth of OPHS behavior. Therefore, governments and institutions should continue to support online mental health services, focus on top-ranked problems of online psychological help-seekers with regard to depression and anxiety, suffering, social phobia, lack of interest, suicidal tendency, worried and afraid, and anger, then cultivate online psychological assistance force related to these problems and take targeted interventions for online psychological help-seekers at different stages of the COVID-19 pandemic.

Third, other influential factors which had small or medium effect sizes are also worthy of attention. (1) The results indicate that linguistic clues of biological processes related to body and interest are relevant to the increase of OPHS behavior of

the public. This is consistent with the previous studies that proposed that chronic diseases lead to poor mental health (54). Therefore, OMHS may be an option for hospitals to deal with mental diseases related to traditional physical diseases during the COVID-19 pandemic. (2) The results indicate that the increase in the linguistic clues of perceptual processes related to hearing, and cognitive processes related to certainty are related to the increase in the OPHS behavior of the public. Previous studies have pointed out that mental health problems are accompanied with abnormal states of individual perception and cognition (55). These abnormal problems may be related to the increase in the OPHS behavior of the public. (3) The results show that the linguistic clues of the topics related to social processes and social phobia are related to the growth of the OPHS behavior of the public. For example, previous research on teenagers found that individuals with a stronger connection to school are less likely to have mental health problems, such as depression and anxiety (56). The present study found that the problematic connection between individuals and the social environment are related to the increase in the OPHS behavior of the public. (4) The results show that linguistic clues of the affective processes related to anxiety and negative emotion, as well as the topics related to suffering, depression, and anxiety are related to the increase in OPHS behavior. Previous studies found that negative emotions significantly affect individual mental health and lead to depression (57). The present study found that these emotional problems are related to the growth of the OPHS behavior of the



**FIGURE 4 |** The Shapley additive explanation (SHAP) summary plots about the adjustment to the predicted ln OPHS numbers (x-axis) for each of the top-20 features with lagging one (A), three (B), seven (C), and fourteen days (D).



**FIGURE 5 |** The SHAP force plots for a number of the OPHS prediction. The number of psychological help-seeking (PHS) rated in this example shows a prediction of 78.28 on the rating scale. In particular, the positive new case count of the people, equal to 6,463, increases its rating.

public. (5) The result shows that the linguistic clues of personal concern related to death are related to the OPHS behavior of the public. As suicidal tendency related to greater help-seeking and perceived need (58), the positive relationship between deaths and the OPHS behavior is supported.

## Strengths and Limitations

The present study has some strengths and limitations which need to be considered when weighing the findings. The following strengths are found in the present study.

To the best of our knowledge, the present study was the first to predict the OPHS behavior using the machine learning method in China in the context of the COVID-19. We considered four types of features, which avoided the underfitting problem

caused by a single type of feature. This research seems to be a competitive illustration of the power of always-on mental health data sources: if we had used traditional data sources, we would not have obtained such a high-resolution timeline and real-time prediction of the immediate mental health response of the public to an unexpected event, such as the COVID-19 pandemic.

Specifically, first, despite the successes of machine learning in mental healthcare, the concerns about the black-box nature of these complex models have hampered their further applications, especially in those critical decision-making domains like policy responses to COVID-19. The present study proposes an interpretable machine learning method that makes the predictions easy to understand and supports operational decision-making. This could help governments and



organizations identify risk factors for the increase in OPHS behavior. For example, unemployment has been proven to be an influential factor in the increase in the OPHS number related to psychological crisis during the COVID-19 pandemic (15), as the factor of unemployment was included in the present predictive model. Thus, by analyzing the discourses of the OPHS, the prediction can quickly sense the emergencies and the changes of risky, predictive factors, and help governments and organizations in making policy tools and administrative interventions for the public mental health.

Second, previous prediction studies driven by big data from social media tended to believe that measurement in big data sources was much less likely to change behavior, namely the nonreactivity. However, even though some big data sources are nonreactive, they are not always free of social desirability bias, as people always want to present themselves in the best possible way (59). For example, as one respondent in an interview-based study said, "It's not that I don't have problems, I'm just not putting them on Facebook" (60). Therefore, nonreactivity does not ensure that these data can directly reflect psychological problems of people to some degree in social media-based mental health prediction of the public. The present study used the always-on anonymous OPHS data, enabled the investigation of unexpected mental health events, and real-time measurement for the status of public mental health.

Third, previous studies tracked mental status of people on a large scale in social media including Facebook and Twitter without obtaining their consent and awareness have raised ethical concerns (61). The present study found that the continuous operation of the anonymous online mental health community in big data systems could enable researchers to study emergencies and provide real-time information for decision-makers, while could also avoid this problem.

The present study is not without limitations. First, the large sample size in the present study limited the possibility of selection bias. However, we have to admit that the topic features need to be further explored. Although the topic features perform better than the LIWC features when they are used alone, the topic features in the best predictive model did not play a relatively important role, which was inconsistent with our hypothesis. One possible explanation is that the topic features (14 dimensions) contain much fewer dimensions compared to the LIWC (101 dimensions). Therefore, topic features not only have competitive positive and negative predictive power compared to LIWC, but the dimensions in the topics also have stronger average predictive power, so its prediction of the OPHS number is more targeted. Another possible explanation is that the OPHS number changed for each type of psychological problem, while the overall number of the OPHS behavior remained stable.

Lastly, compared to the classical time series forecast method, the proposed method does not achieve absolute advantages on all lag days. The reason may be that we can only get relatively few OPHS data when conducting this study (in 2020 during the COVID-19 pandemic). Subsequent research can collect more data and use

deep learning forecasting methods to improve the existing results.

## Implications

A previous study points out that there is an explosive increase in OPHS after the outbreak of the COVID-19, and the OPHS number varies across different stages during the pandemic (62). From the perspective of taking immediate crisis response, the use of machine learning techniques may provide more accurate predicted values of OPHS behavior, which enables governments and OMHS platforms to rationally organize and allocate valuable counselors based on the help-seeking trends.

From the perspective of psychological intervention, using the interpretable machine learning, we can explore the underlying risk factors (e.g., work, marriage, interpersonal relationship, etc.) that cause an increase in the OPHS behavior, which offers policy suggestions for governments to undertake follow-up psychological intervention strategies. Take the prediction of the peak (02/28/2020) of the OPHS number as an example. The local interpretability of this method predicted and explained the peak 14 days in advance (78.28 people), as shown in **Figure 5**. We can see that the new confirmed cases were 6,463, which ranked second among the influential factors. These findings allow governments and organizations identifying risk factors during the increase in the OPHS number in advance, such as the surge in COVID-19 cases, the massive unemployment, and decreased access to mental health services, to facilitate the use of targeted administrative measures.

The global interpretability of this method helps government, OMHS platforms, and researchers understand how risky factors influence the dynamics of psychological response of the public and contribute to the development of psychological interventions policy. For example, the significant growth in the risky factors of COVID-19 cases, and topics of work, money in the prediction may indicate that financial relief should be provided for the unemployed during the social isolation, and targeted psychological support should be delivered to the public who return to work and school. Propaganda about the pandemic should avoid misinformation and massive panic.

## CONCLUSION

The present study investigated and predicted the OPHS number in China during the COVID-19 pandemic. Predicting and interpreting the OPHS behavior has a greater practical significance. Rational arrangements of the number of psychological counselors in advance are very important, which not only avoid the waste of the human resources but also enable help-seekers to get help promptly, especially in China where the number of psychological counselors is limited.

By understanding the risk and the protective factors in the OPHS behavior, the government can take administrative measures to prevent the potential psychological crisis. Besides, the OPHS behavior reflects, on one hand, the mental health literacy of the public, and on the other hand the number of psychological problems among the public. Therefore, using the

ecological paradigm and big data techniques to study help-seeking behavior is a valuable research field.

## DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: Raw data were generated at <https://www.xinli001.com/>. Derived data supporting the findings of this study are available from the corresponding author Yinghui Huang on request. Requests to access these datasets should be directed to yhhuang@ccnu.edu.cn.

## AUTHOR CONTRIBUTIONS

YH, HL, and LZ conceptualized the study, were involved in writing, and original draft preparation. YH and HL conceived the methodology and performed a formal analysis. HL, YH, SL, ZZ, ZR, and WW were involved in the process of writing, reviewing, and editing. HL was involved in visualization. WW and YH were involved in the process of obtaining funding and acquisition. All authors have read and agreed to the published version of the manuscript.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2022.814366/full#supplementary-material>

**Supplementary Figure 1** | Silhouette Coefficient for K-Means model with different number of clusters.

**Supplementary Table 1** | Results of 10-fold cross-validation (Random Forest).

**Supplementary Table 2** | Details of features.

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# Post-traumatic Growth and Psychological Resilience During the COVID-19 Pandemic: A Serial Mediation Model

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Although the World Health Organization (WHO) has issued guidelines for managing to contain, mitigate, and limit of the COVID-19. However, it is more essential to highlight the urgency and importance of evaluating social functioning and mental health status during the pandemic. College students have experienced serious problems and have had to overcome many negative situations brought about by the pandemic. Accordingly, the present study intended to use Chinese college students as sample to examine the positive adoption and changes during the ongoing COVID-19. Guided by literatures in this field, we explored the internal mechanism of post-traumatic growth affecting psychological resilience, and considered about mediation roles of positive coping styles and cognitive reappraisal. A total of 463 college students from universities in China effectively completed online questionnaires. The result indicated that these four variables were positively correlated with each other ( $p$ s < 0.001). More importantly, our findings proved a direct and positive effect on psychological resilience. Positive coping styles and cognitive reappraisal, respectively, mediated the relationship between post-traumatic growth and psychological resilience. Over all, the hypothesized serial model conclusively fits the data: students with high-level post-traumatic growth tended to report increased use of positive coping strategies, which further facilitated their cognitive reappraisal, and subsequently, promoted their psychological resilience. The findings obtained in this study will provide a theoretical basis and possible viable strategies for both targeted crisis intervention and psychological trauma recovery plans.

**Keywords:** post-traumatic growth, psychological resilience, positive coping, cognitive reappraisal, college students

## INTRODUCTION

The novel coronavirus disease (COVID-19) is a respiratory disease characterized by high transmissibility and mortality rates (1). On January 30, 2020, the World Health Organization (WHO) declared the outbreak of a public health emergency of international concern. As this pandemic continues to spread with strong momentum and a lack of specific treatment, restrictions on social contact (large-scale lockdowns), and appropriate infection prevention strategies (travel limitation, quarantine, and self-isolation) have been implemented to control virus propagation.



Obviously, both the COVID-19 emergency and the extraordinary measures to contain it have had a profound and wide range of psychosocial impact (2). More and more experts have highlighted the urgency and importance of evaluating social functioning and mental health status during the COVID-19 pandemic.

In response to the outbreak of infection, the Chinese government and health agencies have ordered nationwide school closures as an emergency measure to control the pandemic. Students in higher education experience multifaceted pressures, such as academic workload, economic difficulties, relationship issues, and employment concerns brought about by the pandemic (3). These stressful experiences may put college or university students at a high risk of future mental health problems (4, 5). However, negative experience can be a “catalyst” for positive change. Recovery from initial heightened levels of distress may be more common, particularly when adversity involves extensive disruptions over an extended period of time (6). Given the ongoing nature of the COVID-19 pandemic, people in their respective regions need to quickly adjust their minds and lifestyles and adapt to the “new normal.” Hence, it is imperative to identify factors that may have protective effects on the physical and mental status of college students.

The American Psychological Association defines psychological resilience (PR) as “a process of good adaptation in the face of adversity, trauma, tragedy, threats, or other significant sources of stressors such as family and relationship problems, serious health problems, or financial problems” (7). In general, PR is a context-dependent “reconfiguration,” refers to an individual’s ability to quickly rally, recover, and return to their pre-crisis status after trauma exposure (8). Similarly, PR is also viewed as a measure of stress coping ability in response to adversity, which can help individuals reduce their vulnerability to challenges and difficulties (9). Focus on university and college students, studies have documented that improving PR can cushion the psychological trauma caused by stress and can contribute to students’ academic success (10), improve their sense of well-being (11), and enable them to effectively cope with stressful situations (12).

With regard to COVID-19, PR was identified as a negative predictor of depression, anxiety, and somatization in the general population during the peak of the pandemic in China (13). The available data suggests that PR plays a protective role against the fear of COVID-19, individuals with high psychological resilience experience fear less (14). In fact, these studies provide evidence on psychological resilience factors, such as protective factors for mental health disorders, have been extensively discussed (15). However, the specific mechanism of PR as the outcome variable has scarcely been investigated, especially among college students in the context of the COVID-19 pandemic.

## Post-traumatic Growth and Psychological Resilience

Although traumatic events alter daily life to a certain extent, people who have been confronted with trauma not only have post-traumatic negative symptoms but may also undergo positive psychological changes. Post-traumatic growth (PTG) is one of the

most widely discussed salutogenic post-traumatic consequences, which is defined as “positive psychological change experienced as a result of the struggle with highly challenging life circumstances” (16). The occurrence of PTG can help individuals think more and take coping measures more proactively after experiencing traumatic events. Indeed, PTG enables individuals to reframe their experiences and perceive meaningful personal growth potential from a major life crisis, which can improve relationships with others, create new possibilities, enhance personal strength, bring spiritual development, or increase appreciation of life (17). These deep reconsiderations are what will facilitate individuals to establish new life goals. The maintenance of the growth experienced may require unpleasant periodic cognitive reminders of what has been lost, so that in an apparently paradoxical way, what has been gained remains in focus (18). Therefore, this process can sometimes take months or years and, in some cases, as PTG also depends on personal traits, individuals who have been confronted with trauma may never experience positive psychological changes (19). As both psychological states emphasize transformation after a trauma, PTG is considered to have a close correlation with PR (19, 20). In fact, growth is not a result of the event itself, but rather a result of the struggle to deal with it, which means that PTG not only requires one’s post-traumatic response and relief, but also helps to enhance oneself and become stronger (21).

As aforementioned, individuals with higher levels of PTG feel powerful enough to handle problems in their life and can easily adapt to traumatic events by focusing on positive outcomes, as they possess improved coping mechanisms and improved psychological well-being (22). In this regard, the abilities and resources possessed before the event should receive more attention. PTG ensures a deeper perspective and strength to people after traumatic events, which contributes to stronger beliefs and ability for action, increasing psychological resistance to negative effects when dealing with subsequent adversity (16, 23). Theoretically, experience and positive changes after trauma can be antecedent factors for the development of PR. However, no empirical research has confirmed the mechanisms of PTG with regard to PR systematically. The current study aimed to test whether PTG of college students can predict PR positively in the context of the COVID-19 epidemic. Thus, the following hypothesis is proposed:

Hypothesis 1: PTG is directly associated with PR.

Post-traumatic growth emphasizes individuals’ transformation in the aftermath of stressful events that may reshape their assumptive world, requiring a reconceptualization of fundamental beliefs about the self, others, and the future (24). Several studies have suggested that positive sense-making, positive reframing/reinterpretation, and positive affect/attitude are positively correlated to PTG (19, 25). We suggest that growth from traumatic events may provide individuals with more positive coping strategies and effective emotion regulation to deal with subsequent trauma, which could play an essential role in fostering PR. Even so, there remains a dearth of in-depth studies on the serial mediating mechanism of “PTG-PR.”



## The Mediating Role of Coping Style

Coping style has been identified as a process of managing external or internal demands and an important intermediary regulating factor in the process of psychological stress (26). Some coping styles involve adaptive or constructive coping strategies, such as seeking support and trying to change, while some are mainly considered maladaptive, such as avoidance and venting (27). In accordance with this viewpoint, Xie proposed to divide coping styles into positive coping (PC) styles and negative coping (NC) styles (28). The former helps to buffer the impact on individuals and maintain both physical and mental health (29), whereas the latter plays a contrary role (30).

Coping involves using behavioral, cognitive, and emotional strategies to handle and manage stressful events or negative psychological outcomes, whereas resilience refers to the adaptive capacity to recover from adversity and the successful final result of effectively implementing these strategies (31). However, the nature of the relationship between resilience and coping style has not yet been clearly established. One study found that coping style mediates the relationship between resilience and psychological well-being (32), while other studies have observed that coping style predicts resilience (33, 34). Using of coping strategies such as positive reinterpretation appears to be a resilience-building intervention. Such interventions provide opportunities to exercise and develop adaptive coping responses with appropriate scaffolding and guidance, which is integral to realize one's resilience potential.

A higher level of positive coping styles may be related to increased levels of positive cognitive and behavioral adjustments in the face of trauma. A burgeoning body of literature have proved that utilization of PC mechanisms such as seeking social support, positive thinking, and problem solving was associated with lower levels of traumatic stress, stigma (35). Moreover, one study demonstrated that PTG was predictive of hope and PC but negatively predictive of anxiety (36). Although there has been limited investigation of direct effects of PC on the PR of college students during this major public health event, based on these previous findings, it can be inferred that PTG is indirectly associated with PR via PC. Thus, the following hypothesis is proposed:

Hypothesis 2: PC mediates the relationship between PTG and PR.

## The Mediating Role of Emotion Regulation

Emotion regulation (ER) is identified as the cognitive behavioral process whereby individuals consciously and/or non-consciously adjust internal affective states to respond to environmental demands appropriately, thereby generating adaptive responses (37, 38). An accumulating body of evidence indicates that enhanced ER is positive related to PR and that discrete ER strategies (e.g., reappraisal and suppression) are likewise related to PR (39, 40). In particular, the positive association between cognitive reappraisal (CR) and PR was confirmed in six studies, even when controlling for other explanatory variables (41–46). In the same way, it can be easily proposed that PTG is indirectly

associated with PR via CR. Thus, the following hypothesis is proposed:

Hypothesis 3: CR mediates the relationship between PTG and PR.

Notably, improved coping capacity further enhances PR by contributing to emotion- and problem-focused coping during and after negative experiences (47). The relationship between PC and CR is not yet clear; however, their common core emphasizes that protective factors provide to individuals facing adversity determines the existence and development of their PR. In this case, the enhancement of PR after trauma lies not in avoiding stress but in how people adopt positive solving means and emotion regulation strategies to handle it. Therefore, we offer the following hypothesis:

Hypothesis 4: PTG can affect PR through the serial mediating roles of PC and CR.

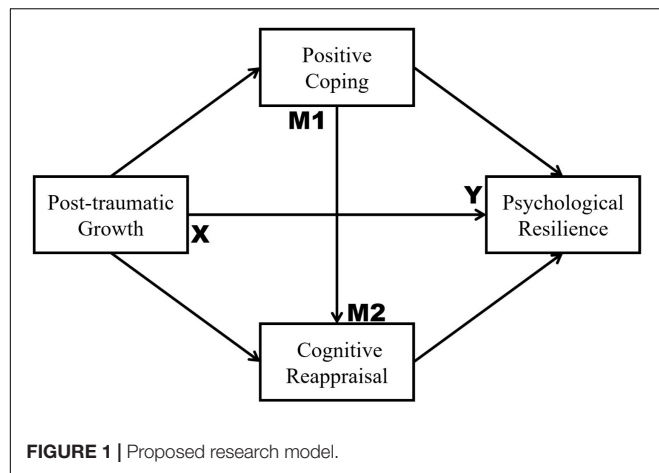
## The Current Study

The WHO has issued guidelines for managing containment, mitigation, and limiting of COVID-19. However, it is our contention that psychological preventive and therapeutic measures are just as crucial in facing the pandemic. College students have experienced serious problems and have had to overcome many negative situations during this period (48). Accordingly, the present study used Chinese college students as sample to observe positive characteristics adoption and changes during the ongoing COVID-19 pandemic. Boosting mental resilience can help to successfully deal with the coronavirus pandemic. The findings obtained in this study will provide a theoretical basis and possible viable strategies for both targeted crisis intervention and psychological trauma recovery plans. For instance, psychologists or other professionals could be called on to provide psychological education or rapid and easy-to-access interventions (e.g., online counseling or hotlines), aimed at guiding effective coping behavior and positive emotional cognition in the face of this and other potential public health emergencies. To this end, we aimed to propose a serial mediation model and test the internal mechanism of PTG affecting PR, and in particular, to examine the mediating roles of PC and CR in Chinese college students during the COVID-19 pandemic (see Figure 1).

## MATERIALS AND METHODS

### Sampling Procedure and Sociodemographic Background

The present study is a cross-sectional analysis that used convenience sampling methods. Convenience sampling is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher. The online survey was conducted between May 18 and July 22, 2021, by distributing QR codes to full-time undergraduate students in mainland China through the



Wenjuanxing platform<sup>1</sup>. Before participating in the survey, all subjects were informed of the nature of the study and provided informed consent. They were also assured that personal information would not be shared with others without their permission. The recruitment and data collection procedures were approved by the Ethics Committee of Liaoning Normal University.

Participants were asked to complete a battery of online questionnaires. Only after completing all items was the questionnaire submitted. Otherwise, the assessment system automatically recorded the data as incomplete. The test time was set by pretest results, and questionnaires with test times of less than 4 min were deleted. Excluding invalid questionnaires from 24 participants, the final sample size was 463. Among 463 respondents, 365 (78.83%) were female. The majority (78.2%) were 2nd and 3rd year undergraduates, 18.8% were first year undergraduates. Approximately one in five of the sample were medical students. Over a half were from only child families. Only 40.6% lived in rural areas.

To ensure the statistical power and effect size, we conducted a *post hoc* statistical power calculator (G\*Power, version 3.1.9.7; Heinrich Heine University Düsseldorf) with a medium effect size ( $r = 0.3$ ), the desired statistical power level of 0.8, and significance level ( $\alpha$ ) of 0.05. The result showed that the observed power ( $1 - \beta$ ) for two-tailed hypothesis was 0.99, indicating an acceptable power and effect size.

## Materials

Instructions were provided at the beginning of the questionnaire, while general data included sociodemographic factors, the COVID-19 awareness and the impact of the pandemic. Sociodemographic demographic details covered gender, grade, residence, major (medical, non-medical), and only-child status or not. Awareness and impact of COVID-19 were collected through: “How much you care about your physical/mental health during this outbreak,” “Your recognition of the effectiveness of the epidemic prevention and control measures in China,” and “Your assessment of the future epidemic situation in China.”

<sup>1</sup> <https://www.wjx.cn/>

The previous three questions were assessed using a 5-point Likert scale ranging from 1 (none) to 5 (very significant). Besides, data about the online psychological assessments were composed of four scales: (a) post-traumatic growth inventory, (b) psychological resilience scale, (c) simplified coping style questionnaire, and (d) emotion regulation questionnaire.

## Post-traumatic Growth Inventory

The Post-traumatic Growth Inventory was developed by Tedeschi and Calhoun to assess the positive experiences of individuals who have experienced traumatic events (49). The Chinese version adapted to suit the Chinese context has demonstrated adequate psychometric properties. The 21-item scale is divided into five dimensions, including relationship to others (seven items), new possibilities (five items), personal strength (four items), spiritual change (two items), and appreciation of life (three items). Each item is scored on a 6-point Likert scale ranging from 0 (no change) to 5 (complete change). The total PTG score was the sum of all item scores. A higher score represents additional positive psychological changes in the aftermath of the trauma. The PTG scale here was emphasized to response considering the COVID-19 epidemic context by specific description. In the current study, Cronbach's Alpha was 0.96 and McDonald's Omega was 0.96.

## Psychological Resilience Scale

The Connor-Davidson Resilience Scale (CD-RISC) is considered a reliable and valid instrument for evaluating psychological resilience (50). The adapted Chinese version of the CD-RISC measures personal resilience over the past 30 days and has adequate content validity, internal consistency, and test-retest reliability (51). This revised version is divided into three factors: optimism (four items), strength (eight items), and tenacity (13 items). Participants respond to 25 items using 5-point scoring, ranging from 0 (never) to 4 (always). Consequently, the total score can be obtained by adding up the responses (values) of all items, ranging from 0 to 100. Higher scores reflect a greater degree of psychological resilience. In the current study, Cronbach's Alpha was 0.91 and McDonald's Omega was 0.92.

## Simplified Coping Style Questionnaire

The Simplified Coping Style Questionnaire (SCSQ, Chinese version) was developed by Xie to assess participants' attitudes and coping styles regarding specific life events or difficulties encountered in their daily lives (28). A total of 20 items encompasses two dimensions: items 1–12 describe positive coping styles (e.g., “to be free from work, study, or some other activities”) and items 13–20 describe negative coping styles (e.g., “relieve trouble by smoking, drinking, taking medicine, and holding things”). Each item is rated on a 4-point Likert scale ranging from 0 (never) to 3 points (very often). The higher the dimension score, the more habitually the corresponding coping style is used by individuals with stress. Based on the hypotheses, only positive coping styles were utilized in the mediation model. In the current study, Cronbach's Alpha was 0.85 and McDonald's Omega was 0.85.

## Emotion Regulation Questionnaire

The Emotion Regulation Questionnaire was developed by Gross and John to assess ER strategies (52). The Chinese translations of these items were adopted (53). The questionnaire consists of 10 items rated on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree), which have two opposing dimensions. Six items measured the degree of cognitive reappraisal (e.g., “When I wanted to feel less negative emotion, I changed the way I was thinking about the situation”), and four items measured the degree of expressive suppression (e.g., “I controlled my emotions by not expressing them”). The total score ranges from 10 to 70, with higher scores reflecting greater use of the specific emotion regulation strategy. Based on the hypotheses, only cognitive reappraisal was utilized in the mediation model. In the current study, Cronbach's Alpha was 0.82 and McDonald's Omega was 0.82.

## Statistical Analysis

Upon completion of data collection, all analyses were performed utilizing SPSS 28.0 (IBM Corp., Armonk, NY, United States). First, the original questionnaire data needed to be preliminary analysis. Common method variance (CMV) is one of the main sources of measurement error threatens the validity of the conclusions about the relationships between measures. CMV means that variance is attributable to the measurement method rather than to the constructs the measures represent (54). Thus, we undertook procedural and process remedies to control the effect of CMV (55). On the one hand, an *ex ante* approach was adopted in the design of questionnaires (56). Participants were assured confidentiality and anonymity by an introductory message to minimize social desirability effect (57). On the other hand, Harman's single-factor test (SPSS 28.0 version) and the method-factor approach (Mplus 8.3 version) were conducted to ensure statistical control. Harman's test assumes that if CMV is presented in the data, one variable will account for more than 40% of the covariance in the independent and dependent variables (54, 58). In other words, the variation between the independent and dependent variables was caused more by the methods of data collection and measurement than by difference in the nature of variables. Second, the internal consistency for each measure was checked by reliability tests using Cronbach's Alpha and McDonald's Omega coefficient (59). Third, for the sociodemographic variables and awareness of COVID-19, descriptive statistics were reported as means and standard deviations for continuous variables and percentages for categorical variables. Fourth, Spearman's correlation analysis was conducted to examine the relationships between four variables. Finally, as shown in **Figure 1**, the serial mediation model posits how, or by what means, one predictor (X) affects one outcome variable (Y) through two potential mediators (M1 and M2). Three models were fitted: regressing the first mediator on the predictor, regressing the second mediator on the first mediator and the predictor, and regressing the outcome on all mediators and the predictors (60). Moreover, our study used bootstrapping, a non-parametric resampling procedure, to test hypotheses about mediation. Bootstrapping involves resampling

the raw data and forming an empirical distribution of the indirect effect point estimates to form the confidence interval (CI) of an indirect effect (60, 61). Compared with conventional methods, this method has higher power while maintaining reasonable control over the type I error rate (62). Repeated sampling 5,000 times were generated from the original sample set ( $N = 463$ ) to calculate the 95% CI. The absence of zero in the 95% CI of the standardized path coefficient indicated that the mediation effects were significant. The hypotheses were tested using the SPSS plug-in PROCESS macro program (version 3.4). All differences were considered statistically significant at  $p < 0.05$  (two-sided).

## RESULTS

### Common-Method Variance Test

An explanatory factor analysis (EFA) including all variables using unrotated principal components factor analysis was performed to statistically verify the presence of CMV (54). The results revealed that 12 factors had eigenvalues greater than 1, and the general factor accounted for only 27.29% of the total variance, which did not exceed the critical value of 40%. Furthermore, a confirmatory factor analysis (CFA) was also carried out. All items are allowed to load on their theoretical constructs, as well as on an unmeasured latent CMV factor (adding a first-order factor with all of the measures as indicators to the theoretical model), and the significance of the structural parameters is examined both with and without the latent CMV factor in the model. The results showed that the goodness-of-fit was not significantly improved after adding the common method factor ( $\chi^2/df = 2.800$ ,  $CFI = 0.770$ ,  $RMSEA = 0.062$ ,  $TLI = 0.761$ ,  $SRMR = 0.228$ ) to the four-factor model of this study ( $\chi^2/df = 2.674$ ,  $CFI = 0.786$ ,  $RMSEA = 0.060$ ,  $TLI = 0.778$ ,  $SRMR = 0.059$ ). All these tests concluded that CMV was not a concern.

### Socio-Demographic Variables and Awareness of COVID-19

The characteristics regarding the sociodemographic data and self-assessment about COVID-19 of the study population are shown in **Table 1**. Regarding the awareness of the pandemic, participants concerned more about their physical and mental health during the epidemic and showed a positive attitude toward the situation. Most of them are satisfied with local pandemic prevention measures and not worried about the future epidemic situation in China.

### Descriptive Statistics and Correlation Analysis

Descriptive statistics and a correlation matrix of the study variables are given in **Table 2**. The Shapiro–Wilk normality test found that only PR data is normally distributed ( $p > 0.05$ ). Hence, the present data was described by first quartile (Q1), Median and third quartile (Q3), and was calculated using Spearman's correlation analysis. Bivariate correlation analyses showed that

**TABLE 1** | Socio-demographic characteristics and awareness of the COVID-19.

Category	Subcategory	N (%)	Concern (Mean ± SD)	Satisfaction (Mean ± SD)	Estimation (Mean ± SD)
Gender	Female	365 (78.8%)	3.17 ± 1.01	4.40 ± 0.85	1.72 ± 0.65
	Male	98 (21.2%)	3.01 ± 1.17	4.47 ± 0.86	1.64 ± 0.68
Grade	1	87 (18.8%)	3.07 ± 1.08	4.46 ± 0.79	1.69 ± 0.56
	2	211 (45.6%)	3.31 ± 1.03	4.42 ± 0.85	1.81 ± 0.67
	3	151 (32.6%)	2.97 ± 1.01	4.38 ± 0.89	1.59 ± 0.66
	4	10 (2.2%)	2.60 ± 0.70	4.30 ± 1.06	1.30 ± 0.48
	5	2 (0.4%)	3.00 ± 2.83	4.50 ± 0.71	2.00 ± 1.41
	Other	2 (0.4%)	3.00 ± 2.83	4.50 ± 0.71	1.50 ± 0.71
Major	Medical	95 (20.5%)	2.84 ± 1.03	4.39 ± 0.89	1.55 ± 0.61
	Non-medical	368 (79.5%)	3.21 ± 1.04	4.42 ± 0.84	1.75 ± 0.66
Residence	Urban	275 (59.4%)	3.11 ± 1.06	4.42 ± 0.80	1.73 ± 0.67
	Rural	188 (40.6%)	3.18 ± 1.04	4.40 ± 0.93	1.67 ± 0.63
Family	Only child	257 (55.5%)	3.17 ± 1.06	4.40 ± 0.84	1.75 ± 0.66
	Multiple-children	206 (44.5%)	3.09 ± 1.04	4.43 ± 0.87	1.65 ± 0.64

(N = 463).

**TABLE 2** | Descriptive statistics and correlation coefficients.

	Median (Q1, Q3)	PR	PC	CR
PR	2.44 (2.16, 2.80)			
PC	2.00 (1.75, 2.33)	0.58***		
CR	5.50 (4.83, 6.00)	0.41***	0.42***	
PTG	2.62 (1.95, 3.23)	0.51***	0.49***	0.29***

(N = 463).

PR, psychological resilience; PC, positive coping; CR, cognitive reappraisal; PTG, post-traumatic growth.

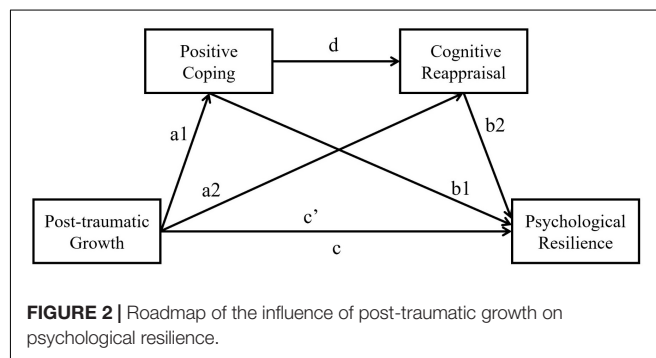
\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

PR, PC, CR, and PTG were positively correlated with each other ( $ps < 0.001$ ). Results of the Spearman correlations between research variables are generally in line with our expectation, which met the prerequisites for subsequent research hypotheses and conducting mediation testing.

## Serial Mediation Model

For further testing the mediation effects, a serial mediation model was conducted with PROCESS (model 6) for SPSS, using with PTG as predictor, two serial mediators (PC→CR), and PR as outcomes. The conceptual model (see **Figure 2**) is based on three linear regression analyses. The first regression analysis tests the effects of PTG on PC (path a1). The second regression model tests the combined predictive effects of PTG and PC on CR (paths a2 and d). The third regression predicts the PR by the independent variable PTG and the two mediators (paths b1, b2, and c'). Here, path c' depicts the direct effect of PTG on the PR controlled for the effects of the two mediators. In contrast, path c indicates the total effect of PTG on PR without considering the mediators.

Model indices are depicted in **Table 3**. In the path of a1→b1, PTG had a significant positive effect on PC ( $\beta = 0.22$ ,  $p < 0.001$ ), while PC had a significant positive effect on PR ( $\beta = 0.42$ ,  $p < 0.001$ ). Thus, PTG enhanced PR by adopting more positive coping strategies. In the path of a2→b2, PTG



had a significant positive effect on CR ( $\beta = 0.09$ ,  $p < 0.05$ ), while CR had a significant positive effect on PR ( $\beta = 0.11$ ,  $p < 0.001$ ). Thus, PTG improved PR also by increased reappraisal emotion regulation. In the path of a1→d→b2, PC had a significant positive effect on CR ( $\beta = 0.64$ ,  $p < 0.001$ ). This indicates that the PC was closely related to students' CR. Furthermore, PTG enhanced the CR by increase PC, which finally increased students' PR. These results supported hypotheses 1–4.

For the prediction of PR (**Table 4**), PTG was a statistically significant and positive predictor ( $c = 0.22$ ,  $p < 0.001$ ) in the total effect model without consideration of the mediators. However, the explained variance increased by  $\Delta R^2 = 0.21$  when the mediators, PC and CR, were included in the model. All three possible indirect effects were significant [a1→b1:  $b = 0.10$ , 95% CI (0.07–0.13); a2→b2:  $b = 0.01$ , 95% CI (0.00–0.02); a1→d→b2:  $b = 0.02$ , 95% CI (0.01–0.02)]. Correspondingly, the total indirect effect was significant [ $b = 0.12$ ,  $p < 0.001$ ; 95% CI (0.09–0.15)], whereas the direct effect was reduced by inclusion of the mediators but remained significant, too [ $c' = 0.10$ ,  $p < 0.001$ ; 95% CI (0.07–0.14)]. The effect size of the mediating pathways was calculated using the formula (ab)/c, showed that path a1→b1, a2→b2 and a1→d→b2 accounted for 42.62, 4.02, and 6.75% of the total effect, respectively.



**TABLE 3 |** Regression results for mediation analysis.

Model	Outcome	Predictors	$\beta$	SE	t	LLCI	ULCI
Model 1	PC	Constant	1.43	0.06	26.00***	1.33	1.54
		PTG	0.22	0.02	11.00***	0.18	0.26
		$R^2 = 0.21, F = 121.06^{***}$					
Model 2	CR	Constant	3.91	0.15	26.06***	3.61	4.20
		PTG	0.09	0.04	2.16*	0.01	0.16
		PC	0.64	0.08	7.92***	0.48	0.80
		$R^2 = 0.19, F = 52.42^{***}$					
Model 3	PR	Constant	0.78	0.11	6.76***	0.55	1.00
		PTG	0.10	0.02	5.37***	0.07	0.14
		PC	0.42	0.04	10.15***	0.34	0.51
		CR	0.11	0.02	4.64***	0.06	0.15
		$R^2 = 0.43, F = 116.01^{***}$					

PR, psychological resilience; PC, positive coping; CR, cognitive reappraisal; PTG, post-traumatic growth; LLCI, boot CI lower limit; ULCI, boot CI upper limit.

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

**TABLE 4 |** Effects and 95% confidence intervals for Model 3.

	Effect	SE	t	LLCI	ULCI
Total effect	0.22	0.02	11.06***	0.18	0.26
Direct effect	0.10	0.02	5.37***	0.07	0.14
PTG→PC→PR	0.10	0.01	—	0.07	0.13
PTG→CR→PR	0.01	0.00	—	0.00	0.02
PTG→PC→CR→PR	0.02	0.00	—	0.01	0.02

PR, psychological resilience; PC, positive coping; CR, cognitive reappraisal; PTG, post-traumatic growth; LLCI, boot CI lower limit; ULCI, boot CI upper limit.

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

## DISCUSSION

People can be at the greater risk of developing various mental health problems following traumatic stress (63). The identification of protective factors of mental health problems is vital to improve the well-being and the psychological health of individuals when facing difficulties (15, 64). What remains to be answered is whether PTG plays a positive role in PR and how PTG contributes to PR during the later pandemic period among Chinese college students. According to the thorough review on previous studies, both PC and CR are effective protective factors related to enhanced PR (33, 34). However, the aforementioned four concepts have not been handled in a holistic manner. In this regard, it is crucial to address the direct and indirect relationships between PTG, PR, PC, and CR. Calhoun and Tedeschi proposed that the first step toward PTG is “cognitive engagement” (65). This reconstruction process that occurs after a traumatic event leads individuals to rethink repeatedly about the circumstances of the setbacks they have experienced, in the hope of giving it some meaning and build new life goals, which takes months or years (19). Since our survey was conducted in June 2021, more than 1 year after the initial outbreak, we can reasonably infer that college students have had a sufficient amount of time to adapt to such stressful environment and fulfill positive changes eventually. Indeed, the high PTG and PR

scores in our sample (Median 2.62 and Median 2.44, respectively) confirmed the psychological rebound and recovery in the context of the pandemic.

This study focused on college students during the COVID-19 pandemic in the Chinese background. As shown in **Table 1**, the demographic analysis about individuals’ awareness of COVID-19 indicated that most of the sample hold a positive attitude toward the pandemic (as measured by Estimation score), such as paying more attention to their physical and mental health than usual (as measured by Concern score) and satisfying with the present prevention measures at present (as measured by Satisfaction score). These may provide ample evidence that when facing this ongoing trauma, Chinese college students still showcased hope and optimism. Although initially severely affected by the outbreak, China has since made significant progress in the prevention and control of the infection that causes COVID-19. To date, most Chinese students have been safely guarded benefit by the Home Quarantine Order and carried out Nucleic Acid Test screening, at the same time, colleges and universities have formulated flexible learning plans for students through online course training as appropriate to ensure normal teaching. In addition, Chinese colleges have conducted vigorous advocacy about the outbreak responses and reduced the panic caused by the fear on a variety of mass media platforms.

The current study found that all the hypotheses we initially proposed have been supported. To be specific, our findings prove that PTG has a direct and positive association with PR. PC and CR, respectively, mediated the relationship between PTG and PR. Thus, serial mediation existed among those variables: students with high-level PTG tended to report increased use of PC, which further facilitated their CR and subsequently, promoted their PR. As predicted, a positive correlation between PTG and PR was assessed, this result is basically consistent with Hypothesis 1 and with previous research (19), in which a positive relationship between PTG and PR was found. A previous study examined the relationship between PTG and PR of nursing university students after the COVID-19



alarm status in Turkey and found a predictive effect of PR on PTG (66). However, the present result indicates that PTG is a significant predictor of PR, which potentially provides a novel perspective of the impact factor studies of PR. PR, reflecting problem-solving ability or positive adaptation, is an individual's ability to overcome adversities with positive developments. It has already been verified to enhance individuals' understanding of happiness and promote mental health (3). PR is regarded as a mediator, moderator, or dependent variable in most previous studies. For instance, one study examined undergraduate and graduate students from China, Ireland, Malaysia, South Korea, United States and so on, and found that increased PR weakened the relationships between perceived stress and anxiety on sleep quality during the height of the COVID-19 pandemic (67).

Nevertheless, no study has further investigated the PR improvement mechanism among college students especially in the COVID-19 background. Specifically, PR can be promoted in different ways, such as providing a supportive social network (68), elevating general self-efficacy (23), enhancing active coping self-efficacy strategies (e.g., enhancing the perception that one is able to manage or recover from a stressful event), learning mindfulness skills (e.g., deep breath and focusing on the present moment), as well as nurturing a sense of purpose in life and the ability to find meaning (69–71). According to the dimensions of PTG, traumatic events may have caused individuals to undergo positive changes and improvement in interpersonal relationships, future possibilities, personal strength, mental state, and attitudes toward life. PTG differs from PR in that it is characterized by the gain of positive psychological benefits, whereas resilience is characterized by a return of the individual to its initial state (pre-crisis state) (19).

The present study proposed that positive gains of PTG may be correlated with the aforementioned factors from a different angle (23). Indeed, our findings are consistent with Hypothesis 2, 3, and 4 and previous studies, especially, confirming that serial mediation existed in the above relations in the context of the pandemic. In terms of the intermediary model, PC and CR, respectively, mediated the relationship between PTG and PR. Firstly, we found support for Hypothesis 2 that PC can partially and positively mediate the relationship between PTG and PR. This means that the effect of college students' PTG on their PR is partly produced through PC. An individual with PC strategies can successfully evaluate and address difficulties in their lives. Based on a previous literature, a cross-sectional study was conducted using an online-based survey among university students during the official lockdown in Hungary when dormitories were closed, and teaching was conducted remotely. Results showed that among the domestic students, cognitive restructuring as a PC strategy was associated with lower levels of stress and anxiety (72). Also, PC is correlated to higher levels of positive cognitive and behavioral adjustments (73), which are representative of PTG in the face of stressful events. It has been reported that college students who were more optimistic and used positive coping methods were more willing to participate in social activities and manage the adverse impact of stress (74). Secondly, we found support

for Hypothesis 3 that CR can partially and positively mediate the relationship between PTG and PR. This means that PTG strengthened PR via CR, a kind of ER strategies. Psychologists have theorized that ER bolsters PR by facilitating adaptive psychosocial processes (52, 75). More importantly, numerous studies have demonstrated that reappraisal is positively associated with PR (42, 76). CR is conceptualized as an adaptive strategy of positively reinterpreting a stressor to mitigate or control its emotional impact (77). One potential explanation for this finding is that more motivated individuals for positive growth prefer seek to implement efficient ways to adjust emotion and recontribute confidence when facing stressful situations (78, 79). Finally, for the first time, we found support for the serial mediation model of Hypothesis 4. College students who gained growth from traumatic events would be more easily to get recovery and adaption in the following crisis through emotional cognition reinterpreting, which is utilized based on a more positive coping strategy. Hence, it is essential to treat PC and CR which developed from PTG as viable options to promote PR among Chinese college students under trauma and adversity.

In the present study, the relationship between the PTG developed due to the COVID-19 pandemic and PR was dealt with in the context of PC and CR, which are discussed by considering the constructed models. However, the findings obtained from the present study need to be considered in the context of several limitations. On the one hand, all demographics and primary psychological variable assessment data were self-reported by students recruited by their teachers. Therefore, this data might have been affected by participants' potential reporting bias. Future research should give sufficient consideration to the principle of voluntariness. On the other hand, due to the cross-sectional design, the current study did not allow us to establish definite inferences about a causal/directional relationship between the investigated variables. A prospective longitudinal design and experimental studies are required to demonstrate the causal linkage. During data interpretation, it is essential to consider that the mediator/moderator might be correlated with unobserved prognostic variables that may confuse the outcome. Therefore, future studies could employ a multimodal approach or assess the presence of other intermediary pathways with underlying effect to overcome this issue and enrich literature linking different variables.

That said, taken together, the present study contributes the literature on positive psychological resources among college students in China during the COVID-19 pandemic. Novel theoretical and empirical insights into the understanding of how PTG can facilitate PR have been provided. Findings show that students with post-traumatic growth developed more positive coping styles and cognitive reappraisal strategies, thereby encouraging them to maintain a higher level of psychological resilience. It is hoped that this study will stimulate further research and discussion concerning positive psychological growth. Notably, the mental health of college students is significantly affected due to the COVID-19 pandemic. They require the help and support of society, family, and colleges. What's more, in order to improve a higher level of students'

mental well-being, government and schools ought to pay due attention to the specific aspects of resilience and collaborate to resolve this problem in order to provide high-quality psychological care to college students.

## 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 Liaoning Normal University. The patients/participants provided their written informed consent to participate in this study.

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Both authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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# The Correlation Between Probiotics and Anxiety and Depression Levels in Cancer Patients: A Retrospective Cohort Study

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**Objective:** Studies have shown a correlation between gut microbiota and anxiety and depression levels. However, these studies are mainly animal studies or clinical studies of non-cancer patients, there is still a lack of relevant studies in cancer patients. The main objective of this trial was to analyze the correlation between probiotics and anxiety and depression levels in cancer patients.

**Methods:** We screened all cancer patients consecutively admitted to the inpatient department of the First Affiliated Hospital, Zhejiang University School of Medicine in May 2020. A total of 292 cancer patients met our inclusion criteria. Then, we followed up all patients for 24 weeks. Patients who had incomplete data or loss of follow-up were excluded. In addition, in patients who took probiotics, those did not take probiotics consistently or did not take specific probiotics were excluded. Ultimately, the number of patients enrolled was 82 in probiotics cohort and 100 in non-probiotics cohort. The 17-item Hamilton Depression Scale (HAMD-17) questionnaire was used to measure the depression levels of the patients, and we also used Hamilton Anxiety Scale (HAMA) questionnaire to assess the patients' anxiety levels. A logistic regression model was used to analyze whether the difference in baseline data of two cohorts would affect the final result.

**Results:** Demographic and clinical characteristics of all cancer patients enrolled in probiotics cohort and non-probiotics cohort were similar except the cancer therapy ( $P = 0.004$ ). According to the HAMA score, we divided cancer patients into non-anxiety group (HAMA score  $< 14$ ) and anxiety group (HAMA score  $\geq 14$ ). Similarly, cancer patients were also divided into non-depression group (HAMD-17 score  $\leq 7$ ) and depression group (HAMD-17 score  $> 7$ ). The results demonstrated that there was no statistical difference in the proportion of patients with anxiety (6.1 and 13.0%, respectively,  $P = 0.121$ ) and depression (30.5 and 23.0%, respectively,  $P = 0.254$ ) between probiotics and non-probiotics cohorts. The results of logistic regression model analysis further proved that the baseline difference in cancer therapy did not affect the conclusions.



**Conclusion:** Our results still suggest that there is no significant correlation between probiotics and anxiety and depression levels in cancer patients. Therefore, we do not recommend supplementing probiotics for cancer patients to prevent anxiety and depression. Moreover, high-quality RCTs are also needed to further confirm the conclusions of this study.

**Keywords:** probiotics, anxiety, depression, cancer patients, gut microbiota

## INTRODUCTION

Cancer, a serious disease in which cells grow indefinitely, is one of the leading causes of death worldwide (1). Various factors affected the cancer patients such as unpredictability of tumor recurrence, stressful treatments and constant anticipatory threats (2–5). Therefore, emotional distress is a common symptom in cancer patients. Depression and anxiety are considered two common comorbidities of cancer, and could lead to many adverse events in the treatment of cancer, for example influencing life quality and negatively impacting medical adherence, cancer survival, and costs of treatments (6).

Several studies have reported the influence of the gastrointestinal microbiota on the gut-brain axis, and its possible function in neuropsychiatric disorders such as Alzheimer's disease, anxiety, depression, autism, and Parkinson's disease (7–10). It has been shown that compound probiotic bacteria could produce neurotransmitters and neuropeptides, including serotonin, Gamma-Amino Butyric Acid (GABA), and Brain-Derived Neurotrophic Factor (BDNF), which could regulate people's emotion (11, 12). Several studies supported this theory that probiotic bacteria are effective on improving central nervous system (CNS) function, including functions associated with mental illness, such as anxiety, depression, memory capability, and stress response (13, 14).

However, the current studies on the correlation between probiotics and anxiety and depression are mostly animal studies, and human studies are still relatively lacking. In a previous study, healthy people were given a probiotics mixture, which included *B. longum* R0175, *Lactobacillus helveticus* R0052, or placebo for 30 days. Results revealed that the probiotics administration group showed significantly less emotional distress than control group (15). Similarly, in another clinical study, healthy subjects were treated randomly either a milk drink with probiotic or placebo for 3 weeks, and mood was assessed before treatment and after 10 and 20 days of administration. Subjects who initially presented with depression or anxiety showed significant improvement in mood disorders after receiving probiotics (16). However, there are still some disputes about whether probiotic can improve mood disorders. Therefore, meta-analysis was performed to get a comprehensive result. The results of a meta-analysis suggested that probiotics only benefit to animals, but do not significantly alleviate anxiety symptoms in healthy and anxious samples (17). Another meta-analysis also showed that probiotics only significantly improved depressive symptoms in patients with major depressive disorder, but not in patients with mild to moderate depression or in healthy people (18). In addition, another meta-analysis demonstrated that probiotics

significantly improved symptoms in patients with mild to moderate depression, but not in healthy people (19).

The above studies suggested that the efficacy of probiotics may vary depending on the study population. Studies have shown that there are significant differences in the composition of the gut microbiome among cancer patients, psychiatric patients, and healthy individuals (20–22), which may be one of the main reasons for the differences in the efficacy of probiotic supplementation in these populations. Several studies explored the efficacy of probiotics for anxiety and depression in both psychiatric patients and healthy individuals, but there was still no literature on whether probiotics could play a preventive role in mood disorders of cancer patients. Therefore, the main objective of this study was to analyze the correlation between probiotics and anxiety and depression levels in cancer patients.

## MATERIALS AND METHODS

### Participants

We screened all cancer patients consecutively admitted to the inpatient department of the First Affiliated Hospital, Zhejiang University School of Medicine in May 2020. The number of all cancer patients included was 292. A pathology report was required for each patient. The patients included in our study were admitted to our hospital but were then discharged. Then, we followed up all patients for 24 weeks whether they had been taking probiotics as prescribed and finally scored their anxiety and depression levels. The follow-up time points were the first, third and sixth months.

### Inclusion and Exclusion Criteria

The inclusion criteria for patients were: (1) 18–70 years old, no gender restrictions; (2) diagnosed with cancer; (3) no previous use of probiotics; (4) no previous diagnosis of anxiety or depression; (5) patients who were admitted to our hospital in May 2020. The exclusion criteria for all patients were: (1) incomplete medical records; (2) loss of follow-up; for patients who took probiotics were: (1) not taking probiotics consistently during follow-up; (2) not taking specific strains of *Lactobacillus* genera and *Bifidobacterium* genera. Patients who did not take probiotics during hospitalization and follow-up after discharge were included in the non-probiotics group.

### Probiotics

One study suggested that probiotics consisting of specific strains of *Lactobacillus* genera and *Bifidobacterium* genera might have

**TABLE 1** | The types and dosages of probiotic strains in our study.

Probiotics	Types and dosages of probiotic strains (1 tablet)	Company (Country)	Recommended dosage of drug instructions
(1) Compound eosinophil-lactobacillus tablets	(1) <i>Lactobacillus acidophilus</i> : $5.0 \times 10^6$ CFU	Tonghua Golden-horse Pharmaceutical Group Co., Ltd. (China)	2 tablets, 3 times a day, take with warm water
(2) Live combined bifidobacterium, lactobacillus and enterococcus capsules	(1) <i>Bifidobacterium longum</i> : $\geq 1 \times 10^7$ CFU (2) <i>Lactobacillus acidophilus</i> : $\geq 1 \times 10^7$ CFU (3) <i>Enterococcus faecalis</i> : $\geq 1 \times 10^7$ CFU	Shanghai Shangyao Xinyi Pharmaceutical Co., Ltd. (China)	3 tablets, twice a day, take with warm water half an hour after meals

CFU, Colony-Forming Unit.

the potential to prevent and treat depression and anxiety disorders (23). Therefore, probiotics in this study included compound eosinophil-lactobacillus tablets, and live combined bifidobacterium, lactobacillus and enterococcus capsules. These probiotics are commercial products, the types and dosages of probiotic strains are shown in **Table 1**. Patients took probiotics for 24 weeks according to the recommended dosage of drug instructions.

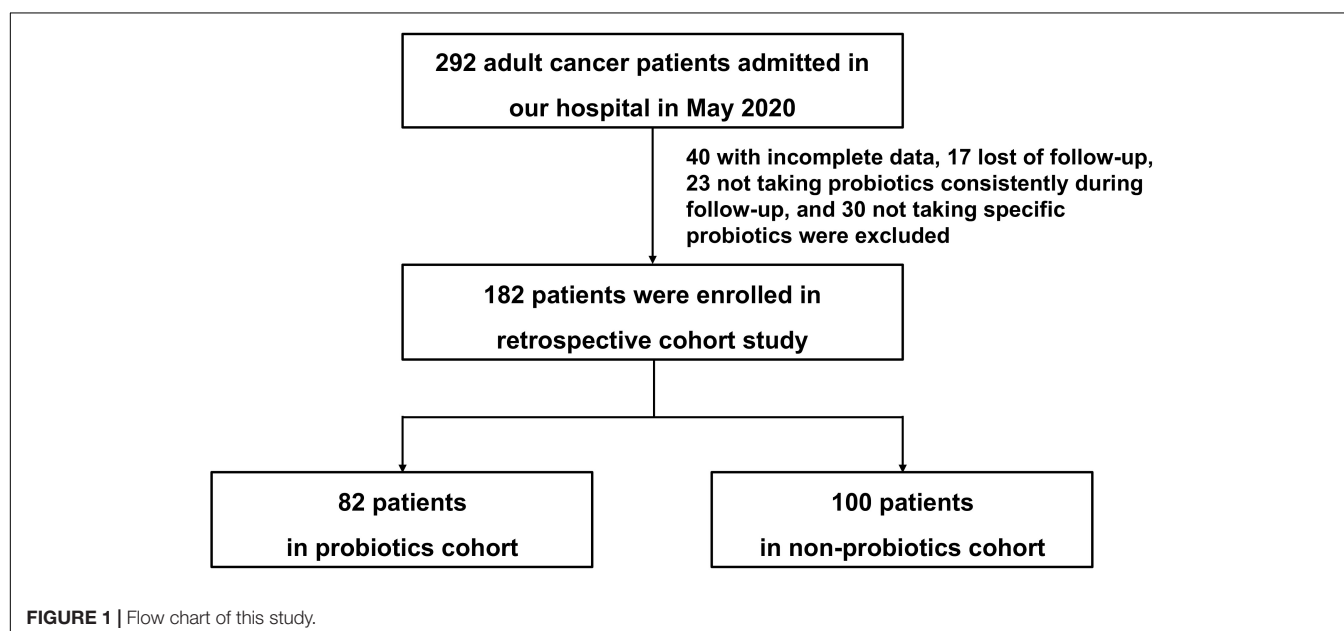
## Measures

We reviewed the electronic medical records system and extracted socio-demographic information of eligible participants, including name, gender, age, smoking, drinking, education level, residence, cancer types, tumor size, tumor stage, and cancer therapy. Psychiatrist of our team assessed the depression and

anxiety levels of these cancer patients by phone, and the 17-item Hamilton Depression Scale (HAMD-17) questionnaire was used to measure depression levels of the patients (24, 25). This questionnaire consists of 17 items, each with a score of 0–4. A total score less than 8 indicates no depression, 8–17 indicates mild depression, 18–24 indicates moderate depression, and more than 24 indicates severe depression. We also used Hamilton Anxiety Scale (HAMA) questionnaire to assess the patients' anxiety levels (25). This questionnaire consists of 14 items, and each item is 0–4 points. When the total score less than 7 suggests no anxiety, the total score  $\geq 7$  suggests possible anxiety, the total score  $\geq 14$  suggests certain anxiety, the total score  $\geq 21$  suggests significant anxiety, and the total score  $\geq 29$  suggests severe anxiety.

## Statistical Analysis

The Kolmogorov-Smirnov test was performed to verify whether continuous variables conform to normal distribution. Mean  $\pm$  Standard Deviation (SD) or median (interquartile range) was calculated for continuous variables, and frequency and percentage for categorical variables. We applied the Student's *t*-test to compare the differences between probiotics cohort and non-probiotics cohort for continuous variables with normal distribution, otherwise, Mann-Whitney U test was used. Chi-square test or Fisher's exact test was used for categorical variables. To assess the correlation between probiotics administration and anxiety and depression levels in cancer patients, we set the HAMD-17 score of 7 and the HAMA score of 14 as a cut-off value of depression and anxiety. Logistic regression models were used to analyze whether the difference in baseline data of two cohorts would affect the final result. The IBM Statistical Package for Social Sciences (SPSS, version 26) software was used to do all statistical analyses and two-tailed  $p < 0.05$  was considered to be statistically significant.



## RESULTS

### Demographic and Clinical Characteristics of All Cancer Patients Enrolled

A total of 292 cancer patients at the First Affiliated Hospital, Zhejiang University School of Medicine in May 2020 met our inclusion criteria. We reviewed the electronic medical records system, 40 patients with incomplete data, 17 patients who lost follow-up in all patients were excluded. In addition, 23 patients who took probiotics irregularly during follow-up, and 30 patients who didn't take the specific strains of *Lactobacillus* genera and *Bifidobacterium* genera in patients who took probiotics were excluded. Finally, the number of patients enrolled was 82 in probiotics cohort and 100 in non-probiotics cohort. The flow chart of this study was detailed in **Figure 1**.

Demographic and clinical characteristics of all cancer patients enrolled in probiotics and non-probiotics cohorts are shown in

**TABLE 2 |** Demographic and clinical characteristics of all cancer patients enrolled.

Variables	Probiotics (N = 82)	Non-probiotics (N = 100)	P-value
Gender, n (%)			0.918
Male	56 (68.3)	69 (69.0)	
Female	26 (31.7)	31 (31.0)	
Age, years	64 (55, 70)	63 (54, 68)	0.452
Smoker, n (%)			0.721
Yes	38 (46.3)	49 (49.0)	
No	44 (53.7)	51 (51.0)	
Drinker, n (%)			0.943
Yes	25 (30.5)	30 (30.0)	
No	57 (69.5)	70 (70.0)	
Highest level of education, n (%)			0.081
Higher professional education	9 (11.3)	2 (2.1)	
Secondary education	43 (53.8)	55 (57.3)	
Primary education	22 (27.5)	33 (34.4)	
Illiteracy	6 (7.5)	6 (6.3)	
Unknown	2	4	
Residence, n (%)			0.277
City	52 (63.4)	71 (71.0)	
Rural	30 (36.6)	29 (29.0)	
Cancer type, n (%)			0.992
Liver cancer	38 (46.3)	48 (48.0)	
Pancreatic cancer	22 (26.8)	25 (25.0)	
Lung cancer	21 (25.6)	25 (25.0)	
Other cancers	1 (1.2)	2 (2.0)	
Tumor size, cm	3.5 (2.1, 4.6)	3.5 (2.1, 5.0)	0.972
Stage, n (%)			0.557
III-IV	44 (53.7)	58 (58.0)	
I-II	38 (46.3)	42 (42.0)	
Cancer therapy			<b>0.004</b>
Only surgery/radiation therapy	25 (30.5)	51 (51.0)	
First-line therapy	45 (54.9)	45 (45.0)	
Second-line and above therapy	12 (14.6)	4 (4.0)	

**Bold value means statistically significant at  $P < 0.05$ .**

**Table 2.** The median age of patients in two cohorts was 64 and 63, respectively. Male patients (68.3 and 69.0% in probiotics cohort and non-probiotics cohort, respectively), patients with secondary education (53.8 and 57.3%), and patients living in city (63.4 and 71.0%) accounted for the majority of enrolled patients. The proportion of non-smokers (53.7 and 51.0% in probiotics cohort and non-probiotics cohort, respectively) and non-drinkers (69.5 and 70.0% in probiotics cohort and non-probiotics cohort, respectively) were relatively higher. The cancer types of the patients in these two cohorts mainly included liver cancer, pancreatic cancer, and lung cancer. There were no statistical differences in the demographic and clinical characteristics of the cancer patients enrolled in these two cohorts ( $P > 0.05$ ) except the cancer therapy ( $P = 0.004$ ).

### Comparison of Anxiety and Depression Levels Between Two Cohorts

According to the HAMA criteria, patients with HAMA scores  $\geq 14$  were considered definitely anxiety, so we regarded cancer patients with a HAMA score  $\geq 14$  as anxious patients, and those with a HAMA score  $< 14$  as non-anxious patients. Our results suggested that the proportion of anxious patients in probiotics cohort (6.1%) was lower than non-probiotics cohort (13.0%), but the difference was not statistically significant ( $P = 0.121$ , as shown in **Table 3**).

According to the HAMD-17 criteria, patients with HAMD-17 scores  $> 7$  were considered depression, so we divided cancer patients into non-depression group (HAMD-17 scores  $\leq 7$ ) and depression group (HAMD-17 scores  $> 7$ ). The results demonstrated that the proportion of patients with depression was similar between probiotics and non-probiotics cohort (30.5 and 23.0%, respectively,  $P = 0.254$ , as shown in **Table 3**).

Logistic regression models were used to analyze whether the difference in baseline data of two cohorts would affect the final result. The results further proved that the baseline difference in cancer therapy did not affect the conclusions ( $P > 0.05$ , as shown in **Tables 4, 5**).

## DISCUSSION

We have mentioned that there are significant differences in the composition of the gut microbiome of cancer patients, psychiatric

**TABLE 3 |** Comparison of anxiety and depression levels between probiotics and non-probiotics cohorts.

Outcome measures	Probiotics (N = 82)	Non-probiotics (N = 100)	X <sup>2</sup>	P-value
HAMA, n (%)			2.409	0.121
<14	77 (93.9)	87 (87.0)		
$\geq 14$	5 (6.1)	13 (13.0)		
HAMD-17, n (%)			1.301	0.254
$\leq 7$	57 (69.5)	77 (77.0)		
$> 7$	25 (30.5)	23 (23.0)		

HAMA, Hamilton Anxiety Scale; HAMD-17, 17-item Hamilton Depression Scale; SD, Standard Deviation.

**TABLE 4 |** Logistic regression model analysis of the effect of cancer therapy on the correlation between probiotics and anxiety in cancer patients.

Variables	Total (N = 182)	Non-anxiety (N = 164)	Anxiety (N = 18)	OR	95% CI	P-value
Probiotics	82 (45.1)	77 (47.0)	5 (27.8)	0.402	0.133-1.215	0.106
<b>Cancer therapy</b>						
Only surgery/radiation therapy	76 (41.8)	70 (42.7)	6 (33.3)	–	–	0.487
First-line therapy	90 (49.5)	79 (48.2)	11 (61.1)	1.886	0.650-5.474	0.243
Second-line and above therapy	16 (8.8)	15 (9.1)	1 (5.6)	1.137	0.120-10.745	0.911

OR, odds ratio; CI, confidence interval.

**TABLE 5 |** Logistic regression model analysis of the effect of cancer therapy on the correlation between probiotics and depression in cancer patients.

Variables	Total (N = 182)	Non-depression (N = 134)	Depression (N = 48)	OR	95% CI	P-value
Probiotics	82 (45.1)	57 (42.5)	25 (52.1)	1.410	0.712-2.792	0.324
<b>Cancer therapy</b>						
Only surgery/radiation therapy	76 (41.8)	58 (43.2)	18 (37.5)	–	–	0.885
First-line therapy	90 (49.5)	65 (48.5)	25 (52.1)	1.169	0.573-2.385	0.668
Second-line and above therapy	16 (8.8)	11 (8.2)	5 (10.4)	1.270	0.376-4.290	0.700

OR, odds ratio; CI, confidence interval.

patients, and healthy individuals. Compared with healthy individuals, patients with colorectal cancer have more abundant of 11 operational taxonomic units belonging to the genera *Enterococcus*, *Escherichia/Shigella*, *Klebsiella*, *Streptococcus*, and *Peptostreptococcus*, but less abundant of 5 operational taxonomic units belonging to the genus *Roseburia* and other butyrate-producing bacteria of the family *Lachnospiraceae* (22). Similarly, one study showed that the levels of *Bacteroidetes*, *Proteobacteria*, and *Actinobacteria* were significantly increased and the levels of *Firmicutes* were significantly decreased in patients with major depression disorder compared with healthy people (21). Differences in gut microbiome in different populations may lead to different effects of probiotic supplementation on anxiety and depression levels. These differences prompted us to conduct this study, and we want to explore whether probiotics are associated with anxiety and depression levels in cancer patients. Currently, there are many probiotic products that contain different strains of probiotic bacteria. Are all probiotics useful for reducing anxiety and depression symptoms? One study suggested that probiotics consisting of specific strains of *Lactobacillus* genera and *Bifidobacterium* genera might have the potential to prevent and treat depression and anxiety disorders (23). Therefore, only patients using probiotics consisting of specific strains of *Lactobacillus* genera and *Bifidobacterium* genera were included in this study. This could effectively rule out interference with the outcomes of this study by other strains that may not be effective in improving anxiety and depression.

In the current study, we found that cancer patients supplemented with probiotics did not significantly reduce the levels of anxiety and depression, which is consistent with the conclusions of some meta-analysis for non-cancer patients (17–19). However, one study reported that supplementing with

probiotics improved the clinical anxiety and stress biochemical characteristics of patients undergoing laryngectomy, and taking probiotics reduced the anxiety level of patients from HAMA 19.8–10.2 (26). Although the population in this study is also cancer patients, they mainly discussed the effects of probiotics on anxiety levels in surgical patients, which is different from our research perspective.

We know that gender is one of the common risk factors for depression and anxiety, and the prevalence is higher in women (27, 28). In addition, age also affects the development of depression and anxiety disorders (29, 30). The results of a Chinese study demonstrated that age and education level were risk factors for depression, while age and gender were risk factors for anxiety disorders (31). Chemotherapy is also thought to significantly affect the gut microbiome, which may further affect the anxiety and depression levels of cancer patients (32). Besides, studies demonstrated that the gut microbiota may be associated with the development of several cancer types, such as colorectal cancer (33), gynecological cancer (34), liver cancer, lung cancer, gastric cancer, and pancreatic cancer (35–38). Additionally, the composition of the gut microbiomes differs significantly among tumor stages (39), so the differences in cancer types and tumor stages may also affect our results. Therefore, we investigated baseline characteristics of enrolled cancer patients including age, gender, education level, residence, smoking and drinking habits, type of cancer, tumor size, stage of cancer, and cancer therapy in both cohorts, so as to exclude the influence of these factors on our results. As a result, we found that patients in both cohorts were similar with respect to these factors except the cancer therapy ( $P = 0.004$ ). However, the results of logistic regression model analysis further proved that the baseline difference in cancer therapy did not affect the conclusions.



Over the past few years, there has been growing evidence that gut microbiomes play an important role in the hypothalamic-pituitary-adrenal (HPA) axis and stress reactivity (40). An approach between them, we call it gut-brain axis. Probiotics can influence neuroplasticity-related and neurotransmitter systems through the gut-brain axis (41). An experimental study showed that a specific strain of *Bifidobacteria* could increase the levels of plasma tryptophan and alter dopamine and serotonin turnover in the brain areas associated with mental disorders (42). Goehler et al. reported that intestinal microflora could influence neural transmission in the central nucleus of the amygdala, the paraventricular hypothalamus, and the bed nucleus of the stria terminalis which were involved in the emotions processing related to anxiety and depression (43). These studies provided a theoretical basis for supplementing probiotics for the prevention and treatment of anxiety and depression. However, these theories were based on animal models. Although clinical research results had found that probiotics were effective for major depression disorder, they were not effective for anxious and healthy people. However, studies have been inconsistent as to whether probiotics are beneficial for mild to moderate depression (17–19). The results of our study demonstrated that there was no statistical difference in the proportion of cancer patients with anxiety (6.1 and 13.0%, respectively,  $P = 0.121$ ) and depression (30.5 and 23.0%, respectively,  $P = 0.254$ ) between probiotics and non-probiotics cohorts. Therefore, it is not recommended to supplement probiotics to reduce anxiety and depression levels in cancer patients.

Although this study shows that probiotic supplementation does not significantly reduce anxiety and depression levels in cancer patients, some limitations of this study need to be considered. First, the sample size of our study is relatively small, which may lead to bias in our results. Second, this is a retrospective cohort study that cannot directly clarify the relationship between probiotics supplementation and anxiety and depression levels in cancer patients. Third, it is well known that the symptoms of anxiety and depression are related to many factors such as environmental factors. During follow-up, it was found that none of the patients took supplements to promote mental state, but some patients took yogurt occasionally (less than 3 times a week), which might slightly affect our conclusions. Due to our design limitations, these cannot be completely eliminated. Therefore, our results need to be confirmed in a larger sample of cancer patients with better designs, such as randomized controlled trials.

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## CONCLUSION

Our results still suggest that there is no significant correlation between probiotics and anxiety and depression levels in cancer patients. Therefore, we do not recommend supplementing probiotics for cancer patients to prevent anxiety and depression. Moreover, high-quality RCTs are also needed to further confirm the conclusions of this study.

## DATA AVAILABILITY STATEMENT

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

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the First Affiliated Hospital, Zhejiang University School of Medicine (Approval number: IIT20210103A). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

ZY and SY designed this study. MD and SL collected the data of the patients. YZ contributed to the data analysis. ZY, QZ, and SY participated in the writing and revision of the manuscript. All authors approved the final version of the article and agreed to be responsible for all aspects of the work.

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# Psychological Distress, Fear and Coping Strategies During the Second and Third Waves of the COVID-19 Pandemic in Southern Germany

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**Background:** The COVID-19 pandemic has imposed enormous psychological discomfort and fear across the globe, including Germany.

**Objectives:** To assess the levels of COVID-19 associated psychological distress and fear amongst Southern German population, and to identify their coping strategies.

**Methods:** A cross-sectional survey using an online questionnaire was conducted in healthcare and community settings in the region of Ulm, Southern Germany. Assessment inventories were the Kessler Psychological Distress Scale (K-10), the Brief Resilient Coping Scale (BRCS), and the Fear of COVID-19 Scale (FCV-19S), which were valid and reliable tools.

**Results:** A total of 474 Individuals participated in the study. The mean age was 33.6 years, and 327 (69%) were females. Most participants ( $n = 381$ , 80.4%) had high levels of psychological distress, whereas only 5.1% had high levels of fear, and two-thirds of participants showed higher levels of coping. Moderate to very high levels of psychological distress were associated with being female, living alone, distress due to employment changes, experiencing financial impact, having multiple co-morbidities, being a smoker, increased alcohol use over the previous 6 months, contact with COVID-19 cases and healthcare providers for COVID-19-related stress. Individuals who were  $\geq 60$  years, lived with non-family members, had co-morbidities and visited a healthcare provider had higher levels of fear. Higher levels of education and income showed better coping amongst participants.

**Conclusion:** Psychological distress was very high during the COVID-19 pandemic in Germany and associated with low levels of coping. This study identified vulnerable groups of people, who should be given priorities for addressing their health and wellbeing in future crisis periods.

**Keywords:** COVID-19, psychological distress, fear, cross-sectional survey, coping, mental health, Germany

## INTRODUCTION

The coronavirus disease (COVID-19) has spread into 222 countries and territories worldwide and the World Health Organization (WHO) declared a global public health emergency on 30 January 2020 (1). As of 23 November 2021, Germany reported more than five million confirmed cases and almost 100,000 deaths from COVID-19 (2). This led to enact public health measures by the Government such as physical distancing, canceling large gatherings, imposing travel restrictions and lockdown in large cities, ensuring obligatory quarantine for positive cases, primary close contacts, along with closing of educational institutions. The lockdown also resulted in the closure of many small businesses, and the unemployment rate increased to 4.1% in summer 2020 compared to 3.1% just before the pandemic (3). Ongoing restrictions also impacted on the physical and mental health of the population, especially older adults with multiple comorbidities (4). Ongoing social isolation and uncertainty of further COVID-19 pandemic waves could potentially trigger long-term mental disorders (5).

Furthermore, Unemployment and social isolation were associated with risky behaviors such as increased tobacco and alcohol consumption (6). Lockdown measures and social distancing restrictions caused a shift to telehealth facilities (7). Previous studies showed that healthcare workers engaged in the diagnosis and management of COVID-19 patients were more prone to psychological distress and various mental disorders, such as depression, anxiety, anger, fear of spreading the infection to their relatives, friends, or colleagues (8, 9).

Studies from several countries around the world including Germany found that the pandemic caused higher psychological distress, anxiety, and depression amongst a large proportion of community members (10–16). Studies also showed that depression, stress, and anxiety during the pandemic triggered sleep disorders and increased consumption of tobacco and alcohol (17). However, with increased vaccination rates and easing of restrictions, impacts may change during the current pandemic waves. Although there are previously published studies that assessed anxiety, fear and distress amongst community members and healthcare workers in Germany during the COVID-19 pandemic, the existing evidence lacks a full understanding of the impacts of the pandemic on mental health and coping strategies amongst the public in Germany and identification of the relevant predictors. Therefore, this study aimed to assess the levels of psychological distress, fear of the COVID-19 disease, and coping strategies among a wide range of population in Germany; it also aimed to identify critical factors associated with those outcomes. The population subgroups who were at higher risk of developing poor mental health outcomes would be identified in this study, which would enable the policymakers to optimize psychosocial interventions targeted to those vulnerable groups of population and guide resource planning to avoid long-term mental health impacts.

## MATERIALS AND METHODS

### Study Design and Setting

A cross-sectional study was conducted according to The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement Checklist (18). This study was a part of a large study involving 17 countries and was led by the last author (10). Participants were informed about the study using social media and received the link of the questionnaire through social media or by emails. In addition, Quick Response (QR) codes were used on professional posters in outpatient clinics to inform patients about the study and invite participation. Data were collected from healthcare settings, including General Practices, hospitals, allied health professionals, and community settings, using a structured self-administered online questionnaire (10, 13, 14, 19).

### Study Population

Adult participants who were  $\geq 18$  years old with the capacity to respond to an online questionnaire in German language were included in three main groups: (a) patients who attended a healthcare setting, either for face-to-face or telehealth consultation in the last 4 weeks irrespective of respiratory/COVID-19 symptoms, (b) healthcare workers (full time, part-time or casual) who have been in contact with patients in the last 4 weeks in a healthcare setting (doctor, nurses, allied health professionals, technicians, patient service attendants, receptionists, etc.) irrespective of caring for respiratory/COVID-19 patients, and (c) community members who did not consult any healthcare provider in the last 4 weeks.

### Data Collection

An online link to the web-based questionnaire was developed using Google forms to collect data from February to April 2021 during the second and third waves of the COVID-19 pandemic. According to Robert Koch Institute, the second German wave began in October 2020 (<https://www.shorturl.at/shortener.php>), while the third wave started in March 2021 (<https://www.shorturl.at/loqHP>). Initially, there was a screening question related to age to confirm eligibility; subsequently data were collected on: (a) socio-demographics as age, gender, location of residence, marital status, living conditions (alone or with families), the highest level of education, country of birth; (b) profession as a primary occupation, the impact of COVID-19 on occupation, identification as a frontline healthcare worker; (c) self-reported comorbidities as hypertension, cardiovascular diseases, chronic respiratory diseases, diabetes, cancer; (d) behavioral risk factors as current smoking, alcohol intake; (e) health service utilization (in the last 4 weeks) as consultation with a healthcare provider for any symptom, admission to the hospital including reasons for admission; (f) exposure and contact history of COVID-19, test and diagnosis of COVID-19, close contact, isolation and quarantine status; (g) psychological impact measured by the Kessler Depression Scale (K-10) (20), and fear measured by the Fear of COVID-19 Scale (FCV) (21); (h) coping strategies measured by the Brief Resilient Coping Scale



(BRCS) (22); and (j) access to mental health resources (in the last four weeks) (see **Appendix 1**).

## Study Tools

### Kessler Psychological Distress Scale (K10)

The K10 scale is a 10-item self-rated questionnaire that measures distress based on depressive and anxiety symptoms. Each item has five possible answers (none of the time = 1, a little of the time = 2, some of the time = 3, most of the time = 4, all of the time = 5) allowing for a total score of 50. A score of 10–15 is likely to be well, 16–29 is medium risk for anxiety or depression and 30–50 is high risk for anxiety or depressive symptoms (20). Cronbach's alpha for this tool was 0.902, which was satisfactory.

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

The FCV-19S is a seven-item scale that assesses fear of COVID-19 among the general population. Each item has five possible answers (strongly disagree = 1 disagree = 2 neutral = 3 agree = 4 strongly agree = 5) allowing for a maximum score of 35, a score of 7–22 is considered low fear and 23–35 is considered high fear of COVID-19 (21). Cronbach's alpha for this tool was 0.82, which was satisfactory.

### Brief Resilient Coping Scale (BRCS)

The BRCS is a 4-item scale that measures a psychological well-being construct: resilience. Each item is a 5-point response (does not describe me at all = 1, does not describe me = 2, neutral = 3, describes me = 4, describes me very well = 5). The maximum possible score is 20, and it is categorized into low resilience (score 4–13), medium resilience (score 14–16) and high resilience (Score 17–20) (22). Cronbach's alpha for this tool was 0.758, which was satisfactory.

## Sample Size Calculation

All participants fulfilling the inclusion criteria were invited to participate. Considering Germany's population of 84 million according to World Population Prospects (23), the prevalence of lifetime mental health issues amongst Germans was 31.1% (24), at 95% confidence intervals, margin of error (5%), and 80% power, the required sample size was 329. The sample size was calculated using Open Epi Info software version 7.2. Convenient sampling was used to recruit the study participants by following snowball sampling.

## Ethics

Ethical approval was obtained from the Research Ethical Committee (REC) of the Ulm University (Ethical Approval Number 448/20 – FSt/Sta).

## Statistical Analysis

International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) statistics software version 25 was used for data analysis. Descriptive analyses were conducted and followed by inferential analyses. Continuous variables were presented as mean  $\pm$  standard deviation (SD), while categorical variables were presented as numbers and percentages. Internal consistency of the instruments was calculated using Cronbach's alpha. The study outcomes were

categorized into binary variables as follows: K-10 score was categorized into low (score 10–15) and moderate to very high (score 16–50), FCV-19S score was categorized into low (score 7–21) and high (score 22–35) and BRCS score was defined into low (score 4–13) and medium to high (score 14–20) resilient copers. Univariate and multivariate logistic regression (adjusted for age, gender, born in Germany, living status, employment status, level of education) were performed to explore the association between population characteristics and the study's outcomes. Odds ratios (ORs), adjusted odds ratios (AORs) and 95% confidence intervals (95% CIs) were obtained. Firth logistic regression with penalized maximum likelihood was used for fear of COVID-19 outcome as the number of events was relatively low for the number of adjusted variables. To measure the association between distress, fear and coping, partial rank correlation was conducted on the overall score as a continuous variable for each scale. This was done after controlling for potential confounding factors (age, gender, born in Germany, living status, employment status and level of education). P values less than 0.05 were considered statistically significant.

## RESULTS

### Population Characteristics

A total of 474 people participated in the study. The mean age of the participants was 33.6 (13.3) years, and 327 (69%) were females. Most of them were born in Germany (89.9%,  $n=426$ ), and around half lived with family members (48.5%,  $n = 230$ ). Two-thirds (62.4%,  $n = 296$ ) of the participants had a source of income during the pandemic, and only 2.1% ( $n = 10$ ) had their jobs affected by the pandemic. Half of the participants (57%,  $n = 270$ ) reported change in the employment situation, and half of them (49.4%,  $n = 196$ ) had higher perceived distress due to that change. About half participants (47.3%,  $n = 224$ ) self-identified as essential service workers and 54.6% ( $n = 259$ ) reported being healthcare workers. Only 7.4% ( $n = 35$ ) participants reported having psychiatric or mental health issues, although a quarter of the participants (24.1%,  $n = 114$ ) perceived their mental health status as poor to fair. **Table 1** shows the characteristics of included participants, and **Tables 2–4** shows multivariate analyses of psychological distress, fear, and coping.

### Psychological Distress

After adjusting for potential confounders, multivariate analyses showed that being a female, living alone, those with distress due to employment change, worsened financial situation, having multiple co-morbidities, smoking, increased alcohol consumption over the last 6 months, contact with COVID-19 case whether direct or indirect, direct experience of COVID-19 and healthcare use to overcome pandemic stress in the last 6 months were associated with moderate to very high levels of psychological distress (**Table 2**).

### Fear of COVID-19

Multivariate logistic regression showed that being over 60, living with non-family members, those having a diploma or a trade qualification, those with single or multiple comorbidities,

**TABLE 1** | Baseline demographic characteristics of the participants (*N* = 474).

Characteristic	No.	%
<b>Age</b>	<b>474</b>	
Mean ( $\pm$ SD)	33.6 $\pm$ 13.32	
Age groups	474	
18–29	232	48.9
30–59	220	46.4
>60	22	4.6
Gender	474	
Female	327	69.0
Born in Germany	474	
Yes	426	89.9
Living status	474	
Live with family members	230	48.5
Live with non-family members	145	30.6
Live alone	99	20.9
Highest educational/vocational qualification	474	
Secondary/Higher Secondary/Grade 7 to 12	188	39.7
Certificate/Diploma/Trade qualifications	83	17.5
Bachelor/Masters/PhD	203	42.8
Current employment condition	474	
Unemployed/Housewife/Homemaker/Home duties (No source of income)	168	35.4
Jobs affected by COVID-19 (lost job/working hours reduced/afraid of job loss)	10	2.1
Have an income source (employed/Government benefits)	296	62.4
Perceived distress due to change of employment status	397	
A little to none	201	50.6
Moderate to a great deal	196	49.4
Improved working situation due to change of employment status	406	
A little to none	352	86.7
Moderate to a great deal	54	13.3
Self-identification as frontline or essential service worker	474	
Yes	224	47.3
Self-identification as a healthcare worker	474	
Yes, doctor	64	13.5
Yes, nurse	18	3.8
Yes, another healthcare worker	177	37.3
COVID-19 impacted the financial situation	474	
Yes, impacted positively	43	9.1
Yes, impacted negatively	67	14.1
Affected by the change in a financial situation	474	
Not at all	198	41.8
Unsure	53	11.2
Somewhat	130	27.4
A great extent	39	8.2
Co-morbidities	474	
Psychiatric/Mental health problem	35	7.4
Other co-morbidities*	102	21.5
Co-morbidities	474	
Single co-morbidity	98	20.7
Multiple co-morbidities	43	9.1
Perceived status of own mental health	474	
Good to Excellent	360	75.9
Poor to Fair	114	24.1

(Continued)

**TABLE 1 |** Continued

Characteristic	No.	%
Smoking	474	
Ever smoker (Daily/Nondaily/Ex)	59	12.4
Increased smoking over the last 6 months	59	
Yes	24	41.7
Current alcohol drinking (last 4 weeks)	474	
Yes	200	42.2
Increased alcohol drinking over the last 6 months	200	
Yes	46	23
Contact with known/suspected case of COVID-19	474	
Unsure	51	10.8
Yes, I had indirect contact	78	16.5
Yes, provided direct care	105	22.2
Experience related to COVID-19 pandemic	474	
No known exposure to COVID-19	334	70.5
Treated in hospital / Ordered to quarantine/ Tested positive / Lived with someone who had COVID-19	123	25.9
Traveled overseas and had to quarantine	17	3.6
Self-identification as a patient (visited a healthcare provider in the last 6 months)	474	
Yes	224	47.3
If yes, which type of healthcare did you use? (Multiple responses)	268	
Visit a primary care physician or health care professional	184	68.7
Telehealth consultation (online or by phone) with a general practitioner, specialist, or health professional	10	3.7
I was tested for COVID-19 at a special test site	42	15.7
Hospital emergency room	8	3.0
I was in a hospital for other reasons	24	9.0
Healthcare service used to overcome COVID-19 related stress in the last 6 months	474	
Yes	25	5.3
If yes, which type of healthcare did you receive? (Multiple responses)	61	
Consulted a primary care physician	26	42.6
Consulted a psychologist	17	27.9
Consulted a psychiatrist	4	6.6
Used specialty mental health services (hospital, community mental health services, inpatient mental health services)	2	3.3
Used mental health resources (pamphlets, brochures, leaflets, and books provided by mental health staff and distributed at hospital)	3	4.9
Mental health resources used and available through media (methods and techniques of psychological support provided by psychologists through online media, television news, or various online and social networking platforms)	5	8.2
Mental health support services used (including mental health program)	4	6.6

Data are presented as the mean and standard deviation (SD) or number (n) and percentage (%).

COVID-19, Coronavirus Disease 19; K-10, Kessler Depression Scale; FCV, Fear of Coronavirus-19 Scale; BRCS, Brief Resilient Coping Scale.

\*Cardiac diseases/ Stroke/ Hypertension/ Hyperlipidaemia/ Diabetes/ Cancer/ Chronic respiratory illness.

perceived mental health status as poor to fair, direct experience of COVID-19, visiting a health care provider in the past 6 months and using healthcare service to overcome pandemic related stress in the last 6 months were associated with higher levels of fear of COVID-19 (Table 3).

## Coping Strategies

Multivariate analyses revealed that having an income source and being a healthcare worker were associated with higher levels of coping. Conversely, higher levels of education, distress due to

change in employment, worsened financial situation due to the pandemic, and perceived status of mental health as poor to fair were the factors that predicted lower levels of coping amongst the study participants (Table 4).

## Association Between Psychological Distress, Coping and Fear of COVID-19

The K-10 distress score correlated significantly with the FCV-19S score (spearman's  $r = 0.331$ ,  $p < 0.001$ ), the BRCS score showed an inverse relationship with the distress and fear scores

**TABLE 2 |** Factors associated with high psychological distress among the study population (based on K10 scoring).

Characteristics	Low distress		High distress		Unadjusted analysis				Adjusted analysis*			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Age groups	93		381									
18–29	23	9.9	209	90.1	Ref				Ref			
30–59	58	26.4	162	73.6	<b>&lt;0.001</b>	<b>0.31</b>	<b>0.18</b>	<b>0.52</b>	<b>0.029</b>	<b>0.41</b>	<b>0.18</b>	<b>0.91</b>
>60	12	54.5	10	45.5	<b>&lt;0.001</b>	<b>0.09</b>	<b>0.04</b>	<b>0.24</b>	<b>0.000</b>	<b>0.10</b>	<b>0.03</b>	<b>0.33</b>
Gender	93		381									
Male	51	34.7	96	65.3	Ref				Ref			
Female	42	12.8	285	87.2	<b>&lt;0.001</b>	<b>3.61</b>	<b>2.26</b>	<b>5.76</b>	<b>0.000</b>	<b>4.04</b>	<b>2.41</b>	<b>6.77</b>
Born in the same country of residence	93		381									
No	7	14.6	41	85.4	Ref				Ref			
Yes	86	20.2	340	79.8	0.357	1.48	0.64	3.42	0.055	0.41	0.16	1.02
Living status	93		381									
Live with family members	63	27.4	167	72.6	Ref				Ref			
Live with non-family members	16	11.0	129	89.0	<b>&lt;0.001</b>	<b>3.04</b>	<b>1.68</b>	<b>5.51</b>	0.530	1.32	0.55	3.17
Live alone	14	14.1	85	85.9	<b>0.011</b>	<b>2.29</b>	<b>1.21</b>	<b>4.32</b>	<b>0.041</b>	<b>2.05</b>	<b>1.03</b>	<b>4.01</b>
Highest educational/vocational qualification	93		381									
Secondary/Higher	21	11.2	167	88.8	Ref				Ref			
Secondary/Grade 7 to 12	23	27.7	60	72.3	<b>0.001</b>	<b>0.33</b>	<b>0.17</b>	<b>0.64</b>	0.094	0.49	0.21	1.13
Certificate/Diploma/Trade qualifications	49	24.1	154	75.9	<b>0.001</b>	<b>0.40</b>	<b>0.23</b>	<b>0.69</b>	0.317	0.68	0.32	1.44
Bachelor/Masters/PhD	93		381									
Current employment condition	22	13.1	146	86.9	Ref				Ref			
Unemployed/Housewife/Home maker/Home duties (No source of income)	1	10.0	9	90.0	0.778	1.36	0.16	11.23	0.272	3.56	0.37	34.23
Jobs affected by COVID-19 (lost job/working hours reduced/afraid of job loss)	70	23.6	226	76.4	<b>0.007</b>	<b>0.49</b>	<b>0.29</b>	<b>0.82</b>	0.522	1.27	0.61	2.63
Have an income source (employed/Government benefits)	68		329									
Perceived distress due to change of employment status	47	23.4	154	76.6	Ref				Ref			
A little to none	21	10.7	175	89.3	<b>0.001</b>	<b>2.54</b>	<b>1.45</b>	<b>4.44</b>	<b>0.001</b>	<b>2.85</b>	<b>1.54</b>	<b>5.27</b>
Moderate to a great deal	72		334									
Improved working situation due to change of employment status	65	18.5	287	81.5	Ref				Ref			
A little to none	7	13.0	47	87.0	0.327	1.52	0.66	3.52	0.735	1.17	0.48	2.85
Moderate to a great deal	93		381									
Self-identification as a frontline or essential service worker	44	17.6	206	82.4	Ref				Ref			
No	49	21.9	175	78.1	0.243	0.76	0.48	1.20	0.656	1.15	0.63	2.08
Yes												

(Continued)



TABLE 2 | Continued

Characteristics	Low distress		High distress		Unadjusted analysis				Adjusted analysis*			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Self-identification as a healthcare worker	93		381									
No	37	17.2	178	82.8	Ref				Ref			
Yes, doctor	16	25.0	48	75.0	0.166	0.62	0.32	1.22	0.199	1.80	0.73	4.42
Yes, nurse	2	11.1	16	88.9	0.51	1.66	0.37	7.54	0.385	2.08	0.40	10.79
Yes, other healthcare worker	38	21.5	139	78.5	0.287	0.76	0.46	1.26	0.538	0.82	0.43	1.55
COVID-19 impacted financial situation	93		381									
No impact	80	22.0	284	78.0	Ref				Ref			
Yes, impacted positively	6	14.0	37	86.0	0.228	1.74	0.71	4.26	0.286	1.74	0.63	4.78
Yes, impacted negatively	7	10.4	60	89.6	<b>0.035</b>	<b>2.41</b>	<b>1.06</b>	<b>5.49</b>	<b>0.006</b>	<b>3.61</b>	<b>1.45</b>	<b>9.00</b>
Affected by the change in financial situation	79		341									
Not at all	55	27.8	143	72.2	Ref				Ref			
Unsure	6	11.3	47	88.7	<b>0.017</b>	<b>3.01</b>	<b>1.22</b>	<b>7.45</b>	<b>0.046</b>	<b>2.78</b>	<b>1.02</b>	<b>7.61</b>
Somewhat	16	12.3	114	87.7	<b>0.001</b>	<b>2.74</b>	<b>1.49</b>	<b>5.04</b>	<b>0.001</b>	<b>3.34</b>	<b>1.67</b>	<b>6.68</b>
A great extent	2	5.1	37	94.9	<b>0.008</b>	<b>7.12</b>	<b>1.66</b>	<b>30.35</b>	<b>0.009</b>	<b>7.51</b>	<b>1.66</b>	<b>33.94</b>
Co-morbidities	93		381									
No	66	19.6	271	80.4	Ref				Ref			
Psychiatric/Mental health problem	3	8.6	32	91.4	0.123	2.60	0.77	8.74	0.095	2.97	0.83	10.64
Other co-morbidities*	24	23.5	78	76.5	0.388	0.79	0.47	1.35	0.622	0.86	0.48	1.56
Co-morbidities	93		381									
No	64	19.2	269	80.8	Ref				Ref			
Single co-morbidity	24	24.5	74	75.5	0.256	0.73	0.43	1.25	0.400	0.77	0.42	1.42
Multiple co-morbidities	5	11.6	38	88.4	0.232	1.81	0.68	4.78	<b>0.042</b>	<b>3.12</b>	<b>1.04</b>	<b>9.33</b>
Perceived status of own mental health	93		381									
Good to Excellent	93	25.8	267	74.2	Ref							
Poor to Fair	0	0.0	114	100.0	<b>0.002</b>	<b>80.04</b>	<b>4.93</b>	<b>1,300.40</b>	<b>No. is too low to estimate</b>			
Smoking	93		381									
Never smoker	88	21.2	327	78.8	Ref				Ref			
Ever smoker (Daily/Nondaily/ Ex)	5	8.5	54	91.5	<b>0.027</b>	<b>2.91</b>	<b>1.13</b>	<b>7.49</b>	<b>0.007</b>	<b>4.13</b>	<b>1.48</b>	<b>11.58</b>
Increased smoking over the last 6 months	5		54									
No	5	14.3	30	85.7	Ref							
Yes	0	0.0	24	100.0	0.14	8.83	0.46	167.70	0.112	6.69	0.70	886.78
Current alcohol drinking (last 4 weeks)	93		381									
No	51	18.6	223	81.4	Ref				Ref			
Yes	42	21.0	158	79.0	0.518	0.86	0.55	1.36	0.958	1.10	0.61	1.70
Increased alcohol drinking over the last 6 months	42		158									
No	39	25.3	115	74.7	Ref				Ref			
Yes	3	6.5	43	93.5	<b>0.011</b>	<b>4.86</b>	<b>1.43</b>	<b>16.55</b>	<b>0.019</b>	<b>4.77</b>	<b>1.29</b>	<b>17.61</b>

(Continued)

TABLE 2 | Continued

Characteristics	Low distress		High distress		Unadjusted analysis				Adjusted analysis*			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Contact with known/suspected case of COVID-19	93		381									
No	58	24.2	182	75.8	Ref							
Unsure	10	19.6	41	80.4	0.486	1.31	0.62	2.77	0.542	1.30	0.56	3.02
Yes, had indirect contact	10	12.8	68	87.2	<b>0.037</b>	<b>2.17</b>	<b>1.05</b>	<b>4.48</b>	<b>0.043</b>	<b>2.26</b>	<b>1.03</b>	<b>4.98</b>
Yes, provided direct care	15	14.3	90	85.7	<b>0.041</b>	<b>1.91</b>	<b>1.03</b>	<b>3.56</b>	<b>0.017</b>	<b>2.33</b>	<b>1.17</b>	<b>4.68</b>
Experience related to COVID-19 pandemic	93		381									
No known exposure to COVID-19	80	24.0	254	76.0	Ref				Ref			
Treated in hospital / Ordered to quarantine / Tested positive / Lived with someone who had Covid-19	11	8.9	112	91.1	<b>0.001</b>	<b>3.21</b>	<b>1.64</b>	<b>6.26</b>	<b>0.009</b>	<b>2.59</b>	<b>1.26</b>	<b>5.30</b>
Traveled overseas and had to quarantine	2	11.8	15	88.2	0.260	2.36	0.53	10.55	0.428	1.89	0.39	9.06
Self-identification as a patient (visited a healthcare provider in the last 6 months)	93		381									
No	54	21.6	196	78.4	Ref				Ref			
Yes	39	17.4	185	82.6	0.252	1.31	0.83	2.07	0.271	1.34	0.80	2.26
Level of fear of COVID-19 (FCV-19S categories)	93		381									
Low (score 7–21)	91	20.2	359	79.8	Ref				Ref			
High (score 22–35)	2	8.3	22	91.7	0.170	2.79	0.64	12.08	0.142	3.26	0.67	15.74
Level of coping (BRCS categories)	93		381									
Low resilient coping (score 4–13)	24	15.2	134	84.8	Ref				Ref			
Medium to high resilient coping (score 14–20)	69	21.8	247	78.2	0.087	0.64	0.39	1.07	0.097	0.61	0.34	1.09
Healthcare services used to overcome COVID-19 related stress in the last 6 months	93		381									
No	93	20.7	356	79.3	Ref				Ref			
Yes	0	0.0	25	100.0	<b>0.004</b>	<b>13.37</b>	<b>1.84</b>	<b>1,702.70</b>	<b>0.006</b>	<b>13.58</b>	<b>1.77</b>	<b>1,752.73</b>

Data are presented as number (n) and percentage (%).  $P \leq 0.05$  were considered statistically significant.

ORs, Odds Ratio; AOR, Adjusted Odds Ratio; CI, Confidence Interval; Ref, Reference category; COVID-19, Coronavirus Disease 19; K-10, Kessler Depression Scale; FCV, Fear of Coronavirus-19 Scale; BRCS, Brief Resilient Coping Scale.

\*Adjusted for Age, Gender, born in Germany, living status, employment status and level of education.

Bold indicated statistical significance.

(spearman's  $r = -0.276$  and  $-0.173$ ,  $p < 0.001$ ). People with higher distress had higher levels of fear of COVID-19 and lower coping. On the other hand, people with better coping had lower distress and fear of COVID-19 (Table 5).

## DISCUSSION

Moderate to very high levels of psychological distress were associated with being a female, living alone, suffering employment change or worsening the financial situation, and poor mental health, smoking and alcohol consumption. Higher levels of fear of COVID-19 were markable in people of

$\geq 60$  years, or those with comorbidities or poor mental health. Having an income source and being a healthcare worker was associated with higher levels of coping.

During the COVID-19 pandemic, the course of psychological disturbances which were associated with psychological distress, fear, and coping strategies among the community members including healthcare workers across the world were well-studied (25). Our study can be seen as a supplement to a global cross-sectional study involving 17 countries (10). The same online instruments were used like the prior global study led by the last author (MAR), but the current study adapted German language. In this study, more females participated than males,

**TABLE 3 |** Factors associated with high levels of fear of COVID-19 among the study population (based on FCV-19S scoring).

Characteristics	Low levels of fear		High levels of fear		Unadjusted analyses				Adjusted analysis			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Age groups	450		24									
18–29	223	96.1	9	3.9	Ref				Ref			
30–59	209	95.0	11	5.0	0.564	1.30	0.53	3.21	0.091	3.40	0.84	17.49
> ≥60	18	81.8	4	18.2	<b>0.009</b>	<b>5.51</b>	<b>1.54</b>	<b>19.65</b>	<b>0.002</b>	<b>13.93</b>	<b>2.66</b>	<b>84.21</b>
Gender	450		24									
Male	144	98.0	3	2.0	Ref				Ref			
Female	306	93.6	21	6.4	0.057	3.29	0.97	11.22	0.057	2.74	0.97	10.44
Born in the same country of residence	450		24									
No	47	97.9	1	2.1	Ref				Ref			
Yes	403	94.6	23	5.4	0.340	2.68	0.35	20.32	0.651	1.46	0.34	13.62
Living status	450		24									
Live with family members	221	96.1	9	3.9	Ref				Ref			
Live with non-family members	136	93.8	9	6.2	0.316	1.63	0.63	4.20	<b>0.041</b>	<b>4.12</b>	<b>1.06</b>	<b>17.39</b>
Live alone	93	93.9	6.1	3.9	0.395	1.58	0.55	4.58	0.164	2.19	0.71	6.35
Highest educational/vocational qualification	450		24									
Secondary/Higher Secondary/Grade 7 to 12	178	94.7	10	5.3	Ref				Ref			
Certificate/Diploma/Trade qualifications	77	92.8	6	7.2	0.540	1.39	0.49	3.95	<b>0.034</b>	<b>7.75</b>	<b>1.19</b>	<b>40.49</b>
Bachelor/Masters/PhD	195	96.1	8	3.9	0.517	0.73	0.28	1.89	0.756	1.21	0.37	4.08
Current employment condition	450		24									
Unemployed/Housewife/Home maker/Home duties (No source of income)	161	9.8	7	5.1	Ref				Ref			
Jobs affected by COVID-19 (lost job/working hours reduced/afraid of job loss)	8	80.0	2	20.0	<b>0.047</b>	<b>5.75</b>	<b>1.03</b>	<b>32.25</b>	0.978	0.98	0.29	3.23
Have an income source (employed/Government benefits)	281	94.9	15	5.1	0.661	1.23	0.49	3.07	0.451	0.65	0.21	2.01
Perceived distress due to change of employment status	375		22									
A little to none	189	94.0	12	6.0	Ref				Ref			
Moderate to a great deal	186	94.9	10	5.1	0.706	0.85	0.36	2.01	0.616	0.79	0.31	1.96
Improved working situation due to change of employment status	384		22									
A little to none	332	94.3	20	5.7	Ref				Ref			
Moderate to a great deal	52	96.3	2	3.7	0.553	0.64	0.15	2.81	0.932	1.06	0.21	3.64
Self-identification as a frontline or essential service worker	450		24									
No	237	94.8	13	5.2	Ref				Ref			
Yes	213	95.1	11	4.9	0.886	0.94	0.41	2.15	0.982	1.01	0.37	2.93

(Continued)

TABLE 3 | Continued

Characteristics	Low levels of fear		High levels of fear		Unadjusted analyses				Adjusted analysis			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Self-identification as a healthcare worker	450		24									
No	201	93.5	14	6.5	Ref				Ref			
Yes, doctor	63	98.4	1	1.6	0.157	0.23	0.03	1.77	0.345	0.42	0.04	2.41
Yes, nurse	15	83.3	3	16.7	0.126	2.87	0.74	11.11	0.453	1.87	0.34	9.02
Yes, other healthcare worker	171	96.6	6	3.4	0.169	0.50	0.19	1.34	0.121	0.41	0.13	1.27
COVID-19 impacted financial situation	450		24									
No impact	349	95.9	15	4.1	Ref				Ref			
Yes, impacted positively	40	93.0	3	7.0	0.395	1.75	0.48	6.29	0.184	2.48	0.61	7.85
Yes, impacted negatively	61	91.0	6	9.0	0.099	2.29	0.86	6.13	0.163	2.30	0.70	6.66
Affected by the change in financial situation	450		24									
Not at all	188	94.9	10	5.1	Ref				Ref			
Unsure	51	96.2	2	3.8	0.700	0.74	0.16	3.47	0.940	0.94	0.16	3.76
Somewhat	124	95.4	6	4.6	0.858	0.91	0.32	2.57	0.896	0.93	0.31	2.63
A great extent	36	92.3	3	7.7	0.511	1.57	0.41	5.98	0.340	1.94	0.46	6.64
Co-morbidities	450		24									
No	320	95.0	17	5.0	Ref				Ref			
Psychiatric/Mental health problem	33	94.3	2	5.7	0.864	1.14	0.25	5.16	0.429	1.84	0.34	6.72
Other co-morbidities*	97	95.1	5	4.9	0.954	0.97	0.35	2.70	0.590	1.33	0.44	3.55
Co-morbidities	450		24									
No	326	97.9	7	2.1	Ref				Ref			
Single co-morbidity	89	90.8	9	9.2	<b>0.003</b>	<b>4.71</b>	<b>1.71</b>	<b>13.00</b>	<b>0.001</b>	<b>5.76</b>	<b>2.01</b>	<b>17.44</b>
Multiple co-morbidities	35	81.4	8	18.6	<b>&lt;0.001</b>	<b>10.65</b>	<b>3.64</b>	<b>31.12</b>	<b>&lt;0.001</b>	<b>9.48</b>	<b>2.89</b>	<b>32.19</b>
Perceived status of own mental health	450		24									
Good to Excellent	350	97.2	10	2.8	Ref				Ref			
Poor to Fair	100	87.7	14	12.3	<b>&lt;0.001</b>	<b>4.90</b>	<b>2.11</b>	<b>11.37</b>	<b>&lt;0.001</b>	<b>5.83</b>	<b>2.41</b>	<b>15.02</b>
Smoking	450		24									
Never smoker	392	94.5	23	5.5	Ref				Ref			
Ever smoker (Daily/Nondaily/ Ex)	58	98.3	1	1.7	0.235	0.29	0.04	2.22	0.167	0.35	0.04	1.46
Increased smoking over the last 6 months	58		1									
No	35	100.0	0	0.0	Ref				Ref			
Yes	23	95.8	1	4.2	0.361	4.53	0.18	116.04	0.334	3.48	0.27	276.80
Current alcohol drinking (last 4 weeks)	450		24									
No	258	94.2	16	5.8	Ref				Ref			
Yes	192	96.0	8	4.0	0.370	0.67	0.28	1.60	0.377	0.68	0.27	1.59
Increased alcohol drinking over the last 6 months	192		8									
No	147	95.5	7	4.5	Ref				Ref			
Yes	45	97.8	1	2.2	0.481	0.47	0.06	3.90	0.928	0.92	0.10	4.72
Contact with known/suspected case of COVID-19	450		24									
No	230	95.8	10	4.2	Ref				Ref			
Unsure	50	98.0	1	2.0	0.464	0.46	0.06	3.68	0.942	0.94	0.10	4.36

(Continued)

TABLE 3 | Continued

Characteristics	Low levels of fear		High levels of fear		Unadjusted analyses				Adjusted analysis			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Yes, had indirect contact	70	89.7	8	10.3	<b>0.050</b>	<b>2.63</b>	<b>1.00</b>	<b>6.92</b>	0.057	2.64	0.97	7.07
Yes, provided direct care	100	95.2	5	4.8	0.803	1.15	0.38	3.45	0.513	1.47	0.44	4.46
Experience related to COVID-19 pandemic	450		24									
No known exposure to COVID-19	322	96.4	12	3.6	Ref				Ref			
Treated in hospital / Ordered to quarantine/ Tested positive / Lived with someone who had Covid	112	91.1	11	8.9	<b>0.025</b>	<b>2.64</b>	<b>1.13</b>	<b>6.14</b>	<b>0.021</b>	<b>3.09</b>	<b>1.19</b>	<b>8.12</b>
Traveled overseas and had to quarantine	16	94.1	1	5.9	0.630	1.68	0.21	13.71	0.149	4.95	0.49	26.65
Self-identification as a patient (visited a healthcare provider in the last 6 months)	450		24									
No	244	97.6	6	2.4	Ref				Ref			
Yes	206	92.0	18	8.0	<b>0.008</b>	<b>3.55</b>	<b>1.39</b>	<b>9.12</b>	<b>0.024</b>	<b>2.81</b>	<b>1.14</b>	<b>7.77</b>
Level of psychological distress (K10 categories)	450		24									
Low (score 10–15)	91	97.8	2	2.2	Ref							
Moderate to Very High (score 16–50)	359	94.2	22	5.8	0.170	2.79	0.64	12.08	0.162	2.61	0.71	14.59
Level of coping (BRCS categories)	450		24									
Low resilient coping (score 4–13)	147	93.0	11	7.0	Ref							
Medium to high resilient coping (score 14–20)	303	95.9	13	4.1	0.187	0.57	0.25	1.31	0.190	0.56	0.23	1.35
Healthcare services used to overcome COVID-19 related stress in the last 6 months	450		24									
No	433	96.4	16	3.6	Ref							
Yes	17	68.0	8	32.0	<b>&lt;0.001</b>	<b>12.74</b>	<b>4.79</b>	<b>33.84</b>	<b>&lt;0.001</b>	<b>15.26</b>	<b>4.88</b>	<b>48.84</b>

Data are presented as number (n) and percentage (%). P-values  $\leq$  of 0.05 were considered statistically significant.

ORs, Odds Ratio; AOR, Adjusted Odds Ratio; CI, Confidence Interval; Ref, Reference category; COVID-19, Coronavirus Disease 19; K-10, Kessler Depression Scale; FCV, Fear of Coronavirus-19 Scale; BRCS, Brief Resilient Coping Scale.

\*Adjusted for Age, Gender, born in Germany, living status, employment status and level of education.

Bold indicated statistical significance.

which was in line with other similar German studies (16, 26–28) in the first wave of the pandemic, and also supports an Australian (10), Egyptian (15), Bangladeshi (14), Malaysian (13), and global study (10). A possible explanation might be that women were more inclined to share their experiences by participating in the study or women were more impacted due to the pandemic, lockdown or financially that prompted them to participate in the study. The mean age (33.6 years) showed that the study participants of this study were younger than those who were included in similar German studies (16, 26, 27).

For the issue of psychological distress in this study, there were more participants with moderate to very high distress, which was in line with the results of previous studies conducted in

Germany (27), Australia (10), Malaysia (13), Bangladesh (14), Hong Kong (19) and globally (10), as well as other studies (28–31). Furthermore, similar to this study, previous studies (10, 13, 14, 27) also reported that females and younger respondents had higher psychological distress compared to the reference group. A previous study showed that women seemed to be more impacted by the pandemic in terms of wellbeing than men (32). According to the findings of this study, the common factors associated with moderate to very high levels of psychological distress were being females, those with change in the employment status, and worsening the financial situation, which was supported by earlier evidence (10, 13, 14). Similarly, Hetkamp and Schweda (33) found that respondents reported reduced sleep quality and moderate generalized anxiety and psychological burdens. A



**TABLE 4 |** Factors associated with coping among the study population (based on BRCS scoring).

Characteristics	Low levels of coping		High levels of coping		Unadjusted analysis				Adjusted analysis			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
<b>Age groups</b>	<b>158</b>		<b>316</b>									
18–29	81	34.9	151	65.1	Ref				Ref			
30–59	71	32.3	149	67.7	0.553	1.13	0.76	1.66	0.830	0.94	0.52	1.69
>60	6	27.3	16	72.7	0.472	1.43	0.54	3.80	0.687	1.25	0.43	3.66
<b>Gender</b>	<b>158</b>		<b>316</b>									
Male	45	30.6	102	69.4	Ref				Ref			
Female	113	34.6	214	65.4	0.400	0.84	0.55	1.27	0.547	0.87	0.56	1.36
<b>Born in the same country of residence</b>	<b>158</b>		<b>316</b>									
No	18	37.5	30	62.5	Ref				Ref			
Yes	140	32.9	286	67.1	0.519	1.23	0.66	2.28	0.788	1.09	0.57	2.11
<b>Living status</b>	<b>158</b>		<b>316</b>									
Live with family members	69	30.0	161	70.0	Ref				Ref			
Live with non-family members	48	33.1	97	66.9	0.528	0.87	0.55	1.35	0.753	1.11	0.59	2.06
Live alone	41	41.4	58	58.6	<b>0.045</b>	<b>0.61</b>	<b>0.37</b>	<b>0.99</b>	0.063	0.61	0.36	1.03
<b>Highest educational/vocational qualification</b>	<b>158</b>		<b>316</b>									
Secondary/Higher	61	32.4	127	67.6	Ref				Ref			
Secondary/Grade 7 to 12												
Certificate/Diploma/Trade qualifications	33	39.8	50	60.2	0.245	0.73	0.43	1.24	<b>0.013</b>	<b>0.43</b>	<b>0.22</b>	<b>0.83</b>
Bachelor/Masters/PhD	64	31.5	139	68.5	0.846	1.04	0.68	1.60	<b>0.034</b>	<b>0.53</b>	<b>0.29</b>	<b>0.95</b>
<b>Current employment condition</b>	<b>158</b>		<b>316</b>									
Unemployed/Housewife/Home maker/Home duties (No source of income)	73	43.5	95	56.5	Ref				Ref			
Jobs affected by COVID-19 (lost job/working hours reduced/afraid of job loss)	4	40.0	6	60.0	0.831	1.15	0.31	4.24	0.525	1.56	0.40	6.08
Have an income source (employed/Government benefits)	81	27.4	215	72.6	<b>&lt;0.001</b>	<b>2.04</b>	<b>1.37</b>	<b>3.04</b>	<b>&lt;0.001</b>	<b>3.33</b>	<b>1.90</b>	<b>5.87</b>
<b>Perceived distress due to change of employment status</b>	<b>116</b>		<b>236</b>									
A little to none	53	26.4	148	73.6	Ref				Ref			
Moderate to a great deal	81	41.3	115	58.7	<b>0.002</b>	<b>0.51</b>	<b>0.33</b>	<b>0.78</b>	<b>0.003</b>	<b>0.51</b>	<b>0.33</b>	<b>0.80</b>
<b>Improved working situation due to change of employment status</b>	<b>140</b>		<b>266</b>									
A little to none	116	33.0	236	67.0	Ref				Ref			
Moderate to a great deal	24	44.4	30	55.6	0.1	0.61	0.34	1.10	0.189	0.67	0.36	1.22
<b>Self-identification as a frontline or essential service worker</b>	<b>158</b>		<b>316</b>									
No	97	38.8	153	61.2	Ref				Ref			
Yes	61	27.2	163	72.8	<b>0.008</b>	<b>1.69</b>	<b>1.15</b>	<b>2.50</b>	0.370	1.26	0.76	2.08
<b>Self-identification as a healthcare worker</b>	<b>158</b>		<b>316</b>									
No	90	41.9	125	58.1	Ref				Ref			
Yes, doctor	24	37.5	40	62.5	0.534	1.20	0.68	2.13	0.482	0.76	0.36	1.63

(Continued)

TABLE 4 | Continued

Characteristics	Low levels of coping		High levels of coping		Unadjusted analysis				Adjusted analysis			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
Yes, nurse	5	27.8	13	72.2	0.249	1.87	0.64	5.44	0.534	1.45	0.45	4.64
Yes, other healthcare worker	39	22.0	138	78.0	<0.001	2.55	1.63	3.98	0.016	1.91	1.13	3.24
<b>COVID-19 impacted financial situation</b>	<b>158</b>		<b>316</b>									
No impact	114	31.3	250	68.7	Ref				Ref			
Yes, impacted positively	14	32.6	29	67.4	0.869	0.95	0.48	1.86	0.669	0.86	0.43	1.73
Yes, impacted negatively	30	44.8	37	55.2	0.033	0.56	0.33	0.96	0.023	0.51	0.29	0.91
<b>Affected by the change in financial situation</b>	<b>145</b>		<b>275</b>									
Not at all	61	30.8	137	69.2	Ref				Ref			
Unsure	23	43.4	30	56.6	0.087	0.58	0.31	1.08	0.091	0.57	0.29	1.10
Somewhat	37	28.5	93	71.5	0.650	1.12	0.69	1.82	0.843	1.05	0.63	1.75
A great extent	24	61.5	15	38.5	<0.001	0.28	0.14	0.57	<0.001	0.23	0.11	0.47
<b>Co-morbidities</b>	<b>158</b>		<b>316</b>									
No	111	32.9	226	67.1	Ref				Ref			
Psychiatric/Mental health problem	17	48.6	18	51.4	0.067	0.52	0.26	1.05	0.061	0.49	0.24	1.03
Other co-morbidities*	30	29.4	72	70.6	0.504	1.18	0.73	1.91	0.954	0.99	0.60	1.63
<b>Co-morbidities</b>	<b>158</b>		<b>316</b>									
No	102	30.6	231	69.4	Ref				Ref			
Single co-morbidity	38	38.8	60	61.2	0.131	0.70	0.44	1.11	0.110	0.66	0.40	1.10
Multiple co-morbidities	18	41.9	25	58.1	0.140	0.61	0.32	1.17	0.144	0.59	0.29	1.20
<b>Perceived status of own mental health</b>	<b>158</b>		<b>316</b>									
Good to Excellent	87	24.2	273	75.8	Ref				Ref			
Poor to Fair	71	62.3	43	37.7	<0.001	0.19	0.12	0.30	<0.001	0.20	0.13	0.33
<b>Smoking</b>	<b>158</b>		<b>316</b>									
Never smoker	133	32.0	282	68.0	Ref				Ref			
Ever smoker (Daily/Nondaily/ Ex)	25	42.4	34	57.6	0.117	0.64	0.37	1.12	0.110	0.62	0.34	1.12
<b>Increased smoking over the last 6 months</b>	<b>25</b>		<b>34</b>									
No	16	45.7	19	54.3	Ref				Ref			
Yes	9	37.5	15	62.5	0.531	1.40	0.49	4.05	0.349	1.99	0.47	8.38
<b>Current alcohol drinking (last 4 weeks)</b>	<b>158</b>		<b>316</b>									
No	89	32.5	185	67.5	Ref				Ref			
Yes	69	34.5	131	65.5	0.645	0.91	0.62	1.34	0.375	0.83	0.55	1.25
<b>Increased alcohol drinking over the last 6 months</b>	<b>69</b>		<b>131</b>									
No	52	33.8	102	66.2	Ref				Ref			
Yes	17	37.0	29	63.0	0.690	0.87	0.44	1.73	0.423	0.74	0.35	1.55
<b>Contact with known/suspected case of COVID-19</b>	<b>158</b>		<b>316</b>									
No	85	35.4	155	64.6	Ref				Ref			
Unsure	24	47.1	27	52.9	0.121	0.62	0.34	1.14	0.153	0.64	0.34	1.18
Yes, had indirect contact	19	24.4	59	75.6	0.072	1.70	0.95	3.04	0.077	1.70	0.95	3.06
Yes, provided direct care	30	28.6	75	71.4	0.215	1.37	0.83	2.26	0.290	1.32	0.79	2.20

(Continued)

TABLE 4 | Continued

Characteristics	Low levels of coping		High levels of coping		Unadjusted analysis				Adjusted analysis			
	n	%	n	%	p	ORs	95% CIs		p	AORs	95% CIs	
<b>Experience related to COVID-19 pandemic</b>	<b>158</b>		<b>316</b>									
No known exposure to COVID-19	116	34.7	218	65.3	Ref				Ref			
Treated in hospital / Ordered to quarantine/ Tested positive / Lived with someone who had Covid-19	38	30.9	85	69.1	0.442	1.19	0.76	1.86	0.378	1.23	0.78	1.93
Traveled overseas and had to quarantine	4	23.5	13	76.5	0.348	1.73	0.55	5.42	0.278	1.92	0.59	6.20
<b>Self-identification as a patient (visited a healthcare provider in the last 6 months)</b>	<b>158</b>		<b>316</b>									
No	79	31.6	171	68.4	Ref				Ref			
Yes	79	35.3	145	64.7	0.398	0.85	0.58	1.24	0.446	0.86	0.58	1.27
<b>Level of fear of COVID-19 (FCV- 19S categories)</b>	<b>158</b>		<b>316</b>									
Low (score 7–21)	147	32.7	303	67.3	Ref				Ref			
High (score 22–35)	11	45.8	13	54.2	0.187	0.57	0.25	1.31	0.201	0.55	0.22	1.38
<b>Level of distress K-10 Score categories)</b>	<b>158</b>		<b>316</b>									
Low (score 10–15)	24	25.8	69	74.2	Ref				Ref			
Moderate to Very High (score 16–50)	134	35.2	247	64.8	0.087	0.64	0.39	1.07	0.130	0.64	0.36	1.14
<b>Healthcare services used to overcome COVID-19 related stress in the last 6 months</b>	<b>158</b>		<b>316</b>									
No	146	32.5	303	67.5	Ref				Ref			
Yes	12	48.0	13	52.0	0.115	0.52	0.23	1.17	0.184	0.55	0.23	1.33

Data are presented as number (n) and percentage (%).  $P \leq 0.05$  were considered statistically significant.

ORs, Odds Ratio; AOR, Adjusted Odds Ratio; CI, Confidence Interval; Ref, Reference category; COVID-19, Coronavirus Disease 19; K-10, Kessler Depression Scale; FCV, Fear of Coronavirus-19 Scale; BRCS, Brief Resilient Coping Scale.

\*Adjusted for Age, Gender, Born in Germany, living status, employment status and level of education.

Bold indicated statistical significance.

possible explanation could be that participants might experience crucial interference with their everyday lives, which was likely to increase psychological distress while the accessibility of conventional mental health care was limited (25). It could also be assumed that uncertainties about the novel coronavirus, its progression, and variable nature of pandemic, and availability and access to the varied range of evidence also could contribute to the report of various country-wise reports of moderate to a high level of psychological stress. There was also a higher correlation between potential contact with COVID-19 cases, whether direct or indirect, experience with the pandemic, and healthcare use to overcome pandemic stress.

Regarding the issue of fear in this study, there were more participants with low fear, which supports studies conducted in Bangladesh (14), Australia (10), Malaysia (13), and globally (10). That indicated habituation to the threatening situation of the pandemic. However, generalized anxiety could remain elevated over time due to the ongoing nature of pandemic (33).

Similarly, a largescale German study among 3,500 randomly selected participants reported mental health (anxiety, depression) impact shortly after the lockdown came into effect (34). This study identified the factors associated with higher fear of COVID-19, which were similar as reported in the earlier studies: being female, and middle-aged, or over 60 (10, 13, 14). Being born in the same country of residence, and having at least a trade/certificate/diploma or bachelor degree were associated with higher levels of fear in this study, which were similar to the study conducted in Bangladesh (14).

Regarding the issue of coping in this study, there were more participants with high levels of coping, which is supported by the previous Malaysian (13) and the global study (10). High resilience coping could be explained by the long period of pandemic in Germany. Having an income source and being a healthcare worker were associated with higher levels of coping, findings of which were different compared to the previous studies (10, 13, 14). Finally, results showed that the COVID-19 pandemic

**TABLE 5 |** Association between psychological distress, coping and fear of COVID-19 using spearman's partial rank correlation.

Variables	Distress	Fear of COVID	Coping
Distress	1	0.331*	-0.276*
Fear of COVID		1	-0.173*
Coping			1

Controlling for Age, Gender, born in Germany, living status, employment status and level of education.

\*Significant at  $p < 0.001$  level.

and subsequent lockdown measures in early 2020 might slow the spread of the virus. However, those restrictions forced a sudden and dramatic change to the daily routines of community people, although not all individuals were impacted in the similar way. Some situational factors such as occupation, family status, financial and health impact, personality traits could influence individuals' experience during the ongoing COVID crisis in Germany (35).

This study had few limitations. The participants were included from the Ulm region in Southern Germany, which limits the generalizability across the whole German territory. Furthermore, it wasn't possible to exclude more responses from distressed individuals than non-distressed individuals, potentially resulting in selection bias. Finally, the study findings were limited to individuals who could access to online platforms in order to participate; therefore, there was limited generalizability due to the focus to internet-literate people. However, due to the lockdown measures applied during data collection, an online survey was the only available option to perform this study. One of the most crucial points in our study was collecting the targeted sample size during the pandemic lockdown period. Lastly, this study was the only German study that assessed the factors associated with psychological distress, fear, and coping strategies during the second and third waves of the COVID-19 pandemic. The data collection period coincided with the transition between the second and third waves in Germany, therefore, it was also not unlikely to have increased prevalence of psychological distress amongst the participants who participated in this study.

## CONCLUSIONS

This study identified levels of psychological distress, fear and coping amongst the community members during the COVID-19 pandemic in the Ulm region in Southern Germany. In addition, several factors and risk groups that were associated with those outcomes, were identified.

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The identified higher risk groups should be prioritized for receiving mental health support from the relevant healthcare providers such as family physicians and psychiatrists, and automated follow-up reminders could be sent through text messages which would prevent further deterioration of mental health conditions.

## DATA AVAILABILITY STATEMENT

The original contributions generated for 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 Research Ethical Committee (REC) of the Ulm University (Ethical Approval Number 448/20 - FSt/Sta). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

ME had substantial contribution to the conception or design of the study, data collection, and scientific writing of the manuscript. CS-L contributed to the conception and revised the manuscript critically. XW coordinated data collection. KD performed the statistical analysis. MK took part in scientific writing. ER, RA, MD, MG, and BC revised the manuscript critically for important intellectual content. SA, BB, and WC provided critical feedback on the narrative structure and methods and results. MAR conceptualized the study, coordinated data collection, provided critical feedback, and revised the manuscript. All authors contributed to the article and approved the submitted version.

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# Grit and Life Satisfaction Among College Students During the Recurrent Outbreak of COVID-19 in China: The Mediating Role of Depression and the Moderating Role of Stressful Life Events

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The global recurrent outbreak of COVID-19 has brought immense psychological distress to those affected. We conducted this study to explore the relationship among grit, stressful life events, depression, and life satisfaction in college students during the recurrent outbreak of COVID-19. According to the properties of the bias-corrected bootstrap method, we surveyed 888 college students, with an average age of 20.84 ( $SD = 1.57$ ) years. Participants completed questionnaires regarding grit, depression, stressful life events, and life satisfaction. The results showed that 1) grit was correlated with life satisfaction ( $r = 0.426, p < 0.001$ ); 2) depression mediated the relationship between grit and life satisfaction [indirect effect = 0.0292,  $SE = 0.009$ , 95%  $CI_{boot} = (0.135, 0.500)$ ]; 3) The relationship between grit and depression was moderated by stressful life events ( $\beta = 0.107, SE = 0.028, p < 0.001$ , 95%  $CI [0.053, 0.161]$ ). The association between grit and depression became weaker for college students with high stressful life events. The results indicated that concerned about depression and stressful life events may be the main targets for improving life satisfaction among college students during the recurrent outbreak of COVID-19.

**Keywords:** grit, life satisfaction, depression, stressful life events, COVID-19, Chinese college students

## INTRODUCTION

Life satisfaction was first described in the psychological literature by Shin (1), was referred to as a cognitive assessment of an individual's entire life. Life satisfaction is an important indicator to measure an individual's living situation, and it has received more and more attention. In addition, Proctor et al. (2) found that life satisfaction can affect an individual's future psychological state, and has important implications for an individual's physical and mental development. Previous researches have shown that higher life satisfaction predicts an individual's future mental state, and also improving college students' academic performance, academic well-being, and lowering student psychology health risks; lower life satisfaction predicts mental dysfunction (3). Therefore, improving life satisfaction is critical for college students to adapt to school and grow up healthily. College students are at a stage where they are not clear about their future plans and constantly adjust

their life goals, so their life satisfaction is highly susceptible and unstable (4). In that case, any events they experience in their lives can easily affect their life satisfaction. Since the outbreak of COVID-19 in 2020, it has been exerting tremendous influence not only on the physical behavior of individuals but also on their mental health (5). At present, tens of thousands of people around the world are infected with COVID-19. Study suggests that people who are quarantined during the COVID-19 experience anxiety, anger, confusion, and stress which may affect people's life satisfaction (6). The perception of stress, social adaptation to the COVID-19, and a series of epidemic control measures (blocking schools, maintaining social distance, prohibiting large student gatherings, etc.) during the COVID-19 epidemic may lead to a decline in the life satisfaction of college students (7–9). So, it is important to explore the factors affecting individuals' life satisfaction during the recurrent outbreak of COVID-19. Helping individuals improve their life satisfaction is important.

## Grit and Life Satisfaction

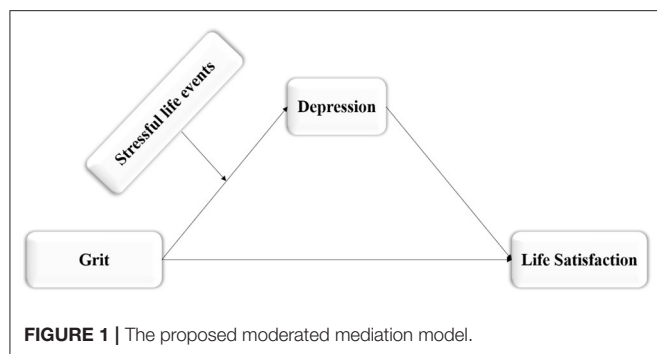
Because life satisfaction is so important to an individual's mental health, researchers are increasingly focusing on the factors that influence individual life satisfaction. People generally believe that individual traits explain why some are more satisfied with their lives than others in the same circumstances (10). Character strengths theory points out that character strengths is vital for improving individual life satisfaction and obtaining happiness (11). Grit, as a personal trait, is sustained enthusiasm and persistence for long-term goals (12), and has been one of the research hotspots in psychology in recent years. Research shows that grit is related to individual academic achievement, career success, and physical health (13, 14). Life satisfaction is deeply affected by individual life purpose (15). The purpose of life often needs to be achieved through the pursuit of meaningful goals, and grit plays a vital role in this process (16). People with high grit may not have high IQ, but have high perseverance and enthusiasm for long-term goals (10). Individuals with high level of grit are more likely to be inspired to achieve the goal of life and pursue the meaning of life (17). Therefore, grit is of great significance to the growth of college students and can encourage college students to pursue and achieve their life goals through efforts when they are in adversity, and improve their life satisfaction in the process. Previous studies have shown that grit is also positively correlated with life satisfaction, and individual with higher grit also have higher life satisfaction (18). The COVID-19 changes individual's lifestyles and has an impact on people's life satisfaction. However, grit can help an individual maintain mental health in the adaptation to social changes. During the period of the outbreak of COVID-19, the mental health of individuals with high grit is higher than that of individuals with lower grit (19). Therefore, during the epidemic period, the life satisfaction of Chinese college students with high grit is also higher, while the life satisfaction of college students with low grit quality is lower. This study will test the relationship between grit and college students' life satisfaction during the recurrent outbreak of COVID-19 and reveal the underlying mechanism.

## The Mediating Role of Depression in the Relation Between Grit and Life Satisfaction

Although past research has accumulated lots of knowledge about the relation between grit and life satisfaction (18, 20), some questions have not been fully discussed. For example, though previous theoretical studies have shown that grit may be related to life satisfaction, few studies empirically test the potential mechanism between them. Depression may mediate the path of grit relating to life satisfaction. Depression is a key index to diagnose the level of individual mental health and usually refers to the continuous negative emotional experience in individuals' lives, such as depression, anxiety, sadness, pain, etc (21). Individuals with high depression usually have sleep disorders, loss of appetite, self-mutilation, suicide, other behaviors (22). Depression has become one of the main diseases endangering human health. Depression in COVID-19 poses a serious threat to the mental development of young people, especially college students (23). In China, a study shows that depression due to COVID-19 is prevalent among University students (24), and the pooled prevalence estimate of clinically elevated depressive symptoms for adolescents during the COVID-19 pandemic is 30.6% (25). Grit, as an important psychological trait, helps an individual maintain mental health in the adaptation to social changes, and is positively correlated with well-being and life satisfaction (16). From the perspective of resource theory (26), the grit of college students is an important positive psychological resource for individuals to deal with life pressure. Individuals with a higher level of grit are more likely to see difficulties and stress in life as an inevitable part of the struggle, which makes individuals with a higher level of grit be less likely to be depressed (26). The study has shown that the occurrence of depression is inversely related to the quality of life and that more severe depression is associated with a decline in quality of life (27). The decline in life quality will lead to decline in individuals' life satisfaction, and previous studies have found a significant negative correlation between depression and life satisfaction (28). Therefore, this study believes that depression plays a mediating role in the process that college students' grit positively affects life satisfaction.

## The Moderating Role of Stressful Life Events

Grit may affect depression, but not for everyone, so the process by which perseverance affects depression may be influenced by other factors. Previous studies on grit and depression only focused on the effect of grit on depression (29–31), and did not integrate grit and environmental characteristics into consideration of their interaction effects on depression. Specifically, the organism-environment interaction model holds that individuals and the environment are complex systems in which the elements do not act independently but depend on each other (32). That is, the role of individual factors (such as grit) may vary with environmental factors (such as stressful life events). As the most basic environmental factor in an individual living environment, stressful life events have an impact on the growth of college students. Stressful life events refer to some negative life events



that people may encounter in daily life and bring pressure to individuals, which can have a negative impact on individuals' mental health (33), and it is of great significance to the development of individual psychology and behavior. A previous study has pointed out that if faced with fewer stressful life events, individuals can cope normally, but if faced with more stressful life events, the individual's psychological adjustment mechanism will be damaged, resulting in some psychological problems (34). According to the above reaches, both individuals with higher grit and low grit may have different effects on depression when faced with less stressful life events and more stressful life events. O'neal et al. (35) have shown that stressful life events negatively affect an individual's grit. Therefore, stressful life events may moderate the process of grit affects depression. According to the diathesis-stress interaction theory (36), depression stems from stress in life, and stress in life has a positive predictive effect on depression. So, stressful life events are the risk factors for depression among college students during the recurrent outbreak of COVID-19. Studies show that during COVID-19 the pressure of life on college students has increased, college students face more stressful life events such as pressure from study, employment, interpersonal relationship, and so on (37).

According to the organism-environment interaction model (32), stressful life events and grit may interact with depression of college students. According to the protective-reactive model (37), the effect of one protective factor is greater when the risk factor is higher. The relationship between grit and depression should be stronger for individuals experiencing higher stressful life events than those experiencing lower stressful life events. Based on this, we speculate that during the recurrent outbreak of COVID-19, stressful life events as a risk factor moderate the effect of grit on the depression of college students.

## The Present Study

This study constructed a moderated mediation model (see **Figure 1**) to test the mediating effect of depression and the moderating effect of stressful life events. Based on existing research conclusions and theories, this study puts forward 2 specific hypotheses:

Hypothesis 1: depression mediates the relationship between grit and life satisfaction.

Hypothesis 2: stressful life events moderate the association between grit and depression.

## METHOD

### Participants

A total of 907 college students from China were surveyed and all filled out the questionnaire, and 888 participants were left after deleting invalid participants (e.g., < 100 s to complete questionnaires). Therefore, the valid response rate of this study was 97.91%. Among them, there were 381 man (42.9%) and 507 women (57.1%), aged between 17 and 25 ( $M = 20.84$ ,  $SD = 1.57$ ). There were 306 (42.2%) rural residents and 647 (57.8%) urban residents. 11.3% were 1st years, 30% were 2nd years, 29.7% were 3rd years, 21.7% were 4th years.

## Measures

### Grit Scale

College students' grit was assessed with new version of the grit scale-Oviedo Grit Scale developed by Postigo et al. (38), which was used to measure grit. This scale is one-dimensional, with 10 items (e.g., "I spend as much time and energy as I can on reaching my goals"). Participants rate each item on a 5-point scale (1 = strongly disagree to 5 = strongly agree). Individual with higher total scores indicating higher levels of grit. In this study, these 10 items were forward and back-translated by Chinese professors who were fluent in both Chinese and English. And we did some slight changes to make sure the items could be applied to typical Chinese cultures. The scale had good validity in this study and was in line with various psychometrics standards. The Cronbach's alpha of the scale in this study was 0.891. Validity information of Oviedo Grit Scale was CFI = 0.973, TLI = 0.965, RMSEA = 0.056, SRMR = 0.026.

### Stressful Life Events Scale

Stressful life events experienced by the participants were assessed with the Stressful Life Events Scale (39) which consists of 16 items (eg, "falling behind in study"). Each item represented a stressful event and participants reported whether or not these stressful events had occurred in the past year. Each item was rated on a 6-point scale (0 = did not occur to 5 = occurred and extremely stressful). The average score for each of the 16 items was calculated. The higher the score, the greater the number of stressful life events they experienced. The Cronbach's alpha of the scale in this study was 0.915.

### Depression Scale

Depression in this study was assessed with the Patient Health Questionnaire Depression Self-Rating Scale (40). Bian et al. (41) revised the scale in Chinese. The scale is a depression screening tool based on nine symptoms of depression in the Diagnostic and Statistical Manual of Mental Disorders, Edition IV (DSM-IV). Compared with other depression scales commonly used, it has the advantages of fewer items and is easy to understand. There are nine items (eg, "Feeling down depressed or hopeless"), and each item was rated on a 4-point scale (0 = not at all to 3 = almost every day), with higher total scores indicating higher levels of depression. The Cronbach's alpha of the scale in this study was 0.922.

## Life Satisfaction Scale

The Chinese Version of the Life Satisfaction Scale (42), adapted from the Life Satisfaction Scale (43), was used to evaluate college students' life satisfaction. This scale consists of 5 items (e.g., “*In most ways my life is close to ideal*”). Participants rated their life satisfaction on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). Higher total scores indicated higher level of life satisfaction. The Cronbach's alpha of the scale in this study was 0.888.

## Procedure

The study was approved by the ethics committee of the first author's University. In this study, participants over the age of 18 provided informed consent, and participants under the age of 18 obtained the consent of their legal guardians. Because of the social distancing order issued by the government during the recurrent outbreak of COVID-19. The survey was hosted on Wenjuan Web (Shanghai Zhongyan International Science and Technology, Shanghai) from December 18 to December 28, 2021. In this study, all responses were anonymous. There was no compensation for participating in this study, and the participants participated entirely voluntarily.

## Analytical Strategy

First of all, SPSS26.0 were used to calculate the descriptive statistics for the study variables, and then their correlation between the study variables were calculated. Next, we tested the mediating effect of grit by using the PROCESS (Model 4) macro of SPSS26.0 software (44). Thirdly, we investigated the moderating effect of gratitude on the indirect relationship between grit and depression by using the PROCESS (Model 14) macro of SPSS26.0 software (44).

## RESULTS

### Preliminary Analysis

The results of Harman's single-factor test suggested that the variance for unrotated first factors was 26.69%, below the threshold of 40%, which indicated that there was no significant common method bias in the study (45).

**Table 1** showed the descriptive statistics and means, standard deviations for all variables, including the bivariate correlations of grit, stressful life events, depression, life satisfaction. Grit was positively associated with life satisfaction ( $r = 0.426$ ,  $p < 0.001$ ) and negatively associated with depression ( $r = -0.167$ ,  $p < 0.001$ ). In addition, depression was negatively associated with life satisfaction ( $r = -0.236$ ,  $p < 0.001$ ). What's more, stressful life events were positively associated with depression ( $r = 0.595$ ,  $p < 0.001$ ).

### Mediation Effect Analysis

We analyzed the data after adding age, gender, and grade as covariates. In Hypothesis 1, we assumed that depression would mediate the relationship between grit and life satisfaction. We tested this hypothesis with Model 4 of the PROCESS (44). As **Table 2** showed, grit was positively associated with life satisfaction [ $\beta = 0.402$ ,  $SE = 0.031$ ,  $p < 0.001$ , 95%  $CI$

**TABLE 1 |** Descriptive statistics and correlations.

Variable	<i>M</i>	<i>SD</i>	1	2	3	4
1 Grit	3.967	0.591	1			
2 Stressful life events	1.267	0.939	0.086*	1		
3 Depression	1.086	0.744	-0.167***	0.595***	1	
4 Life satisfaction	4.552	1.2564	0.426***	-0.079*	-0.236***	1

$n = 888$ ; \* $p < 0.05$ , \*\*\* $p < 0.001$ .

(0.342, 0.462)] and negatively associated with depression [ $\beta = -0.173$ ,  $SE = 0.033$ ,  $p < 0.001$ , 95%  $CI$  (-0.238, -0.107)]. Depression was negatively associated with life satisfaction [ $\beta = -0.169$ ,  $SE = 0.031$ ,  $p < 0.001$ , 95%  $CI$  (-0.229, -0.110)]. The direct effect of grit on life satisfaction remained positive. Therefore, depression partially mediated the effect of grit on life satisfaction [indirect effect = 0.0292,  $SE = 0.009$ , 95%  $CI_{boot} = (0.135, 0.500)$ ], accounting for 6.78% of the total effect. Therefore, Hypothesis 1 was supported.

### Moderated Mediation Effect Analysis

We analyzed the data after adding age, gender, and grade as covariates. In Hypothesis 2, we assumed that stressful life events would moderate the association between grit and depression. The PROCESS of the SPSS macro program was used to test the moderated mediation model and evaluate the moderating effect. The results of the moderated mediation test were shown in Model 3 of **Table 2**. The product (interaction term) of grit and stressful life events had a significant predictive effect on depression [ $\beta = 0.107$ ,  $SE = 0.028$ ,  $p < 0.001$ , 95%  $CI$  (0.053, 0.161)].

For description purposes, we plotted examined grit against depression, separately for low and high levels of gratitude. The interaction effect was visually plotted in **Figure 2**. Simple slope tests showed that for college students with highly stressful life events, grit was not significantly associated with depression,  $\beta_{simple} = -0.004$ ,  $t = -0.102$ ,  $p > 0.05$ , 95%  $CI = [-0.082, 0.074]$ , and as for college students with low stressful life events, grit had significant effect on depression,  $\beta_{simple} = -0.218$ ,  $t = -5.867$ ,  $p < 0.001$ , 95%  $CI [-0.291, 0.145]$ . In summary, these results indicated that stressful life events moderated indirect associations between grit and depression.

## DISCUSSION

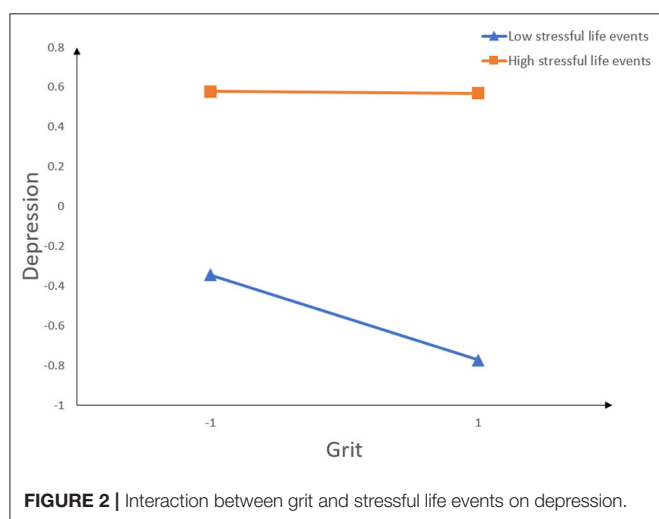
The COVID-19 has had a dramatic impact on individual's daily lives, particularly in the area of mental health. Life satisfaction is a vital indicator of individual's mental health, and it can measure the quality of an individual's life. People all over the world are eager to live a better life in the pursuit of happiness. At the same time, life satisfaction is not only an important indicator of individual adaptation to society but also an important symbol of social harmony. As an important social group, college students' life satisfaction during the recurrent outbreak of COVID-19 should be paid attention to, as well as the factors and mechanisms that affect college students' life satisfaction. The current study examined the relationship among grit, depression, stressful life



**TABLE 2** | Testing the moderated mediation model.

Predictor	Model 1 (Depression)		Model 2 (Life satisfaction)		Model 3 (Depression)	
	$\beta$	$t$	$\beta$	$t$	$\beta$	$t$
Age	0.048	1.761	−0.030	−1.199	0.045	2.019*
Gender	−0.164	−2.452*	−0.010	−0.171	−0.058	−1.079
Grade	−0.084	−1.975*	−0.010	−0.270	−0.071	−2.100*
Grit	−0.173	−5.187***	0.402	13.140***	−0.111	−4.130***
Stress Life Events					0.562	20.709***
Depression			−0.169	−5.556***		
Grit × Stressful Life Events					0.107	3.878***
$R^2$	0.039	0.213	0.381			
$F$	8.902***	47.669***	90.498***			

$n = 888$ ; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .



events, and life satisfaction. The results of this study showed that depression played a partial mediating role in the relation between grit and college students' life satisfaction. Moreover, the relationship between grit and depression was further moderated by stressful life events. Our findings further contributed to the literature by testing a moderated mediation model, showing that depression acted as a mediator in the relationship between grit and life satisfaction. Moreover, the relationship between grit and depression was further moderated by stressful life events.

## The Relationship Between Grit and Life Satisfaction

This study examined the relationship between grit and life satisfaction and found that grit was significantly positively correlated with life satisfaction, which was consistent with previous research results (16, 18). Studies on grit have shown that the quality of grit can significantly predict individual achievement, in the academic field (12), the work field (14). At the same time, studies have also found that individuals with higher levels of grit have better mental health and can effectively

cope with various emergencies caused by the COVID-19 (19). Generally speaking, grit, as an important personality trait in positive psychology, is also a psychological quality that can be cultivated, which has an important influence on individuals' physical and mental development. Combined with this study, life satisfaction can be improved and the negative impact of the epidemic on people can be weakened by cultivating individual grit during the recurrent outbreak of COVID-19.

## The Mediating Role of Depression

In this study, we added depression to explore the specific mechanism by which grit affected life satisfaction during the recurrent outbreak of COVID-19. The results showed that depression had a significant negative relation to college students' life satisfaction, which was consistent with the previous research results (27, 28). More importantly, this study found that depression was a bridge between grit and life satisfaction. Depression was found to partially mediate the relationship between grit and life satisfaction. In other words, the impact of grit on life satisfaction is not only direct, but also indirectly through depression. Here, depression played an important role as a bridge, which not only reflected the relationship with grit, but also reflected the relationship with life satisfaction, and answered "how" or "why" of grit would play a role in life satisfaction. Therefore, depression was an important internal cause of grit affecting college students' life satisfaction. Firstly, grit reduced the level of college students' depression, which was the same as the previous conclusion (26, 31). Grit as a stable positive personality trait can strongly influence an individual's attitude toward failure and misfortune (12). Specifically, Duckworth et al., (12) pointed out that in pursuit of long-term goals, individuals with high grit tend to remain perseverance and enthusiasm in the face of obstacles. Thus, grit can help an individual escape the belief that failure is inevitable in the pursuit of success, and ultimately resist the sense of difference that comes with high personal standards (29). In other words, for individuals with high grit, when facing negative results, there may be more optimistic attribution style (46). Therefore, high grit will reduce the level of depression. Previous studies have found that depression has a strong impact on individual life satisfaction (28, 47). In summary,



during the period of recurrent outbreak of COVID-19, grit not only directly affected life satisfaction but also indirectly affected college students' life satisfaction by affecting college students' depression. This mediating role is of practical significance. On the one hand, it suggests that the impact of grit on life satisfaction is complex, on the other hand, the mediating effect provides a theoretical basis for improving life satisfaction of college students by reducing their depression.

## The Moderating Role of Stressful Life Events

From the perspective of the individual-environment interaction model (32), the influence of college students' factors (grit quality) and common environmental factors (stressful life events) on depression was comprehensively investigated. The results indicated that stressful life events moderated the relationship between grit and depression during the recurrent outbreak of COVID-19. To be specific, the relationship between grit and depression was weaker for college students with high stressful life events. However, the relationship between grit and depression was stronger for college students with low stressful life events. According to the stress vulnerability hypothesis, positive factors in individuals tend to lose their original protective effects in high-pressure environments (48). In the present study, the impact of stressful life events on individuals reduced their grit traits during the recurrent outbreak of COVID-19. According to the stress vulnerability hypothesis, grit loses its protective effect on depression when college students experience more stressful life events. Specifically, when individuals encounter more stressful life events, whether the level of individual grit is high or low, the level of depression of college students is at a high level. Our results showed that for college students who suffer less stressful life events, the higher the level of grit, the faster the level of depression decreases. Duckworth et al. (46) find that when facing negative results, individuals with high grit have a more optimistic attribution style. In particular, it should be noted that when stressful life events are high, the level of an individual's depression is very high regardless of whether the level of an individual's grit is high or low. In other words, people with high grit can benefit from reducing stressful life events, which supports the stress vulnerability hypothesis. This study shows that stressful life events play an important role in college students' depression. Therefore, this study also found that grit had a limited protective effect, and under high stressful life events, grit lost its protective effect. In order to reduce the depression problem of college students during the recurrent outbreak of COVID-19, it is necessary not only to cultivate the quality of grit but also should strive to reduce the pressure that college students may suffer, to promote the solution of college students' depression and improve their mental health.

In conclusion, grit affected college students' life satisfaction through depression during the recurrent outbreak of COVID-19, and the first half of this process was moderated by stressful life events. Schools and relevant social departments should create better living environment for college students, pay more attention to cultivating and improving

individual grit, attach importance to students' depression and provide timely treatment, try to reduce the adverse effects of stressful life events that college students may encounter in their life, to improve the life satisfaction of college students.

## Limitations

There are some limitations in the current study that need to be noted. First of all, the cross-sectional design of this study makes it impossible to infer the causal relationship between variables, so experimental and longitudinal designs could be utilized in future research. Second, the self-reported questionnaire survey used in this study may be affected by social desirability, especially for variables with very high social desirability such as life satisfaction. In the future, measures with less social desirability effect, such as forced selection questionnaire, can be considered. Family socioeconomic status (SES) or household income may have influenced the results, and future research should collect the information about SES or household income and consider the effect of SES or household income on the results. Moreover, the subjects in this study were all college students, and the results should be tested in more groups in the future. Finally, COVID-19 is currently spreading around the world, and we can conduct further investigations in other countries seriously affected by COVID-19 to further validate the result in diverse samples.

Although there are some limitations, the contributions of the research are theoretical and practical. This study further extends previous research by examining the mediating role of depression and the moderating role of stressful life events. This study can inspire educators to pay attention to the cultivation of individuals' grit, promote their physical and mental health development, reduce the risk of depression and improve life satisfaction. Through this study, we found that stressful life events not only increase the risk of depression in college students but also reduce the level of life satisfaction in college students. Therefore, we should pay attention to improving the living environment of college students, and appropriately relieving pressure on college students, especially during this particular time of the recurrent outbreak of COVID-19.

## CONCLUSION

To sum up, the study was of great importance in exploring how grit was related to the Chinese college students' life satisfaction during the recurrent outbreak of COVID-19, even if further replication and extension were required. This study suggested that depression was an underlying mechanism through which grit was associated with life satisfaction. In addition, stressful life events moderated the relationship between grit and depression, and college students with high level of stressful life events had a weaker negative relationship between grit and depression during the recurrent outbreak of 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 school of Psychology, Jiangxi Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

## AUTHOR CONTRIBUTIONS

HL: conceptualization, investigation, writing—original draft, visualization, and revised manuscript. ZY:

conceptualization, writing—original draft. BY: conceptualization, methodology, investigation, statistical analysis, data curation, visualization. QY: project administration, and funding acquisition. All authors read and approved the final manuscript.

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# Bullying Experiences, Depression, and the Moderating Role of Resilience Among Adolescents

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**Introduction:** Resilience refers to the ability to adapt to difficult situation or adversity. Resilience is what gives people the psychological strength to cope with stress and hardship. Previous studies have investigated the relationship between resilience and bullying victimization and mental health problems. But whether the moderating effect of resilience against depression varies among victims of different types of bullying victimization remains unknown.

**Methods:** The study used data from the Taiwan Adolescent to Adult Longitudinal Study (TAALS), which was a school based, nationwide, longitudinal study conducted among adolescents in Taiwan. Between 2015 and 2019, the survey was repeated three times to capture changes in health behaviors. Meanwhile, our study is a cross-sectional study focusing on the 2nd follow-up survey of the TAALS, where we recruited 4,771 Grade 7 (12–13 years) and Grade 10 (15–16 years) students who had experienced bullying at school.

**Results:** This study confirms the protective effect of resilience on depression among adolescents who have experienced bullying. The mode resilience score was used as a reference group. Compared to the reference group, victims of verbal bullying from the lowest resilience group were at the greatest risk of depression (OR = 5.91, CI = 4.38–7.99). Compared to the reference group, victims of cyber bullying from the highest resilience group had the lowest risk of depression (OR = 0.72, CI = 0.57–0.90).

**Conclusion:** Regardless of the type of bullying victimization, resilience has been shown to offer protection against depression. Specifically, higher resilience levels offer the greatest protection against depression for victims of cyber bullying compared to other three types of bullying victimization. Early interventions to reduce negative effects of bullying victimization may start with increasing an individual's resilience during adolescence.

**Keywords:** bullying, victimization, depression, resilience, adolescent, mental health



## INTRODUCTION

Adolescence is a critical period of development and the start of the transition to adulthood. One important reason for evaluating young people's experiences of bullying and being victimized by bullies is these experiences have significant associations with a range of mental health problems (1, 2). Being bullied during adolescence is a common, distressing and preventable experience and has been associated with mental illness, substance misuse, and suicide risk in adulthood (3–5). Bullying can take many forms including physical violence, name calling, social exclusion, spreading rumors, and sending insulting or threatening online messages. Exposure to violence has been associated with severe and permanent mental health problems; such as low self-esteem, depression or anxiety, antisocial or disruptive behaviors, academic failure, or self-harm (6–8). Violence here is defined as direct physical abuse, witnessing parental violence, and perceptions of neighborhood violence (6, 8). Studies have suggested that victims of bullying not only have a high risk of developing depression or anxiety but are also likely to commit self-harm (9, 10). Several studies have estimated that approximately 20–35% of adolescents have had at least one experience of bullying, victimization, or both (11, 12). In Taiwan, a recent study estimated that ~19% of junior high school students in Taiwan have experienced violence in school (13). The high prevalence of bullying in schools in Taiwan has prompted calls for Taiwan's government to develop a policy response to prevent bullying in schools.

Although bullying has been strongly correlated with mental health problems among adolescents, some positive psychological traits like “resilience” and “positive-thinking personality” may be protective during stressful circumstances and prevent adolescents from developing mental health problems following a bullying episode (14). Resilience comes from the accumulation of positive interactions with family members, peers, neighbors, and the community, rather than being an inherent personality trait (14, 15). Resiliency theory provides a conceptual framework for understanding why youths grow up to be healthy adults despite exposure to adversity (16–18). Resiliency focuses on positive contextual, social, and individual variables that interfere with the developmental trajectories from adversity to problematic behaviors, mental distress, and poor health outcomes. These positive contextual, social, and individual variables are known as promotive factors, work in opposition to adversity, and help youth to overcome negative effects of adversity exposure (19, 20). The two types of promotive factors identified by Fergus and Zimmerman (19) are assets and resources. Self-efficacy or problem-solving skill are known as positive factors reside within individuals. On the other hand, resources are referred to factors outside individuals such as social support, family support, interpersonal skills, mentorship programs that provide opportunities for youth to learn and practice skills (21). For instance, in a cross-sectional study conducted by Santos et al., it analyzed resilience as a protective factor against the development of depression symptoms and decreased satisfaction with life among victims of cyberbullying (22). In a meta-analysis, resilience was found to correlate negatively

with anxiety and depression, but positively with positive indicators of mental health and life satisfaction (23). Adolescents with higher resilience appear to have better outcomes after encountering adversity than adolescents with lower resilience. Resilient individuals bounce back from stressful events more quickly and effectively (24).

Previous studies have investigated the relationship between resilience and bullying victimization and various mental health problems including depression, suicide, or psychiatric disorders. Many studies have shown that adolescents exposed to violence are more likely to have adverse outcomes in adulthood including mental health problems and suicidal thoughts (8, 25). Resilience is likely to be a recovery mechanism that restores individuals' emotional status back to normal after experiencing adversity or stress (26). Other studies have shown that resilience can be strengthened by other protective factors like self-esteem and social support (27, 28).

Many studies have indicated that resilience is negatively related to bullying and cyberbullying, and it moderates the relation between bullying victimization and youths' negative mental health outcomes. For instance, Zhou et al. (29) found resilience is an important factor that mediates the relationship between bullying victimization and childhood depression. Huang and Mossige (30) found that resilience has a significant negative association with poor mental health, and also moderates the negative relation between poly-victimization and young people's mental health. Many recent studies investigating the effect of resilience on mental health have some limitations. For instance, many studies have focused on estimating whether resilience can reduce mental health problems following bullying but few studies have examined if the interaction between resilience, bullying, and mental health problems varies by the type of bullying victimizations (31). Secondly, previous studies have mostly evaluated the mean effect of resilience without considering the range of different resilience levels that bullying victims have. Different levels of resilience may exert different modifying effects on mental illness and psychological distress following bullying. Resilience also showed significant correlation with positive mental health indicators such as life satisfaction and perceived wellbeing (32–34). One study examined late adolescents' resilience as a moderator of the relationship between poly-bullying victimization and subjective wellbeing (35). Therefore, the aim of this study is to examine whether resilience plays a protective role in preventing depression among bullying victims and whether the extent of protection differs depending on the type of bullying victimization and resilience level.

## METHODS

### Study Design and Participants

The present study used data from the Taiwan Adolescent to Adult Longitudinal Study (TAALS) (36), which was a school-based, nationally representative, longitudinal study conducted among adolescents between 2015 and 2019. A multistage stratified sampling approach with probability proportional to size sampling was applied to obtain a nationally representative sample



of adolescents. The baseline survey for the TAALS was conducted in 2015, and between 2015 and 2019 the survey was repeated three times. During the first wave of the cohort study (Wave 1), 6,903 junior high school students and 11,742 high school students were interviewed, for a total of 18,645 students. Among those 18,645 students, in the second wave of the cohort study (our present study), 4,771 students Grade 7 students (age range: 12–13) and Grade 10 students (age range: 15–16) were identified as ever had bullying experience at school. Bullying experiences were defined as “pure-targets” and “target-perpetrators.” Target-perpetrators refers to participants who were not only bullied but also bullied others. The questionnaire used for the TAALS was developed through a systematic review of multiple large-scale international youth studies. The TAALS was a cohort study funded by Taiwan’s Health Promotion Administration (HPA) and our access to the TAALS dataset was granted by the HPA. The original data collection for the TAALS study and our subsequent analysis of the survey results were both approved by the Joint Institutional Review Board of Taipei Medical University, Taiwan (TMU-JIRB-201410043).

## Measurement of Depressive Symptom

Depressive symptoms were evaluated using the Chinese version of the Center for Epidemiological Studies Short Depression Scale (CES-D) (37). Shrout and Yager (38) had examined the sensitivity and specificity of the 5, 10, and 20-item versions of CES-D scale and found the sensitivity and specificity of the 5-item CES-D scale was similar to those of the full 20-item scale. Previous studies have also suggested that researchers can select CES-D items with the highest factor loading through factor analysis. Therefore, we used factor analysis to select 5 items with the 5 highest factor loadings from the 10-item CES-D scale. Depressive symptoms experienced in the past seven days was evaluated using the following questions: (1) I did not feel like eating; my appetite was poor; (2) I could not get “going;” (3) I felt depressed; (4) I felt everything I did was an effort; (5) I felt lonely. The 5-point scale was validated by an internal expert committee meeting who reviewed the validity of different versions of the CES-D scale and selected the final version of the survey. The five-item scale was found to have a high internal consistency with a Cronbach  $\alpha$  value of 0.79. Finally, item responses were rated on a four-point Likert scale ranging from 0 to 3 and the sum of all the responses was used to calculate a total score, which ranged from 0 to 15. Participants who obtained a score  $\geq 7$  were considered to have depression.

## Measurement of Resilience

The questionnaire used to evaluate resilience level was adapted from the Chinese version of the Inventory of Adolescent Resilience (IAR), which is a 28-item questionnaire that was used in a previous study to assess resilience levels among Taiwanese 7 and 9th grade students (39). The IAR contains 4 dimensions: problem solving and cognitive maturity, hope and optimism, empathy and interpersonal interaction, and emotional regulation. In addition to the expert evaluation, like Shrout and Yager (38), we applied factor analysis to select three questions with the highest factor loadings from each of the four dimensions,

resulting in 12 questions for the entire survey. The twelve questions used to measure resilience are: “I can solve problems in an organized way,” “I am an optimistic person,” “I can control my emotion when being upset by others,” “I can find effective solutions to the problems,” “I am an outgoing person,” “I choose not to react to the people who make fun of me,” “When I’m upset, I usually can quickly return to peace,” “I can make myself happy,” “I can make others feel warm and willing to share emotions and feelings with me,” “I don’t give up easily when encountering setbacks,” “I can treat others with kindness and generosity.” These 12 questions were used to measure resilience level and all questions reached a good internal consistency (Cronbach’s  $\alpha$  coefficient of 0.84). Responses were rated on a 4-point Likert scale ranging from 1 to 4 (strongly disagree, disagree, agree, and strongly agree) and the sum was used to calculate a total score. A higher score indicated that a participant is more resilient.

## Measurement of Bullying Victimization

Participants’ bullying experiences and type of bullying victimization were determined in this study. We modified the assessment tool developed by the U.S. Centers for Disease Control and Prevention (CDC) called “Measuring Bullying Victimization, Perpetration, and Bystander Experiences” (40) to determine whether participants had been exposed to bullying at school during the past 6 months. We used the following four questions to assess participants’ bullying experience during the past 6 months: “I was pushed, shoved, slapped, or kicked by other students,” “I was teased by other students,” “I was ignored or felt left out of activities or games on purpose,” and “Some pictures or words were posted online, (through email, computer text message, or Facebook), by someone else to make others laugh.” Each question was rated on a 5-point scale ranging from 0 being “Never” to 4 being “Always.” If students scored 1–4 for one of the questions, they were identified as victims. In addition, we adopted a similar approach to identify students’ bullying victimization type. For example, if participants scored 1–4 on the question “I was pushed, shoved, slapped, or kicked by other students,” they were identified as being a victim of physical bullying. If participants scored 1–4 on the question “I was teased by other students,” they were identified as being a victim of verbal bullying. If participants scored 1–4 on the question “I was ignored or felt left out of activities or games on purpose,” they were identified as being a victim of relational bullying. Finally, if participants scored 1–4 on the question “Some pictures or words were posted online by someone else to make others laugh,” they were identified as being a victim of cyber bullying.

## Measurement of Social and Family Support

The level of peer support was quantified using a 5-item questionnaire developed by the U.S. Centers for Disease Control and Prevention (CDC) (40). Questions used to access peer support during the past 6 months included “My classmates/friends truly care about things that happened to me,” “When I am in need for help, my classmates/friends will help me,” “I have classmates/friends that I can trust,” “My classmates/friends care about my feelings,” “My classmates/friends only care about themselves,” and “My

classmates/friends think that I'm not good enough." Responses were rated on a 4-point scale ranging from 0 (None of them) to 3 (All of them) and summed up to calculate the total score. The total score ranged from 0 to 15, and the higher score indicated stronger peer support. The level of perceived support from family was measured by the 6-item questionnaire adapted from the 40-item Inventory of Socially Supportive Behaviors (ISSB) (41). The questions used to access family support during the past 3 months included: "My family members understand and support my decisions and behaviors," "My family members are willing to listen when I need to vent about something," "When I'm feeling down, my family members will talk to me and encourage me," "My family members will fully support me regardless the cost when is necessary," "When I encounter some problems, my family members will share their solutions with me," and "When I need to make a decision, my family members will discuss and share their ideas with me." Responses were rated on a 4-point scale ranging from 0 (Never) to 3 (Always) and summed up to calculate the total score. The total score ranged from 0 to 18, and the higher score represented more family support received.

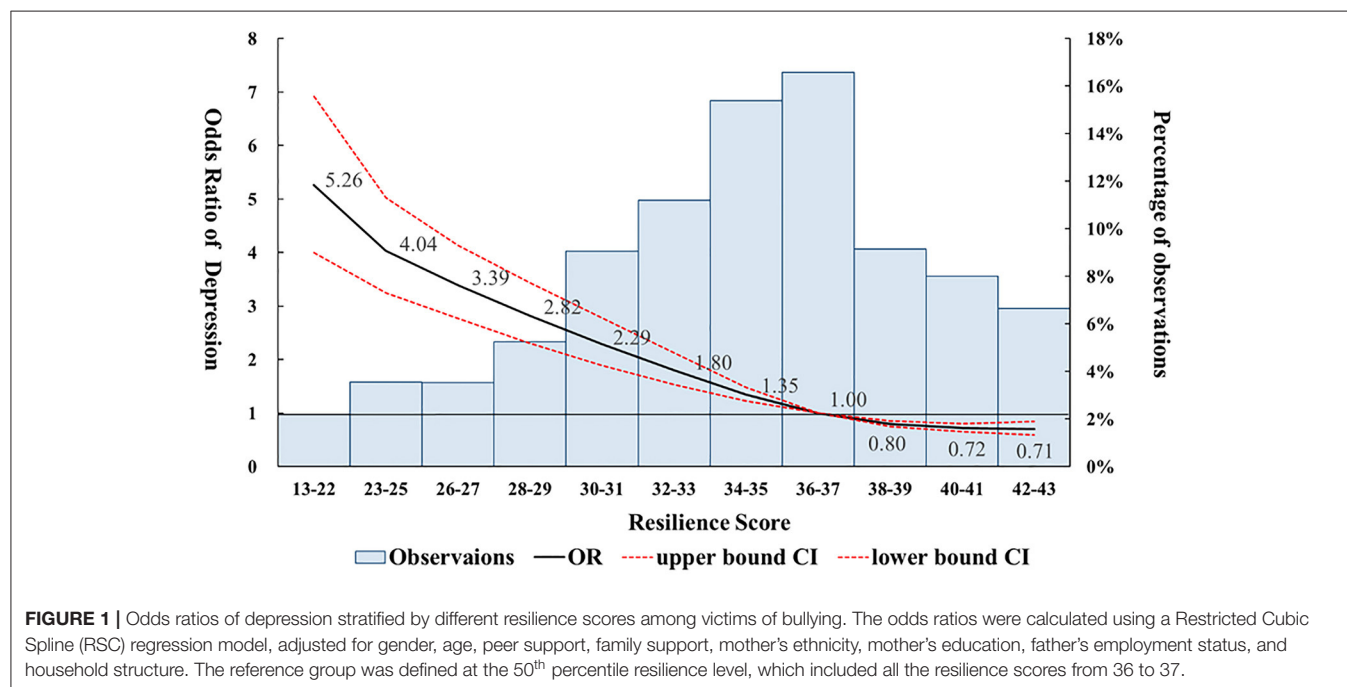
## Confounders

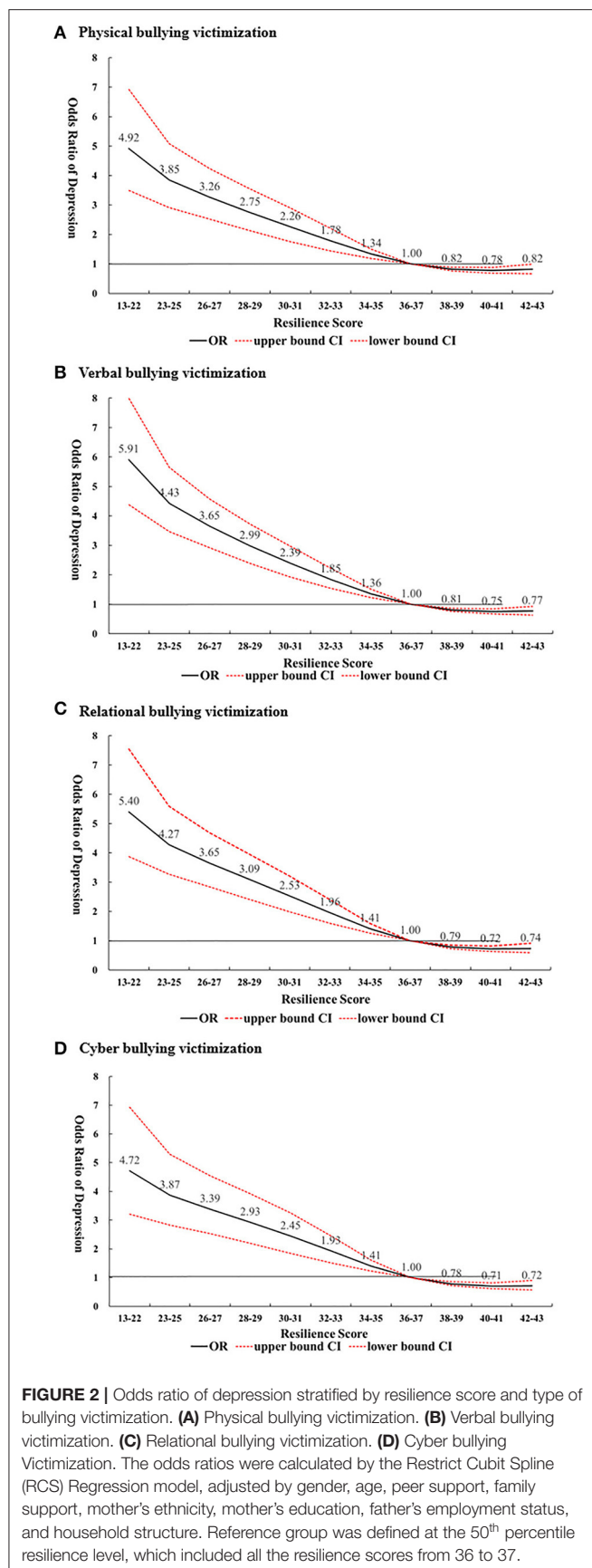
Sex, academic grade level, family support, and peer support were measured at baseline and were incorporated as potential confounders in both the regression and the RCS models. Additionally, socioeconomic factors including mother's highest level of education achieved (junior high school graduate or below, senior high school graduate, or University graduate), mother's ethnicity (Chinese/Aboriginal/immigrant), father's employment status (full-time, part-time, unemployed), and household structure (live with parents and grandparents, live with parents, live with only grandparents, live with collateral

relatives) are also important confounders affecting an individual's resilience level, and were adjusted in both the regression and the RCS models.

## Statistical Analysis

Descriptive statistics were used to describe individual and socioeconomic characteristics among participants with and without depression. Differences in bullying experience (pure targets/target-perpetrators), bullying victimization type, resilience level, mother's ethnicity, mother's education level, father's employment status, household structure were evaluated using a chi-square test. Because there are currently no universal cutoff values available to define levels of resilience, we therefore took an approach of dividing the resilience scores into six groups according to centiles. The six levels of resilience were classified as the following:  $\leq 10$ th percentile (resilience score  $\leq 28$ ), 11–20th percentile (resilience scores between 29 and 31), 21–40th percentile (resilience scores between 32 and 34), 41–60th percentile (resilience scores between 35 and 37), 61–80th percentile (resilience scores between 38 and 41), and  $\geq 80$ th percentile (resilience scores  $\geq 42$ ). In order to capture any change in the protective effect from different levels of resilience against depression, two methods were used: a logistic regression model and a restricted cubic spline (RCS) regression model (42). First, we divided resilience levels into six categories by percentile and performed a logistic regression to evaluate the odds ratio of depression among all participants being bullied at school (Table 2). Next, we performed another logistic regression to evaluate the association between resilience level and depression stratified by bullying victimization type (i.e., physical, verbal, relational, and cyber bullying victimization) (Table 3). Since logistic regression models are unable to capture





the continuous changes of non-linear factor (i.e., resilience), we performed a restricted cubic spline (RCS) regression to examine the association between resilience and depression among bullied participants (**Figure 1**). Next, the association between resilience level and depression stratified by bullying victimization types was also analyzed by the RCS regression (**Figure 2**). All statistical analyses were conducted using STATA 12 statistical software and results were considered significant at  $p < 0.05$ .

## RESULTS

### Participants Baseline Characteristics

Participants' characteristics at baseline are presented in **Table 1**. Among the 4,771 participants there were slightly more participants from Grade 10 than from Grade 7 students (53 vs. 47%), and more male than female participants (53 vs. 48%). There were more target-perpetrators than pure targets (71 vs. 29%) and verbal bullying victimization was most common among the four types of bullying victimization (77.2%). Most of the participants had a resilience level at 21–40th and 61–80th percentiles (21.4 and 20.8%), most lived with their parents (75%), and had their father working full-time (83%). Among all the variables, sex, type of bullying victimization, resilience level, father's employment status, household structure, and social support (i.e., peer and family support) were significantly different in participants with depression compared to those without depression. The results showed no significant difference in bullying experience, mother's ethnicity, and mother's education level among participants with depression compared to participants without depression.

### Association Between Resilience Level and Depression

For our regression models, we used the 41–60th percentile resilience level group as the reference group. In the crude model, lower resilience levels, (i.e.,  $\leq 10$ th percentile, 11–20th percentile, and 21–40th percentile), were significantly associated with an increased risk of depression when compared to the reference group. In addition, higher resilience levels, (i.e., 61–80th percentile and  $\geq 80$ th percentile), were associated with a reduced risk of depression when compared to the reference group, however the results were not significant. In the final adjusted model, (adjusting for grade level, age, peer support, family support, mother's ethnicity, mother education, father's employment status, and household structure), similar findings were observed where lower resilience levels were significantly associated with increased risk of depression compared to the reference group. Higher resilience levels were associated with a reduced risk of depression compared to the reference group although the association was not significant (**Table 2**).

### Association Between Resilience Level and Depression Stratified by Bullying Victimization Type

We investigated whether the type of victimization plays a role in the association between resilience level and depression.

**TABLE 1** | Baseline characteristics among victims of bullying with and without depression.

Variables	Total (N = 4,771)		With depression (N = 938)		Without depression (N = 3,833)		P-value
	n	%	n	%	n	%	
<b>Grade level of students</b>							0.826
Grade 7	2,243	47.01	444	47.33	1,799	46.93	
Grade 10	2,528	52.99	494	52.67	2,034	53.07	
<b>Gender</b>							<b>0.007</b>
Male	2,497	52.34	454	48.40	2,043	53.30	
Female	2,274	47.66	484	51.60	1,790	46.70	
<b>Bullying experience</b>							0.207
Pure targets	1,382	28.97	256	27.29	1,126	29.00	
Target-perpetrators	3,389	71.03	682	72.71	2,707	69.71	
<b>Victimization type</b>							
Physical	2,755	57.74	593	63.22	2,162	55.68	<b>&lt;0.001</b>
Verbal	3,684	77.22	774	82.52	2,910	74.94	<b>&lt;0.001</b>
Relational	2,958	62.00	640	68.23	2,318	59.70	<b>&lt;0.001</b>
Cyber	1,979	41.48	452	48.19	1,527	39.33	<b>&lt;0.001</b>
<b>Resilience level</b>							<b>&lt;0.001</b>
≤10 percentile	706	14.80	286	30.49	420	10.82	
11–20 percentile	678	14.21	193	20.58	485	12.49	
21–40 percentile	1,022	21.42	184	19.62	838	21.58	
41–60 percentile	791	16.58	111	11.83	680	17.51	
61–80 percentile	994	20.83	112	11.94	882	22.71	
≥80 percentile	580	12.16	52	5.54	528	13.60	
<b>Mother's ethnicity</b>							<b>0.004</b>
Chinese	4,082	85.56	781	83.26	3,301	85.01	
Aboriginal	177	3.71	30	3.20	147	3.79	
Immigrant	430	9.01	101	10.77	329	8.47	
Unknow	82	1.72	26	2.77	56	1.46	
<b>Mother's education</b>							<b>0.002</b>
Junior high school graduate or below	723	15.15	152	16.20	571	14.71	
Senior/vocational high school graduate	1,998	41.88	375	39.98	1,623	41.80	
University graduate	1,614	33.83	297	31.66	1,317	33.92	
Unknow	436	9.14	114	12.15	322	8.40	
<b>Father's employment status</b>							<b>&lt;0.001</b>
Full-time	3,968	83.17	728	77.61	3,240	83.44	
Part-time	195	4.09	51	5.44	144	3.71	
Unemployment	546	11.44	141	15.03	405	10.43	
Unknow	62	1.30	18	1.92	44	1.15	
<b>Members in the household</b>							<b>&lt;0.001</b>
Parents	3,573	74.89	648	69.08	2,925	75.33	
Single parent	915	19.18	219	23.35	696	17.92	
Grandparents	148	3.10	29	3.09	119	3.06	
Collateral members	135	2.83	42	4.48	93	2.40	
	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>	<b>P-value</b>
Peer Support	13.19	2.17	12.67	2.19	13.32	2.15	<b>&lt;0.001</b>
Family Support	15.00	4.80	13.64	4.81	15.33	4.75	<b>&lt;0.001</b>

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . The bold values are referring to those with statistical significance.

Among all four types of bullying victimization, as the resilience level increased, the risk of depression significantly decreased when compared to the reference group (i.e., 41–60th percentile). Additionally, for all types of bullying

victimization, the highest resilience level (≥80 percentile) was associated with a reduced risk of depression compared to the reference group, although the association was not significant (Table 3).

## Odds Ratio of Depression Calculated by Restricted Cubic Spline Regression

The logistic model showed that lower resilience levels were significantly associated with a higher risk of depression when compared to the reference group. However, the results did not show higher resilience levels were significantly associated with a lower risk of depression using a linear logistic model. Since the relationship between resilience and depression may not always be linear, the RCS model was used to examine the association between these two variables. The RCS model demonstrated

that higher resilience levels are significantly associated with a lower risk of depression among victims of bullying. **Figure 1** shows the odds ratio of depression among participants who were bullied stratified by resilience score. The resilience score at the mode (scores between 36 and 37) was used as reference group to reflect most commonly occurring resilience level among participants. Overall, our results revealed an inverse, non-linear association between higher resilience scores and the risk of depression among bullied participants. Participants who experienced bullying and had a resilience level score of 38 or above had a significantly reduced risk of depression when compared to the reference group. In contrast, participants who experienced bullying and had a resilience level score of 35 or lower had a significantly increased risk of depression when compared to the reference group.

**TABLE 2 |** Odds ratio of depression stratified by different resilience levels among victims of bullying.

	Dependent variable: depression			
	Crude model		Adjusted model	
	OR	95% CI	OR	95% CI
Resilience levels				
≤10th percentile	4.17***	(3.25–5.36)	4.07***	(3.07–5.38)
11–20th percentile	2.44***	(1.88–3.16)	2.51***	(1.87–3.35)
21–40th percentile	1.35**	(1.04–1.74)	1.47***	(1.11–1.95)
41–60th percentile	Reference	N/A	Reference	N/A
61–80th percentile	0.78	(0.59–1.03)	0.95	(0.70–1.29)
≥80th percentile	0.60***	(0.43–0.85)	0.73	(0.50–1.07)

The crude model was a simple logistic regression. The adjusted model was adjusted for gender, age, peer support, family support, mother's ethnicity, mother's education, father's employment status, and household structure. Robust standard deviation was used. A trend test was also completed to examine if resilience score (from low to high) as a continuous variable, has a trend effect on depression and the effect was found to be significant ( $p$ -trend = <0.0001). \*\*\* $p$  < 0.001, \*\* $p$  < 0.01, \* $p$  < 0.05.

## Odds Ratio of Depression at Different Resilience Levels Stratified by Different Types of Victimization

In **Figure 2**, we further stratified the participants based on the type of bullying victimization, (i.e., physical, verbal, relational, and cyber victimization), to investigate whether the type of bullying victimization modifies the protective effect that resilience has against depression. Our results showed that for the lowest resilience level group (score 13–22), victims of verbal bullying had the highest risk of depression (OR = 5.91; CI: 4.38–7.99), followed by victims of relational bullying (OR = 5.40; CI: 3.87–7.55), victims of physical bullying (OR = 4.92; CI: 3.49–6.92), and victims of cyber bullying (OR = 4.72; CI: 3.21–6.93) compared to at the reference resilience level group for each type of bullying (score 36–37). Furthermore, for the highest resilience group (score 42–43), victims of cyber bullying had the lowest risk of depression (OR = 0.72; CI: 0.57–0.90), followed by victims of

**TABLE 3 |** Odds ratio of depression stratified by resilience level and type of bullying victimization among victims of bullying.

	Dependent variable: Depression			
	Model 1: Physical bullying victimization (n = 2,455)	Model 2: Verbal bullying victimization (n = 3,319)	Model 3: Relational bullying victimization (n = 2,654)	Model 4: Cyber bullying victimization (n = 1,777)
Resilience levels				
≤10th percentile	3.72*** (2.60–5.31)	4.17*** (3.06–5.68)	4.53*** (3.19–6.44)	4.04*** (2.69–6.07)
11–20th percentile	2.60*** (1.80–3.77)	2.35*** (1.70–3.25)	3.26*** (2.28–4.64)	2.68*** (1.75–4.10)
21–40th percentile	1.31 (0.91–1.88)	1.43*** (1.05–1.96)	1.56** (1.09–2.23)	1.50* (0.99–2.27)
41–60th percentile	Reference	Reference	Reference	Reference
61–80th percentile	1.02 (0.69–1.50)	0.86 (0.61–1.22)	1.07 (0.73–1.56)	1.03 (0.66–1.60)
≥80th percentile	0.84 (0.53–1.32)	0.80 (0.53–1.21)	0.84 (0.52–1.36)	0.76 (0.45–1.26)

Each model was adjusted for gender, age, peer support, family support, mother's ethnicity, mother's education, father's employment status, and household structure. Robust standard deviation was used. A trend test was also performed to examine if resilience score (from low to high) as a continuous variable, has a trend effect on depression. The trend effects in all four models were found to be significant ( $p$  = <0.0001). \*\*\* $p$  < 0.001, \*\* $p$  < 0.01, \* $p$  < 0.05.



relational bullying (OR = 0.74; CI: 0.60–0.91), victims of verbal bullying (OR = 0.77; CI: 0.64–0.93), and victims of physical bullying (OR = 0.82; CI: 0.67–1.00) compared to those from the reference resilience level group for each type of bullying (score 36–37).

## DISCUSSION

This study not only confirms the protective effect resilience has against depression among young adolescents who have experienced bullying; to the best of our knowledge, it is also one of very few studies to investigate whether different types of bullying victimization affect the strength of the protective effect that resilience has on depression. Our results showed that a lower resilience score was significantly associated with a higher risk of depression in both the logistic regression model as well as the RCS model. However, higher resilience scores were significantly associated with a reduced risk of depression only in the RCS model. Furthermore, the highest resilience level offers the greatest protection against depression for victims of cyber bullying compared to victims of other types of bullying victimization. In contrast, the lowest resilience level was associated with the highest risk of developing depression in victims of verbal bullying compared to victims of other types of bullying victimization.

Consistent with previous studies (43, 44), our main findings indicate that a lower resilience score is associated with an increased risk of depression, while a higher resilience score appears to be protective for victims of bullying against depression. When we first performed the logistic regression to analyze the association between resilience and depression among adolescents who have experienced bullying, our results showed low resilience levels were significantly associated with an increased risk of depression. High resilience levels, on the other hand, were associated with a decreased risk of depression although the association was not significant. When we further performed a restricted cubic spline (RCS) regression, we observed an inverse, non-linear association between resilience level and risk of depression among adolescents with bullying experience. This inverse, non-linear association was consistent with other studies' findings: adolescents who have experienced bullying, (both pure targets and target-perpetrators), usually have a higher risk of depression and suicidal thoughts (45, 46). However, resilience appears to reduce the risk of depression among adolescents who have experienced bullying (15). The consequences of bullying can be severe and long-lasting and include: lower self-esteem, academic failure, behavior problems, psychosis and feelings of hopelessness (47). Resilience often refers to the process of adapting well in the face of significant adversity or stress (16). In many empirical studies, resilience is found to be inversely correlated with indicators of mental illness such as depression, anxiety, and negative emotions, and positively associated with positive indicators of mental wellness, such as subjective wellbeing and positive emotions (23).

Unlike previous studies that examined bullying in general, our present study studied by type of bullying victimization and examined if different types of bully victimization were associated with different risks of depression. Our results indicated that victims of verbal bullying were at the highest risk of depression, followed by victims of relational bullying, victims of physical bullying, and victims of cyber bullying when the resilience level was below the reference group. This finding was consistent with another similar study examining bullying victimization and adolescent mental health, where they also found individuals reporting more frequent verbal bullying experienced higher levels of depression (48). According to our findings, resilience appears to provide varying levels of protection based on the type of bullying victimization. Among all four types of bullying victimization, our results showed higher resilience levels, (above reference group), were associated with greater protection against depression for victims of cyber bullying, followed by relational bullying, verbal bullying, and physical bullying. Despite a large number of studies focusing on the relationship between bullying and depression, very few have examined the associations between the type of bullying victimization, resilience, and depression. Additionally, many previous studies have focused primarily on general bullying, (all kinds of bullying experiences), rather than examining each type of bullying victimization separately. Future research is needed to explore why the modifying effect that resilience has on the association between bullying and depression is different based on the types of bullying victimization (i.e., physical/verbal/relational/cyber bullying).

Because our study provides further evidence of the inverse association between resilience level and depression, it is worthwhile to identify the variables that may enhance resilience. A study of young adult American college students, (aged between 18 and 24), concluded that resilient functioning can be improved by individual and environmental protective factors like emotional intelligence (EI), spirituality, and social support (43). EI is comprised of qualities such as understanding one's feelings, differentiating between emotions, and recognizing the influence that one's emotions may have on others. Such abilities can be trained and enhanced with many cognitive and behavioral therapeutic techniques (49). Several other studies also have shown that various forms of spirituality, are linked to enhanced resilience (50). In a review of research on adolescent spirituality and mental health, Wong et al. (51) found that most studies showed a positive relationship between spirituality and adolescent mental health. Another protective factor associated with resilience is social support. Social support is a key correlate of psychological resilience, and preclinical and clinical research finds that weak social support and isolation are associated with indicators of compromised physical and mental health (52). Social support often refers to support received from parents and peers. Young people who have a good, supportive relationship with their parents are able to build supportive relationships with friends, which in turn is associated with better psychological wellbeing (53). However, it has been argued that during adolescence, individuals start spending more unsupervised time with their peers and friends

and begin relying upon them more than parents for support (54). Maintaining positive peer relationships has been shown to be associated with a lower risk of being bullied and limit the severity of any bullying that does occur (55). In summary, social support plays an essential role in promoting positive outcomes for students who have experienced bullying during adolescence.

## Clinical and Policy Implications

The findings from our study have several important clinical and policy implications. First, our results suggest that during adolescence clinical interventions should focus on individuals who seem the most isolated, because low social support was associated with lower resilience and a higher risk of depression. Second, improving resilience level may help prevent mental health problems among students who have experienced bullying. This suggests that intervention programs to enhance resilience levels among adolescents could reduce the risk of depression among adolescents. Since resilience can be enhanced by social support, school administrators could develop educational materials for teachers and academic counselors about the signs of disengagement and what steps can be taken to connect students with support networks (43). In addition, schools could offer resilience training by introducing classes that focus on teaching students resilience skills such as: positive reinterpretation, humor, active coping, planning and handling problems, seeking help and social support (56). Next, because higher emotional intelligence (EI) is associated with higher resilience, schools could introduce learning lessons related to cognitive and behavioral change techniques that have been shown to increase EI among students (57). Finally, since some of the participants enrolled in our study are considered young adolescents (those who were 12–13 years old), they may not be aware of the signs of depression. Young adolescents may benefit from psychoeducational materials that include specific information regarding the signs and symptoms of depression that require medical attention, as well as strategies to improve resilient functioning.

## Limitations and Strengths

The main strengths of the study lie in its use of a representative sample of adolescents and the use of standardized and previously validated measures of depressive symptoms. Furthermore, to the best of our knowledge, our study is also the first study to investigate the interaction among different types of bullying victimization, the risk of depression, and levels of resilience. We found that high resilience is protective against depression, regardless of the type of bullying victimization, and this finding has significant clinical and policy implications.

A primary study limitation here is the lack of consistent conceptualization and unified methodology around the definition and utility of resilience measures (58). This has hindered comparisons of findings and conclusions from resilience in adolescence research. Therefore, our study could only use the mode of resilience level among our study participants as the reference group in order to estimate the effect of resilience against depression in different resilience

level groups, (i.e., resilience level below or above the reference group). Next, we used the cross-sectional data from the TAALS, resulting in a smaller sample size that may not accurately reflect the bullying situation and presence of depression among all adolescents in Taiwan. Additionally, the cross-sectional study design precludes the possibility of investigating potential variability in resilience over time and makes causal inference difficult. Resilience may be more or less protective against depression depending on what other factors are present (i.e., social support, self-esteem, emotional intelligence, etc.). Therefore, further intervention research is needed to clarify the causal relationships between bullying, resilience and depression. Finally, the use of self-reported data may introduce response bias, as some participants may not feel comfortable providing accurate responses to some sensitive items, such as the frequency of bullying experienced at school or the presence of depressive symptoms.

## CONCLUSION

Our study results demonstrate that victims of bullying are at higher risk for depression and that resilience plays an important protective modifying role in the association between bullying victimization and risk of depression. Among the types of bullying victimization examined in this study, higher resilience levels offer the greatest protection against depression for victims of cyber bullying. On the other hand, lower resilience levels are associated with the highest risk of depression for victims of verbal bullying. Therefore, strengthening resilience levels among adolescents is central to promoting long-term positive mental health outcomes. Likewise, efforts to counsel youth experiencing bullying victimization may improve if the type of victimization (i.e., verbal, physical, relational, or cyber) are taken into consideration.

## DATA AVAILABILITY STATEMENT

Data are available from the authors upon reasonable request and with permission of the Taiwan Health Promotion Administration. Requests to access the datasets should be directed to H-YC, hychiou@tmu.edu.tw.

## ETHICS STATEMENT

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

## AUTHOR CONTRIBUTIONS

L-YL, Y-NC, and H-YC: conceptualization. Y-NC, Y-HC, and L-YL: methodology. Y-NC, Y-HC, and H-YC: validation. Y-NC: formal analysis. L-YL and Y-NC: investigation, writing—original draft preparation, and writing—review and editing. C-YW and H-YC: data curation. Y-HC and H-YC: supervision.

All authors have read and agreed to the published version of the manuscript.

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# Latent Profile Analysis of Positive Solitude During the Recurrent Outbreak of COVID-19

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The current study aimed to identify latent profiles of positive solitude during the recurrent outbreak of COVID-19 among Chinese adults. A total of 902 adults from China completed the questionnaires. We found five different profiles of positive solitude: low positive solitude group, medium-low positive solitude group, quietness positive solitude group, medium-high positive solitude group, and high positive solitude group. Positive and negative affect were significantly different from the five profiles. In addition, gender had different effects on different positive solitude profiles. The results of the study provide a new perspective to understand the positive solitude of Chinese adults during the recurrent outbreak of COVID-19 by using the people-centered approach.

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## INTRODUCTION

Since 2020, the novel coronavirus disease COVID-19 has become a global epidemic. Due to the difficulties of epidemic prevention, COVID-19 has repeatedly broken out in countries around the world. In order to avoid the further spread of COVID-19, the Chinese government has taken many preventive measures, such as succeeding social isolation, limiting traffic and travel, controlling social distance, and studying or working online. And thus individuals' scope of activities narrowed and social activities decreased in this situation. Solitude became the norm for most Chinese people in the COVID-19 period. Some studies have shown that quarantine can affect individuals' physical and mental health (1–3), which varies from person to person (4). While in quarantine, some people may feel depression and anxiety, however, others can remain optimistic, and view it as a kind of positive experience (4). Therefore, solitude does not always bring people anxiety and fear. Even in isolation during the epidemic, some people can remain calm and have a positive experience of privacy, which is commonly referred to as positive solitude.

Positive solitude refers to individuals' ability to positively enjoy alone time without meaningful interaction with others (5). In the whole process of life, individuals have more or less needs for solitude to relieve social pressure, reflect on themselves and conduct emotional renewal (6–10). Compared to Western cultures, Eastern cultures are more concerned with solitude (11, 12), especially Chinese Confucianism and Taoism, which both advocate solitude. This is because in the traditional Chinese cultural concept, solitude is the best way to reflect one's ability and exercise one's psychological qualities as well. Therefore, in the context of Chinese culture, solitude is deemed to be a method of self-cultivation and has been widely implemented in educational practice. During the recurrent outbreaks of COVID-19, individuals face the risk of being quarantined at any time. Studies have shown that positive solitude reduces bad behavior and benefits mental health (10, 13).



Thus, positive solitude may have positive and constructive implications for individuals during COVID-19. Given the importance of positive solitude, it is necessary to investigate individuals' positive solitude during the recurrent outbreak of COVID-19.

## Positive Solitude, Solitude and Loneliness

The concept of solitude was first introduced in 1959 by the sociologist Goffman, and Goffman argued that when individuals are in solitude, they feel the joy of being liberated (14). However, scholars tend to associate solitude with loneliness in some early studies (15, 16). From an evolutionary psychological point of view, solitude is not conducive to the survival of the weak in the environment where the fittest survive. The way humans choose to live in groups and engage in various altruistic behaviors is to improve the fitness of the whole race and thus provide a better chance of passing on their genes (17, 18). Therefore, individuals should avoid solitude as much as possible to increase the possibility of survival (19). In addition, the negative aspect of solitude is mainly loneliness, which many psychologists have studied since loneliness may cause some emotional disorders and affect individuals' mental health (20). As a result, early scholars often focused on the negative aspects of solitude, while the positive aspects of solitude were often ignored.

Nonetheless, some researchers have proposed that solitude and loneliness are two different concepts (21, 22). The concept of "loneliness" first appeared in the field of psychiatry and referred to the impairment of interpersonal communication and emotional expression. From a medical point of view, loneliness is caused by abnormalities in social functioning and communication. In 1973, Weiss published an article on loneliness, which formally introduced the concept of loneliness into the field of psychology (23). Loneliness refers to a painful psychological experience that individuals experience when they feel that their expectations cannot be met in current social interaction (24). However, solitude does not always have to be painful, and it can also be seen as a positive state of being sought rather than avoided (8). Winnicott is the first to regard solitude as a basic positive development ability of individuals, and emphasized the importance of individuality and privacy (25). In Maslow's opinion, the need for solitude is a feature of self-actualizer, who are willing to and actively seeks opportunities to be alone (26). With the reinterpretation of solitude, researchers gradually break away from the prejudice against solitude and turn to the study of its possible positive effects.

Positive solitude was first proposed by Ost Mor in 2020 (27), and Palgi first clearly distinguished positive solitude as an independent solitary capacity from loneliness and solitude in a quantitative way (5). Positive solitude is individuals' purposeful and active choice accompanied by positive affect experience (28). It does not only help individuals to introspect, self-regulate and enhance creativity (27–29), but also plays an important and active role in the mental health of individuals. Moreover, positive solitude may also have great importance during the recurrent outbreak of COVID-19.

## Person-Centered Approach to Positive Solitude

There are qualitative differences among individuals in positive solitude, which can be divided into multiple categories. For example, a qualitative study conducted by Ost Mor et al. investigated 124 participants through interviews, and divided them into seven categories according to different characteristics of individuals' positive solitude (27). Although this study revealed the heterogeneity of positive solitude, the results of qualitative research were difficult to generalize and had limited representativeness (30). In addition, most studies on positive solitude are variable-centered (5, 31). This variable-centered approach mainly uses the total score of the variable or the score of each dimension of the variable. The basic assumption is that there is homogeneity among subtypes, ignoring qualitative differences between individuals. Latent profile analysis (LPA) is a person-centered approach to classify individuals based on response patterns on a set of items, which can ensure the maximum difference between potential categories and the minimum difference within subtypes (32, 33). Meanwhile, it can judge the proportion of different subtypes in the whole population according to the responses of subjects in each item, so as to capture the group inequality that cannot be observed in variable-centered studies (34). Therefore, this study intends to use the method of latent profile analysis to explore latent profiles of positive solitude among Chinese adults. And this was the first goal of the study.

The second goal of this study was to explore the effect of gender on positive solitude. In the previous variable-centered studies, there are some debates on the impact of gender on positive solitude. Some studies have found no difference between males and females in their preference for solitude (35–37), whereas other studies found a significant difference (38). Wong and Csikszentmihalyi assumed that girls, because of their higher affiliation motivation, might have a more negative response for solitude than boys, however, their results did not support the hypothesis (39). Different patterns of positive solitude in different individuals may lead to this mixed pattern. Therefore, this study will use LPA to more accurately explore the impact of gender on positive solitude patterns among Chinese adults during the recurrent outbreak of COVID-19. Maes et al. tested about 1,800 adolescents' attitudes toward solitude. They analyzed the results using a people-centered approach, which showed higher scores for females than males in affinity for solitude (40). Therefore, we hypothesized that females have a higher capacity for positive solitude than males.

Finally, our third goal was to examine the association between positive solitude and affect. From the perspective of valence, affect can be divided into positive affect and negative affect (41). Modern medical research results show that the change of affect can directly affect a variety of physiological activities in the human body (42). Positive affect can reduce personal stress feelings, thus improving individuals' health and quality of life (43). Negative affect will influence many aspects of individuals' life, bringing a series of severe consequences, for example, negative affect will affect physiological function, interfere with

the immune system, and also induce various psychosomatic and mental diseases (43, 44). Some research showed that positive solitude was accompanied by positive affect (5, 45). The research further found that groups with “positive solitude experience” were characterized by positive affect, and almost exhibited no negative affect (45). Palgi et al. (5) also found that positive solitude was positively correlated with positive affect. Therefore, this study will explore the relationship between latent categories of positive solitude and affect from a people-centered perspective. We hypothesized that, in general, adults with higher levels of positive solitude would have higher positive affect and lower negative affect.

## The Present Research

The first purpose of this study was to explore the latent classes of positive solitude by using latent profile analysis. The second objective was to examine the differences in gender between different latent types of positive solitude. A final objective was to investigate differences in positive and negative affect among different latent classes of positive solitude.

## METHODS

### Participants

A sample of 902 adults (367 males and 535 females) from China completed the questionnaires. Among them, 33.92% ( $n = 306$ ) were aged 18 to 24, 31.71% ( $n = 286$ ) were aged 25 to 30, 27.16% ( $n = 245$ ) were aged 31 to 40 and 7.21% ( $n = 65$ ) were aged 41 to 60. In addition, among the 902 participants, 7.21% ( $n = 65$ ) have high school degree or below, 22.51% ( $n = 203$ ) have associate degree, 65.30% ( $n = 589$ ) have bachelor degree, and 4.99% ( $n = 45$ ) have master degree or above.

### Procedure

Nine hundred and two participants from China completed the survey. Specifically, this research publishes recruitment information on the internet, and interested participants can participate in the research. Participants completed a survey anonymously to collect information on gender, age group, positive solitude, and positive or negative affect. The survey was hosted on questionnaire web (Shanghai Zhongyan International Science and Technology, Shanghai, China; <https://www.wenjuan.com/>). Before completing the questionnaire, all participants read and signed the informed consent form. In this study, all responses were anonymous. There was no compensation for participating in this study, and the participants participated entirely voluntarily. The study was approved by the ethics committee of the First Author's University.

## Measures

### Positive Solitude Scale

The nine-item and one-dimensional Positive Solitude Scale (PS) was used to measure the positive solitude ability (5). Individuals rated each item (e.g., “When I find time for myself, I succeed better at making future plans”) on a five-point scale ranging from 1 (*never*) to 5 (*always*). Higher total scores indicated higher positive solitude. This study used a forward and backward translation

technique to translate the Positive Solitude Scale into Chinese (46). First, five graduate students majoring in psychometrics translated the scale according to the Chinese cultural background and language expression habits respectively. Then, the Chinese version was back-translated into English by two bilingual individuals. Finally, a psychometrics expert compared the back-translate English version with the original questionnaire, and some Chinese expressions were altered without changing the items' meaning. In the present study, exploratory factor analysis revealed that the Chinese version of Positive Solitude Scale included one dimension, which explained the total variance of 44.94%. The confirmatory factor analysis showed that the inventory had good construct validity ( $\chi^2/df = 3.02$ , CFI = 0.96, TLI = 0.94, SRMR = 0.03, RMSEA = 0.07) (47, 48). The Cronbach's  $\alpha$  coefficient of the Chinese version of Positive Solitude Scale was 0.85. In addition, the Chinese version of the Positive Solitude Scale was significantly positively correlated with positive affect ( $r = 0.52$ ,  $p < 0.001$ ), and negatively correlated with negative affect ( $r = -0.11$ ,  $p < 0.01$ ). Therefore, the Chinese version of Positive Solitude Scale has good reliability and validity, and hence can be used as a tool to measure positive solitude of Chinese adults. The contents of the questionnaire for the nine items are shown in Table 1.

### Positive and Negative Affect Scale

The Chinese version (49) of Positive and Negative Affect Scale (PANAS) (50) was used to measure positive and negative affect. The scale consists of 20 items and includes two dimensions, of which 10 items are positive affect (e.g., “interested”) and 10 items are negative affect (e.g., “upset”). Each item was rated on a five-point scale (1 = *very slightly* to 5 = *not at all*), with higher scores of positive/negative affect subscale representing higher positive/negative affect. In the present study, Cronbach's  $\alpha$  were 0.91 and 0.94 for the positive affect subscale and negative affect subscale.

## Analytical Approach

Firstly, Mplus 7.0 is used to analyze the latent profile of college students' positive solitude. By referring to Nylund et al. (51), the two classes model was used as a reference point. We

**TABLE 1 |** Contents of the nine-item questionnaire.

No.	Item
1	When I find time for myself, I succeed better at making future plans.
2	I like carving out time to enjoy being by myself in a pleasant place/environment.
3	I enjoy carving out time for myself to look outside my house or gaze at the scenery.
4	When I find time for myself, I feel focused and enable to achieve my best results.
5	When I am by myself, I can achieve the high level of focus that I need.
6	When I am stressed, having time by myself helps me clear my mind.
7	Time for myself gives my life more meaning.
8	Time for myself enhances my creativity.
9	Finding time for myself contributes to my quality of life.

gradually increase the number of model classes for parameter estimation, and we compare these models to find the best model. Some indexes were employed to determine model fit (52–55), including Akaike Information Criterion (AIC) (56), Bayesian Information Criterion (BIC) (57), sample-size-adjusted BIC (aBIC) (58), Entropy (59), Lo-Mendell-Rubin likelihood ratio test (LMR-LRT) (60), and Bootstrap likelihood ratio test (BLRT) (53). The lower the AIC, BIC and aBIC are, the better the model data fit is (61). The entropy value is an important indicator for evaluating the classification accuracy, ranging from 0 to 1, and an entropy value  $>0.80$  indicates high separation among profiles (51). At the same time, significant LMR-LRT and BLRT tests indicate that the corresponding  $k$  class model is better than the  $k-1$  class model (51). Secondly, the classification results of latent profile were taken as dependent variables, and gender was taken as independent variables to establish a multinomial logistic regression model. Finally, SPSS 23.0 was used for variance analysis to explore the impact of latent classes of positive solitude on positive and negative affect.

## RESULTS

### Descriptive Results

The mean value, the standard deviation of each variable and the correlation matrix among variables are shown in Table 2. As the results showed, the association between gender and total score of positive solitude was not significant ( $r = 0.01$ ,  $p > 0.05$ ), but the difference was significant in subsequent latent profile analysis results. And positive solitude was significantly positively correlated with positive affect ( $r = 0.52$ ,  $p < 0.001$ ) and was negatively correlated with negative affect ( $r = -0.11$ ,  $p < 0.01$ ).

### LPA Results

The fit statistics of profile models are presented in Table 3. According to Entropy, the five-class model fits best. Moreover, the AIC, BIC and aBIC of the five-class model were the smallest, so the five-class model was selected as the final model.

Figure 1 depicts the score distribution of the latent class of positive solitude on all items. Class 1 consisted of 17.74% ( $n = 160$ ) of adults who showed low positive solitude (labeled as the low positive solitude group). Class 2 included 23.61% ( $n = 213$ ) of adults and was labeled as the medium-low positive solitude group because they showed medium-low levels of positive solitude. Class 3 consisted of 14.41% ( $n = 130$ ) of adults who scored highest on item 9, which fell into the quietness category in the original initial pool (labeled as the quietness positive solitude group). Class 4 included 25.94% ( $n = 234$ ) of adults who showed medium-low levels of positive solitude (labeled as the medium-low positive solitude group). Finally, Class 5 consisted of 18.29% ( $n = 165$ ) of adults who showed high positive solitude in all items (labeled as the high positive solitude group).

### Associations Between Gender and Positive Solitude Profiles

The results of the multinomial logistic regression model were shown in Table 4. Females were more likely to be positive solitude than males in Profile 2 (Medium-low;  $\beta = 0.559$ ,  $SE = 0.280$ ,  $p < 0.05$ ,  $OR = 1.749$ ) and Profile 4 (Medium-high;  $\beta = 0.479$ ,  $SE = 0.211$ ,  $p < 0.05$ ,  $OR = 1.614$ ) in reference to Profile 3 (Quietness).

### Differences Between Positive Solitude Profiles and Affect

The results are shown in Table 5. And the bar graph for ANOVA is shown in Figure 2. The mean level of positive affect was significantly different among the five groups [ $F_{(4,897)} = 60.147$ ,  $p < 0.001$ ]. Specifically, the high positive solitude group had

TABLE 2 | Descriptive statistics and correlation analysis of each variable.

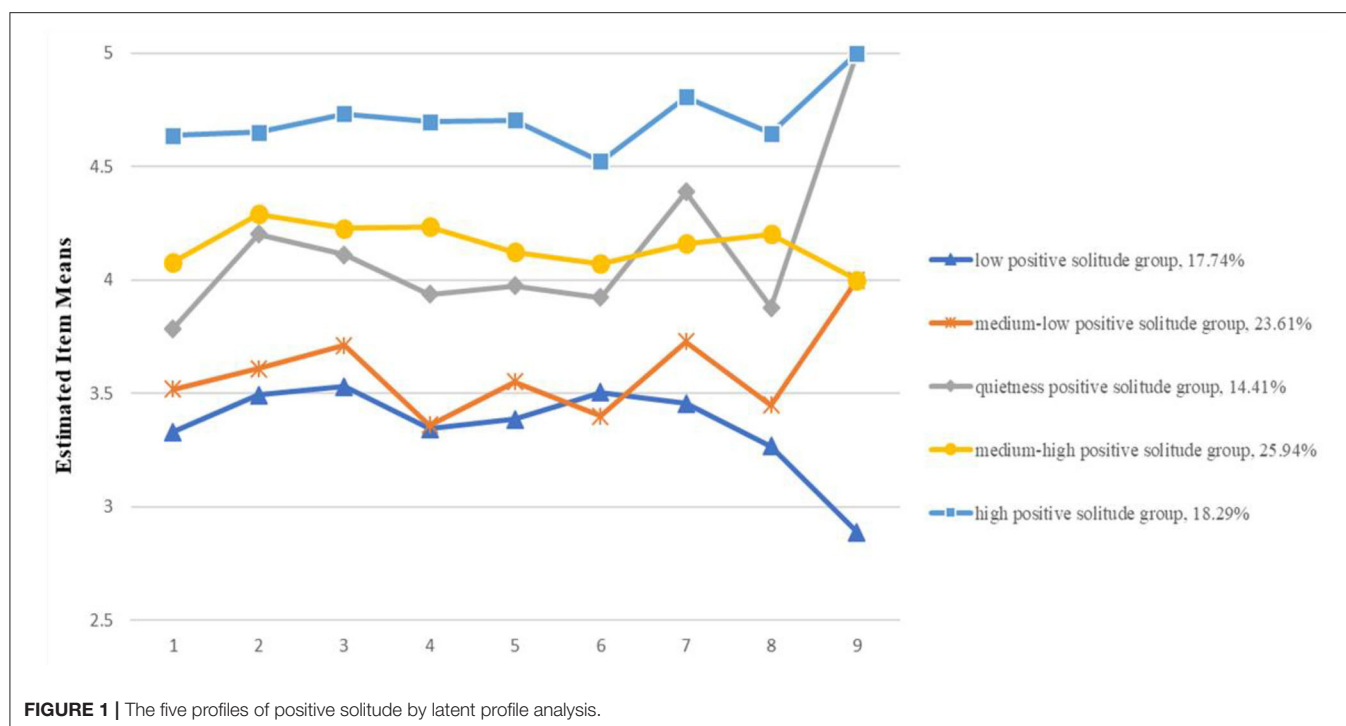
	<i>M</i>	<i>SD</i>	1	2	3	4
1. Gender <sup>a</sup>	–	–	1			
2. Positive solitude	3.98	0.54	0.01	1		
3. Positive affect	3.60	0.70	–0.11**	0.52***	1	
4. Negative affect	2.52	0.93	–0.002	–0.11**	–0.001	1

<sup>a</sup>Gender as a dummy variable, male = 0, female = 1;  $N = 902$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

TABLE 3 | The results of latent profile analysis of positive solitude.

Model	AIC	BIC	aBIC	Entropy	LMR ( $p$ )	BLRT ( $p$ )	Proportion of categories (%)
2	17,574.770	17,709.300	17,620.376	0.809	$<0.001$	$<0.001$	45.90/54.10
3	17,103.333	17,285.909	17,165.227	0.822	$<0.001$	$<0.001$	14.30/51.66/34.04
4	16,995.184	17,225.805	17,073.365	0.768	$<0.001$	$<0.001$	40.69/37.25/11.53/10.53
5	16,346.580	16,625.247	16,441.049	0.882	$<0.001$	$<0.001$	17.74/23.61/14.41/25.94/18.29
6	16,862.427	17,189.140	16,973.183	0.823	$<0.01$	$<0.001$	0.11/10.75/40.02/1.55/35.92/11.64

$N = 902$ .



higher positive affect than the other four groups ( $ps < 0.001$ ). The medium-high positive solitude group had higher positive affect than the low and the medium-low positive solitude group ( $ps < 0.001$ ). The quietness positive solitude group had higher positive affect than the low ( $p < 0.05$ ) and the medium-low positive solitude group ( $p < 0.001$ ). However, there was no significant difference between the low and the medium-low positive solitude groups, and also between the quietness and the medium-high positive solitude groups.

The mean level of negative affect was significantly different among the five groups [ $F_{(4,897)} = 5.347, p < 0.001$ ]. The low positive solitude group had higher negative affect than the quietness ( $p < 0.01$ ), medium-high ( $p < 0.05$ ) and high ( $p < 0.01$ ) positive solitude groups. However, the medium-low positive solitude group did not differ from the other four groups. The quietness positive solitude group did not differ from the medium-high and the high positive solitude groups. And the differences between the medium-high and the high positive solitude groups were not statistically significant.

## DISCUSSION

### Profiles of Positive Solitude in Chinese Adults

This study aimed to identify distinct profiles of positive solitude. Additionally, the current study used multinomial logistic regression to examine how these profiles related to gender. We also examined the differences in positive and negative affect across different latent profiles. Results showed five latent classes: low, medium-low, quietness, medium-high, and high positive solitude groups. Specifically, adults in the high positive

solitude group scored highest on all items, indicating that they had high positive solitude and were better able to adapt to self-isolation during the recurrent outbreak of COVID-19. In contrast, adults in the low positive solitude group displayed low scores across all items, indicating that adults in this group were at a relative disadvantage in positive solitude ability and were more likely to have difficulty in adapting to isolation during the recurrent outbreak of COVID-19. In addition, the quality of life of adults in the quietness positive solitude group improved through positive solitude. According to Ost Mor's definition of "quiet positive solitude," sometimes people need solitude to obtain a quiet environment or condition in order to calm down from their daily burdens. Everyone has a need for quiet, and solitude can help individuals obtain the conditions for quiet (27). Through solitude, individuals can escape from the society's hustle and bustle, let go of all defenses and pretensions, and truly enjoy their quiet time.

### Profiles' Association With Gender

Our findings found that gender was not significantly associated with the total score of positive solitude, but there were significant differences in gender across profiles. This is precisely the characteristic of the latent profile analysis: the overall association between gender and the total score of positive solitude is not significant because the traditional variable-centered approach ignores intra-individual differences, but when we explore the different profiles separately, we can find more detailed differential results. The results of the latent profile analysis partially support our hypothesis. In previous studies, the effects of gender on solitude were controversial, and however, as previously mentioned, the reason for such controversy was probably that



**TABLE 4 |** Results of multinomial logistic regression analysis on gender.

Reference profile		$\beta$	S.E.	Est./S.E.	P	OR
Profile 1: Low	Profile 2: Medium-low	0.279	0.744	0.374	0.708	1.322
	Profile 3: Quietness	−0.280	0.717	−0.390	0.696	0.756
	Profile 4: Medium-high	0.199	0.712	0.280	0.779	1.220
	Profile 5: High	0.121	0.734	0.165	0.869	1.129
Profile 2: Medium-low	Profile 1: Low	−0.279	0.744	−0.374	0.708	0.757
	Profile 3: Quietness	−0.559	0.280	−1.995	0.046	0.572
	Profile 4: Medium-high	−0.079	0.278	−0.284	0.776	0.924
	Profile 5: High	−0.157	0.331	−0.476	0.634	0.855
Profile 3: Quietness	Profile 1: Low	0.280	0.717	0.390	0.696	1.323
	Profile 2: Medium-low	0.559	0.280	1.995	0.046	1.749
	Profile 4: Medium-high	0.479	0.211	2.269	0.023	1.614
	Profile 5: High	0.401	0.257	1.562	0.118	1.493
Profile 4: Medium-high	Profile 1: Low	−0.199	0.712	−0.280	0.779	0.820
	Profile 2: Medium-low	0.079	0.278	0.284	0.776	1.082
	Profile 3: Quietness	−0.479	0.211	−2.269	0.023	0.619
	Profile 5: High	−0.078	0.295	−0.265	0.791	0.925

N = 902.

**TABLE 5 |** Differences in positive and negative affect across latent profiles ( $M \pm SD$ ).

	Low	Medium-low	Quietness	Medium-high	High	F	$\eta^2$	Post-hoc
Positive affect	3.22 ± 0.59	3.35 ± 0.55	3.55 ± 0.67	3.73 ± 0.62	4.17 ± 0.72	60.147***	0.211	5 > 3 > 1; 5 > 4 > 1; 3 > 2; 4 > 2; 5 > 2
Negative affect	2.75 ± 0.78	2.62 ± 0.85	2.37 ± 0.89	2.47 ± 0.93	2.37 ± 1.12	5.347***	0.023	1 > 3; 1 > 4; 1 > 5

N = 902, \*\*\*p &lt; 0.001.

those studies used the variable-centered approach. Although this variable-centered method was simple and effective, some critical individual differences were relatively ignored, which may lead to different conclusions. Multinomial logistic regression results for different models of positive solitude showed that compared with males, females were more likely to be positive solitude than males in Profile 2 (Medium-low) and Profile 4 (Medium-high) in reference to Profile 3 (Quietness). The results of this study suggested that during the recurrent outbreak of COVID-19, attention should be paid to the positive solitude of individuals and whether they also suffered from the difficulty of positive solitude during the isolation period, especially for males. The study found that the positive solitude of males was not as good as that of females, which suggested that a heavier emphasis needs to be placed on males' positive solitude.

## Association Between Profiles and Affect

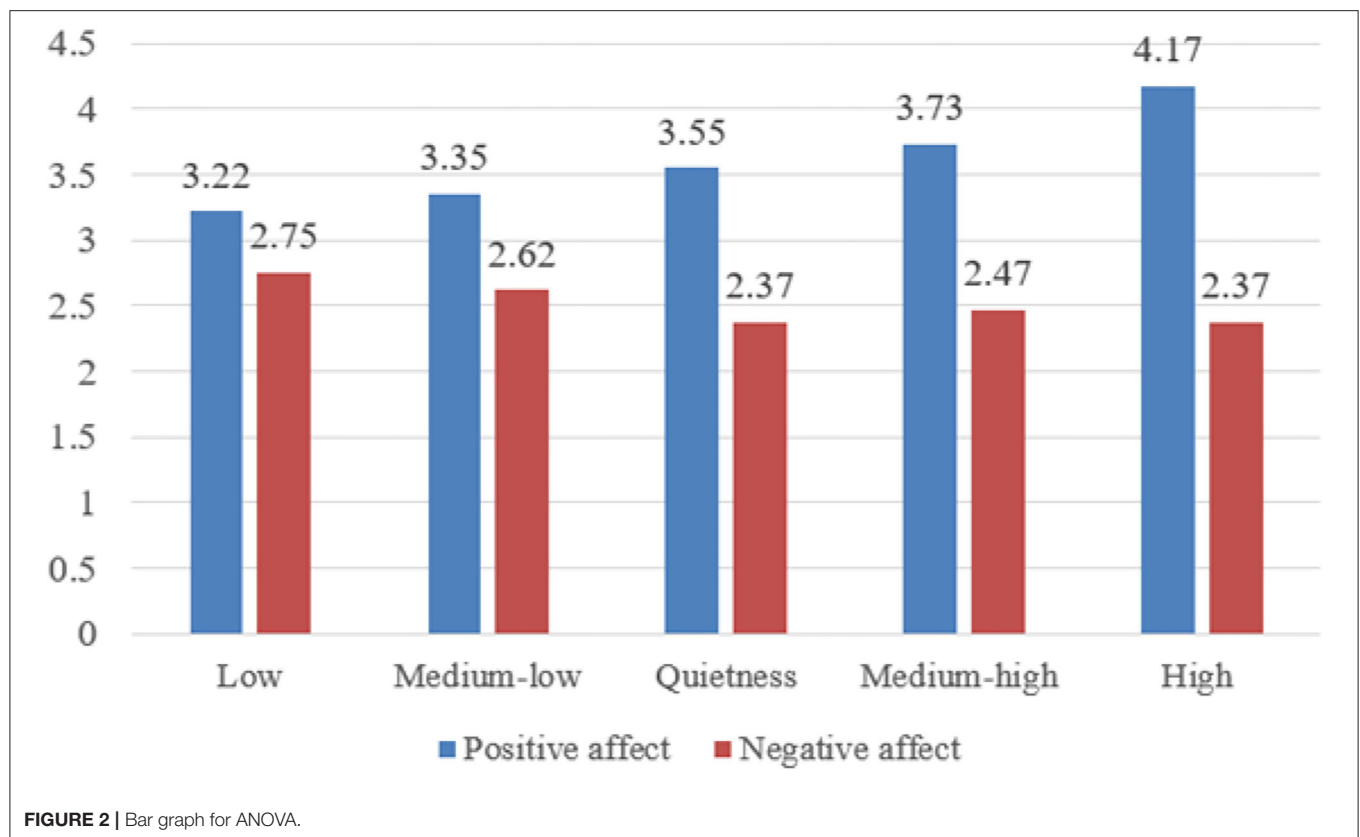
Our hypothesis about the association between profiles and positive and negative affect is basically supported. We found that the positive affect of the high positive solitude group was higher than the other four groups, and the low positive solitude

group had higher negative affect than the quietness, medium-high and high positive solitude groups. This suggested that positive solitude was accompanied by more positive affect and less negative affect. It demonstrated that positive solitude played a key role in mood regulation. Based on the results of positive and negative affect of Chinese adults during the recurrent outbreak of COVID-19, we can provide supportive care to individuals at risk of emotional distress. And in practical work, we should attach great importance to the positive solitude of individuals with high negative affect.

## Limitations and Future Directions

There are some limitations to the current survey which we need to note. First of all, our research hypothesis assumed that gender differences would have an impact on positive solitude, and the results showed that gender causes differences in positive solitude in different profiles. However, the analysis in this study is not sufficient for the differential impact of gender, and more research should be conducted to examine the gender difference in future studies. Secondly, all variables were assessed by self-report measurement in our study, which may affect the validity of this study. Since response bias and social desirability effects





may have influenced the results. In the future, measures with less social desirability effect can be taken into consideration. Thirdly, due to the large sample size, detailed information on the social background of the sample was not available for this study. In future studies, detailed background information of the subjects should be investigated. Finally, given the differences between individualistic and collectivistic cultures and the fact that COVID-19 is currently spreading in many countries worldwide, there may be a need for further investigation and validation of positive solitude affected by COVID-19 in some other diverse samples from different countries.

## CONCLUSION

This study found five latent profiles of positive solitude (low positive solitude group, medium-low positive solitude group, quietness positive solitude group, medium-high positive solitude group and high positive solitude group) among Chinese adults. The results of the multinomial logistic regression model showed that females were more likely to display positive solitude than males in Profile 2 and Profile 4 in reference to Profile 3 (Quietness). These profiles had a unique pattern of association with both positive and negative emotions. The high positive solitude group had higher positive affect than the other four groups; The low positive solitude group had higher negative affect than the quietness, medium-high and high positive solitude groups.

## DATA AVAILABILITY STATEMENT

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

## AUTHOR CONTRIBUTIONS

ZY, BY, and YH designed the study, analyzed the data, and conceptualized the models. ZY collected the data. QY supervised the project. All authors have seen and approved the manuscript and wrote and revised the manuscript.

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# Affective Responses to Both Climbing and Nordic Walking Exercise Are Associated With Intermediate-Term Increases in Physical Activity in Patients With Anxiety and Posttraumatic Stress Disorder - A Randomized Longitudinal Controlled Clinical Pilot Trial

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**Background:** Exercise programs have shown anxiolytic effects in psychiatric patients. Adherence to exercise programs and subsequent long-term lifestyle change is influenced by acute affective responses of the exercise programs. This research aimed to assess acute affective responses of two different exercise modalities compared to a non-exercise control program and its effects on persisting physical activity behavior change.

**Methods:** Sixty-six outpatients diagnosed with an anxiety disorder or posttraumatic stress disorder were randomly allocated to one of three groups in a randomized longitudinal controlled clinical pilot trial: climbing ( $n = 26$ ), nordic walking ( $n = 19$ ), social contact control ( $n = 21$ ). Affective responses were assessed pre, during, and post activity. General physical activity behavior was recorded prior to participation in the program, post program, and at follow-ups three and six months after the program.

**Results:** Multilevel modeling analyzes of 1,066 individual data points revealed increases in affective valence in the exercise sessions compared to the social contact sessions. State anxiety decreased in the climbing group compared to the social contact group. Physical activity behavior was increased immediately following the program as well as at six months follow-up in both exercise groups. A larger increase in affective valence during and after the sessions was associated with higher physical activity post program.

**Conclusions:** Climbing and conventional nordic walking exercise sessions revealed positive affective changes in outpatients indicating therapeutic potential of both modalities for acute emotion regulation. In accordance with theoretical models of human

behavior change, it was judged that the experience of a more pleasant affective state following the exercise sessions induced more persisting effects on physical activity behavior after the exercise programs.

**Trial Registration:** <https://www.clinicaltrials.gov/ct2/show/NCT03758599>, identifier: NCT03758599.

**Keywords:** affective valence, climbing therapy, exercise intervention, psychiatric disorder, anxiety, posttraumatic stress disorder

## INTRODUCTION

Physical activity is valued for its positive effects on physical and psychological health (1, 2). The World Health Organization (WHO) recommends a minimum amount of 150 minutes at least moderate intense physical activity per week (1). About 28% of the world population and 42% of the high-income Western countries do not meet these recommendations (3). A closer look at the people who are insufficiently physically active reveals particularly vulnerable groups: One of these groups are people who suffer from mental health problems, although it is well known that this population gains physical and psychological health benefits from physical activity (2). Given the reduced level of physical activity in people with mental disorders, interventions to increase physical activity behavior are urgently needed.

Studies on exercise programs in the treatment of psychiatric disorders focus predominantly on the effects on symptom severity: For individuals with anxiety disorders, anxiolytic effects can be achieved through exercise programs (4). Individuals with trauma-related disorders such as PTSD can benefit from exercise programs because attendant symptoms such as depression, anxiety, or low sleep quality were reduced (5–7). However, the effect of physical activity interventions in the treatment of depression is not uniformly clarified. In 2012, a major nationally funded RCT in the UK for example failed to find such desired effects (8). Nevertheless, the majority of exercise programs that have been studied in individuals with psychiatric conditions, specifically with anxiety disorders or PTSD, contain aerobic exercise, resistance training, or yoga (4, 5, 9, 10). While aerobic exercise could not be uniformly recommended as an effective treatment a few years ago (9), more recent analyses showed symptom reduction due to aerobic exercise (11). A systematic review and meta-analysis found both aerobic and resistance exercise as well as yoga to be beneficial (10). Some studies implemented alternative programs such as climbing exercise for depressive patients (12–15). A manualized bouldering psychotherapy program showed reduced depressive symptoms compared to a home-based exercise program (12). The practice of climbing exercise showed positive physical benefits (13), increased self-efficacy (14, 15), and decreased depressive and anxiety symptoms (12).

While the positive short-term and long-term effects of exercise on mental health are widely researched and discussed, one of the major challenges is to design interventions which induce persistent behavior change with longer lasting effects within

an evidence-based comprehensive framework (16). Affective responses to single bouts of exercise are associated with motivational processes connected to physical activity behavior (17, 18). Positive affective responses during exercise bouts can increase long-term participation and engagement in physical activity in persons without a mental health disorder (19). In persons with psychiatric disorders, some findings on positive affective responses after single physical activity bouts have been reported. Bouts of aerobic exercise such as walking showed increased positive valence after the activity in individuals with depression (20).

Recently, a controlled, randomized study comparing occupational therapy, swimming, and climbing was carried out in children and adolescents with mental and behavioral disorders: Results showed that climbing has a positive effect on immediate affective responses during the exercise bout compared to both swimming and occupational therapy (21). In a non-randomized controlled trial in depressive inpatients, a single session of rock climbing showed increased positive affect and coping emotions as well as decreased negative affect and depressiveness compared to relaxation (22). These potential differences in affective responses as well as specific exercise preferences should be considered when choosing an exercise modality for individuals with psychiatric disorder (23).

However, study designs in which different exercise program effects are compared are rare, although the importance of this comparison is increasingly recognized (12, 24, 25). To the best of our knowledge, no study is available that assessed immediate affective responses of different exercise programs in patients with anxiety disorders or PTSD. Also, longitudinal exercise studies in individuals with anxiety or PTSD are missing.

Therefore, the primary aim of the present project was to compare affective responses between different exercise programs based on multiple sessions of the programs. For this purpose, an already established program (nordic walking exercise) was compared to a relatively new exercise program (climbing exercise) in groups of individuals with anxiety disorder or PTSD. Exercise programs were controlled for effects of social contact by implementing a social contact control program with the same amount of social contact, but without exercise. The secondary aim was to compare the effects of the two exercise programs on future physical activity behavior and to analyze the role of affective valence during the sessions of the programs on future physical activity behavior.



## MATERIALS AND METHODS

### Study Design and Procedures

The overarching aim of the research project was to analyze the effects of two exercise programs (climbing and nordic walking) in comparison to a social contact control group on various health-related outcomes, including symptom severity, in patients with anxiety disorder or posttraumatic stress disorder. In the present study, we focus on the affective responses and their role in future physical activity behavior as one of the health-related outcomes. Participation in the groups was offered as an add-on to the regular clinical outpatient care program in a low-threshold, interdisciplinary network in the area of Innsbruck, Tyrol.

Participants were screened and enrolled by clinical professionals (e.g., Psychologists, Psychiatrists) in the Department of Psychiatry, Psychotherapy and Psychosomatics at the Medical University of Innsbruck. When assessed as eligible for the study, outpatients were invited to an informative meeting and randomly allocated to one of three groups by use of a computer-generated, blockwise cluster-randomization scheme with an allocation ratio of 1:1:1. Block sizes were a minimum of three and a maximum of eight. Whether participants had a diagnosis of AD vs. PTSD was not considered in randomization. This procedure was of an organizational nature, so that the participants were offered the earliest possible start of the study program to reduce drop out.

Participants received study information and timetables for their group attendances by administrative staff of the

Department. The program started within the following two weeks and the period ended after eight group sessions within four weeks. Follow-up measures were conducted immediately after, three, and six months after the program ended (**Figure 1**).

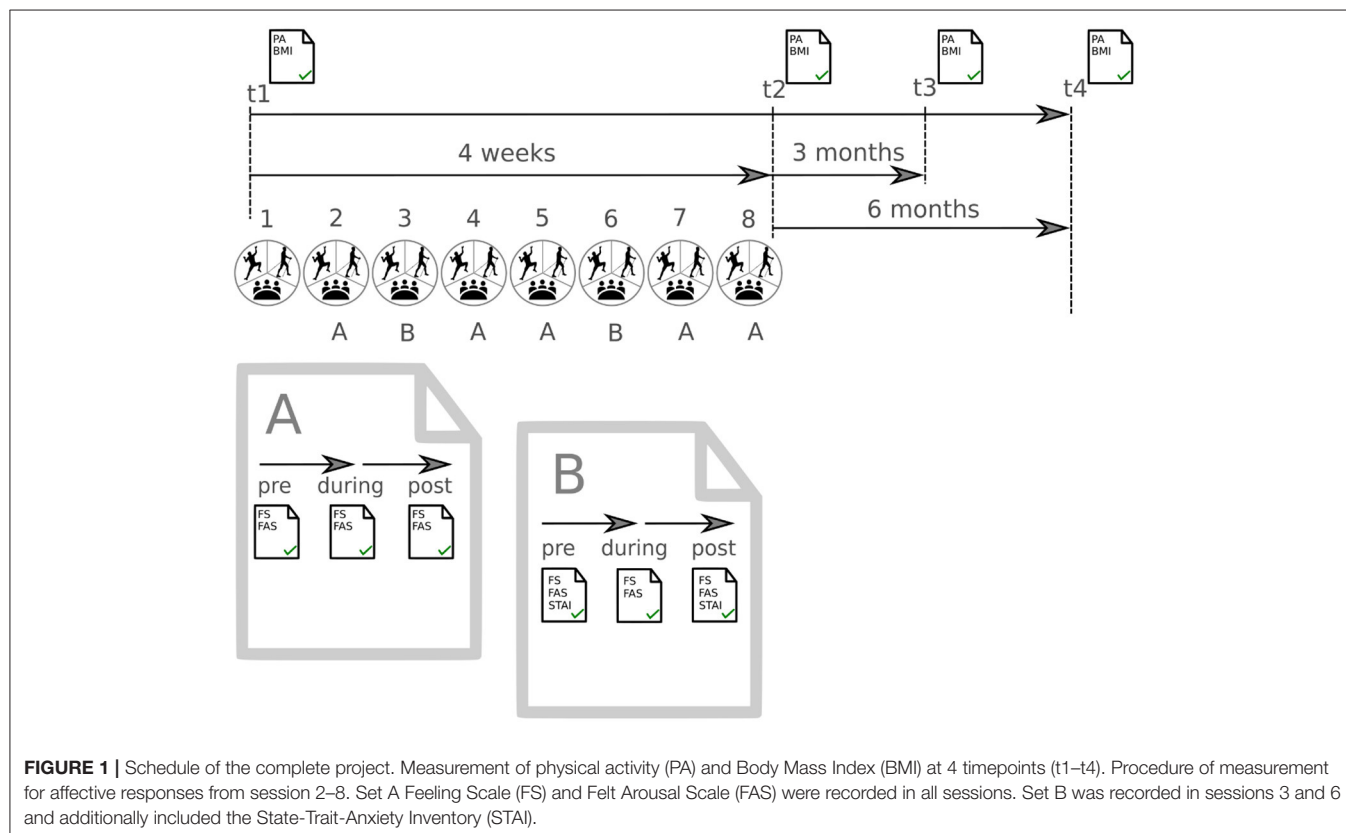
In the first session, focus was set on the practical implementation. Participants were introduced to the program to be able to familiarize with the situation. The intervention was performed and personal assistance was provided as required.

Starting with session two, affective responses (affective valence and perceived activation) were assessed with standardized questionnaires at three points in time at each session: pre (beginning of the session), during (after 45 minutes), and post (immediately after) session (**Figure 1**). In sessions three and six, state anxiety was additionally assessed with a standardized questionnaire, at both pre and post session. State anxiety was assessed only two times to reduce the questionnaire load for the participants. A description of the questionnaires is given in Outcomes. Sociodemographic (age, sex, psychiatric diagnosis) and health-related characteristics (e.g., self-reported physical activity, measured body mass index) were conducted pre program (t1), post program (t2), at follow-up 3 months post program (t3), and at follow-up 6 months post program (t4).

### Participants

The participants were recruited by local treatment staff.

Inclusion criteria were: (a) outpatients with a primary ICD-10 diagnosis of any anxiety disorder or posttraumatic stress



disorder (PTSD) (F 40, F 41, F 43.1; ICD-10; World Health Organization), (b) aged between 18 and 65 years, and (c) giving written informed consent.

Exclusion criteria were: (a) patients with acute psychosis or suicidal behavior, (b) medical contraindication to exercise (assessed by a clinician), (c) somatic comorbidity with contraindication to moderate physical activity (e.g., high risk of cardiac events) (judged by patients primary care physician), (d) cognitive deficits (unsuitable to complete the required questionnaires, diagnosed by the referring psychiatrist, psychologist or psychotherapist), and (e) problems with German language (diagnosed by the referring psychiatrist, psychologist or psychotherapist).

No a priori power analysis is available for the primary outcome affective responses. Since the present study is part of a research project to assess different health-related outcome variables, only one power analysis based on symptom severity was conducted for the research project, an outcome not considered in this study. However, the sample size of the present study is in the range of previously published studies, e.g., (12, 26, 27).

## Programs

All programs were led by two professionals, including clinical health psychologists, sport and exercise psychologists, sport scientists, training therapists, and physicians. All programs consisted of eight 90-minutes sessions spread over four weeks (two sessions per week). Both exercise programs were performed with comparable intensity. Participants in both exercise programs were instructed to perform the sessions with moderate intensity (being able to talk but not sing during the activity).

### Climbing Exercise Group (Climbing Group)

At the beginning of each session, a standardized body-centered warm-up of ten minutes identical with the nordic walking group took place. The group sessions were held in an outdoor climbing gym when weather and temperature conditions allowed. In bad weather conditions, the indoor climbing gym was used. The general warm-up was followed by a climbing specific warm-up, which consisted of bouldering (i.e., climbing horizontally without the use of a rope near the floor) for around 25 minutes. After warm-ups, the actual rope climbing sessions lasted around 45 minutes. During the first five sessions of rope climbing, only the therapist provided rope security. Safety and belaying of partners were trained throughout those sessions. Depending on participants' knowledge and skills, they were allowed to belay each other; however, always guided by a therapist. As in Gallotta et al. (13), climbing sessions contained several sport-specific skills-development training sessions to familiarize the participants with gear and rope management, to learn footwork and route finding, and to locate good belay spots and resting positions while climbing. Every climbing session ended with a short cool-down session of five minutes (i.e., stretching) identical to the nordic walking group.

### Nordic Walking Exercise Group (Nordic Walking Group)

The nordic walking group started with a ten-minute body-centered warm-up identical to the climbing group, followed by a five-minute nordic walking specific warm-up. Afterwards, the group walked with a moderate pace outdoors on varying paths for 70 minutes using the nordic walking technique. Specially designed poles were used in this technique to push against the ground with each stride, activating the upper body while walking. The session ended with a five-minute cool-down session identical to the climbing group.

### Social Contact Control Group (Social Contact Group)

Social interaction is discussed as one of the anxiolytic mechanisms of exercise programs in group settings (28). The social contact control group was included to be able to compare potential effects of exercise in an interactive group setting to effects of an interactive group setting without exercise. Participants allocated to the social contact group received brief background information and then watched a movie in the indoor group sessions. Movies included four animated and feature films on anxiety related topics. One full movie was presented within two sessions, followed by a guided group dialog. The group dialog lasted approximately 30 minutes, depending on movie length and focus on a communicative exchange regarding the movie and anxiety related topics, led by the therapist. However, the participants received the same amount of social interaction and support as the exercise groups.

## Outcomes

### Primary Outcomes

The dimension of affective valence was assessed by the Feeling Scale [FS; (29)]. This single-item rating scale ranges from “+5” (very good) to “−5” (very bad), with anchors at “0” (neutral) and at all odd integers. Convergent validity information for the FS has been provided (30–32). The FS has been used previously in exercise studies within a clinical population, e.g., (21, 25, 33–35).

The dimension of perceived activation was assessed by the Felt Arousal Scale [FAS; (36)]. This single-item rating scale ranges from “1” (low arousal) to “6” (high arousal). The FAS has been used in previous studies on physical activity, demonstrating convergent validity with other measures of perceived activation (32, 36).

The State-Trait-Anxiety Inventory [STAI; (37)] is a 20-item rating scale for each state anxiety (STAI-S), and trait anxiety (STAI-T), ranging from “1” (not at all/almost never) to “4” (very much so/almost always). In this project, only the STAI-S was used. State anxiety is defined as a mood characterized by tension, anxiety, nervousness, restlessness, and fear of future events and is accompanied by increased activity of the autonomic nervous system (38, 39). Unlike other measures of anxiety, the STAI operationalizes “anxiety” close to the body, so that the connectivity of arousal data is facilitated. The participants were asked to rate the extent of anxiety of the present moment (right now). The STAI has been previously used in exercise studies [e.g., (40)].

## Secondary Outcomes

Physical activity was assessed in a practitioner interview that took place four times during study participation. During a pilot phase prior to the present study, patients provided feedback and were observed to have difficulty completing the International Physical Activity Questionnaire [IPAQ; (41)]. Therefore, the procedure was adapted, and standardized interview questions were asked for the type of physical activity, and secondly for the number of hours of this activity in the previous seven days. Following the IPAQ, the interviewer assisted in the assessment of activity and distinguished between a) vigorous, b) moderate, and c) light intense physical activity such as walking. As an indicator of physical activity, the intensity hours were calculated by multiplying physical activity units of at least ten minutes with an intensity weight and adding all intensity hours per week. According to the guidelines of the IPAQ (41), the sum of the specified hours of the respective physical activity was formed as follows:

$$\text{"hours of light intense physical activity/walking"} \times 0.75 + \text{hours of "moderate intense physical activity"} + \text{hours of "vigorous intense physical activity"} \times 2.$$

## Statistical Analysis

The data on affective responses were collected across several sessions and were nested within patients. Since there is no data on comparing several program sessions available, the project included all compiled data. Ordinary methods of analyses of variances might produce biased inferential statistics since the inter-correlation of repeated observations in the same patients over time cannot be accounted for (42). Therefore, multilevel modeling was conducted for the primary research question using the GAMLj module (43) in jamovi v. 1.2 (44). Data of all patients attending at least two sessions of the allocated program were analyzed. The variables patient and session were modeled as cluster variables to account for the hierarchical data structure. The factors time (two or three levels), group (three levels), and the time-by-group interaction were included as fixed effects. The time-by-group interaction analysis was the primary analysis of interest. Pre-planned simple contrasts were conducted for the factor time using the time point "pre" as the reference category and for the factor group using "climbing group" as the reference category. Random effects were first defined for patient and session allowing the intercepts to vary across patients and sessions. Whenever the variation across patients and/or sessions was too small (indicated by the likelihood ratio test on random effects), the random effect was excluded. Three outcome variables for affect were analyzed: affective valence, perceived activation (each assessed three times in seven sessions), and state anxiety (each assessed two times in two sessions) (see **Figure 1**).

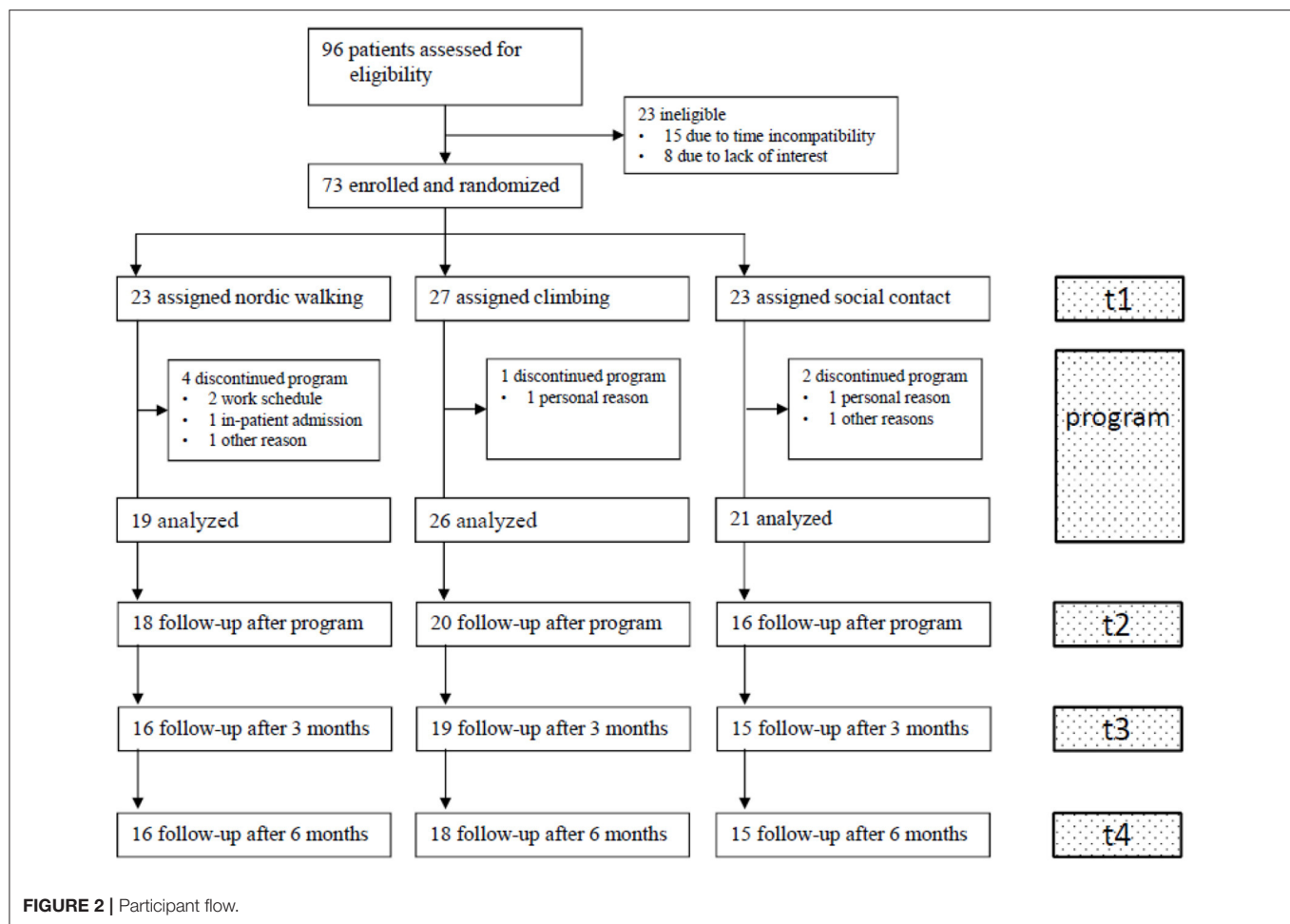
Cohens *d* (45) was calculated as an effect size for pairwise comparisons subtracting mean change over time of the nordic walking group/social contact group from mean change over time in the climbing group divided by the pooled standard deviation. Consequently, positive effect sizes indicate a larger increase in the climbing group compared to the other groups.

For the secondary research question, the differences in physical activity between groups were analyzed using SPSS version 26 (IBM, New York, USA) on a per protocol basis. In a series of analyses of covariance with physical activity at t1 (pre program) as a covariate, group differences in physical activity at t2 (post program), at t3 (follow-up three months post program), and at t4 (follow-up six months post program) were analyzed. Pre-planned simple contrasts with "climbing group" as the reference category were conducted. Following the analyses on group differences, generalized estimating equations (GEE) were calculated to assess the role of affective valence in future physical activity. A linear relationship was chosen in accordance to previous literature (19) and a working correlation matrix with exchangeable structures was used for all GEE models. Like multilevel modeling, GEE allows to account for the hierarchical data structure by using patient and session as cluster variables. In total, six separate GEE models were calculated to model the three outcome variables "physical activity" at t2, t3, and t4. The outcome variables were modeled by the factors physical activity at t1 to control for differences in physical activity at baseline and by affective valence according to the Feeling Scale. One GEE model each was calculated for affective valence during and post session to be able to compare regression coefficients of affective valence during session and post session. To control for daily fluctuations, the changes in affective valence (during—pre session and post—pre session) were used in the GEE models. Accordingly, higher changes in affective valence indicate more positive changes in affect. Other potential confounders (e.g., sex, age, or body mass index) were believed to be more appropriately reflected in physical activity at t1 and were therefore not included in the model. Quasi-information criterion (QIC) was given for the GEE model with a lower QIC value indicating better model fit (46).

*P*-values < 0.05 were considered as significant. Unless otherwise stated, data are presented as mean ± SD.

## RESULTS

Between Oct 16, 2017, and Dec 18, 2019, 96 patients followed the invitation for the information meeting and 23 declined to participate due to time incompatibility (*n* = 15) or lack of interest (*n* = 8). Seventy-three patients were randomized, and seven patients dropped out after the first session [one for the climbing group due to personal reasons; four for the nordic walking group due to time incompatibility (*n* = 2), inpatient admission (*n* = 1), unclear reason (*n* = 1); and two for the social contact control group due to personal reasons (*n* = 1) and unclear reason (*n* = 1)]. The total sample for the analysis of affective responses consisted of 66 patients (mean age 44.2 ± 13.2 years). Twenty-six patients participated in the climbing group, 19 in the nordic walking group, and 21 in the social contact group (**Figure 2**). Follow-up measurements were conducted between Nov 11, 2017, and Aug 11, 2020. **Table 1** shows sociodemographic and health-related characteristics in each of the three groups. No harmful event was observed in any of the patient groups.



## Affective Valence and Perceived Activation

For affective valence, 1,066 observations from 66 different patients were available (climbing group: 411, nordic walking group: 345, social contact group: 310). For perceived activation, 1,065 observations from 66 different patients were available (climbing group: 410, nordic walking group: 345, social contact group: 310). The intercepts for affective valence varied significantly across patients, variance = 2.4,  $p < 0.001$ , and across sessions, variance = 0.05,  $p = 0.004$ . The intercepts for perceived activation varied significantly across patients, variance = 0.7,  $p < 0.001$ , but not across sessions, variance < 0.01,  $p < 1.000$ .

A significant time-by-group interaction emerged for affective valence,  $F(4, 988.7) = 14.83$ ,  $p < 0.001$  (Figure 3). Simple contrasts showed a significantly larger pre vs. during increase in affective valence in the climbing group compared to the social contact group,  $p < 0.001$ ,  $d = 0.77$ , but no significantly different pre vs. during change compared to the nordic walking group,  $p = 0.292$ ,  $d = 0.13$ . A significantly larger pre-post increase in affective valence was found in the climbing group compared to both the social contact group,  $p < 0.001$ ,  $d = 0.52$ , and to the nordic walking group,  $p = 0.010$ ,  $d = 0.33$ . Significant main effects on affective valence were found for the factors time,  $F(2,988.7) = 81.30$ ,  $p < 0.001$ , and group,  $F(2,63.0) = 6.28$ ,  $p = 0.003$ .

Perceived activation showed a significant time-by-group interaction,  $F(4,994.0) = 2.53$ ,  $p < 0.001$  (Figure 3). No significantly different changes between groups were found for the pre-during comparison,  $p > 0.094$ ,  $d < 0.24$ . A significantly larger pre-post increase in perceived activation emerged for the climbing group compared to the social contact group,  $p = 0.002$ ,  $d = 0.46$ , but not compared to the nordic walking group,  $p = 0.230$ ,  $d = 0.34$ . Significant main effects on perceived activation were found for the factor time,  $F(2,994.0) = 18.64$ ,  $p < 0.001$ , but not for the factor group,  $F(2,63.3) = 0.49$ ,  $p = 0.617$ .

## State Anxiety

For state anxiety, 188 observations from 60 different participants were available (climbing group: 65, nordic walking group: 66, social contact group: 57). The intercepts for state anxiety varied significantly across participants, variance 108.6,  $p < 0.001$ , but not between sessions, variance < 0.01,  $p < 1.000$ .

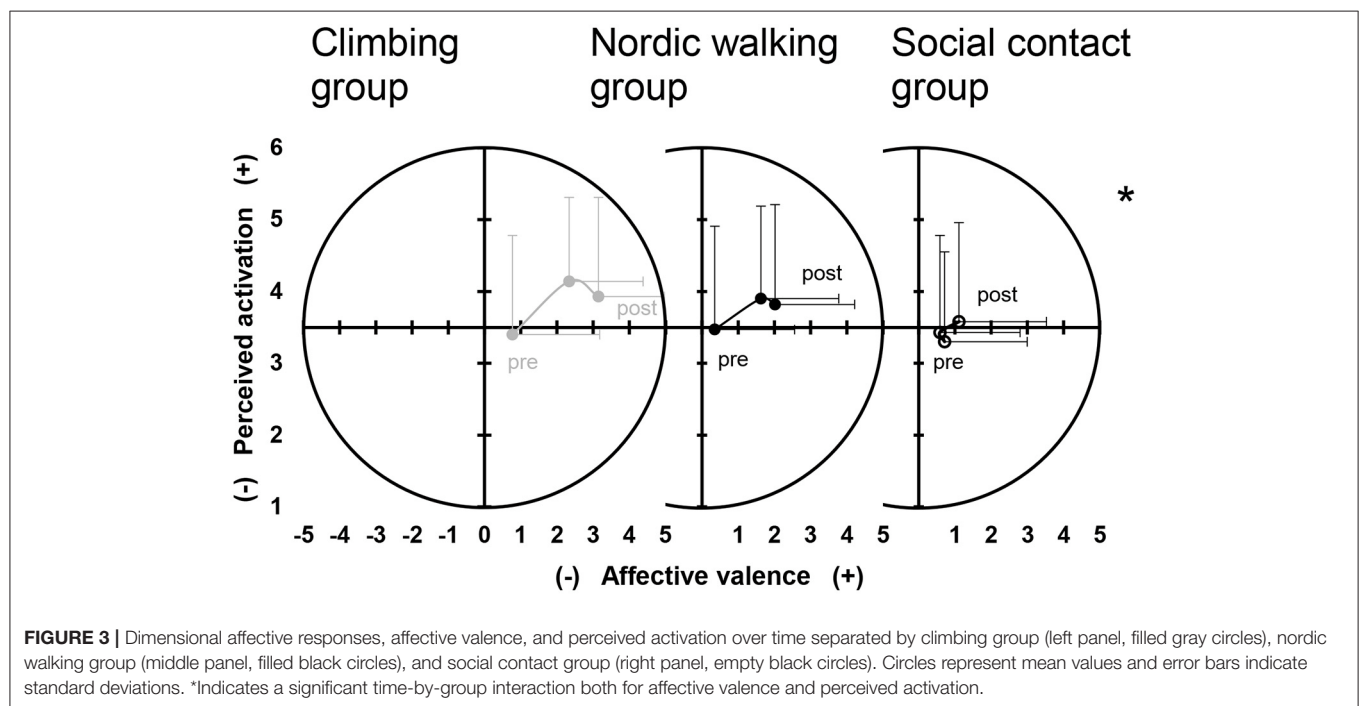
A significant time-by-group interaction emerged for state anxiety,  $F(2,125.6) = 4.14$ ,  $p < 0.018$  (Figure 4). Simple contrasts showed a significantly larger decrease in state anxiety in the climbing group compared to the social contact group,  $p = 0.010$ ,  $d = -0.55$ , but no significantly different change compared to the nordic walking group,  $p = 0.810$ ,  $d = -0.07$ . Significant main



**TABLE 1** | Sociodemographic and health-related characteristics of participants.

Variable	Climbing group	Nordic walking group	Social contact group
Number (%)	26 (39%)	19 (29%)	21 (32%)
Age in years: M ± SD	44.6 ± 13.7	44.7 ± 13.1	43.3 ± 13.3
Sex absolute numbers (%)	18 (69%) female; 8 (31%) male	16 (84%) female; 3 (16%) male	16 (76%) female; 5 (24%) male
<b>Diagnosis</b>			
Anxiety disorder absolute numbers (%)	20 (77%)	15 (79%)	12 (57%)
PTSD absolute numbers (%)	5 (19%)	3 (16%)	7 (33%)
Anxiety Disorder and PTSD absolute numbers (%)	1 (4%)	1 (5%)	2 (10%)
<b>Body mass index</b>			
t1: M ± SD	25.0 ± 4.4	26.2 ± 6.6	27.4 ± 4.1
t2: M ± SD	24.6 ± 4.6	26.4 ± 6.2	27.9 ± 4.2
t3: M ± SD	24.5 ± 4.6	26.0 ± 6.1	28.1 ± 4.6
t4: M ± SD	24.5 ± 4.2	25.9 ± 6.0	28.1 ± 4.9

M, mean; SD, standard deviation; PTSD, posttraumatic stress disorder; t1, pre program; t2, post program; t3, follow-up 3 months post program; t4, follow-up 6 months post program.



effects on state anxiety were found for the factor time,  $F_{(1,125.6)} = 44.10$ ,  $p < 0.001$ , but not for factor group,  $F_{(2,56.9)} = 2.17$ ,  $p = 0.123$ .

### Group Differences in Physical Activity

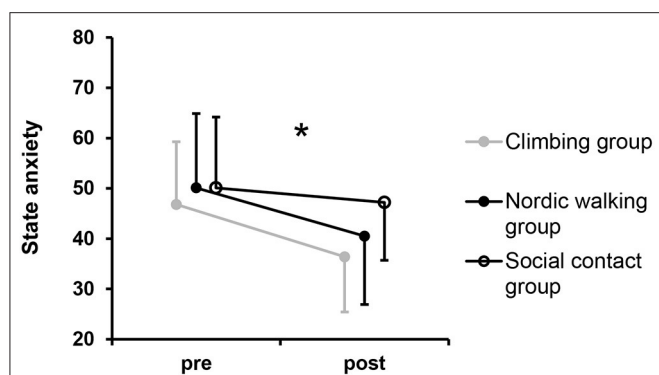
When adjusted by physical activity at t1, significant group differences in physical activity were found at t2,  $F_{(2,50)} = 18.98$ ,  $p < 0.001$ , and at t4,  $F_{(2,45)} = 3.89$ ,  $p = 0.028$  (Figure 5). Simple contrasts revealed a significantly higher physical activity of the climbing group compared to the social contact group, t2:  $p < 0.001$ ,  $d = 1.21$ , t4:  $p = 0.016$ ,  $d = 0.91$ , but not compared to the nordic walking group, t2:  $p = 0.404$ ,  $d = 0.32$ , t4:  $p = 0.920$ ,  $d = 0.10$ . No

significant difference was found at t3,  $F_{(2,46)} = 1.97$ ,  $p = 0.151$ ,  $d < 0.51$ .

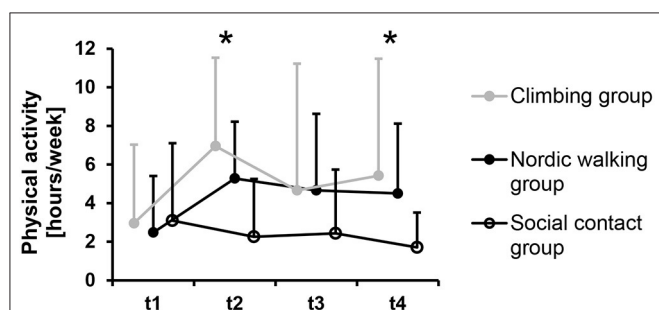
### Physical Activity and Affective Valence

Generalized estimating equations showed the best model for the prediction of physical activity post program at t2 (Table 2). Physical activity pre program showed significant associations with physical activity post program at all time points. Higher physical activity pre program was associated with higher physical activity post program. Changes in affective valence were positively associated with physical activity only post program at t2. A more positive affective state during,  $B = 0.41$ , and post sessions,  $B = 0.37$ , was associated with higher physical activity





**FIGURE 4 |** State anxiety over time separated by groups. Circles represent mean values and error bars indicate standard deviations. \*Indicates a significant time-by-group interaction.



**FIGURE 5 |** Physical activity pre program (t1), post program (t2,  $n = 54$ ), at follow-up 3 months post program (t3,  $n = 50$ ), and at follow-up 6 months post program (t4,  $n = 49$ ) separated by groups. Circles represent mean values and error bars indicate standard deviations. \*Indicates a significant group difference in the analysis adjusted by physical activity pre program.

at t2. No significant associations between changes in affect and physical activity were found for t3 and t4,  $p > 0.280$ . The models using the change in affective valence from pre-during session and pre-post session were widely similar.

## DISCUSSION

The main findings of the present study are

- (1) Both types of exercise sessions resulted in more pleasurable and higher activated affective states as well as a short-term anxiolytic effect in individuals with anxiety or posttraumatic stress disorder, compared to social contact sessions without exercise.
- (2) Higher positive affective states during and after the exercise sessions were associated with intermediate term increases in physical activity.
- (3) The modality of exercise appears to be secondary for affective states, although small-sized beneficial effects were found in affective valence for climbing sessions compared to nordic walking sessions.

- (4) The increase in physical activity persisted six months following completion of the clinical pilot trial.

## More Pleasant, Higher Activated State During and After Exercise Sessions

The finding of a more pleasant, higher activated state after exercise sessions is consistent with findings in existing literature on single exercise bouts in psychiatric patients, e.g., (20, 21, 25, 33). The positive changes in affective states (especially in pleasure) are desirable from a motivational perspective for future physical activity behavior (18). The present study extends existing findings of single bouts of exercise on combined information over several sessions. As suggested by Unick et al. (47), findings are more valid if several sessions are taken into account.

In the present study, a more pleasant, higher activated state during and after exercise was found in comparison to social contact sessions. Currently, the effect of social contact may be underestimated and only few studies control for these effects, e.g., (21, 25).

However, when the exercise sessions are not compared to a physically inactive control condition, but the two exercise modalities are compared, similar beneficial changes in affect were observed (21, 25). The largest differences between exercise modalities were that climbing exercise resulted in a larger pre-post increase in affective valence and perceived activation compared to the nordic walking group. Reasons for the more pleasant state after climbing sessions may result from psychological, social, and physiological parameters. The relatively new modality of climbing exercise in this setting brings up new challenges of focusing attention and requiring facing and overcoming feelings of anxiety. Focus on the present moment interrupts rumination and enables the building of trust in one's own abilities (self-efficacy) and trust in others (48). Furthermore, climbing is a type of skill-specific training that could involve activation of brain areas associated with executive control that could potentially have positive impact for patients with AD and PTSD (49). Studies in the field of climbing therapy or bouldering psychotherapy also point out these and further positive effects of climbing exercise that go beyond the conventional health benefits of exercise (12, 21). Compared to nordic walking, however, climbing is logistically more complex to conduct.

There is a further influence from indoor and outdoor effects. While in this study climbing was practiced indoors or outdoors, depending on the weather conditions, nordic walking took place outdoors all the time. The social contact group took place indoors under all weather conditions. In studies with depressive in-patients it could be shown that the same physical activity in the outdoors produced better results on the affective state (33, 50, 51). This green exercise effect should be taken into account in the interpretation (52).

When looking at perceived activation, this dimension increased pre-post programs in climbing exercise compared to nordic walking exercise and non-exercise control. From previous studies it is known that even a few minutes of exercise increase perceived activation (53). An increase in perceived activation is desirable for people with symptoms of mental health

**TABLE 2 |** Generalized estimating equations with the outcome physical activity post program (t2), at follow-up 3 months post program (t3), and at follow-up 6 months post program (t4) separately for pre-during and pre-post changes in affective valence.

	Variable	During—pre				Post—pre			
		<i>B</i>	<i>SE B</i>	<i>p</i>	<i>QIC</i>	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>QIC</i>
t2	Physical activity pre program	0.86	0.09	<0.001*		0.86	0.09	<0.001*	
	Change in affective valence	0.41	0.09	<0.001*	1,957	0.37	0.08	<0.001*	1,956
t3	Physical activity pre program	0.99	0.22	<0.001*		1.00	0.22	<0.001*	
	Change in affective valence	0.08	0.18	0.660	4,038	−0.01	0.17	0.960	4,046
t4	Physical activity pre program	0.73	0.25	0.003*		0.73	0.24	0.003*	
	Change in affective valence	0.20	0.18	0.281	4,267	0.19	0.18	0.279	4,260

*B*, unstandardized regression coefficient; *SE B*, standard error of *B*; *QIC*, Quasi-information criterion; \*Indicates significant coefficients.

disorders, e.g., depressive symptoms. However, for a population of individuals with anxiety or PTSD symptoms who often suffer from hyperarousal, an increase in activation is not always considered adjuvant (54). Considering the high affective valence, the slight increase in activation during climbing exercise can be interpreted as positive (53).

## The Potential of Exercise as a Short-Term Anxiolytic Intervention

State anxiety showed a larger decrease with moderate effect size in climbing exercise compared to non-exercise control, but not compared to nordic walking exercise. This finding points out the potential of exercise and confirms earlier research results (55).

It is remarkable that climbing showed a decrease in state anxiety although some components in climbing are associated with increased anxiety (e.g., height, trust in the climbing partner, and perception of an increased heart rate). These findings are in line with previous findings in depressive patients (12).

Interrupting social withdrawal and increasing social interaction is one of the mechanisms seen responsible for the anxiolytic effect of exercise (28). This study explicitly aimed to control for this effect by including a non-exercise control group.

## Physical Activity Behavior After the Programs Including the Role of Affective Valence

Given the low rate of physical activity and the health benefits connected with physical activity (2, 56), it is worth considering the longer-term effects of exercise programs on physical activity behavior.

Findings of the present study showed higher physical activity with a large effect size in the climbing group after the program ended and six months after the program ended in the follow-up, compared to the non-exercise control group. In the social contact control group, the weekly amount of physical activity decreased slightly over the seven-month observation period. We therefore conclude that exercise might trigger consciousness for physical activity in general; a desirable finding from a health behavior perspective (19, 56). Similar to affective responses, the exercise modality seems to be less relevant for longer-term

behavior changes toward augmenting physical activity. Previous findings showed positive exercise effects due to different exercise modalities such as resistance training (57) and aerobic exercise (58).

Exploring the role of affective valence in longer term physical activity behavior, the present study showed that a more positive affective state during and post sessions was associated with higher physical activity in the post program period. A change of one unit on the Feeling Scale used to measure affective valence was associated with an increase of 25/22 minutes per week for climbing/nordic walking. This result is similar to an augmentation of 38 minutes that has been reported in the study of Williams et al. (19). However, this was an intermediate term effect as it only applied for the post program period and no comparatively high levels of physical activity in the longer term could be observed for six or twelve months as reported by Williams et al. (19).

Regarding the timing of affective assessment, the present results do not suggest a stronger association of physical activity to affective valence during the exercise compared to affective valence post sessions. For the time points three and six months after program, however, no significant association of physical activity to affective valence was found. The regression coefficients of affective valence during and post exercise were similar suggesting that affective valence post sessions should not be neglected at least for the present population. This finding contradicts Rhodes and Kates (59) who concluded that positive affective responses during the engagement in physical activity is more important in predicting long term physical activity than positive affect after a physical activity session. Therefore, more studies should be conducted in the future that capture the affective responses of different types of exercise before, during, and after the bouts in specific at-risk populations.

## Strengths and Limitations

To the best of our knowledge, this is the first study comparing two exercise modalities and further control for social contact group effects in people with anxiety disorder or PTSD. Another strength of the project was to analyze several sessions instead of a single bout of exercise as well as the long-term follow-up.

However, in order to attract participants, it was necessary to make the program suitable for everyday use. This was accompanied by some limitations that have to be considered when interpreting the findings. Firstly, a program period of only eight sessions was limited in scope. Secondly, the project investigators had no control about who agreed or refused to participate in the program. Therefore, the randomization process was weakened because patients may have dropped out because their randomized group did not match their interest (e.g., choice of preferred exercise). Thirdly, the project included outpatients with a psychiatric diagnosis of PTSD or any anxiety disorder. Ideally, the results would be interpreted in a diagnosis-homogeneous manner. Due to the sample size, a differential diagnosis was not considered. Fourthly, the assessment of physical activity was methodologically relatively weak. Since reported and actual PA are known to differ, accelerometers would have ideally been used.

## CONCLUSION

The present findings provide new insights in immediate affective responses to exercise compared to non-exercise programs based on multiple sessions. The more pleasant and higher activated affective state during and after exercise sessions as well as the anxiolytic effect suggest a benefit of exercise beyond social effects of the exercise group settings. Both nordic walking and climbing are considered appropriate exercise modalities for acute emotion regulation in outpatients with anxiety disorder or PTSD. The equipment expenditure for climbing should be critically weighted against small affective advantages of climbing compared to nordic walking when selecting an appropriate exercise modality for patients with anxiety disorder or PTSD. While the affective responses during and following exercise were associated with intermediate term increases in physical activity, the increase in exercise at six months post intervention indicates longer-lasting behavioral changes induced by the exercise programs. The difficulty of achieving sustainable behavioral changes is one of the major challenges in medicine, and this study shows promising results in a hard to reach group with anxiety disorder or PTSD.

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## 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 Medical University of Innsbruck. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

CB and MK were responsible for the investigation, concept, and design of the study. MG, KH, and BS-U provided the acquisition of data. MN and CB were given visualizations and charge of the methodology. The project administration was given by MG, BS-U, KH, and CB while resources were provided by MK and BS-U. MN sub served data curation and formal analysis that was validated by CB and MK. MK and BS-U supervised the project. CB, MN, and MK wrote the first draft of the manuscript which was reviewed and edited by KH, MG, and BS-U. All authors contributed to manuscript revision, read, and approved the submitted version.

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# Perceived Family Function and Associated Predictors in Nurses: A Cross-Sectional Study

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**Background:** Nurses play a key role in the health care system. However, clinical nurses experience different kinds of stressors that might impact the nurses' quality of life or quality of care. Family is one of the main social support resources, and quality family function might improve the quality of care provided by nurses. However, evidence on family function in Chinese clinical nurses is quite limited.

**Objectives:** The current study was to evaluate the family function of the Chinese clinical nurses, and to explore associated predicting factors.

**Methods:** A multi-center cross-sectional anonymous online survey was carried out. Chinese Family Function Scale was used in the study. Spearman's rank correlation analysis, Mann-Whitney U test, or Kruskal-Wallis H test was performed in the univariate analysis. The pairwise comparison method was used to determine whether the difference was significant between pair groups. Categorical regression (optimal scaling regression) was the main method to analyze factors that had been confirmed to be statistically significant in the univariate analysis.

**Results:** Nineteen thousand four hundred and twenty-two nurses completed the online questionnaires. The median of the nurse's perceived family function score was three (Inter-quartile Range: IQR 2–5). The multivariate analysis showed that the highest education level ( $P < 0.001$ ), the hospital level ( $P < 0.001$ ), rotation shift status ( $P < 0.001$ ), working department ( $P < 0.001$ ), number of children ( $P < 0.001$ ), monthly income per family member ( $P < 0.001$ ) were significantly associated with family function. Moreover, the importance of the factors was the number of children (49.1%), monthly income per family member (20.7%), rotation shift status (12.4%), the highest education level (8.0%), the hospital level (7.6%), and working department (2.4%) in turn.

**Conclusions:** The family function was associated with multiple factors, which hints that managers, leaders, and government could make strategies to improve nurses' family function in order to lead nurses to make a balance between family and work. Policymakers, nursing managers, and employers should make strategies such as promoting children-care services, increasing nurses' income, educating and training enough nurses, and building a well-established system of career development to help clinical nurses improve their family function so that to improve the quality of care.

**Keywords:** determinant, family function, nurse, predictors, cross-sectional study

## INTRODUCTION

Family, as the basic social characteristic, provides material and spiritual support for family members. Therefore, family plays a core role in individual physical and mental health. Family function (FF), which was proposed by researchers in the 1970s (1), was originally studied in children. As the research goes on, different theories about FF have been developed. The definition differs depending on various theories. According to previous studies, FF was defined as “the ability of families to coordinate and adapt the changes throughout life, resolve the conflict, cooperate between members and success in disciplinary patterns, respect the boundaries between individuals and respect the rules and principles which help the family to protect the entire family system” (2). From this perspective, FF is a concept with multiple dimensions encompassing family roles, duties as well as functions (3). Particularly, FF involves the whole process of communicating, solving problems, labor dividing, managing conflict, and attaching emotions between family members (4).

In recent years, FF has received increased attention in both psychological and medical research areas. A growing number of studies have focused on FF in different subjects, for instance, male cancer patients (5), groups with or without diabetic women (3), patients with traumatic brain injury (6), children with asthma (7), adolescents (8), children with chronic conditions (9), first-episode psychosis (10), pediatric obsessive-compulsive and related disorders (11), school-aged children with Sickle Cell Disease (12), adolescents left behind by migrating parents (13), patients with stroke (13–15), elderly patients with hypertension (16), or patients with blood diseases (17). Based on demonstrable evidence of FF, quite a lot of those studies indicate that FF was largely associated with individuals' health conditions. For example, a meta-analysis carried out by Leeman et al. (9) demonstrated that good FF was deemed relevant with positive outcomes such as better quality of life, competence, adherence, and physical health. Another study revealed that adolescents with a higher level of FF got higher scores in perceived subjective well-being (8). In the study of Bennich et al. (18), there was a correlation between healthy FF and less burden of diabetes and better quality of life. Conversely, family dysfunction or adverse FF was linked with some psychological disorders or unfavorable health outcomes. For instance, Murphy and Flessner (11) conducted a literature review on FF in pediatric obsessive-compulsive and related disorders and found that poor FF might be a potential or maintaining factor in such a group. Some scholars applied structural equation modeling to demonstrate that mental disability was directly affected by FF in patients with schizophrenia (19).

In the healthcare system, nurses play a core role and encompass the main workforce in any healthcare organization. According to the statistics of the World Health Organization (WHO), there are 43.5 million health workers worldwide, while nurses are more than 20 million (20). Notably, more than 4 million registered nurses are in China (21). In other words, Chinese nurses count for nearly one-fifth of global nurses.

Nurses deliver diverse healthcare services in different settings as healthcare providers, protectors, communicators, coordinators, decision-makers, and teachers (22). In fact, nurses are usually the first responders to different health-related conditions to promote health and rehabilitation and prevent disease (22).

Nurses, as a special professional group, play a vital role in the health care system. However, the job of a nurse is perceived as one challenging and stressful profession with high and complicated physical and psychological demands (23). In fact, nurses experience a high level of stress due to various dimensions of stressors such as death and dying stressors, discrimination, excessive workload especially frequent rotation shift working, conflict with a physician, patient, and workmates, which might significantly impact the quality of life of nurses, even worse, that might lead to negative quality of care (23). Family is one of the most important social support resources (24) for nurses to cope with such stressors. Therefore, the level of FF is of great concern. Appropriate FF plays a vital role in ensuring and promoting nurses to deal with occupational stress, which may promote job efficiency and quality of care (25). On the contrary, dysfunction of the family may increase the stress for nurses so that nurses could hardly deal with conflict from family and work (25, 26).

Despite of advances in studies on FF, to the best of our knowledge, research on FF as well as its predictors in nurses has been quite limited to date. Only a few studies evaluating nurses' FF were based on surveys with small sample sizes or in specific settings. In the study of Sun et al. (26), researchers investigated 124 ICU nurses working at a military hospital in Beijing, China, and they found that 56.45% of the investigated nurses were in families with good function. However, nearly 40% of nurses lived in a family with moderate dysfunction, even 4% with severe dysfunction. Similarly, Deng et al. (27) assessed 184 registered nurses who worked at a surgical department. According to their survey, 67.4% of the participants had healthy FF, while 25.5% had mild family dysfunction and even 7.1% had severe family dysfunction. Besides, evidence about factors associated with nurses' FF is quite rare. To our best knowledge, a recent study (25) tested factors that might be related to FF, and the result indicated that there was a significant relationship between education background, work unit, and family income with FF among pregnant nurses with second children. However, Tai et al. (28) believed that marital status and shift work predicted the FF in registered nurses. Additionally, some authors thought personality trait was an important factor in predicting FF in nurses (29). However, it is difficult to generalize the conclusion to nurses' FF because of limited reports with a small sample size or one single-center study. In response to those limitations of previous empirical studies, there is a growing need to conduct a study with a large sample size to get a better understanding of the perceived FF in nurses, particularly in China, and to identify relative predictors.

The main purpose of the current study was to gain an insight into the FF among Chinese nurses. The following research questions would be answered: (1) What level of FF was among nurses in China? (2) Which of the observed factors was related to nurses' FF?

## MATERIALS AND METHODS

### Design, Setting and Participants

A multi-center cross-sectional survey was carried out from January 8<sup>th</sup>, 2020 to January 30<sup>th</sup>, 2020 in 42 hospitals from 26 cities, 16 provinces in China. The hospitals involved were located in the west, southwest, south, central, east, and north of China. In addition, these hospitals, which were representative of different levels of healthcare services, were including primary, secondary, and tertiary institutions. Registered nurses who were working as staff nurses in the selected hospital were included. Nursing students and retired nurses were excluded.

The investigation was completed online. Firstly, researchers imported the informed consent agreement and the questionnaires, Chinese Family Function Scale (CFFS) (30), on an online survey plat, Chinese Questionnaire Star (<https://www.wjx.cn/>), then freely created a QR code. Researchers released the QR code through the social media application WeChat. Participants could scan the QR to read and submit the informed consent agreement and questionnaires. Each participant was only allowed to submit once in order to avoid double submission.

### Variables and Measurements

Independent variables in the study were some sociodemographic characteristics including gender, age, basic education background, highest education background, hospital level, working years, rotation shift status, working department, marital status, number of children, living with parents, monthly income per family member.

In terms of the primary outcome, CFFS was used since our main purpose was to assess FF in the current study. CFFS was developed by Zhang and Yuan (30). The scale was composed of 18 items. Participants could choose “yes” or “no” to answer each item. In items of 1, 2, 3, 4, 6, 12, 13, 14 and 18, “yes” = 1, “no” = 0. However, in the other items, “yes” = 0, “no” = 1. Thus, the total score of the 18 items ranged from 0 to 18. The higher scores, the more severer family dysfunction. The Cronbach's  $\alpha$  was 0.873.

### Data Collection

Two researchers who didn't know the study design collected the data. Before the data collection, those two researchers received training courses about how to collect the data, check the data, input and code the data into IBM SPSS 25.0. After the training courses, they took part in an exam related to data collection. Only if they passed through the exam could they be involved in collecting data.

### Data Analysis

All data were imported into IBM SPSS 25.0. In terms of continuous data, tests for normality and homogeneity of variances must be performed first. Mean  $\pm$  standard deviation ( $M \pm SD$ ) was used to describe if the continuous data were normally distributed. However, median and IQR were used to describe the non-normally distributed continuous variables. Categorical variables were presented as frequency (N) and percentages. In order to test the potential factors associated with FF, a univariate analysis was conducted first. At this stage, we

used Spearman's rank correlation analysis to test the correlation between two continuous variables, and the Mann-Whitney U test or Kruskal-Wallis H test was performed to assess the difference of FF scores in different demographic pairs. If the results showed the statistical significance of FF score in demographic pairs, the pairwise comparison method was used to determine whether they were significantly different from each other. After that, categorical regression (optimal scaling regression) was the main method to analyze factors that had been confirmed to be statistically significant in the univariate analysis. In the current study,  $P$ -value was two-tailed and we inferred statistical significance if  $\alpha$  was  $< 0.05$ .

## RESULTS

### Demographic Characteristics of the Participants

Nineteen thousand five hundred and twenty-two nurses completed the questionnaires. However, 100 questionnaire answers were removed from the analysis because of the following reasons: (1) Responders' age was logically incorrect; (2) Participants' working years were more than their age. Therefore, the effective response rate was 99.49%.

As shown in **Table 1**, female nurses dominated the main responders (95.66%). Participants' age ranged from 18 to 62 years old and the median age was 29 years old (IQR:26–33). Most (55.11%) of the included nurses originally graduated from higher vocational school (HVS), while only 4,531 nurses (23.33%) originally graduated from college or university and got a bachelor's degree. However, 54.91% of the included nurses finally got a bachelor's degree after receiving continuous education. Ten thousand four hundred eighty-seven nurses were working at a secondary level of hospital and 8,619 nurses were at a tertiary hospital. In the current study, the working years of nurses ranged from 1 to 41 years and the median of the working years was 6. Nurses who worked rotation shifts were more than 55%. Besides, nurses on rotation shift working were younger, less working age, mainly never married, less educated than those without rotation shift. And more than 70% of the respondents worked at the Inpatient general department. 68.02% of the nurses were married and 28.71% were never married. Only 36.75% of the nurses reported without any child. Nearly 80% of the respondents reported a monthly income per family member of more than 2000 RMB (¥ 2000).

Nurses' perceived FF scores ranged from 0 to 18, and the median was 3 (IQR 2–5). As explained before, the less score on the FF scale, the higher level of FF. In the current study, 1,145 nurses got 0 scores. More than 55% (10,848) of nurses got  $< 4$  scores, and about 96.69% of nurses got FF scores  $< 11$ , while 838 (3.31%) nurses got a score greater than or equal to 11. Whereas, only 12 nurses (0.06%) reported 18 scores.

### Univariate Analysis

The outcome of univariate analysis of FF score and pairwise comparison in different demographic pairs was namely presented in **Tables 1, 2**. Results in the **Table 1** showed that age ( $R = 0.021$ ,  $P = 0.004$ ) and working years ( $R = 0.016$ ,  $P = 0.031$ ) might

**TABLE 1** | Demographic characteristic and outcome of univariate analysis ( $N = 19,422$ ).

	Frequency(%)	Mean rank	U/H	P
<b>Gender</b>				
Male	842(4.34)	9803.26	7744916.000	0.624
Female	18,580 (95.66)	9707.34		
<b>Age</b>	29.00 <sup>a</sup> (21–33) <sup>b</sup>		0.021 <sup>c</sup>	<b>0.004</b>
<b>Basic education level</b>				
Diploma of SVS	4,187 (21.56)	9736.62	0.793	0.673
Diploma of HVS	10,704 (55.11)	99728.77		
Bachelor Degree	4,531 (23.33)	9647.48		
<b>Highest education level</b>				
Diploma of SVS	495 (2.55)	9821.85	36.514	<0.001
Diploma of HVS	8,234 (42.40)	9432.17		
Bachelor Degree	10,664 (54.91)	9920.93		
Master Degree	27 (0.14)	10048.33		
PHD Degree	2 (0.01)	11151.75		
<b>Hospital level</b>				
Primary or community	316(1.63)	10277.43	69.415	<0.001
Secondary	10,487 (54.00)	9997.85		
Tertiary	8,619 (44.38)	9342.34		
<b>Working years</b>	6.00 <sup>a</sup> (3–11) <sup>b</sup>		0.016	<b>&lt;0.031</b>
<b>Rotation shift status</b>				
Yes	10,846 (55.84)	9987.72	43511762.5	<0.001
No	8,576 (44.16)	9362.17		
<b>Working department</b>				
Outpatient	2,277 (11.72)	9332.97	31.595	<0.001
Emergency	1,165 (6.00)	9789.49		
Inpatient general ward	13,599 (70.02)	9678.57		
ICU	2,381 (12.26)	10223.42		
<b>Marital status</b>				
Never married	5,577 (28.71)	9353.18	34.462	<0.001
Married	13,211 (68.02)	9869.66		
Widowed	47(0.24)	9680.77		
Divorced	587(3.02)	9558.76		
<b>Number of children</b>				
0	7,138 (36.75)	9198.45	126.504	<0.001
1	7,701 (39.65)	9804.82		
2	4,507 (23.21)	10339.44		
3	76 (0.39)	11202.85		
<b>Living with parents</b>				
Yes	9,852 (50.73)	9646.85	46504885.00	0.990
No	9,570 (49.27)	9778.06		
<b>Monthly income per family member</b>				
≤550	690(3.55)	10688.62	158.777	<0.001
551 1,200	2,185 (11.25)	10283.94		
1,201 2,000	3,005 (15.47)	10078.86		
2,001 3,000	5,025 (25.87)	9891.73		
3,001 6,000	6,142 (31.62)	9475.42		
>6,000	2,375 (12.23)	8665.37		

<sup>a</sup>Media; <sup>b</sup>IQR; <sup>c</sup>Spearman's Correlation Coefficient (R); SVS, Secondary Vocational School; HVS, Higher Vocational School. Bold values are statistically significant.



be related to FF scores. The results in **Table 1** didn't show the significance of the distribution of FF scores in nurses of different gender ( $P = 0.624$ ), basic education backgrounds ( $P = 0.673$ ), and in nurses who lived with their parents ( $P = 0.990$ ). However, data analysis highlighted that the highest education level, hospital level, rotation shift working, working department, marital status, number of children, monthly income per family member might be factors associated with the difference in FF score distribution in nurses ( $P < 0.05$ ) (seen in **Table 1**).

**Table 2** revealed the outcome of pairwise comparison if there was significance in the distribution of FF score among 3 groups of the demographic variables. There was a difference in the FF score in nurses with diplomas of HVS and with bachelor's degrees, and the difference was statistically significant (Adjusted  $P < 0.001$ ). However, we did not detect any significant differences in the FF score in nurses when conducting a pairwise comparison between other two different highest education levels (**Table 2**). In addition, the level of FF score was significantly different between nurses working in tertiary and secondary levels of the hospital (Adjusted  $P < 0.001$ ), tertiary and primary/community hospitals (Adjusted  $P = 0.010$ ). In terms of rotation shift working, we found that the mean rank of FF score in nurses working rotation shift was 9987.72, while it was 9362.17 in nurses who were not working rotation shift, and the difference was statistically significant ( $P < 0.001$ ). In addition, the FF score in nurses working rotation shifts was higher than those not working rotation shifts. Results in **Table 2** indicated that there was a significance in the level of FF score in nurses who worked in outpatient vs. inpatient general ward ( $P = 0.036$ ), outpatient vs. ICU ( $P < 0.001$ ), and inpatient general ward vs. ICU ( $P < 0.001$ ). Compared with nurses with children, nurses without children had less FF scores, and the difference of that was also detected in a pairwise comparison (**Table 2**). In the current study, we also found that FF scores varied in nurses with different monthly incomes per family member, the higher monthly income per family member, the less FF scores, especially when nurses' families got monthly income per family member of more than ¥ 3000, and the difference was significant (**Table 2**).

## Multivariate Analysis

The result of the multivariate analysis, presented in **Table 3**, showed that the highest education level, hospital level, rotation shift working, working department, number of children nurses had, and monthly income per family member were included in a regression model, and the model was significant ( $P < 0.001$ ). However, the regression model did not include age ( $P = 0.050$ ), working years ( $P = 0.898$ ), and marital status ( $P = 0.051$ ) although they were significantly associated with FF score when conducting univariate analysis. The outcome of importance was summarized in **Table 4**. Notably, the result pointed to the importance of the highest education level, hospital level, rotation shift working, working department, the number of children, and monthly income per family member in predicting nurses' perceived FF score in such a regression model. In particular, the number of children was the dominant factor in predicting the FF score (49.1%). Monthly income per family member was another important factor to predict the FF score (20.7%). The importance

**TABLE 2 |** The outcome of pairwise comparison in different demographic pairs.

	Test statistics	Adjusted <i>P</i>
<b>Highest education level</b>		
Diploma of HVS-Diploma of SVS	389.673	1.000
Diploma of HVS-Bachelor Degree	-488.759	<b>&lt;0.001</b>
Diploma of HVS-Master Degree	-616.161	1.000
Diploma of HVS-PHD Degree	-1719.577	1.000
Diploma of SVS-Bachelor Degree	-99.087	1.000
Diploma of SVS-Master Degree	-226.488	1.000
Diploma of SVS-PHD Degree	-1329.905	1.000
Undergraduate-Master Degree	-127.401	1.000
Undergraduate-PHD Degree	-1230.818	1.000
Postgraduate-PHD Degree	-1103.417	1.000
<b>Hospital level</b>		
Tertiary-secondary	655.509	<b>&lt;0.001</b>
Tertiary-primary or community	935.091	<b>0.010</b>
Secondary-primary or community	279.582	1.000
<b>Working department</b>		
Outpatient-inpatient general ward	-345.602	<b>0.036</b>
Outpatient-emergency	-456.528	0.134
Outpatient-ICU	-890.458	<b>&lt;0.001</b>
Inpatient general ward-emergency	110.926	1.000
Inpatient general ward-ICU	-544.856	<b>&lt;0.001</b>
Emergency-ICU	-433.93	0.172
<b>Marital status</b>		
Never married-divorced	-205.584	1.000
Never married-widowed	-327.589	1.000
Never married-married	-516.485	<b>&lt;0.001</b>
Divorced-widowed	122.005	1.000
Divorced-married	310.901	1.000
Widowed-married	188.896	1.000
<b>Number of children</b>		
0-1	-606.372	<b>&lt;0.001</b>
0-2	-1140.988	<b>&lt;0.001</b>
0-3	-2004.398	<b>0.01</b>
1-2	-534.616	<b>&lt;0.001</b>
1-3	-1398.025	0.173
2-3	-863.41	1.000
<b>Monthly income per family member</b>		
>6,000-3,001 6,000	810.047	<b>&lt;0.001</b>
>6,000-2,001 3,000	1226.361	<b>&lt;0.001</b>
>6,000-1,201 2,000	1413.488	<b>&lt;0.001</b>
>6,000-551 1,200	1618.571	<b>&lt;0.001</b>
>6,000-≤550	2023.252	<b>&lt;0.001</b>
3,001 6,000-2,001 3,000	416.314	<b>0.001</b>
3,001 6,000-1,201 2,000	603.442	<b>&lt;0.001</b>
3,001 6,000-551 1,200	808.524	<b>&lt;0.001</b>
3,001 6,000-≤550	1213.205	<b>&lt;0.001</b>
2,001 3,000-1,201 2,000	187.128	1.000
2,001 3,000-551 1,200	392.21	0.087
2,001 3,000-≤550	796.891	0.006
1,201 2,000-551 1,200	205.082	1.000
1,201 2,000-≤550	609.763	0.138
551 1,200-≤550	404.681	1.000

*Bold values are statistically significant.*



of other independent variables in predicting FF score, in turn, was rotation shift working status (12.4%), the highest education level (8%), the hospital level (7.6%), and working department (2.4%).

## DISCUSSION

The current study provided empirical evidence for FF in registered nurses. Our study examined the FF of nurses and identified some relative factors which might predict nurses' perceived FF scores. We recruited 19,522 registered nurses in this descriptive cross-sectional study. Nineteen thousand four hundred twenty-two nurses finally completed the online questionnaires. The results showed most of the nurses who participated in the study demonstrated appropriate FF. The result was in accordance with the study conducted by Guo (31).

The present study explored factors that might be predictors of nurses' perceived FF. The final results showed that the highest education level, hospital level, rotation shift status, working department, number of children, and monthly income per family member were associated with FF scores.

Interestingly, our study highlights the importance of the number of children. The result indicated that the number of children was the most important factor with an importance ratio of 49.1% in predicting nurses' FF. Compared to nurses without any children, the FF score was higher in nurses having children, which indicated less level of FF. In addition, our study showed that the more children nurse had, the less level of FF. On one hand, Chinese nurses experience a higher level of workload than nurses in developed countries. According to WHO's World Health Statistics 2020 (32), the density of nursing and midwifery personnel (per 10,000) was 26.6 in China, while that was 81.7 in the United Kingdom, 99.4 in Canada, 145.5 in the United States of America. On the other hand, nurses, especially female nurses, are still the main force of taking responsibility for caring for and educating children in their families in China (33). The reasons above make it sense that a higher level of work-family conflict was reported in subjects who had dependent care responsibilities for child/children because of inflexible commitments at home or less level of control over work when arranging childcare and caring for sick child/children (34). Compared to nurses having one child, nurses having more than one child would face a higher level of challenges in balancing work and family demands. As a result, they might involve in a lower level of satisfaction with work-family responsibilities and less level of FF (35). The Chinese government issued a universal two-child policy in 2015 (36), while issued the third-child policy in 2021 to encourage births (37). However, the supporting measures, especially for supporting daycare of children before attending kindergarten for income households still need to be improved. In other countries like Japan, the government releases childcare services covering 0–5 years old children (38) to reduce work-family conflicts for residents. Thus, the current study suggests government, Policymakers, and hospitals should take measures to promote children-care services for nurses.

One of our key findings was a significant relationship between monthly income and nurses' perceived FF. There are some

ongoing debates on the relationship between monthly income and FF. Some scholars believed that monthly income was one of the influence factors of FF (1, 39). One possible reason might be that work interference with the family occurs less in families with greater monthly income (35). However, some authors argued that monthly income was not associated with work-family conflict (40). Our study offered an insight into the relationship between monthly income and FF in nurses. In the current study, we analyzed whether monthly family income, especially monthly income per family member, would be a predictor of nurses' perceived FF. Similarly, our results showed that monthly income per family member, with an importance ratio of 20.7%, was one of the most important factors predicting nurses' FF. The result is consistent with Dai and Wang's study (1, 39). Additionally, the results also indicated that nurses with a higher level of monthly income per family member showed a higher level of perceived FF. According to national statistical data, the annual mean wage of Chinese health care workers was 115,449 Yuan (< \$20,000) in 2020 (41), which was much less than that of American registered nurses whose annual wage ranged from \$59,450 to \$120,250 (42). However, the nurse density per 10,000 population in China was 31.4 (43), while that in America was 83.4 (44). In other words, Chinese nurses' income was much more disproportionate to the intensity of their workload than that of developed countries. Therefore, we suggest that measures should be taken by policymakers and employers to increase nurses' income in order to improve their FF.

In the present study, 55.84% of participants were working rotation shifts. According to the results of our study, shift working was found as an important factor associated with nurses' perceived FF score. Compared to dayshift nurses, rotation shift or evening shift nurses got higher FF scores in the study, which implied less level of FF. Our findings corroborated with the result of Tai et al. (28). They did a survey in 1,438 registered nurses and found that the FF was poor in nurses who were on rotation shift than those on dayshift (OR = 1.38, 95%CI: 1.01–1.88). Several studies have been done to explore whether there is a relationship between shift working and work-family conflict in nurses (35, 45–47). There is an ongoing debate in shift working and the work-family conflict. Some authors (47) highlighted that, for night shift nurses, the effect of the night shift on the conflict between work and childcare was not significant. Some other authors argued that irregular work schedule was one of the main contributors to work-family conflict. To our knowledge, nurses provide health services for clients, and such a job is perceived as a high-demand job. In other words, nursing is a job with overtime, intensity, irregular work schedule, inflexible work (46). In particular, nurses have to work shifts in order to ensure continuous health care for patients (48). Additionally, nurses usually experience irregular sleeping times. Besides, nurses rarely take a normal break on holidays. Thus, nurses spend less time being together with family or communicating with their relatives, which may increase the risk of disruption to social and family interactive life (28), which may lead to a less level of FF. On one hand, as described above, the nurse density per 10,000 population in China was 31.4 (43), which demonstrated that there was a large shortage in the nursing workforce in China. On the other hand, there was a high rate

**TABLE 3 |** The outcome of coefficients table.

	SC			F	P
	Beta	SE of Beta	df		
Age	−0.039	0.020	1	3.829	0.050
Highest education level	0.052	0.007	3	52.291	<b>&lt;0.001</b>
Hospital level	−0.046	0.007	2	39.331	<b>&lt;0.001</b>
Working years	−0.003	0.020	1	0.017	0.898
Rotation shift status	−0.071	0.008	1	72.691	<b>&lt;0.001</b>
Working department	0.026	0.007	3	14.368	<b>&lt;0.001</b>
Marital status	−0.012	0.008	3	2.590	0.051
Number of children	0.155	0.012	3	170.248	<b>&lt;0.001</b>
Monthly income per family member	−0.081	0.008	5	108.718	<b>&lt;0.001</b>

Dependent variable: FF score; SC, Standardized Coefficients; SE, Standardized error; df, Degree of Freedom. Bold values are statistically significant.

**TABLE 4 |** The outcome of Correlation and Tolerance.

	Correlation			Importance	Tolerance	
	Zero-order	Part	PC		BT	AT
Age	−0.013	−0.012	−0.012	0.017	0.096	0.097
Highest education level	0.047	0.050	0.050	<b>0.080</b>	0.912	0.915
Hospital level	−0.049	−0.046	−0.045	<b>0.076</b>	0.946	0.942
Working years	−0.022	−0.001	−0.001	0.002	0.101	0.101
Rotation shift status	−0.052	−0.065	−0.064	<b>0.124</b>	0.800	0.750
Working department	0.027	0.027	0.026	<b>0.024</b>	0.993	0.900
Marital status	0.053	−0.009	−0.009	−0.021	0.536	0.629
Number of children	0.095	0.104	0.103	<b>0.491</b>	0.438	0.617
Monthly income per family member	−0.077	−0.076	−0.075	<b>0.207</b>	0.864	0.863

Dependent variable: FF score; PC, Partial correlation; BT, Before transformation; AT, After transformation. Bold values are statistically significant.

of nurse turnover (49). As a result, nurses in the clinical settings had to work with more night shift rotations. Therefore, strategies should be implemented to solve the deficit of nursing staff, and to educate and train enough nurses to meet the demands of healthcare system (50), as well as to improve nurses' FF.

The association between education level and FF is also demonstrated in this study. Interestingly, we did not find any relationship between basic education level and FF. Whereas, there was a significant relationship between the highest education level. Comparatively, nurses with a Master's degree or PH.D. got higher FF scores. In other words, nurses with higher education backgrounds might experience poor FF. In China, nurses' basic education was classified into three levels: secondary vocational school, higher vocational school, and bachelor's degree. Nurses could gain higher education levels through continued education. With greater nursing education levels, nurses might face more frequent family interference with work (35). Yu revealed that, in clinical settings, nurses with a higher education level worked in many different roles. They had to complete the clinical work as a caregiver, communicator, educator et al. they may also be under high pressure with scientific research. Hence, they could not make a good balance between work and family, on one hand, resulting in poor feelings in their family roles (25). On

the other hand, that made it difficult to satisfy family-related responsibilities (35). We supposed that such a problem was due to a big gap in career development for clinical nurses, especially for clinical research nurses in China. In China, nurses with master's degrees or higher education always are assigned research masks. However, the development of clinical research nurses was in the initial stage so there was a lack of relative rules or regulations to define or clarify the job of clinical research nurses (51). Therefore, our result suggested that Policymakers and nursing managers should design clear plans and specific strategies to build a well-established system in order to reach nurses' best potential and improve their FF.

Based on the results of the study, the hospital level might also play an important role in influencing nurses' FF. In China, China's Ministry of Health classified the hospital level into Primary (level 1), Secondary (level 2), and Tertiary (level 3) hospitals based on the beds number of a hospital (52). Yu's study also addressed the relationship between the hospital level and FF. They found that nurses working in the Tertiary hospital faced a higher level of family-work conflict because of higher job-related pressure, leading to inappropriate FF (25). However, our study indicated that the FF of nurses working in higher-level hospitals was better. We supposed that, in China, the average income of

nurses working in higher-level hospitals was much better than those in lower-level hospitals. As the above data showed that there was a significant association between monthly income and FF. Hence, the FF of nurses working in the Tertiary hospital was better than others in Secondary and Primary hospitals in our study.

The relationship between the working department and FF was also tested in this study. The result verified the significant association between these two variables. Specifically, it is notable that nurses working in the ICU got the highest FF score, followed by those working in the Emergency, inpatient general ward, and outpatient departments in turn. Specifically, previous research documented that ICU was a place where the nursing staff was stressful and challenging because of staff shortage, the complex nature of patients' conditions, frequent rescue, overload working, high expectations from administrators, sophisticated technology systems, ethical dilemmas in dealing with death, as well as inadequate income (53). Nurses in the ICU environment may feel a higher level of stress and work-family conflict than nurses working in other units. Therefore, they may experience a higher level of family dysfunction. Comparatively, outpatient nurses gained a higher level of FF, which might be explained by that they don't need to work rotation shifts. Additionally, patients in the outpatient department usually are with chronic illnesses or in less critical conditions. Thus, outpatient nurses are under less stress so they could handle work-family conflict much better than nurses working in other units.

In previous studies, scholars found that FF decreased in nurses who worked for longer years (31). They supposed that nurses with longer working years lived with some degree of social status and a stable living environment. They are faced with much less sense of crisis so they might take negative coping strategies when dealing with family-related conflicts. In the current study, the relationship between working years and FF was not significant according to the result of the regression, even though that was significant in the univariate analysis.

## LIMITATIONS AND RECOMMENDATIONS FOR FUTURE STUDIES

There are several limitations that need to be acknowledged in the study. First and foremost, due to the nature of the cross-sectional design, we could not gain more and further data, especially about nurses' feelings or experiences on FF because of lacking qualitative evidence in this study. The mixed methodology could be used in future studies to take a deeper insight into nurses' FF. Second, the study is conducted only in China, there are reasons to believe that the results may be different in other countries due to cultural diversity and differences. Future studies could collect data from nurses in different countries to explore cultural-related factors in predicting FF.

## CONCLUSIONS

The current cross-sectional study explored Chinese nurses' perceived FF level and the associated predictors. The result

showed that most of the nurses who participated in the study demonstrated appropriate FF. Moreover, the study also demonstrated that the highest education level, hospital level, rotation shift status, working department, number of children, and monthly income per family member were significantly associated with nurses' perceived FF. The importance of those predictors was, in turn, the number of children, monthly income per family member, rotation shift status, the highest education level, the hospital level, and the working department.

According to the results of the study, FF was associated with multiple factors, which hints that managers, leaders, and government could make strategies to improve nurses' FF in order to lead nurses to make the balance between family and work. In that way, nurses could make it realized to achieve success of both their nursing careers and in their personal families. Therefore, we suggested that policymakers, nursing managers, and employers should make strategies such as promoting children-care services, increasing nurses' income, educating and training enough nurses, and building a well-established system of career development to help clinical nurses improve their FF so that to improve the quality of care.

## DATA AVAILABILITY STATEMENT

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

## ETHICS STATEMENT

Under the guidance of principles of the World Medical Association Declaration of Helsinki (54), it was taken into the first consideration to respect participants' rights and to protect their health and rights. The investigation was an anonymous survey. Informed consent was delivered verbally when participants were included and accessed online. Since the current study was a cross-sectional study in which the only risk was about participants' privacy, when conducting the survey, the participants would be informed about the purpose of the study, the way and the time of conducting the survey, their rights to refuse the survey, and how their information was stored, protected, and used in an academic way. The study was approved by the Ethical Committee of the corresponding institution, Guizhou Provincial People's Hospital (reference 2018072).

## AUTHOR CONTRIBUTIONS

WZ, QF, SS, and YY conceived and designed the study. CW and DL collected input and checked the data. BT, ZZ, and PL analyzed the data. WZ drafted the manuscript. All authors read and approved the final manuscript.

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# The Relationship Between CDC Personnel Subjective Socioeconomic Status and Turnover Intention: A Combined Model of Moderation and Mediation

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A stable and motivated CDC workforce is critical for Chinese public health system improvement in the post-pandemic period of COVID-19. Meanwhile, the lack of career development prospects, low income, low status and the widespread and increasingly serious job burnout of employees CDC staff is a complex and difficult problem for the government. Therefore, this study explored the relationship between CDC personnel subjective socioeconomic status and turnover intention using a sample of 2,502 grass-roots CDC personnel who were administered with a subjective socioeconomic status scale, turnover intention scale, job burnout scale, and payment questionnaire. The results showed that: (1) subjective socioeconomic status had a significant association with job burnout and turnover intention; (2) all three dimensions of job burnout played a mediating role in the relationship between subjective socioeconomic status and turnover intention; (3) expected salary change played a moderating role between subjective socioeconomic status and turnover intention. The effect was stronger for workers with low expected salary change, which means due to the multidimensional comparative and complex mechanism of salary change, which had limited effect on turnover intention. These findings provide a basis for the relationship between turnover intention and socioeconomic status of grass-roots CDC personnel, and also provide ideas for reducing job burnout and staff turnover.

**Keywords:** subjective socioeconomic status, turnover intention, job burnout, grass-roots CDC personnel, expected salary change

## INTRODUCTION

The COVID-19 pandemic has made more and more people to realize the importance of a robust public health system to respond appropriately to emerging and traditional health challenges (1, 2). Chinese center for disease control and prevention (CDC) personnel play a seminal role in epidemic prevention and control and promoting the health of the entire population; therefore, a stable personnel team is the foundation of China's public health system improvement (3). Unfortunately, due to the lack of career development prospects, low income and low status, the attrition of CDC personnel has been a serious problem in recent years. The number of CDC personnel

in China was 206,485 in 2005 after the SARS pandemic but by 2020 was only 194,425. Therefore, exploration of the generation mechanism and influencing factors of turnover can not only mitigate the current situation of CDC personnel turnover, but also indirectly promote the reform of public health system.

Turnover has been a central topic for economists, psychologists, and management scholars (4, 5). Turnover intention reflects an individual's conscious and deliberate willfulness to quit one's job or organization within a certain period, which directly affecting the choice of departure (6, 7). A considerable number of predictive modeling formulas of voluntary turnover has been established, and researchers generally supported that the turnover intention is associated with social support, relationships, personal aspirations and family life (8, 9). Among them, personal will and choice are the fundamental factors, and career income and career prospect are the principal element that need to be considered.

The subjective socioeconomic status of CDC personnel refers to the individual's perception and identification of their position in the social and economic structure (10), and is strongly associated with a sense of social justice (11). Several studies suggested that subjective socioeconomic status reflects the individual's sense of belonging to the social class, and attitude toward future prospects, social phenomena and job choices (12, 13). According to the social comparison theory, team of employees do not work in a vacuum, they are always comparing and the results of that comparison will influence their career choice (14). In China, the huge income gap, low social status and poor career development path between CDC personnel and clinicians are important reasons for the loss of CDC personnel, especially at the grass-roots level, which are closely related to subjective economic status. Therefore, it is necessary to investigate the subjective socioeconomic status of grass-roots CDC personnel and its influence on turnover intention based on the actual situation of China.

In the late 1980's, Pines and Aronson defined job burnout as a state of physical, emotional and mental exhaustion (15, 16). The CDC personnel job burnout, refers to the emotional and behavioral exhaustion caused by the long hours and the lack of goals, which consists of three components referred to as emotional exhaustion, depersonalization and reduced personal accomplishment. In recent years, there has been a high incidence of burnout among medical staff, with a survey in 2010 showing that 52.4% of medical staff have job burnout (17). CDC personnel have higher levels of psychological stress and burnout compared with medical staff, 58.65% of grass-roots workers were detected job burnout in one research (18). Looking from the former researches, job burnout has a strong positive relationship with turnover intention (19). In addition to direct effects, we propose that job burnout serves as a mediator through which subjective socioeconomic status affects turnover intention as well (20).

Moreover, employees are often more focused on relative salary differences than absolute differences, and we called it expected salary change, which is the difference between expected income and actual income. A meta-analysis of 203 studies revealed that discrepancy between actual pay and deserved pay is the primary determinant of turnover intention and actual turnover (21).

However, few studies have investigated the moderating effect of expected salary change between subjective socioeconomic status and CDC staff turnover intention and between job burnout. Therefore, it is necessary to examine the role of expected salary change in the mechanism of CDC personnel turnover intention generation.

To sum up, our study intends to select district and county-level CDC staff, a group with serious attrition problem, to investigate the impact of grass-roots CDC staff subjective socioeconomic status on turnover intention, the mediating role of job burnout between them, and the moderating role of expected salary change. This is of great significance for promoting the subjective socioeconomic status of grass-roots workers and decreasing their turnover intention.

## CDC Personnel Subjective Socioeconomic Status and Turnover Intention

In previous studies, scholars paid more attention to objective economic status, including social identity, occupational status, income level, education level and other factors, which can be used as a basis to divide individuals into higher and lower social classes (22). While, subjective socioeconomic status is reflected in how do individuals perceive and identify their position in the social and economic structure. CDC personnel subjective socioeconomic status refers to the position of CDC Personnel in a specific social class which is a comprehensive reflection of education, income, occupation and residential area (23). Scholars of various countries have been exploring the mechanism of confirming and evaluating the effect of socioeconomic status on individual physical and mental health from both subjective and objective aspects. However, there are not many research studies that directly study the relationship between subjective socioeconomic status and turnover intention.

Since the outbreak of COVID-19, the work content and intensity of grassroots CDC personnel have greatly increased, but their professional effort is severely disproportionate to the reward received. As a matter of fact, grass-roots CDC staff are facing serious self-development stress, such as poor salaries, limited development prospects and low social status, which will affect their cognition of subjective socioeconomic status results and have the intention to leave. Therefore, there is an urgent need to investigate the current situation of Chinese CDC staff subjective socioeconomic status and the possible impact on turnover intention.

Previous research studies revealed that people with different income levels and occupational status have significantly different turnover tendencies, and had a predictive effect on turnover intention. Based on these, we established our first hypothesis:

**Hypothesis 1:** Subjective socioeconomic status can significantly negatively predict turnover intention.

## The Mediating Role of Job Burnout

Job burnout refers to the emotional exhaustion caused by pressure from work or other reasons. According to current research, job burnout of CDC personnel is harmful in three aspects. The first is the impact on personal physical and

mental health, such as depression and metabolic syndrome. Secondly, it will reduce work efficiency and cause tension in interpersonal relationship. Last but not least, long-term job burnout will have a huge impact on the organization of the individual, increase the turnover rate of CDC personnel, resulting in the instability of the CDC team (24). There is a stable negative correlation between job burnout and turnover intention. In addition, many studies in China have shown that the job burnout of CDC personnel is serious, for example, a survey of 244 CDC professionals in Sichuan province showed that the total detection rate of job burnout was 80.73%, and it may have increased in the COVID-19 pandemic.

There are not many research studies that directly study the relationship between subjective socioeconomic status and burnout. However, many studies have shown that education level, job title and income, which are important indicators of social and economic status, can have impact on job burnout. Subjective socioeconomic status is a comprehensive assessment of the subjective perception of an individual on the basis of a simple assessment of his or her social and economic status. We propose that it is necessary to study the influence of CDC personnel subjective socioeconomic status on job burnout, and whether it will have an impact on turnover intention. Based on this, we established our second hypothesis:

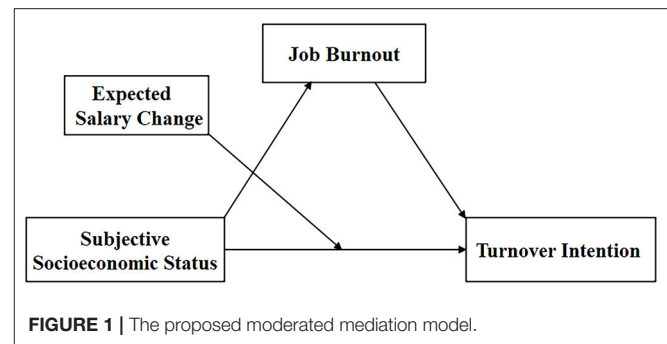
**Hypothesis 2:** Job burnout plays a mediating role in subjective socioeconomic status and turnover intention.

## The Moderating Role of Expected Salary Change

One of the key factors that determines turnover intention is job satisfaction, and the least satisfied in CDC staff of all is the salary (25). Pay satisfaction is largely determined by the discrepancies between actual salary and personal salary reference points, such as what employees feel they deserve, want, or see others receiving (26). When making job-related decisions, individuals simultaneously consider their salary bottom line, current pay level, and desired salary (27). As suggested by equity theory and the discrepancy models of pay satisfaction (28), we assume that A is in the clinical laboratory of CDC and B is in the clinical laboratory of hospital, however, in terms of work intensity:  $A=B$ ; in terms of salary:  $A<B$ , whether individuals consciously or unconsciously compare their income levels horizontally or vertically. Horizontal comparison refers to whether labor compensation is directly proportional to work intensity under the same work intensity; vertical comparison refers to whether the salary will increase with the promotion of the position, mainly based on the establishment, professional title level and position of different expected income, that is expected salary change. Based on these, we established our third hypothesis:

**Hypothesis 3:** Expected salary change plays a moderating role in the direct path of the mediating path.

In summary, this study constructed a model (as shown in **Figure 1**) to explore the mediating mechanisms of subjective



socioeconomic status predicting the disease prevention and control personnel, to provide ideas for preventing and relieving the loss of CDC personnel. Three hypotheses were put forward: (1) subjective socioeconomic status has a significant predictive on turnover intention; (2) job burnout plays a mediating role in the relationship between SSS and turnover intention. (3) Expected salary change plays a moderating role in the direct path.

## MATERIALS AND METHODS

### Participants

The participants included 2,502 county-level CDC staff from Shandong province, China. Stratified sampling was carried out according to the regional economic conditions, and 10 cities in Shandong province were selected to issue questionnaires in the form of electronic questionnaire. After excluding invalid questionnaires with incomplete answers, 2,502 valid questionnaires were obtained (valid recovery rate = 99.8%). Among the valid samples, there were 928 men (37.1%) and 1,574 women (62.9%). The average age of participants was 40.85 years ( $SD = 9.67$ ), 2,043 (81.7%) were married, and 459 (18.3%) were unmarried; 864 (33.8%) had a college degree, 1,549 (61.9%) had a bachelor degree, and 107 (4.3%) had a master's degree; 249 (10.0%) Senior title, 928 (37.1%) had an intermediate title and 1,325 (53.0%) had a junior and below title. The years of working experience ranged from 1 to 43 years, including 936 (37.4%) with 1–9 years, 634 (25.3%) with 10–19 years, 627 (25.1%) with 20–29 years, and 305 (12.2%) with over and 30 years of working experience in CDC. The average number of years of working experience was 14.93 years ( $SD = 11.08$ ).

### Measures

#### Chinese Version of the Subjective Socioeconomic Status Scale (CSSS)

CSSS is translated from the Mac Arthur Scale of Subjective Social Status for adults developed by Adler et al. (29). The Subjective Socioeconomic Status Scale contains two items, which are “please determine your family’s economic position based on the socioeconomic development of your province” and “please compare your social and economic status with those around you.” And each item was divided into 10 levels and the participants are asked to choose which step they are on. From bottom to top, a score of 1 represents those who have the least

money, the least education and the least decent jobs, while a score of 10 represents those who have the most money, the most education and the most decent jobs, with higher socioeconomic status as they go up. In this study, the Cronbach's alpha for this scale was 0.90.

### Burnout Questionnaire (MBI-HSS)

Job burnout is a kind of long-term reaction caused by the individual's inability to cope with the constant pressure at work, which is manifested as emotional exhaustion, depersonalization and personal accomplishment (30). The job burnout scale adopts the Chinese version of the original scale (31), with 22 questions and 7 points of self-evaluation. The scoring method is 0–6, 0 means “never” and 6 means “very frequently.” Three subscales were used to measure the three dimensions of job burnout, including emotional exhaustion (nine questions), depersonalization (five questions), and personal accomplishment (eight questions). The three dimensions of the burnout questionnaire were scored separately. In terms of emotional exhaustion and dehumanization, the higher the score was, the stronger the burnout degree was. In terms of personal achievement, the higher the score, the less burnout. Emotional exhaustion score below 19 is mild, 19–26 is moderate, and above 26 is high. A dehumanization score of <6 is mild, 6–9 is moderate, and above 9 is high. Job satisfaction scores above 39 are mild, 34–39 is moderate, and below 34 is high. When all three aspects are high, it is considered that there is a high degree of job burnout. In this study, Cronbach's  $\alpha$  of the total scale and three dimensions were 0.86 and 0.90, 0.81, and 0.87, respectively, showing high intrinsic reliability.

### Turnover Intention Scale

The Turnover Intention Scale was developed by Tao et al. and has been widely used in sociological field (32). It consists of four items, each rated on a five-point Likert scale [1 = completely disagree to 5 = completely agree). Participants are asked to rate each statement, for example, “I will look for other job opportunities,” based on how much they agree or disagree with it. Higher scores indicate higher employee turnover intention. In this study, the Cronbach's alpha for this scale was 0.92.

### Payment Questionnaire

The payment questionnaire is designed on the basis of literature review (33), including three questions: actual income, whether they are satisfied with the current income, and expected income. Expected salary change represents the difference between actual and expected wages (expected salary change = expected salary-actual salary).

### Data Analysis

SPSS version 25.0 (IBM, NY, United States) was used for the statistical analysis. Descriptive statistics were produced for all variables, while the PROCESS macro for SPSS (Model 4) was applied to examine the mediating effect of job burnout. Finally, the PROCESS macro for SPSS (Model 5) was used to examine

the moderated mediating effect of expected salary change on the direct path (8).

## RESULTS

### Common Method Deviation Test

As all the survey data were from the CDC staff self-reports, there may be common method deviation. Therefore, the Harman single factor test was used to test the deviation of variables. The results showed that the eigenvalues of 6 factors were >1, and the explanatory power of the first factor was <40% of the critical value (the value of variation was 31.99%). Therefore, common method bias did not affect the data results.

### Preliminary Analysis

The descriptive statistical results are shown in Table 1. The results showed that grass-roots CDC staff subjective socioeconomic status was negatively correlated with emotional exhaustion ( $r = -0.19, p < 0.001$ ), depersonalization ( $r = -0.09, p < 0.001$ ) and turnover intention ( $r = -0.21, p < 0.001$ ), and was positively correlated with personal accomplishment. Emotional exhaustion and depersonalization were positively correlated with turnover intention ( $r = 0.53, p < 0.001$ ;  $r = 0.37, p < 0.001$ ), and personal accomplishment was negatively correlated with turnover intention ( $r = -0.13, p < 0.001$ ). In addition, expected salary change was positively correlated with turnover intention ( $r = 0.16, p < 0.001$ ). A *t*-test was conducted to assess whether there were gender differences between the following variables. The results showed that there were significant gender differences in depersonalization, personal accomplishment, expected salary change and turnover intention ( $t = 4.06, p < 0.001$ ;  $t = -4.68, p < 0.001$ ;  $t = 4.51, p < 0.001$ ;  $t = 6.35, p < 0.001$ ). Compared with male CDC workers, female workers had higher burnout, expected salary change and turnover intention. The ANOVA on educational level shown that the higher degree workers had higher burnout and turnover intention.

### Mediating Effect Analysis

Model 4 of the PROCESS macro was used to investigate the predictive effect of CDC staff subjective socioeconomic status on turnover intention, and the mediating role of job burnout (8). Since the scores of the three subscales of job burnout are independent of each other, the total score cannot be calculated together. Therefore, the effects of the three sub-dimensions on the subjective socio-economic impact on turnover intention were respectively analyzed by regression analysis. As Table 2 shows, subjective socioeconomic status was negatively associated with emotional exhaustion and depersonalization ( $\beta = -0.79, t = 9.69, p < 0.001$ ;  $\beta = -0.16, t = -3.99, p < 0.001$ ), which in turn was positively related to CDC staff turnover intention ( $\beta = 0.15, t = 29.49, p < 0.001$ ;  $\beta = 0.21, t = 18.75, p < 0.001$ ). And subjective socioeconomic status was positively associated with personal accomplishment ( $\beta = 0.21, t = 2.88, p < 0.001$ ), which in turn was negatively related to CDC staff turnover intention ( $\beta = -0.33, t = -5.00, p < 0.001$ ). In all three dimensions, the negative direct association



**TABLE 1** | Descriptive statistics and correlation among variables ( $N = 2,502$ ).

Characteristics	1	2	3	4	5	6	7	8	9
1. Gender	1								
2. Age	−0.16***	1							
3. Education level	0.09***	−0.33***	1						
4. SSS	0.03	0.07***	0.04*	1					
5. EE	−0.14	−0.16***	0.17***	−0.19***	1				
6. Depersonalization	−0.08***	−0.15***	0.05*	−0.09***	0.66***	1			
7. PA	0.10***	0.11***	−0.03	0.07**	−0.01	−0.14***	1		
8. ESC	−0.09***	0.04*	0.036	−0.18***	0.15***	0.10***	−0.03	1	
9. Turnover intention	−0.13***	0.05*	0.07**	−0.21***	0.53***	0.37***	−0.13***	0.16***	1
M	1.63	40.85	1.70	9.06	27.50	9.97	39.34	2,074.05	10.38
SD	0.48	9.67	0.54	2.94	12.45	6.13	10.86	2,326.48	3.70

SSS, Subjective Socioeconomic Status; EE, Emotional exhaustion PA, Personal accomplishment; ESC, Expected salary change.

\* $p < 0.05$ , \*\* $p < 0.01$ , and \*\*\* $p < 0.001$ .

between subjective socioeconomic status and turnover intention perpetration remained significant (EE:  $\beta = -0.14$ ,  $t = -6.45$ ,  $p < 0.001$ ; DE:  $\beta = -0.22$ ,  $t = -9.77$ ,  $p < 0.001$ ; PA:  $\beta = -0.2$ ,  $t = -10.33$ ,  $p < 0.001$ ). Therefore, Hypothesis 1, 2 were supported. Job burnout partially mediated the relationship between subjective socioeconomic status and turnover intention [EE: indirect effect =  $-0.12$ ,  $SE = 0.01$ , 95% CI =  $[-0.11, -0.07]$ ; DE: indirect effect =  $-0.03$ ,  $SE = 0.01$ , 95% CI =  $[-0.04, -0.01]$ ; PA: indirect effect =  $-0.01$ ,  $SE = 0.002$ , 95% CI =  $[-0.01, 0.000]$ ]. The mediation effect of EE, DE, PA accounts for 46.54, 13.25, 2.71% of the total effect of subjective socioeconomic status on turnover intention.

## Moderated Mediation Effect Analysis

To test the moderated mediation model, we used Model 5 of the SPSS PROCESS macro compiled by Hayes (8). After controlling for gender, age, and education level, the expected salary change moderation test was conducted; the results are shown in **Table 3**. As shown in the model (Turnover intention), the product of subjective socioeconomic status and expected salary change had a significant predictive effect on turnover intention ( $\beta = 0.05$ ,  $t = 2.01$ ,  $p < 0.05$ ). Therefore, we plotted predicted subjective socioeconomic status against turnover intention, separately for low- and high-levels of expected salary change ( $M \pm 1SD$ ). Simple slope tests showed that for CDC workers with high expected salary change, subjective socioeconomic status significantly predicted turnover intention,  $\beta_{\text{simple}} = -0.20$ ,  $t = 11.69$ ,  $p < 0.001$ . However, for CDC workers with low expected salary change, subjective socioeconomic status conflict significantly predicted turnover intention but to a much weaker extent,  $\beta_{\text{simple}} = -0.31$ ,  $t = 11.11$ ,  $p < 0.001$  (**Figure 2**). The results showed that with the increase of expected salary change of CDC worker, the predictive effect of subjective socioeconomic status on turnover intention gradually increased.

## DISCUSSION

### The Effect of Subjective Socioeconomic Status on Turnover Intention

The results showed that subjective socioeconomic status had a significant negative predictive effect on turnover intention, so Research Hypothesis 1 was verified. It has confirmed a relationship between the subjective socioeconomic status and turnover intention of the Chinese grass-roots CDC staff, and expanded the application of social comparison theory in the Chinese context. At the same time, it is call on the government to pay attention to CDC personnel not only in the level of oral propaganda, but also to think about how to solve their practical difficulties, such as raising their salary, implement the epidemic prevention subsidy and optimize their career path (34). On the one hand, CDC personnel actively have carried out epidemic prevention and control work under the condition of low salary and low social recognition, which will lead to negative influence on their subjective social and economic identity. If measures are not taken to change the situation of CDC personnel, it is difficult to sustain the work of epidemic prevention and control under normal conditions by relying solely on spiritual motivation (35). On the other hand, CDC personnel also face real pressures in life, such as house, car, and their children education. If public health is not respected and the salary is not improved, many people will still leave the CDC after COVID-19 pandemic (36).

### The Mediating Role of Job Burnout

This study found that job burnout played a mediating role between the subjective socioeconomic status and turnover intention of grass-roots CDC personnel, so Research Hypothesis 2 was verified. COVID-19 pandemic has been going on for 2 years, and the long hours of high-intensity work and great mental pressure have placed a huge burden on the physical and mental health of CDC personnel. In the case of serious inequality between pay and income, it is easy to cause job burnout. To some extent, it fills a research gap by confirming the mediating



**TABLE 2 |** Fractional testing the mediation effect of subjective socioeconomic status on turnover intention ( $N = 2,502$ ).

Predictors	Model 1 (turnover intention)		Model 2 (emotional exhaustion)		Model 3 (turnover intention)	
	$\beta$	$t$	$\beta$	$T$	$\beta$	$t$
Gender	-0.13***	-6.88	-0.99	-1.96	-0.99***	-6.82
Age	-0.01	-1.34	-0.13***	-4.95	0.01	1.36
Education level	0.53***	3.81	3.38***	7.19	0.02	0.18
SSS	-0.26***	-10.58	-0.79***	9.69	-0.14***	-6.45
Emotional exhaustion					0.15***	29.49
$R^2$	0.065	0.075	0.307			
$F$	44.69***	52.05***	222.11***			

	Model 1 (turnover intention)		Model 2 (depersonalization)		Model 3 (turnover intention)	
	$\beta$	$t$	$\beta$	$T$	$\beta$	$t$
Gender	-1.03***	-6.88	-1.37***	-5.42	-0.75***	-5.28
Age	-0.01	-1.34	-0.10***	-7.48	0.01	1.36
Education level	0.53***	3.81	0.14	0.41	0.50***	3.84
SSS	-0.26***	-10.58	-0.16***	-3.99	-0.22***	-9.77
Depersonalization					0.21***	18.75
$R^2$	0.065	0.04	0.18			
$F$	44.69***	26.31***	111.04***			

	Model 1 (turnover intention)		Model 2 (PA)		Model 3 (turnover intention)	
	$\beta$	$t$	$\beta$	$T$	$\beta$	$t$
Gender	-1.03***	-6.88	2.55***	5.66	-0.95***	-6.31
Age	-0.01	-1.34	0.12***	5.59	-0.01	-0.78
Education level	0.53***	3.81	-0.07	-0.17	0.53***	3.81
SSS	-0.26***	-10.58	0.21**	2.88	-0.25***	-10.33
PA					-0.33***	-5.00
$R^2$	0.07	0.03	0.07			
$F$	44.69***	17.53***	41.09***			

SSS, Subjective Socioeconomic Status; PA, Personal accomplishment.

\*\* $p < 0.01$ , and \*\*\* $p < 0.001$ .

mechanism between CDC staff subjective socioeconomic status and turnover intention. Low subjective socioeconomic status will aggravate job burnout, and then affect the turnover tendency of CDC personnel. Our study emphasizing the important role of personal subjective feelings in turnover intention, improving their compensation and treatment, and paying more attention to their mental health should become the important contents of the CDC system improvement, which is the core of solving the problem of staff turnover.

With the development of social economy, we are faced with more and more public health problems, and the work scope and pressure of disease control personnel are getting bigger and bigger (37). However, compared with clinical work, public health is not easy to see direct results, so it is not understood and valued by the public. Above all, clinicians and public health students are all medical school graduates, but CDC personnel earn half or even a third as much as doctors. Based on equity and social comparison theory, if low socioeconomic status is not addressed, it is likely to affect the emotional and psychological resources

invested by CDC staff in their work, which leads to serious job burnout, and then produce turnover tendency (38).

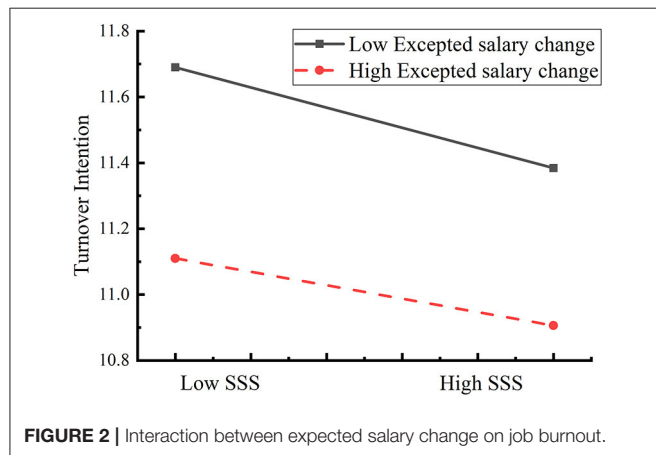
## The Moderating Role of Expected Salary Change

The results of the moderating effect analysis showed that expected salary change played a significant moderating role in the path of subjective socioeconomic status to turnover intention, which verified Hypothesis 3. The results showed that the grass-roots CDC workers, who have higher expected salary change, will have higher degree of turnover intention (39). It may due to high expected salary change means the CDC staff were not satisfied with their actual income, which in turn lead to higher levels of job dissatisfaction and turnover intention. In addition, our study found that for CDC workers with lower expected salary change, although the degree of turnover intention was lower than workers with high expected salary change, the predictive effect of subjective socioeconomic status on turnover intention was stronger. Previous studies have shown

**TABLE 3 |** Testing the moderated mediation effect of subjective socioeconomic status on turnover intention.

Predictors	$R^2$	$F$	$\beta$	$t$
Model (turnover intention)	0.07	4.02*		
Gender			−0.13***	−6.86
Age			−0.03	−1.48
Educational level			0.08***	3.72
SSS			−0.20***	−10.44
ESC			0.07**	2.76
SSS*ESC			0.05*	2.01

SSS, Subjective Socioeconomic Status; ESC, Expected Change.

\* $p < 0.05$ , \*\* $p < 0.01$ , and \*\*\* $p < 0.001$ .**FIGURE 2 |** Interaction between expected salary change on job burnout.

that absolute compensation has limited impact on employee satisfaction, discrepancy between actual pay and deserved pay is the primary element. People with low expected salary change means, they are likely to be satisfied with their income and have stable cognition of subjective socioeconomic status, but this result is to the contrary (40). This may because expected salary change simply represents the longitudinal comparison of individual's income, that is, a comparison of their past, present and future. Subjective socioeconomic status includes not only horizontal comparison, but also vertical comparison, such as comparison with peer doctors and civil servants. More attention should be paid to relative compensation and the fairness of compensation between CDC personnel and medical staff, which is the ranger way to reduce staff turnover. In addition, individual with low expected salary change may pay more attention to social status, career development and other factors that are more difficult to change in a short time, thus affecting turnover intention.

## Practical Significance and Limitations

The current research has the following crucial theoretical and practical contributions. First, it is emphasized that more attention should be paid to the current situation of low social status and low salary of CDC personnel, which reflect that the problem of appreciating medical treatment but neglecting prevention

is still outstanding. Second, during the fight against COVID-19, CDC staff are overworked, facing great work pressure and risk of infection, and the detection rate of job burnout is high. Relevant departments should provide appropriate care and support. The degree of job burnout can be alleviated by improving staff's self-identification with their professional value and social status and strengthening organizational support, and the talent team of disease prevention and control system should be expanded to relieve the working pressure of existing CDC staff. Finally, this study revealed that expected salary change has a complex role in subjective economic status, highlighting that raising wages alone will do little to reduce attrition, it should be considered from multiple dimensions such as fairness of salary distribution, career development prospect and social status.

Several limitations need to be considered when interpreting the findings. First, our cross-sectional data limit causal inferences. Previous studies have also indicated that job burnout can contribute to subjective economic status. Therefore, it is necessary to use longitudinal designs to obtain stronger empirical evidence of causal evidence in future research. This survey adopts the method of network non-probabilistic sampling, and the sample representativeness is limited to some extent. However, the conclusions and findings of this study still have certain reference value. Finally, although this study tested the moderating role of expected salary change between subjective economic status and turnover intention, future research needs to conduct a more in-depth study on more multi-level and multi-angle salary demand, to let CDC personnel get equal income with their efforts.

## CONCLUSION

In summary, this study is an important step forward in understanding how subjective socioeconomic status relates to the turnover intention of Chinese grass-roots CDC personnel. It has very important significance for the Chinese grass-roots CDC personnel who want to improve their socioeconomic status, and provides reference basis for the government to formulate corresponding measures to alleviate the loss of CDC personnel and reduce job burnout. First, it reveals the relationship between subjective socioeconomic status and burnout of grass-roots CDC personnel in the critical period of modernization improvement of disease prevention and control. Second, it shows that job burnout serves as a mediating role between subjective socioeconomic status and turnover intention, which highlights the important role of occupational mental health in socioeconomic status and talent force stability. Moreover, the relationship between subjective socioeconomic status and turnover intention is moderated by expected salary change, and the relationship appears to be stronger for CDC workers with low expected salary change than for those with high expected salary change. Finally, we hope that the government and society have more understanding and attention to the CDC personnel. Only understanding can bring understanding and empathy, and further bring participation, support, cooperation and construction.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board of Shandong University. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

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## AUTHOR CONTRIBUTIONS

SL was the principal investigator. YS and GL collected and analyzed the data under the supervision of SL. SL and YS designed the study, contributed to materials and analysis tools, and contributed to the writing of the manuscript. SL and CZ provided guidance to the manuscript. All authors contributed to the article and approved the submitted version.

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# Stress, Personality, Attachment, and Coping Strategies During the COVID-19 Pandemic: The STERACOVID Prospective Cohort Study Protocol

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**Background:** Due to the lockdown linked to the COVID-19 pandemic, the French National Authority for Health has recommended reinforced follow-up of psychiatric patients, with particular attention to people over 65 years. Cross-sectional studies reported an increased risk of anxiety, depression, and suicide during this period. Older people with psychiatric disorders are at higher risk of developing severe COVID-19 and worsening their psychiatric symptoms.

**Objective:** The main objective is to evaluate the link between coping strategies and the onset of post-traumatic stress disorder (PTSD) after lockdown. The secondary objective is to assess the psychological factors influencing lockdown experiences such as personality, attachment type, or coping strategies.

**Method/Design:** this is a multicenter cohort study including 117 patients followed up by phone in two French geriatric psychiatry units. Sociodemographic variables, psychiatric diagnoses, lockdown conditions, coping strategies, anxiety, and depressive symptoms reported during the first lockdown will be collected retrospectively from the medical file. A first prospective assessment including personality traits, attachment type, and traumatic life events will be conducted at 12 months (T1). Follow-up visits assessing anxious-depressive symptoms and PTSD will be made 18 (T2) and 24 months (T3) after the first lockdown. The primary outcome measure is PTSD symptoms. Secondary outcomes measures are coping strategies, generalized anxiety, anxiety about the COVID-19 pandemic, and quality of life.

**Discussion:** This study aims to determine if the type of coping strategies usually employed have an impact on the onset of PTSD after a lockdown period. It will also determine if these coping strategies are influenced by other factors such as sociodemographic variables, lockdown conditions, particular personality traits, attachment type, and traumatic life events. This study could help identify factors



associated with a poorer experience of lockdowns and pandemic crisis in elderly patients followed in a psychiatric center, and guide support in future similar situations.

**Trial Registration:** ClinicalTrials.gov: <http://clinicaltrials.gov/show/NCT04760795>, Registered 18 February 2021.

**Keywords:** COVID-19 pandemic, lockdown, older adults, psychiatric disorders, PTSD, personality, attachment, coping strategies

## INTRODUCTION

In December 2019, the World Health Organization (WHO) (1) reported a new coronavirus (SARS-CoV-2) that quickly became pandemic, leading worldwide countries to take drastic measures. From March 2020, in France (2) unprecedented measures have been voted to limit travel (3), prescribing social distancing and isolation. Thus, several factors could affect the population's mental health, including the lack of scientific data on coronavirus disease 2019 (COVID-19), 24-h news channels reporting daily death count, and the government's lack of visibility on lockdown measures.

The epidemic situation and the resulting measures being unprecedented, the psychological consequences are difficult to predict. Previous studies on the mental health of the population, on the impact of quarantine measures, have been carried out on epidemics such as the severe acute respiratory syndrome (SARS) in 2003, the H1N1 flu in 2009 and 2010, the Middle East Respiratory Syndrome (MERS) in 2012, or Ebola in 2014. A recent literature review showed that quarantine measures hurt mental health leading to Post-Traumatic Stress Disorder (PTSD) susceptible to last for months or even years after measures implementation [Brook et al., (4)]. Indeed, anxiety, depressive symptoms, and PTSD were reported in the general population more than 1 year after the Ebola epidemic in 2014 (5). Some factors might affect the negative impact of quarantine, among them: sociodemographic characteristics and lockdown conditions (6), insufficient access to necessities including medical supplies and regular medical care (7–9), a lack of clarity in the information provided by the public health authorities, and a quarantine period exceeding 10 days (10). At the beginning of 2020, the French population experienced issues with the supply of masks and a long lockdown duration. Additionally, factors such as the government's lack of visibility on lockdown measures and 24-h news channels reporting daily deaths count could have negatively affected the population's mental health.

Self-protective measures such as wearing a mask or social distancing could have increased the onset of some disorders such as compulsive hand washing and agoraphobia, as shown by previous studies (11). Other long-term effects could be observed. Regarding the current COVID-19 pandemic, previous cross-sectional studies showed an increase in anxiety symptoms and depression, higher alcohol consumption, or poorer psychological wellbeing (12, 13). An international population-based study (14) also reported that the lockdown experience was linked to higher risks of depression, PTSD, and suicide (15).

In this context, the elderly population with psychiatric disorders, who is already frailer, might have poorer psychic

health. Indeed, from the beginning of the pandemic, older people were more susceptible to developing severe COVID-19 (16). In addition, the media underlined the fragility of this age group and speculated on the choices that could be made by the intensive care services to favor younger patients in case of saturation. Next, older adults being less familiar with recent technologies and less prone to use video screen communications, the limitation of outings worsened their social isolation. The lockdown also complicated their daily organization because they usually depend on their children or external help (17). Finally, they also experienced more financial precariousness, knowing that socio-economic conditions have been identified as a risk factor for psychological disorders after quarantine measures during previous epidemics (10).

For patients with psychiatric disorders, the risks of social isolation and financial precariousness are increased, as is the risk of medical comorbidities and particularly cardiovascular comorbidities (18), making them even more vulnerable to the virus. Moreover, the onset of PTSD is more frequent in a population with a prevalent psychiatric pathology (19); and a longitudinal study (20) showed that psychiatric history induced anger and anxiety symptoms several months after the end of quarantine. Finally, psychiatric history increased the risk of suicidal ideation during the COVID-19 pandemic (14).

The concept of “coping” was defined by the set of cognitive and behavioral efforts put in place to control, reduce or tolerate internal and external demands that threaten or overwhelm an individual's resources” (21). Two types of coping were distinguished: problem-focused coping which constitutes the efforts undertaken to confront the situation, and emotion-focused coping which aims to decrease the emotional distress related to the situation. A synthesis of studies carried out on the adjustment strategies reveals the third set of strategies: seeking social support (22). Indeed, according to the situation, social support could help to change the problem or emotional state.

Bruchon-Schweitzer identified two determinants of the coping type: dispositional factors (personality traits, beliefs, motivation) and contextual factors, related to the context (nature of the situation, its imminence, duration, ambiguity, frequency, intensity, and controllability). Certain personality traits from the “Big Five” model (23) might influence the coping type. Neuroticism is defined as emotional instability and a persistent trend of negative emotions and might be more often associated with emotion-focused strategies (24).

An individual's response to stress might be associated with the quality of relationships, particularly the attachment dimensions. On the one hand, the attachment type seems to condition the physiological response to stress and the level of stress perceived

by individuals (25). On the other hand, the way to face stress is related to attachment: Ognibene and Collin (26) studied the coping strategies employed according to attachment type in young adults. They showed that individuals with a secure attachment type received more help from friends and family and sought more social support when facing a stressful situation. While individuals with a preoccupied attachment type sought social support and tended to use avoidance strategies. Individuals with fearful and dismissing attachment types were less prone to seek social support.

Previous studies on traumatic events showed that some strategies, particularly problem-focused and seeking social support, were more efficient to prevent psychological repercussions such as PTSD (27, 28).

To our knowledge, no study has investigated coping strategies in epidemic or lockdown situations.

The French Health Authority has recommended a follow-up of the older psychiatric patients during the lockdown period. It advocated maintaining and reinforcement of outpatient care services by favoring teleconsultation by video or phone (2).

The present study includes a population of older outpatients with psychiatric disorders followed-up by phone in French hospitals over the lockdown period.

According to previous studies, we think that: a/ Patients could experience severe anxiety symptoms during this period. This anxiety might last after lifting the lockdown restrictions. However, we hypothesize that individuals who implement

problem-focused and social support-seeking coping strategies might be less anxious. Additionally, the type of coping strategies used could influence the onset of PTSD; b/ Factors such as lockdown conditions, personality traits, attachment type, and life events might affect the coping strategies.

The primary aim of the study is to investigate the link between coping strategies and the onset of PTSD after lockdown.

The secondary objectives are threefold: a/ Identify the coping strategies used during the COVID-19 crisis and measure their efficiency on generalized anxiety and anxiety about the COVID-19 pandemic, b/ Assess the factors which influence the coping strategies used usually and during the lockdown, especially the sociodemographic variables, the lockdown conditions, the type of personality, the attachment type, and the presence of traumatic life events, c/ Evaluate the impact of PTSD on quality of life.

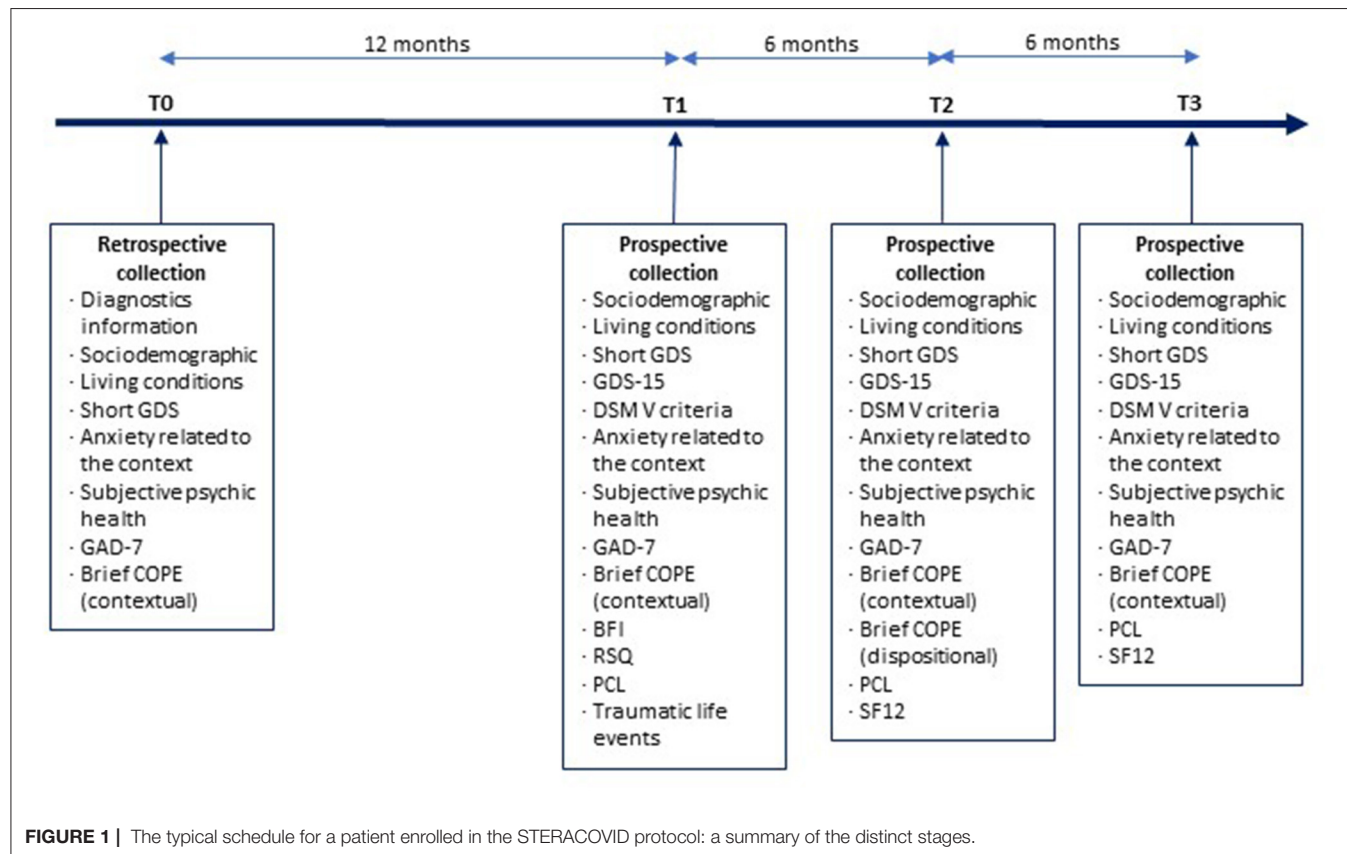
## METHODS AND ANALYSIS

### Study Design

It is a bicentric observational prospective cohort study. **Figure 1** displays the typical schedule for a patient enrolled in the STERACOVID protocol.

### Setting and Patients

The STERACOVID study participants will be recruited among outpatients followed up by phone for psychiatric diseases during the lockdown related to COVID-19 in the geriatrics department



of the University Hospital of Saint-Etienne and the aging psychiatric department of the Vinatier Hospital, Lyon, France.

### Inclusion Criteria

Patients must: (1) be outpatient with a psychiatric pathology; (2) be 60+; (3) regularly followed in the psychiatric unit; (4) be followed by teleconsultation during the first lockdown due to COVID-19; (5) be affiliated or entitled to a social security scheme.

### Exclusion Criteria

Patients with major neurocognitive disorders or hospitalized were excluded from the study.

### Study Withdrawals

Patients withdraw from the study in case of refusal or inability to continue the study for medical reasons. They will not be replaced. Patients will be followed-up as part of their usual care with no substitution treatment.

### Independent Variables

Independent variables will be:

- Sociodemographic characteristics will be collected: Age in years, sex (male/female), and marital status (single/in couple/widowed/divorced). For education, low and high educational levels are defined by the duration of schooling, with a threshold of 12 years ( $\geq 12$  years vs.  $< 12$  years).
- Information on lockdown period: total lockdown without outings (yes/no); social network (maintaining family contact, professional help visits); isolation (does the patient live alone at home?); feeling of loneliness (never/sometimes/often/very often); adoption of protective measures (yes/no); diagnosis of COVID-19 for the patient and/or in the close circle (yes/no); bereavement due to COVID-19; feeling about vaccine (willing to get vaccinated (yes/no/doesn't know/already vaccinated), reception of the announcement of a vaccine (reassured/indifferent/other)); obsessive thoughts of contamination (yes/no); presence and frequency of episodes of panic attack; worry (about oneself, relatives and/or the future); suicidal ideations (yes/no); delusional syndrome eventually linked to the lockdown (yes/no); the past time in watching TV news (0 h/ $< 1$  h/1–3 h/more than 3 h), presence of daily routine (yes/no); information on tobacco and alcohol consumption, and sleep disorders (if yes, increased/stable/decreased), information on pain (type, duration, onset, daily interference, daily analgesic medication).
- The personality will be assessed using the Big Five Inventory (BFI) (29). Built-in English, this self-report inventory has been validated in French and includes 45 items designed to measure the 5 dimensions of personality: openness (open-mindedness, originality), conscientiousness (control, goal-directed behaviors), extraversion (energy, enthusiasm), agreeableness (affection, altruism), and neuroticism (negative mood, anxiety). Each item consists of a short phrase and is rated on a 5-point Likert scale (1 = *disagree a lot* to 5 = *agree a lot*). Scale scores are the sum of the items for each subscale.
- The attachment type will be evaluated using the Relationship Scales Questionnaire (RSQ) (30). It is a self-reported

multidimensional questionnaire including 30 items among which 17 items are specific to relationships and resulting in 4 subscales defining 4 attachment prototypes:

- The “secure” subscale (S) consists of 5 items. The “secure” attachment type indicates that the individual has positive views of self and others. Others are generally assumed available and helpful if necessary.
- The “fearful” subscale (F) consists of 4 items. It indicates negative perceptions of self and others. Others are generally assumed not available.
- The “preoccupied” (P) subscale consists of 4 items. It indicates a negative view of self and a positive view of others. The individual has a sense of personal worthlessness in the eyes of others and the belief that others are not available or caring in case of need.
- The “dismissing” (D) subscale consists of 5 items. It relates to a high level of self-confidence and negative views of others. The individual has a sense of self-worth that one owes only to oneself and very negative expectations of others from whom one should, on the other hand, expect nothing.

Each item is rated on a 5-point Likert scale (1 = *not at all like me* to 5 = *very much like me*). The four combining scores allow calculating the scores of two latent dimensions: the “self-model” and the “others” model.

- The presence of traumatic life events will be collected. Patients will be asked if they experienced one or several traumatic life events.

### Dependent Variables

- The primary endpoint will be PTSD, assessed using the original version of the PTSD checklist (PCL) (31). It focuses on symptoms related to a single traumatic event. The PCL is a standardized self-reported rating scale including 17 items assessing the intensity, in the last month, of 17 PTSD key symptoms. Each item uses a 5-point Likert scale ranging (from 1 = *not at all* to 5 = *extremely*). Scores consist of the total symptom severity (sum of all items going from 5 to 85) and scores of three subscales corresponding to 3 for three PTSD sub-syndromes: re-experiencing of the traumatic event, avoidance of trauma reminders, and hyperarousal.

The secondary endpoints will be:

- The coping strategies usually employed will be assessed using the Brief Coping Orientation to Problems Experienced (COPE) Inventory (32). This scale is a short version of the COPE Inventory developed by Caver and has been validated for a French population. This multidimensional instrument has 14 subscales composed of 2 items each: (1) active coping, (2) planning, (3) seeking instrumental social support, (4) seeking emotional social support, (5) focus and venting emotions (wanting to express feelings), (6) behavioral disengagement, (7) mental disengagement (distraction), (8) self-blaming, (9) positive reinterpretation, (10) humor, (11) denial, (12) acceptance, (13) turning to religion, and (14) substance use. According to guidelines, the scale might be used

from a dispositional or contextual perspective. In this study, the contextual (pandemic situation) and dispositional versions will be used.

- Anxiety in the last 2 weeks will be assessed during phone medical interviews using the Generalized Anxiety Disorder scale (GAD7). The scale was validated in French (33). It consists of 7 items: (1) feeling nervous, anxious, or on edge, (2) not being able to stop or control worrying, (3) worrying too much about different things, (4) having trouble relaxing, (5) being so restless that it is hard to sit still, (6) becoming easily annoyed or irritable, and (7) feeling afraid as if something awful might happen. Each item is 4-scaled: 0- never; 1- several days; 2- more than half the days; 3- nearly every day.
- Anxiety about the COVID-19 crisis will be assessed during medical phone visits using a 10-point ordinal scale (from 0: free of stress to 10: maximum of stress) by answering the question: "On a scale from 0 to 10, how much stress do you feel in the context of COVID-19?"
- Subjective psychic health will be assessed during medical phone visits using a 10-point ordinal scale (from 0: the worst to 10: the best) by answering the question: "How do you rate your mental health? (From 0, the worst ever to 10, the best)."
- Quality of life will be assessed using the 12-Item Short-Form Health Survey (SF-12) (34), a short version of the Medical Outcomes Study Short-Form General Health Survey (SF36) (35). This self-reported questionnaire explores the quality of life related to physical, emotional, and social health. The 12 questions concern the four last weeks and investigate eight domains: physical activity, life and relationships with others, physical pain, subjective health, vitality (energy and fatigue), limitations related to the psychic status, physical condition, and psychic health. The SF-12 allows calculating a mental quality of life score and physical quality of life score.

## Data Collection Procedure

The data collection procedure is displayed in **Figure 1** and **Appendix (Table A)**.

### Inclusion Visit and Retrospective Data Collection

Inclusion and exclusion criteria verification will be based on the patients' records. At T0, between March 17<sup>th</sup> and May 10<sup>th</sup>, 2020, sociodemographic characteristics, psychiatric diagnoses, and lockdown conditions will be collected in medical records if available. Data will be anonymized and stored in a database. Anxiety (GAD-7) and coping scores (Brief COPE) will be collected for Saint Etienne participants during clinical visits and reported in the database.

### Follow-Up

Lockdown assessment is proposed for participants 12 (T1), 18 (T2), and 24 months (T3) after the first lockdown.

The patients withdraw from the study at the end of their participation which will be for a maximum of 2 years.

## Bias Mitigation Measures

All consecutive patients followed up in phone visits who agree to participate in the research and meet the inclusion criteria will be included in the study to avoid selection bias.

Participants will be blinded to the study assumptions to avoid information bias. They will receive the explanations at the end of the session.

The evaluation criteria are sufficiently objective parameters to avoid any evaluation bias.

## Data Analysis

### Sample Size

Given the clinical context of the study population, the expected prevalence of PTSD might be 30% in patients with emotion-focused coping strategies and 10% in those with problem-focused strategies. Assuming an  $\alpha$  risk at 5% and power ( $1-\beta$ ) of 80% (two-sided test), the number of required subjects would be 59 per group, i.e., 118 subjects in total.

### Statistical Analysis

Descriptive analyses will be conducted using Student *t*-tests for quantitative variables and Chi-square tests for qualitative variables. Kruskal-Wallis tests will be performed for non-normally distributed variables. Logistic regression models will be performed to investigate the association of coping strategies with (1) PTSD, (2) personality traits, (3) attachment type, and (4) the presence of life traumatic events. Associations between coping strategies and anxiety will be performed using linear regression models. Univariate and multivariate models will be performed to consider potential confounding factors such as environmental, psychiatric, and socio-cultural factors. Moreover, structural equation modeling including psychometric instruments will be used when appropriate.

For all analyses, a  $p < 0.05$  is considered statistically significant and the 95% confidence intervals (CI) will also be provided.

## DISCUSSION

The STERACOVID study will be the first longitudinal study to investigate coping strategies in the COVID-19 pandemic context in the psychiatric geriatric population. This study aims to determine if the type of coping strategies used has an impact on the onset of PTSD after a lockdown period. It will also determine if these coping strategies are influenced by other factors such as socio-demographics, lockdown conditions, particular personality traits, attachment type, and traumatic life events. Several studies (4, 12–14) suggested that quarantine and pandemic crises hurt mental health leading to PTSD, anxiety, and depressive symptoms.

The originality relies on the choice of the study population and the longitudinal design going from the beginning of the pandemic over the different lockdown and post-lockdown periods. Moreover, it includes several standardized and validated scales to assess PTSD, depressive symptomatology, anxiety, personality trait, attachment type, and coping strategies. We also expect to limit the recruitment bias by using phone call interviews conducted by trained psychologists.



The STERACOVID study also has some limitations. Although most assessment tools are standardized and validated scales and constructs, anxiety about COVID-19, feeling of loneliness, and subjective psychic health assessments rely on unvalidated single-item questions. Thus, for these secondary endpoints, we will conduct correlation tests with validated scales such as the GAD7 scale or the psychic health part of the SF-12 scale.

To have a sufficiently large sample, we chose not to include the types of psychiatric diagnoses in the inclusion criteria. Additionally, this will better reflect the patients seen in medical practice. However, the diagnoses classified according to ICD 10 will be collected, and the analyses will take this information into account.

This study will allow identifying the coping strategies to develop in the psychiatric population of older adults and help clinicians track patients at risk to build better care support. It will favor the implementation of more relevant coping strategies, and better lockdown living conditions to limit anxiety and PTSD.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the Saint-Etienne University Hospital. This committee covers the ethical approval for the three sites of our data collection. All procedures follow the Declaration of Helsinki and the International Conference on Harmonization (ICH) Good Clinical Practice Guidelines. The patients have received an informed written information notice. The STERACOVID study is registered in the Clinical Trials database (Current Controlled Trials NCT04760795 <http://clinicaltrials.gov/show/NCT04760795>). The Ethics

Committee waived the requirement of written informed consent for participation.

## AUTHOR CONTRIBUTIONS

IR conceived the idea for the study, helped to draft the manuscript, and managed the design and coordination of the study. EP participated in its design and coordination management. AE drafted the manuscript for submission to BMC Psychiatry. J-MD, AB, MH, BL, CP, and CL-G participated in its design and coordination. IR, AB, HE, CP, and CL-G are responsible for the participants' inclusion at the University Hospital of Saint-Etienne. J-MD and MH are responsible for the participants' inclusion at the Vinatier hospital. All authors approved the final version of the manuscript.

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## APPENDIX

**TABLE A** | Summary of follow-up data collection.

	<b>T0</b>	<b>T1</b>	<b>T2</b>	<b>T3</b>
	<b>Retrospective collection (on patient's records)</b>	<b>First prospective collection</b>	<b>Second prospective collection</b>	<b>Last prospective collection</b>
<b>Moment/Actions</b>	<b>Between March 17th and May 10<sup>th</sup>, 2020</b>	<b>T0 + 12 months</b>	<b>T0 + 18 months</b>	<b>T0 + 24 months</b>
Diagnostics information	X			
Sociodemographic	X	X	X	X
Interview on living conditions	X	X	X	X
Depression				
Short GDS	X	X	X	X
GDS 15			X	X
DSM V criteria			X	X
Anxiety about the context (ordinal scale)	X	X	X*	X*
Subjective psychic health (ordinal scale)	X	X	X	X
Generalized anxiety (GAD-7)	X	X	X	X
Contextual Coping strategies (BRIEF COPE)	X	X	X	X*
Dispositional Coping strategies (BRIEF COPE)			X*	
Personality (BFI)		X		
Attachment type (RSQ)		X		
Traumatic life events		X		
Post-traumatic stress (PCL)			X	X
Quality of life (SF12)			X	X

\*To ask only if the virus is still circulating. The STERACOVID study, 2020-2022, France.



# Exploring the Potential Relationship Between Global Greenness and DALY Loss Due to Depressive Disorders

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**Objective:** Prior studies have shown that greenness can reduce the burden of depressive disorders. However, most were focused on local-scale analyses while limited evaluated globally. We aimed to investigate the association between greenness and the burden of depressive disorders using data from 183 countries worldwide.

**Methods:** We used the normalized difference vegetation index (NDVI) to estimate greenness. Country-level disability-adjusted life year (DALY) loss due to depressive disorders was used to represent depressive disorder burdens. A generalized linear mixed model was applied to assess the relationship between greenness and depressive disorders after controlling for covariates. Stratified analyses were conducted to determine the effects of greenness across several socio-demographic levels.

**Results:** The findings showed a significant negative association between greenness and the health burden of depressive disorders with a coefficient of  $-0.196$  (95% CI:  $-0.356$ ,  $-0.035$ ) in the DALY changes per interquartile unit increment of NDVI. The stratified analyses suggested beneficial effects of greenness on depressive disorders across sex, various age groups especially for those aged  $<49$  years, with low-income and/or those living in highly urbanized countries.

**Conclusions:** Our study noted that greenness exposure was significant negative association with the burden of depressive disorders. The findings should be viewed as recommendations for relevant authorities in supporting environmental greenness enhancement to reduce the mental burdens.

**Keywords:** country-level, DALY loss, depressive disorders, global analysis, greenness

## INTRODUCTION

Mental illness is one of the most widespread and devastating global problems (1). The impact of mental illness is multiplied because of its ability to trigger other health burdens, such as chronic diseases (2). Even worse, mental illness on its own and in combination with other chronic health conditions is often considered a contributing factor to suicide (3). One of the most common and debilitating mental health burdens, on society is depressive disorders. According to the latest report from World Health Organization (WHO), at a global level, over 264 million people suffer from depressive disorders (4). According to the Global Burden of Disease (GBD) study in 2015, depressive disorders are the second leading causes of global age-specific disability-adjusted life years (DALY) for people aged 20–24 years with the change rate of 0.08 to 0.15 (%), the third for people aged 15–19 years with the change rate of 0.01–0.08 (%), and the fourth also fifth leading cause for people aged 25–44 years (5).

Over time, related issues in the economy, education, and wealth have made socioeconomic status an important focus leading to individual mental health problems, such as depression (6). Previous studies also have documented that the elevated extent of urbanization worldwide is one of the risk factors associated with mental illness. It is estimated that around 60% of the global population will live in cities by 2030 (7). This increasing urbanization will create cities that are more densely populated, further increasing the scarcity of the natural environment in these locations, and subsequently increasing the risk for mental burdens such as depression. The main scarcity of natural environments that often occurs is the limited amount of green space. Previous studies showed that limited green space can increase the concentration of air pollution, which in turn leaves populations more vulnerable to mental illness (8, 9). Numerous studies also reported how green environments could help reduce the burden of depressive disorders (10, 11). In relation to epidemiological studies, estimation of exposure to greenness by using remote sensing data such as normalized difference vegetation index (NDVI) is widely used (12–14). For example, by using multi-temporal NDVI data from MODIS, a study in Korea showed that exposure to greenness could alleviate depressive symptoms in the seven major cities in Korea (15). Roe et al. also confirmed that exposure to greenness is associated with reductions in stress (16). Residential proximity to green space is often linked with reduced levels of disease burden from both physical and psychological conditions, such as diabetes, stroke, cardiovascular disease, and stress (17, 18). By considering that time spent in green space could possibly affect neural mechanisms, previous studies have also investigated the potential pathways by which exposure to greenness benefits mental health and vitality related to cognitive function (19, 20), as well as the extent to which differences in age and sex can influence these outcomes (21). Furthermore, the psycho-evolutionary theory or stress reduction theory, indicating frequent nature contact could evoke positive stimuli, which in turn promotes a reduction in physiological activation and blocks negative thoughts (22).

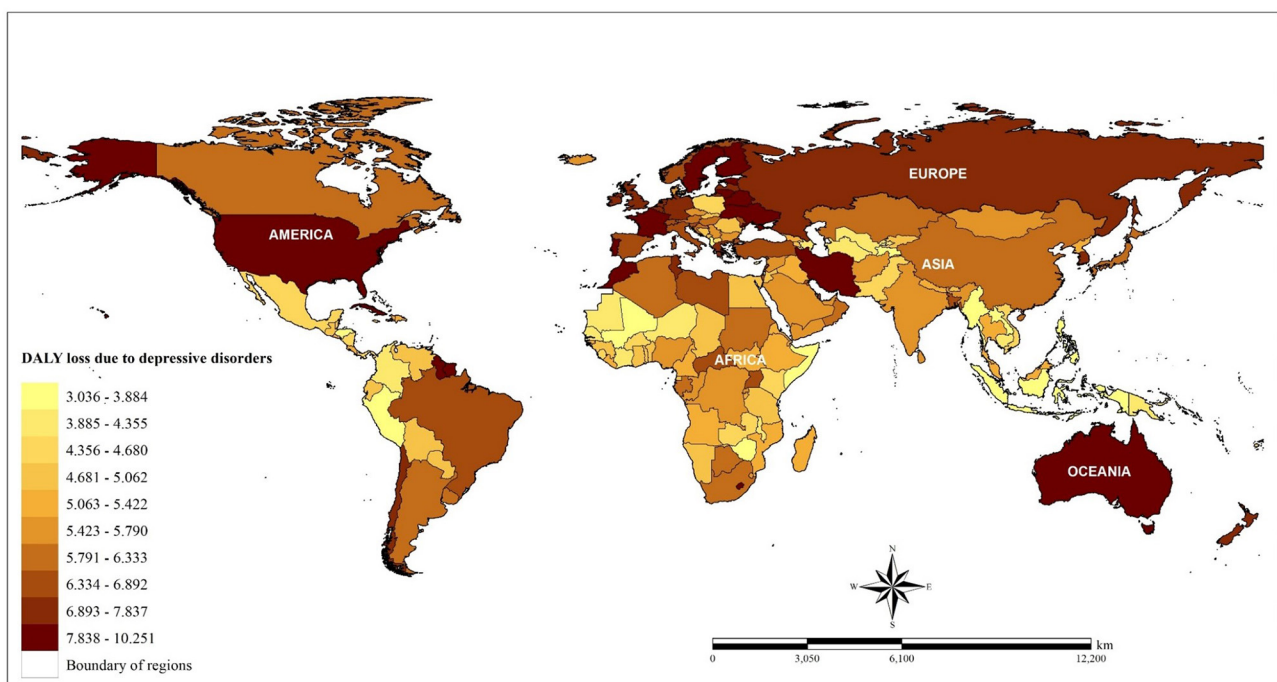
Although previous studies have investigated the positive effect of greenness on depressive disorders such as major depressive

disorder and dysthymia, most were only focused on local-scale analyses while limited available studies have evaluated the benefits of greenness globally. Knowing that depressive disorders is a pioneer for global psychological burden, in this ecological study, we proposed a novel concept to investigate the association between greenness and the burden of depressive disorders in 183 countries worldwide. The main aimed was to respond to scientific gaps related to the relationship between green exposure and mental health burden, which is mostly only carried out in developed countries. By evaluating the association using multinational data, this study proposed to cover the shortfall in evaluating the relationship between greenness exposure and the burden of depression globally, which includes developed and developing countries. We hypothesized that exposure to greenness is inversely associated with the health burden due to depressive disorders globally. We also hypothesized that the beneficial effects of greenness on depressive disorders varies by age, sex, economic status, and urbanization level. Finally, for this study we focused on population-based proxies, therefore the related findings could serve as a baseline for global studies that support environmental development to improve the quality of health and wellbeing.

## MATERIALS AND METHODS

### Health Burden Due to Depressive Disorders

We used the data for disability-adjusted life years (DALY) loss to represent the country-level disease burden due to depressive disorders. This data was provided by the World Health Organization (WHO) from the Global Burden of Disease (GBD) study database. Country-level annual estimation data were available for the four follow-up years (2000, 2010, 2015, and 2016) ([www.who.int/healthinfo/global\\_burden\\_disease/estimates/en/index1.html](http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html)). This data is an estimated value and calculated from a combination of medical data, epidemiology, survey, and meta-regression modeling for each country. In brief, DALY is a summary metric of population health burden due to specific disease. It includes two components: years lived with disability (YLD) and years of life lost due to premature mortality (YLL). This data used a new normative standard life table to compute YLL and adjusted for comorbidity to calculate YLD (23). The DALY data is available for the entire population and is grouped by various factors, such as sex and age group (5–14, 15–29, 30–49, 50–59, 60–69, and  $\geq 70$  years). According to the database used, we defined depressive disorders using International Classification of Diseases 10th revision codes (F32–F33, F34.1) for non-communicable diseases. In total, 183 WHO member countries across five continents with available data on the health burden of depressive disorders were analyzed. **Figure 1** shows the spatial distribution of DALY loss due to depressive disorders. The mental health burden due to depressive disorders was selected as the primary outcome of this study because of the high global burden due to depressive disorders and because previous studies showed that this health burden could trigger an increase in the risk of other health burdens (2, 3).



**FIGURE 1 |** Spatial distribution of DALY loss due to depressive disorders across countries based on the average value from four study periods (2000, 2010, 2015, 2016).

## Assessment of Greenness

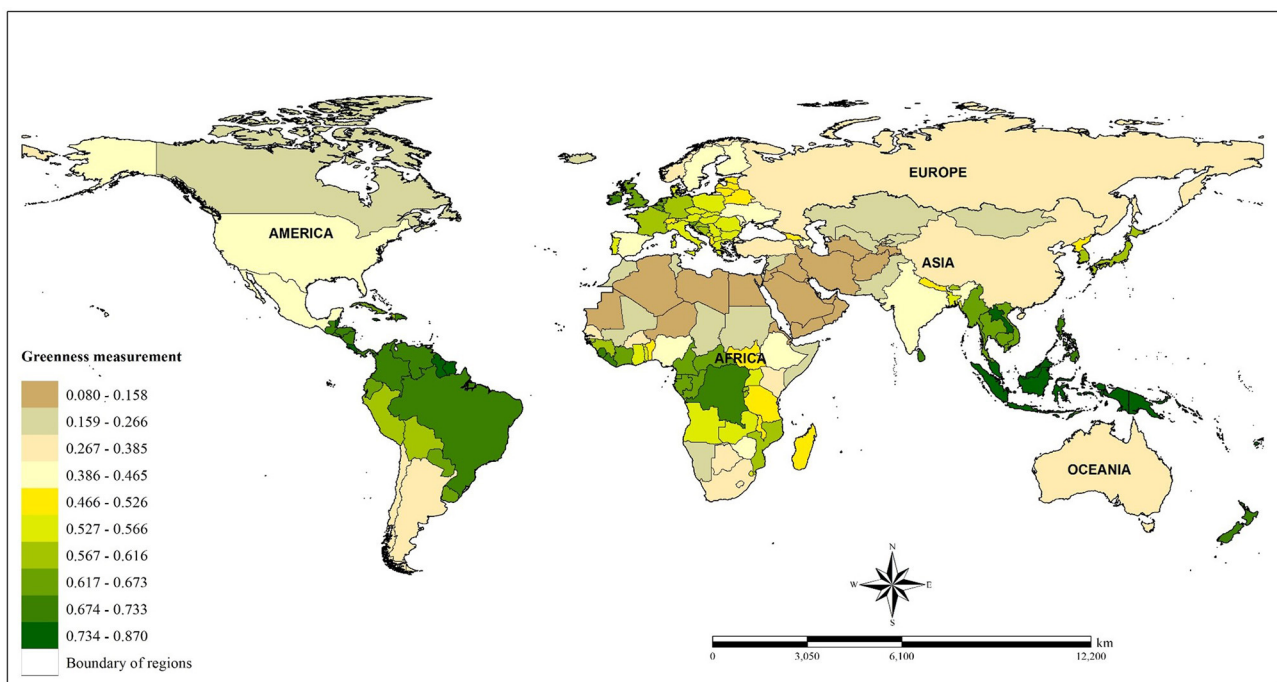
Could cover all regions of the world, the Normalized Difference Vegetation Index (NDVI) measured by a Terra Moderate Resolution Imaging Spectroradiometer (Terra-MODIS) sensor with 1x1 km spatial resolution was used to estimate the presence of greenness in each country (24). The data provided by the National Aeronautics and Space Administration (NASA) includes the monitoring and measuring of vegetation, plants, and biomass production, as well as components of greenness including chlorophyll, canopy structure, and leaf (25). The monthly NDVI used in this study was MOD13A3 version 6 and for a given pixel has a range of values from  $-1.0$  to  $+1.0$ . Positive values represent greener vegetation and negative values indicate limit vegetation (26). Since recent studies have indicated an association between negative NDVI values and the proximity to water (27), pixels with negative values were excluded to avoid misclassification bias due to the effects of water. In our analysis, satellite-images with an acquisition date closer to mid-season were collected for January, April, July, and October; the month settings for the data collection take into consideration countries with two and/or four seasons. In total, 292 MODIS NDVI images were used to assess the greenness of the global area covering the 183 selected countries. For image integration, we generated a monthly global greenness map by combining the 292 images. Next, we established similar procedures to assess greenness for the four selected months. Finally, monthly greenness concentrations were calculated to estimate the annual average values of greenness for each country.

In all, this process integrated a total of 4,672 images across the four follow-up years (2000, 2010, 2015, and 2016). The spatial distribution of greenness in each country based on the NDVI estimations is shown in **Figure 2**.

## Potential Risk Factors

Referring to previous literature, several potential variables assessed in each country were considered for model adjustments (**Supplementary Table 1**). We controlled for demographic covariates including population density, age, and sex provided by United Nations because these factors are often linked with depressive disorders (28, 29). The proportion/ percentage of the educated population on a country-level data obtained from World Bank Group was considered as a protective effect against depressive disorders (30). Because disparity in socioeconomic status is medical health care for each population (31–33), income level data from World Bank Group, as well as the proportion of urban areas in each country, were incorporated into the model. We also considered country-level healthcare expenditure data from World Bank Group (34). Further, sociocultural elements such as religion data provided by United Nations, were also taken into account because they play an important role in helping people adapt to physiological burdens (35). We examined the divorce rate data from United Nations as a social burden since it has been previously linked to depressive disorders (36, 37). Next, we treated blood pressure data from WHO and lifestyle behaviors including smoking and alcohol consumption as covariates obtained from World Bank Group,





**FIGURE 2 |** Spatial distribution of global greenness based on average of NDVI (crude) assessment from four study periods (2000, 2010, 2015, 2016).

as suggested by previous studies (38–41). In this study, we also considered exposure to air pollution such as fine particulate matter ( $PM_{2.5}$ ) estimation with spatial resolution  $1 \times 1 \text{ km}^2$  provided by The Atmosphere Composition Analysis Group, Dalhousie University (in 2000, 2010, 2015, 2016). This is because recent studies confirmed the negative effects of  $PM_{2.5}$  on mental health (42, 43). As a part of covariate adjusted in the association model, country-level  $PM_{2.5}$  data is a daily total column of aerosol optical depth retrievals from satellites that was coupled with the GEOS-Chem transport model and geographically weighted regression model (44). Finally, since a prior study confirmed the link between mental disorders and temperature (45), thus, this study also took into account this meteorological factor in the model adjustment.

## Statistical Models and Sensitivity Test

Descriptive statistics were provided to present the country-level characteristics of all covariates examined in this study, including DALY loss of depressive disorders, environmental exposures (greenness and  $PM_{2.5}$ ), demographic factors (population density, sex, and age), economic status, the prevalence rate of education level, urbanization level, the prevalence rates of populations without religion, divorce rate, lifestyle behaviors (alcohol consumption and smoking), blood pressure, healthcare expenditure, and meteorological factors (i.e., temperature).

The main model with adjustment for the above-listed covariates was developed using the Generalized Linear Mixed Model (GLMM) with a penalized quasi-likelihood (PQL) algorithm to determine the relationship between exposure to

greenness and the health burden of depressive disorders. The GLMMPQL accounts for both fixed and random effects and provides a flexible approach for analyzing health outcomes (46). In the case where spatial data are available from different areas, GLMMPQL can adjust the overall fixed effects while the structure of correlation is nested within areas, enabling the adjustment of regional differences in e.g., autocorrelation distances, and considering spatial autocorrelation only between observations in the same region (47). Given the values for DALY loss due to depressive disorders clustered in some countries, we added an additional term of “continent” as fixed effect in the GLMMPQL calculation to minimize the biases due to the spatial autocorrelation issue. Then, a Spatial Autocorrelation (Global Moran’s I) was performed to examine whether a spatial autocorrelation (SAC) could be detected in the association model (46). By using residual estimation value from the main model, Moran’s I Index and both z-score and *p*-value were calculated. An insignificant Moran’s I with an index close to 0 and *p* > 0.05 supports the evidence that there is no explicit spatial autocorrelation problem in the developed model. Furthermore, generalized variance-inflation factors (GVIFs) were applied to examine the multicollinearity problem across covariates (48, 49). The GVIFs value was < 4 for all covariates, thus all variables were included in our model adjustment (**Supplementary Table 2**).

To evaluate the robustness of our main association model, a sensitivity test was applied. We included different covariates in six separate models adjusted by population density, age, sex, and year in order to discern the change in coefficient estimation and significance. Specifically, **Model 1** only includes greenness

exposure; **Model 2** includes exposure to greenness and PM<sub>2.5</sub> exposure; **Model 3** adds education and economic status in addition to exposure to greenness and PM<sub>2.5</sub> exposure; **Model 4** adds urbanization level and the prevalence rate of the population without religion; **Model 5** adds behavior factors; and **Model 6** considered blood pressure as a risk factor and divorce rates for each country. In this sensitivity analysis, we assumed that there is no significant change in the estimation coefficient or the significance indicator (*p*-value) which indicates the robustness of the main relationship model.

Subsequently, this study conducted stratified analysis based on the level of greenness and socio-demographic factors. First, by using quartile of NDVI (Q1–Q4), the association between greenness in different exposure levels and the burden of depressive disorders were examined. In this case, Q1 represented countries with lower exposure to greenness (as reference), and Q4 represented countries with higher exposure to greenness, quartile 1 (NDVI: 0.085–0.389); quartile 2 (NDVI: 0.390–0.524), quartile 3 (NDVI: 0.525–0.622), and quartile 4 (NDVI: 0.623–0.808). This stratified analysis was considered, given that not all countries have the same green exposure. By completing this analysis, it can be seen whether there is a difference in the effect of the level of green exposure on the outcome. Second, the association between greenness and depressive disorder burdens was examined in different level of socio-demographic factors (50). In this part, we stratified the data by sexes (male and female), six age groups (5–14, 15–29, 30–49, 50–59, 60–69, and ≥70 years), economic statuses (low-income, middle-income, and high-income countries), and urbanization level (low-urban, middle-urban, and high-urban countries).

## Positive-Negative Exposure and Outcome Controls

As a part of validity analysis, positive-negative control variables were used to check the strength of a causal inference of an exposure-outcome association when unobserved factors were thought to be present. Two approaches were used in this study, including a positive-negative outcome control and a positive-negative exposure control. A positive-negative outcome control aimed to identify whether using the same exposure (greenness) and replacing health burden (i.e., DALY loss due to depressive disorders) with other disease burdens from the same dataset could yield consistent results. For positive outcome control, we evaluated the linkage between greenness and the burden of disease due to cardiovascular diseases and for negative outcome control we evaluated Human Immunodeficiency Virus or HIV. Cardiovascular diseases were chosen as a positive outcome control because Yeager's study showed that greenness has a beneficial impact on reducing cardiovascular risk (51). HIV was chosen as a negative outcome control since no studies focused on this issue. In contrast, in the positive-negative exposure control analysis, this study identified whether using studied health burden (i.e., depressive disorders) and replacing greenness exposure could generate a consistent finding. For the positive exposure control, we examined the association between PM<sub>2.5</sub> exposure and burden of IHD. A prior study

confirmed that PM<sub>2.5</sub> was correlated with an increased risk of depressive disorder burdens (52). Then, wind speed was used for the negative exposure control with the assumption that no association between wind speed and depressive disorder burdens.

All of the spatial and statistical analyses were performed using ArcGIS 10.7.1 (Esri Inc., Redlands, California, United States) and R version 3.6.3 (The R packages Foundation for Statistical Computing, Vienna, Austria). Coefficient estimates with 95% confidence intervals (CI) were reported and *p* < 0.05 were considered statistically significant. Further, to avoid false discovery rate for independent test statistics, adjusted *p*-value (Adj. *p*-value) was then calculated using the more powerful adjustment method proposed by Benjamini and Hochberg (53) and Jafari and Ansari-Pour (54).

## RESULTS

### Descriptive Statistics

**Table 1** presents the descriptive statistics of each variable examined in this study. The average global burden due to depressive disorders was 5.62 years [standard deviation (SD): 1.44 years] for the four study periods (2000, 2010, 2015, and 2016). The average amount of greenness—NDVI was 0.49 (SD: 0.21) and estimated per interquartile (IQR = 0.309), the average value was 1.59 (SD: 1.37); average value of PM<sub>2.5</sub> exposure was 19.45 μg/m<sup>3</sup> (SD: 16.10 μg/m<sup>3</sup>); the population density of all selected countries was about 163 population per km<sup>2</sup> (mean ± SD: 163.37 ± 722.47 persons); and almost 50.0% of the global population measured was female.

### Association Models Between Greenness and the Health Burden of Depressive Disorders

A significant negative association between global greenness and depressive disorder burdens were observed (**Table 2**), with a coefficient of the main model was −0.635 (95% CI: −1.155, −0.115) for the DALY changes per increase in NDVI from 0 to 1 or coefficient estimate was −0.193 (95% CI: −0.356, −0.035) in the DALY changes per interquartile unit increment of NDVI (IQR = 0.309). This finding indicates greenness may have a beneficial effect in dealing with the health burden due to depressive disorders. We consistently found significant negative associations between greenness and health outcome from the first six sensitivity test models.

In a detailed assessment, the coefficient estimates for all associated risk factors adjusted in the models were presented in **Supplementary Table 3**. In the main model for the relationship between greenness and DALY loss due to depressive disorders, several variables other than greenness were identified as significant, such as sex (female) and divorce rate with estimated coefficients (95% CI) were 3.253 and 0.264, respectively. Moreover, after controlled for all risk factors, the findings also suggested that greenness had a significant negative relationship with the health burden due to depressive disorders in countries with the highest exposure to greenness (quartile 4); coefficient estimate was −0.510 (95% CI: −1.017, −0.003), compared

**TABLE 1** | Descriptive statistics of variables examined in this study, **(A)** continuous variables and **(B)** categorical variables.

A							
Variable	Mean	SD	Min	25th	Median	75th	Max
DALY loss due to depressive disorders (years)	5.62	1.37	3.04	4.65	5.38	6.47	10.25
Main exposure							
Greenness (continuous NDVI)	0.49	0.21	0.08	0.34	0.54	0.65	0.87
Greenness (IQR of NDVI = 0.309)	1.59	0.67	0.25	1.11	1.74	2.11	2.81
Risk factors							
Population density (people/km <sup>2</sup> )	163.37	722.84	4.88	19.84	49.87	110.13	1,017.36
Sex (female, %)	49.95	3.05	24.17	49.77	50.32	50.92	54.21
Age 5–14 (yrs, %)	19.17	6.42	8.04	13.22	19.05	25.53	31.28
Age 15–29 (yrs, %)	25.38	4.13	14.52	22.30	26.66	28.17	36.76
Age 30–49 (yrs, %)	25.30	5.26	15.77	21.07	25.94	28.70	52.04
Age 50–59 (yrs, %)	8.62	3.58	2.88	5.30	7.85	12.01	16.08
Age 60–69 (yrs, %)	5.89	3.29	1.14	3.16	4.62	8.59	14.30
Age ≥ 70 (yrs, %)	5.10	3.97	0.39	1.95	3.28	7.75	19.08
Education (%)	83.70	19.68	0.00	72.60	92.80	98.80	100.00
Urbanization level (%)	55.68	22.62	10.84	37.04	55.67	73.71	100.00
No religion (%)	0.04	0.10	0.00	0.00	0.01	0.02	0.77
Covariates							
Divorce rate (per 1,000 population)	1.02	1.11	0.00	0.00	0.80	1.72	5.95
Healthcare expenditure (% of GDP)	6.22	2.39	0.00	4.62	6.01	7.84	15.88
Alcohol consumption (liters/population/year)	3.26	3.61	0.00	0.21	2.00	4.82	16.64
Smoking (%)	18.60	13.79	0.00	6.70	19.10	28.30	73.40
Mean systolic blood pressure (mmHg)	126.53	3.39	116.61	124.39	126.65	129.23	134.49
PM <sub>2.5</sub> (μg/m <sup>3</sup> )	19.45	16.10	0.46	7.34	15.02	27.45	87.53
Temperature (°C)	19.64	8.170	−6.211	11.947	23.276	26.151	29.541
B							
Variable	Number (countries)						%
Economic status							
Low-Income	80						43.71
Middle-Income	52						28.42
High-Income	51						27.87
Continent							
Asia	46						25.14
Africa	54						29.51
America	34						18.58
Europe	39						21.31
Oceania	10						5.46

to those with the lowest exposure (quartile 1) (**Table 3**). We also assessed the spatial-autocorrelation effects in the model. As shown in **Supplementary Table 4**, no statistically significant clustering effects ( $p > 0.05$ ) were found in the developed models.

## Stratified Analysis by Socio-Demographic Factors

After adjusting for potential risk factors, the stratified analyses by sex, age group, economic status, and urbanization level were assessed (**Figure 3**). We found a significant beneficial effect of greenness on depressive disorders for both females and males

with coefficient estimate were  $-0.109$  and  $-0.104$  (95% CI:  $-0.213$ ,  $-0.005$  and 95% CI:  $-0.178$ ,  $-0.003$ ), respectively, in the DALY changes per interquartile unit increment of NDVI. This finding suggesting no sex-based inequality in relation to the impact of greenness on depressive disorder burdens. We found that the burden due to depressive disorders had a negative association with greenness in several age groups, especially the group aged 5–49 years rose to significance. The results from the stratified analysis also showed that significant negative associations of greenness with the health burden of depressive disorders were found in low-income countries and countries

**TABLE 2 |** Association models between greenness and depressive disorders in the DALY changes per unit increment of NDVI, supported by stratified analysis.

Model	Coefficient of NDVI* (95% CI)	Adj. <i>p</i> -value	Coefficient of NDVI** (95% CI)	Adj. <i>p</i> -value
Main Model <sup>a</sup>	−0.635 (−1.155, −0.115)	0.030	−0.196 (−0.356, −0.035)	0.030
<b>Sensitivity test adjusted for covariates</b>				
Model 1 <sup>b</sup>	−0.633 (−1.101, −0.166)	0.011	−0.196 (−0.340, −0.051)	0.011
Model 2 <sup>c</sup>	−0.640 (−1.113, −0.167)	0.013	−0.197 (−0.344, −0.051)	0.013
Model 3 <sup>d</sup>	−0.565 (−1.039, −0.091)	0.030	−0.174 (−0.321, −0.028)	0.030
Model 4 <sup>e</sup>	−0.562 (−1.036, −0.088)	0.034	−0.173 (−0.320, −0.027)	0.034
Model 5 <sup>f</sup>	−0.535 (−1.009, −0.061)	0.039	−0.165 (−0.311, −0.019)	0.039
Model 6 <sup>g</sup>	−0.664 (−1.171, −0.158)	0.030	−0.204 (−0.360, −0.047)	0.030

\*Continuous data of NDVI (0–1).

\*\*Interquartile or IQR of NDVI (0.309).

CI, Confidence interval; NDVI, Normalized different vegetation index.

<sup>a</sup>Control variables included population density, sex (% of females), age, PM<sub>2.5</sub>, economic status, the prevalence rate of education, population without religion, the prevalence rate of smoking, alcohol consumption, systolic blood pressure, divorce rate, urbanization level, healthcare expenditure, and temperature.

<sup>b</sup>Adjusted for population density, sex (% of females), and age.

<sup>c</sup>Adjusted for population density, sex (% of females), age, and PM<sub>2.5</sub>.

<sup>d</sup>Adjusted for population density, sex (% of females), age, PM<sub>2.5</sub>, economic status, and the prevalence rate of education.

<sup>e</sup>Adjusted for population density, sex (% of females), age, PM<sub>2.5</sub>, economic status, the prevalence rate of education, and population without religion.

<sup>f</sup>Adjusted for population density, sex (% of females), age, PM<sub>2.5</sub> exposures, economic status, the prevalence rate of education, population without religion, the prevalence rate of smoking, and alcohol consumption.

<sup>g</sup>Adjusted for population density, sex (% of females), age, PM<sub>2.5</sub>, economic status, the prevalence rate of education, population without religion, the prevalence rate of smoking, alcohol consumption, systolic blood pressure, divorce rate, and healthcare expenditure.

**TABLE 3 |** Coefficient estimations of greenness by quartile attributed to depressive disorders in multivariable adjusted models.

	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
	Coefficient of NDVI (95% CI)	Adj. <i>p</i> -value	Coefficient of NDVI (95% CI)	Adj. <i>p</i> -value
Quartile 1 (Q1)* low exposure	Reference	Reference		
Quartile 2 (Q2)*	−0.201 (−0.690, 0.289)	0.466	−0.410 (−0.878, 0.058)	0.148
Quartile 3 (Q3)*	−0.378 (−0.865, 0.109)	0.160	−0.536 (−1.030, −0.042)	0.042
Quartile 4 (Q4)* high exposure	−0.591 (−1.076, −0.106)	0.025	−0.510 (−1.017, −0.003)	0.049

\*Categorical data of NDVI based on the quartile of NDVI.

CI, Confidence interval; NDVI, Normalized different vegetation index.

<sup>a</sup>Additional adjustment for population density, sex, age, and PM<sub>2.5</sub>.

<sup>b</sup>Control variables included population density, sex (% of females), age, PM<sub>2.5</sub>, economic status, the prevalence rate of education, population without religion, the prevalence rate of smoking, alcohol consumption, systolic blood pressure, divorce rate, urbanization level, healthcare expenditure, and temperature.

with high urbanization levels, coefficient estimate was −0.216 and −0.394 (95% CI), respectively, in the DALY changes per interquartile increment of NDVI.

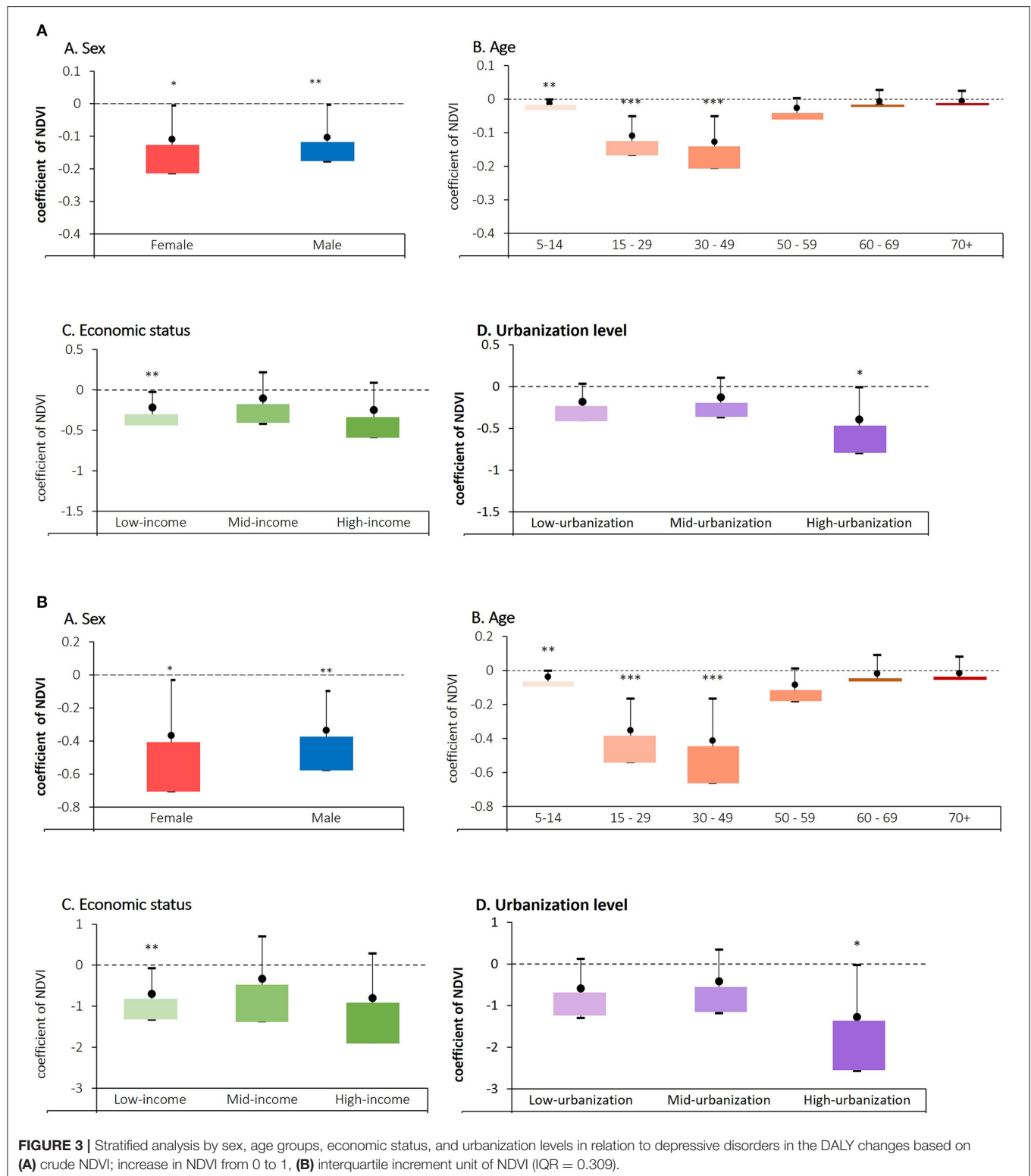
## Positive-Negative Exposure and Outcome Controls

The results of the associations between positive or negative exposures and depressive disorder burdens were shown in **Supplementary Table 5**. First, a significant positive association was observed between fine particulate matter (PM<sub>2.5</sub>), a positive exposure control, and depressive disorders. Second, the relationship between the health burden of depressive disorders and wind speed, a negative exposure control, was not significant. We also examined associations between exposure to greenness and positive or negative outcomes. A significant relationship between greenness and cardiovascular diseases, a

positive outcome control, was found, whereas a non-significant relationship between greenness and HIV, a negative outcome control, was also observed.

## DISCUSSION

To our knowledge, this is the first global ecological study to investigate the association between greenness and the health burden of depressive disorders across multiple countries. Consistent with our hypotheses, our findings showed a significant negative association between greenness and depressive disorder burdens. In various sensitivity analyses, we consistently obtained similar results and supportive evidence that the higher the greenness exposure, the lower the health burden due to depressive disorders. The significant negative association



of exposure to greenness with the burden of depressive disorders remained after accounting for potential country-level risk factors.

Our findings were reinforced by previous local studies. For example, Sarkar et al. observed a protective effect of greenness on depressive disorders, with 4.0% lower odds of major depressive



disorder per interquartile increment in NDVI (odds ratio 0.96, 95% CI 0.93–0.99;  $p = 0.004$ ) (50). In America, a study by Bezold et al. also reported that there was a 6% lower incidence rate of high depressive symptoms related to an interquartile range increase in greenness exposure (55). Taking children as the subject, a cohort study in the United States showed that increased exposure to greenness represented by NDVI was associated with a reduced risk of mental disorders such as depression (56). Moreover, the benefit of living in a green environment on mental health related to a lower incidence of depression was also found in South Africa (57). Applying the waitlist-control randomized controlled trial design, a study in Singapore that evaluated the effects of horticultural therapy on Asian adults showed the effectiveness of this therapy in improving mental wellbeing (58). Further, Takayama's study also reported that both people with and without depressive tendencies, forest bathing have a significant positive effect on improving profile of mood states (59). Supportive findings regarding how greenness exposure is associated with a lower risk of depression were also demonstrated by other previous studies (60–68). The beneficial impact of greenness on reduction in the health burden was also identified for physical health diseases such as cardiovascular mortality (51); malignant neoplasms (69, 70); diabetes mellitus (71, 72); respiratory diseases (73, 74); and on the body's metabolic system (75). In general, this study differed from those previous investigations, where the health burden of depressive disorder was represented by the DALY loss metric (considering year loss due to morbidity and mortality) rather than incident or prevalence rate data.

How the presence of greenness could have a significant negative association with the burden of depressive disorders was explained by several plausible reasons. Ulrich (76) emphasized that there are four pieces of evidence indicating the benefits of greenness on health, including (1) a sense of control: green space could provide a sense of control by allowing people a temporary means of physical or mental escape from a stressful conditions; (2) social support: how green space is used to increase social support; (3) physical movement and exercise; and (4) natural positive distractions in mitigating stress, pain, and frightening. In 2008, Ulrich et al. also reported relationships between environmental interventions and health outcomes in two main categories—reduce pain and reduce stress (77). Furthermore, beneficial pathways of greenness on mental condition confirmed by Kaplan and Kaplan (78) who introduced attention restoration theory (ART). They stated that certain environments including nature are particularly effective at fostering recovery and dealing with fatigue.

We did not find a sex difference in the association between greenness and the burden of depressive disorders. In support of our findings, a systematic review by Bolte et al. showed that no consistent sex differences have been shown related to the impact of greenness on health (79). We did find that the association between greenness and the health burden of depressive disorders extended across various age groups and was significant particularly in those aged 5–49 years. Our findings are supported by several studies suggesting that greenness can reduce the risk of mental health burden among children and

adults (80–90), even during pregnancy (91). Contrary to the previous findings on the impact of greenness on the elderly population (13, 92), we did not find significant association effects after age 49 years. Reasonable explanations may be due to changes in socioeconomic roles and decreased mobility to access green spaces at this age, as has also been suggested by Gilroy (93). In the subsequent analyses, we found a significant negative association between exposure to greenness and depressive disorder burdens in low-income and highly urbanized countries, respectively. Similarly, Tomita et al. also proposed the benefits of greenness for mental wellbeing in sub-Saharan Africa which has been experiencing rapid urbanization and economic transition (57). Moreover, Hoffmann's study also confirmed that exposure to greenness has the potential to mitigate health inequalities associated with socioeconomic deprivation (94).

Several strengths were noted in this study. This is the first global ecological study to investigate the association between greenness and the health burden of depressive disorders across 183 countries worldwide. Thus, our findings can serve as a global baseline for future environmental development research studies. Our methodological considerations were sound and included the use of various spatial-statistical approaches to deal with the spatial autocorrelation issue that may be caused by clustering patterns. Moreover, we adjusted our analytical models for several potential confounders with influence on the effectiveness of greenness in minimizing the burden of depressive disorders.

Some limitations also need to be acknowledged. Recognizing that the DALY data provided by WHO is only available at the country-level, not available at the state and/or city levels. A distinct analysis for big countries within-country variability cannot be done. Coming studies could examine the effects of greenness benefits at local communities in the case a finer-resolution DALY data available. In addition, the health burden data represented by DALY obtained from the Global Burden of Disease (GBD) study is multinational and multitemporal data that can be updated. Knowing this issue, considering the latest DALY data is recommended. Although we used greenness data for the same period as the main outcome, due to the limited accessibility of vegetation species data for each country, we did not adjust for the effects of biodiversity in the models. We only used NDVI value to represent total greenness exposure and assumed that all types of greenery had a positive impact on health. In the case of land use or land cover data showing the diversity of greenness is available on a global scale or other green index derived from satellite could estimate spatial greenness exposure, perhaps this could be a better consideration for future studies. Some related factors are unavailable in the global datasets, such as genetic or hereditary disease, health care quality index and ethnicity and/ or race. It will be important to explore the effects of these important factors on depressive disorders in future studies. This study also used an ecological study design, and the measure of exposure was only proxy-based on the average of the whole population. We recognize that the lack of individual data might have some impact on the strength of evidence provided by this study. Finally, the results of this global analysis cannot be directly compared

to observational studies and the results should be interpreted with caution.

## CONCLUSION

Our findings demonstrate a significant negative association between exposure to greenness and the burden of depressive disorders, particularly in low-income and high-urbanized countries. This study is the first to provide evidence for the link between greenness and depressive disorder burdens on a global scale. The findings from this study should serve as a call to policymakers and communities to deploy environmental interventions in terms of helping to deal with the global health burden of depressive disorders, with the potential for positive repercussions for the world.

## 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

AKA, S-CCL, H-JS, C-DW, and JDS: conceptualization. AA, H-JT, W-CP, YLG, and C-DW: methodology. AKA and W-CP: formal analysis. AKA, H-JT, and C-DW: writing—original draft preparation. AKA, H-JT, W-CP, YLG, C-PY, C-SW, H-JS, S-CCL, C-DW, and JDS: writing—review and editing. C-DW, S-CCL, and H-JS: supervision and funding acquisition. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2022.919892/full#supplementary-material>

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# Role of an Online Skill-Based Mindfulness Program for Healthcare Worker's Resiliency During the COVID-19 Pandemic: A Mixed-Method Study

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The COVID-19 pandemic has highlighted the mental health care needs of health care workers. The primary aim of this study was to explore the effects of an online mindfulness program on resiliency in health care workers during the pandemic using a mixed-methods approach. An online 4-week mindfulness program was delivered to healthcare workers ( $N = 130$ ) in Ontario, Canada. Resiliency was assessed at 3-time points (i.e., pre, post, and 1-month follow-up), and the mindfulness program's efficacy on resiliency was analyzed using linear regression. Semi-structured interviews ( $N = 10$ ) were conducted to substantiate their experiences. Healthcare workers' resiliency significantly increased after the mindfulness program compared to the baseline, maintaining the effect after 1 month in both unadjusted and adjusted regression models. These findings were further bolstered by the positive experiences shared by participants highlighting the program's efficacy on empathy and resiliency. Evidence suggests that mindfulness is associated with promoting resiliency in healthcare workers and may be an important strategy to promote resiliency in this population.

**Keywords:** mindfulness, COVID-19, healthcare workers, resiliency, online delivery

## INTRODUCTION

COVID-19 is one of the most traumatic events in the 21st century, especially for healthcare workers worldwide (1, 2). 1 in 5 healthcare workers reported experiencing depression and anxiety-related symptoms (3). Due to long hours and increased workload, healthcare workers are experiencing psychological stressors such as anxiety, depression, and burnout that have reduced their quality of life (4). Further, lived-experience narratives of healthcare workers' well-being during the first wave of the pandemic reveal that most of the healthcare workers experienced worsening mental health well-being due to stigma, fear, guilt and isolation (5).

In the province of Ontario, Canada, the first case was reported on January 25, 2020, and community transmission was documented on March 1, 2020, in British Columbia (6). Within days of this announcement, the Ontario provincial government declared a state of emergency. This declaration limited the activities and movement of individuals to reduce contact and the spread

of the virus (7, 31). This included the government-mandated closure of non-essential businesses, all indoor recreational programs, schools, public libraries, theaters, and some days later, all outdoor recreational spaces, including parks and walking trails. Public gatherings were also limited to < 50 people. While some of these restrictions were lifted by June 22, 2020, the provincial state of emergency continued until July 24, 2020. Over the next 2 years, a provincial state of emergency has been redeclared on different occasions, and ongoing changes to these restrictions have continued in an effort to slow transmission and alleviate pressures on the healthcare system. Research has revealed that the constant demands and pressures of the COVID-19 pandemic have significantly affected healthcare workers' mental health and well-being (8).

The psychological stressors during the pandemic compromise healthcare workers' capacity to provide care, thus endangering the stability and quality of patient care (9) highlight the importance of acceptance-based coping in their recent perspective article on recovery from COVID-19. The authors indicate that fully accepting emotions arising to the mind is critical to achieving a longer-term resiliency. Resiliency, defined as "the ability of adults... to maintain relatively stable, healthy levels of psychological and physical functioning... as well as the capacity for generative experiences and positive emotions (pp. 20-21)"(10), is vital for healthcare workers and society (1, 9, 11–13). Thus, implementing robust health and educational services that promote resiliency for healthcare workers is paramount to supporting recovery from the global epidemic (1, 14, 15).

Mindfulness programs embody awareness and acceptance-based practices and promote connectedness that can be used to build resiliency (9, 16). Mindfulness is defined as a practice that involves focusing awareness on the present moment while acknowledging and accepting one's feelings, thoughts, and bodily sensations without judgment (17). With over two decades of mounting scientific research demonstrating benefits—from fortifying the immune system to reducing stress and anxiety and improving overall well-being—mindfulness-based intervention has been used to mitigate emotional challenges (18–20). Mindfulness programs are a promising tool supporting resiliency for healthcare workers (9, 16). A recent systematic review on the psychological effects of online-based mindfulness programs during the pandemic that included 6 randomized controlled trials concluded that the online mindfulness program could be useful for reducing anxiety, depression and stress levels of the general population, healthcare workers and patients (32).

However, to our knowledge, whether it can effectively enhance resiliency among healthcare workers during COVID-19 has not been studied yet. There is a growing interest in creating accessible strategies for healthcare workers to promote better mental health and resiliency. The outcome of this study, grounded both on quantitative and qualitative findings, responds to the critical need to cultivate a resilient society amid a global pandemic. Lessons learned will guide healthcare services for healthcare workers (e.g., well-ness programming) throughout physical distancing and beyond as the pandemic slowly transitions to an endemic status.

## METHODS

### Study Design and Participants

A mixed-methods approach was used to examine the role of the 4-week online Mindfulness Ambassador Program (MAP; developed by a non-profit organization, Mindfulness Without Borders), in fostering resiliency during the pandemic and exploring the participant's and facilitator's experience. A total of 130 healthcare workers in Ontario, Canada, participated in the study through a frontline well-ness program at a psychiatric hospital and completed pre-, post-, and follow-up surveys (mean age 31–50 = 53.8%; female = 93%). For the qualitative analysis, we predicted that basic themes may emerge after 4–6 interviews and that saturation will signal the end of recruitment. Among 130 healthcare workers, we aimed to recruit ten random participants for semi-structured interviews through multiple follow-up emails. As saturation began to emerge after seven interviews, where no new data or themes emerged, and as a result, no new codes, we stopped the recruitment for interviews. The interviewees were all women. 67% of the women were between the ages of 31 to 50 years old. 45% had a non-clinical role (e.g., administration, research, IT), and another 45% provided direct patient care. 43% of the interviewees had more than 20 years of working experience in a healthcare setting, and another 43% had <11 years of experience.

### Procedure

The 4-week online Mindfulness Ambassador Program (MAP) was offered to healthcare workers *via* zoom through the institutions' frontline wellness program (October 2020 to March 2021). Any active health care worker (regardless of their history of psychiatric illness or substance use) in the province of Ontario seeking mental-wellness assistance during the COVID-19 pandemic could self-refer and register for the 4-week online mindfulness program through the Frontline Well-ness Program. Registering in the mindfulness program did not constitute registration in this research study. Those who are no longer in active employment as health care workers were excluded from participating in the study but still had access to the MAP if they chose. All health care workers who enrolled in the 4-week MAP were sent a participant information letter by the MAP facilitators, inviting them to participate in the study. After obtaining consent, a pre-survey was administered before the program began.

The MAP program was retooled to provide healthcare workers and the community an in-time well-being service in response to the pandemic. Retooling the MAP program morphed a face-to-face, 12-week and 12-h program into a virtual, 4-week, 2-h skill-based course. After obtaining consent, a pre-survey was administered before the program began. Each mindfulness session ran once a week for 30 min, with one certified MAP facilitator assigned to each group (max 20). A post-survey was administered immediately after the fourth session, with a follow-up survey 1 month after the last session. After the post and follow-up survey, participants were offered a \$20 gift card as a thank-you gift for their time completing the surveys. Surveys for this quantitative component were conducted and completed online. Followed by the post-surveys,

the research team conducted semi-structured interviews with ten randomly selected participants, and program facilitators from April through mid-May 2021 *via* a secure online platform (i.e., Zoom). The interviews took an hour, and an additional \$25 gift card was offered. All participants provided consent to audio-record the interviews. All recorded data and transcriptions were stored in a password-protected laptop.

## Analysis

### Quantitative

Linear regression models using the generalized least squares (GLS) approach, allowing more efficient estimates and unbiased regression parameters for panel data, were conducted to evaluate the efficacy of the mindfulness program on healthcare workers' resiliency, measured by Nicholson McBride Resilience Questionnaire (NMRQ). NMRQ is a 12-item survey with Likert-type responses designed to measure resilience, which is defined as one's capacity to bounce back from extreme occasions or triumph in the face of hardship (Clarke, 2010). Scores range from 12 to 60, where higher numbers are indicative of greater resilience. First, an unadjusted regression model was conducted to examine the change in resiliency total score over time (baseline, post-intervention, and 1-month follow-up after completing the mindfulness program). Next, participant characteristics such as age, sex, healthcare worker's role (clinical, non-clinical), work location (front line or virtual/online), years of occupational service, and mindfulness related variables such as previous exposure to mindfulness program (Yes/No), the number of sessions attended, and the frequency of mindfulness practice was added to the model (Adjusted model). Coefficients and 95% confidence intervals (CIs) are reported. Software for Statistics and Data Science (STATA; V.16.0) was used.

### Qualitative

The interview protocol was developed during a research advisory meeting with seasoned mindfulness practitioners and the research team. All transcriptions were member-checked by participants to ensure the interview data provided an interpretation that resonated with the participant. Thematic analysis (TA), a method to systematically identify, organize and offer insight into patterns of meaning (themes) across a dataset, was used (21) to identify common themes that arose among facilitators' and participants' experiences with 4-week online mindfulness programs and the cultivation of resiliency. The iterative stages of reviewing, defining, and naming themes were completed using the entire dataset. All qualitative analyses were conducted using NVivo software.

## RESULTS

Fifty percent of participants reported working in healthcare for < 10 years, 53% reported working directly with patients, and 64% of participants had no previous mindfulness experience. Participants reported practicing mindfulness 1–3 times per week in both the post and follow-up surveys (post, 65%; the follow-up, 69%). **Table 1** presents the resiliency score based on the participant characteristics and mindfulness-related variables at

**TABLE 1 |** Resiliency score for three-time points based on participant characteristics and mindfulness related variables (mean, SD).

	Baseline	Post-intervention	1-month follow up
<b>Age</b>			
< 31	39.15 (5.33)	38.57 (6.55)	41.55 (6.41)
31–50	40.48 (5.55)	43.32 (6.61)	42.97 (6.42)
> 50	43.60 (6.33)	41.88 (6.75)	44.23 (5.62)
<b>Years worked</b>			
< 11	41.56 (5.18)	43.09 (7.11)	43.89 (4.99)
11–20	42.44 (3.48)	42.89 (4.05)	44.40 (4.62)
> 20	42.71 (6.94)	42.00 (7.50)	43.50 (5.78)
<b>Mode of care</b>			
Direct	41.80 (5.72)	42.50 (6.55)	43.30 (5.41)
Indirect	40.24 (6.09)	41.11 (7.30)	42.40 (6.92)
<b>Mindfulness exposure</b>			
No	41.25 (6.17)	42.19 (6.96)	42.56 (6.82)
Yes	41.07 (5.59)	41.70 (6.63)	43.83 (4.73)
<b># of mindfulness practice</b>			
Never	40.00 (6.93)	40.00 (8.93)	39.25 (8.10)
1–3 times/week	40.39 (6.43)	41.42 (6.62)	43.03 (6.43)
4–7 times/week	41.82 (6.31)	44.53 (5.56)	45.08 (4.98)
<b># MAP sessions attended</b>			
1–2 sessions	39.82 (8.38)	39.33 (8.92)	41.10 (8.95)
3 sessions	40.71 (7.05)	42.33 (6.44)	45.00 (5.93)
4 sessions	41.10 (5.27)	43.39 (5.02)	43.17 (5.34)

three-time points. **Table 2** presents the unadjusted and adjusted regression model findings. Based on the unadjusted model, healthcare workers' resiliency significantly increased after the mindfulness program compared to the baseline, maintaining the effect after 1 month. The efficacy of the mindfulness program was sustained after adjusting for participant characteristics and mindfulness-related correlates. Older age (compared to < 30 years old) and the number of mindfulness practices (4–7 times a week) significantly contributed to resiliency.

Participants' qualitative narrative substantiated and complemented the quantitative findings by providing a nuanced account based on their experience. In general, the positive experiences shared situated the program's positive effect on empathy and resiliency by providing time and space for them to practice self-care and teaching strategies that helped them embody mindfulness. Participants shared that the 4-week program helped them flip the script and develop a better understanding of the importance of self-care and self-compassion, "*It solidified the fact that you know, I am worth it that I need to focus on taking care of myself rather than always focused on taking care of others (31–50 yrs old, female, direct patient care, <11 years of healthcare work experience).*" For this participant and others, the availability of the program and the program itself encouraged them to prioritize their own self-care, provided an "*important reminder*" or the space to actualize self-care. Some also emphasized that the program helped them establish a routine and dedicate time to practice. Others shared

**TABLE 2 |** Associations between resiliency and participant characteristics and mindfulness related variables (Coefficients, 95% CI).

	Unadjusted model	Adjusted model
<b>Time</b>		
Baseline	Ref	Ref
Post-intervention	1.09 (0.12–2.05)*	1.26 (0.18–2.34)*
Follow up	1.66 (0.78–2.54)***	1.73 (0.58–2.87)**
<b>Age</b>		
< 30		Ref
31–50		5.07 (1.69–8.45)**
>51		4.93 (0.55–9.31)*
<b>Years worked</b>		
<11		Ref
11–20		–1.18 (–4.53–2.17)
>20		–1.53 (–4.49–1.44)
<b>Mode of care</b>		
Direct		Ref
Indirect		0.86 (–2.95–4.66)
<b>Mindfulness exposure</b>		
No		Ref
Yes		–2.53 (–5.45–0.38)
<b># of mindfulness practice</b>		
Never		Ref
1–3 times/week		4.93 (–0.60–10.45)
4–7 times/week		8.56 (3.28–13.84)**
<b># MAP sessions attended</b>		
1–2 sessions		Ref
3 sessions		0.67 (–3.59–4.94)
4 sessions		–0.69 (–3.89–2.51)

\* &lt;0.05, \*\* &lt;0.01, \*\*\* &lt;0.001.

that they found the time and space provided with the program a welcome reprieve from the complexity of the support and care they were providing others in their roles. Others who echoed this sentiment shared the responsiveness of the program to provide just in time support, “I’m glad that I was able to participate, and it was just at the right time where I kind of felt like I finally got into a bit of a crisis myself...It was very helpful that way and I just really appreciated it was there. Sort of when I needed it (31–50 yrs old, female, virtual patient care, < 11 years of healthcare work experience).”

Some participants shared that they were applying the strategies taught in the program and that these strategies were supporting their well-being. Others admitted that they were not applying the practice strategies. However, participants of this study all shared how they were embodying mindfulness, revealing that the effects of the strategies taught had become habitual or part of participants’ resiliency toolkit. Some shared that they were pausing to take deep breaths during moments of heightened anxiety or frustration or seizing 5 min to ground by sitting in the car, awakening awareness, beginning to reveal the many ways in which the practices taught were being integrated: “Because it (the body scan) just made me relax better, and I sometimes still

do that when I come home from work, when I told you that I feel like I’m still kind of in overdrive. I try to just go from the top of my head to the bottom of my toes and just sort of and I could do that quietly without even if my husbands in the room, you can just sort of inwardly focus on yourself (51–65 yrs old, female, non-clinical support).”

## DISCUSSION

Providing accessible and flexible resources to improve resiliency in healthcare workers is critical during the pandemic (2, 9, 15). This study investigated the efficacy of a 4-week online mindfulness program and contributing factors in resiliency among healthcare workers during the COVID-19 pandemic using a mixed-method approach. Resiliency significantly increased after the 4-week online mindfulness program, and the effects were maintained after 1 month. Practicing mindfulness techniques frequently (4–7 times a week) and age over 30 years significantly and positively associated with resiliency. The qualitative narratives revealed that the connection between the positive framing of the mindfulness program as self-care conceptualized why participants were drawn to attending, and their shared challenges with carving out time for practice was balanced with the many ways in which practice is being integrated into daily living, something that may not have been captured in reports of frequency of practice.

The results of this study support the efficacy of a 4-week online mindfulness program enhancing resiliency in healthcare workers during the pandemic. The positive impact of mindfulness practice was attributed to the number of daily mindfulness practices and being able to integrate practices into personal and professional lives, reaffirming the importance of pursuing efforts to support continued practice. Our findings on resiliency uniquely add to the growing literature on the efficacy of mindfulness practice on mental well-being during the pandemic (1, 22–24). For instance, mindfulness practice to awaken present moment awareness and practice non-judgmental awareness can lead to positive mental health outcomes during the pandemic, such as improved empathy, self-compassion among healthcare professionals (22), pandemic-related distress (23–25) and emotional problems such as anxiety and depression (24, 25) during COVID-19.

Our study is limited by the small number of interviews to reach data saturation, as a minimum of 13 cases is recommended (21). Despite the low number of interviews, we believe that the resultant response rate provided “rich” insight into the emic experience of healthcare workers. Whereby thick data refers to a large quantity of data, rich refers to its quality. This study’s data was layered, nuanced and enriched the understanding of an experience or phenomenon (26). Further, most healthcare workers who participated in the study are mostly located in rural areas of the province, and mostly females limiting the ability to generalize the findings. Women are the dominant gender group among healthcare workers in Canada. A recent scoping review (27) indicates that female healthcare workers show high anxiety, depression, and burnout during the pandemic.



Despite the skewed sex ratio and region, we believe our study provided the groundwork for mitigating female healthcare workers' mental well-being in rural regions during the pandemic. Additional research using a randomized controlled trial design and comparing the efficacy of mindfulness programs with a different mode, timing, and frequency on resiliency with diverse healthcare workers in broader area is warranted to further determine the efficacy of mindfulness programs in healthcare workers' resiliency.

Despite the limitations, to our knowledge, this is the first study that explored the role of an online mindfulness program to enhance resiliency in healthcare workers, bolstering the online delivery of mindfulness programs during the pandemic. Furthermore, we used panel data and conducted linear regression analysis using the generalized least squares (GLS) approach for efficient estimation and unbiased regression parameters to evaluate the efficacy of the mindfulness program. Knowledge gained from this study will guide organizational development initiatives seeking to build resiliency using mindfulness-based intervention programs. It is worth noting that while mindfulness has been associated with positive health outcomes in this population, research has found barriers to engaging in mindfulness practices that must be considered (28–30). For instance, Valley et al. reported internal barriers to health care workers' adopting mindfulness-based practices include high levels of stress, difficulties with attention, and a lack of prioritization for self-care activities within the workplace. These findings have likely only been further exacerbated by the demands of the pandemic. Further research is warranted to explore how to best tailor mindfulness-based programs to improve adherence to future interventions and the long-term adoption of these practices. Given these findings, at an organizational level, protected time to participate in wellness activities (e.g., mindfulness practice) should be explored as a needed and essential part of preventing mental health and building resilience within health care workers.

In conclusion, our findings have important public health implications, as protecting and restoring healthcare workers' health and well-being is of immediate concern to public

health professionals during the COVID-19 pandemic. These important considerations unearthed through this study may help guide pedagogical and instructional changes in mindfulness-based intervention programs designed to facilitate resiliency in the future. The evidence-base produced through this study will support the widespread implementation of an online mindfulness-based intervention, delivered throughout the period of physical distancing and beyond, as we slowly transition to a "new normal."

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author [SK]. The data are not publicly available due to them containing information that could compromise research participant privacy/consent.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institution's Ethics Review Board (Waypoint Center for Mental Health Care, Protocol ref. # HPRA#20.07.27). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

SK conducted the quantitative data analysis and drafted the manuscript. SH conducted semi-structured interviews and qualitative data analysis. All authors contributed to the conceptualization of this study. All authors contributed to drafting the manuscript, provided critical revisions, and approved the final manuscript.

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**Conflict of Interest:** SH worked as a facilitator with Mindfulness Without Border (MWB) during the data collection period facilitating mindfulness programs for other institutions (not related to this study) and was no longer in contract with MWB during the manuscript preparation period.

The remaining 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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# Risk factors for community-acquired pneumonia among inpatients with mental disorders in a tertiary general hospital

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**Introduction:** Community-acquired pneumonia (CAP) is an important cause of hospitalization and death in patients with mental disorders. It is critical to understand the risk factors of CAP and determine prevention strategies to reduce CAP. The aim of this study is to explore the characteristics of inpatients with mental disorders who have CAP and analyze the risk factors.

**Methods:** This retrospective study included 16,934 inpatients with mental disorders who were admitted for the first time to a tertiary general hospital between January 2017 and July 2021 (excluding January 2020–May 2020). Risk factors for CAP were identified by logistic regression analysis after propensity score matching (PSM, 1:4) for age, gender, and BMI.

**Results:** The CAP rate of inpatients with mental disorders was 1.78%. Inpatients who had CAP had a significantly prolonged hospital stay, and were more often admitted to a closed ward or the ICU. After PSM, the multivariable analysis revealed that clozapine use (OR = 3.212, 95% CI = 1.744–5.915,  $P < 0.001$ ), schizophrenia spectrum disorder (OR = 2.785, 95% CI = 1.684–4.607,  $P < 0.001$ ), alcohol consumption (OR = 2.549, 95% CI = 1.586–4.096,  $P < 0.001$ ), cardiovascular disease (OR = 2.299, 95% CI = 1.362–3.879,  $P = 0.002$ ), Charlson comorbidity index (CCI)  $\geq 3$  (OR = 2.092, 95% CI = 1.342–3.260,  $P = 0.001$ ), organic mental disorder (OR = 1.941, 95% CI = 1.194–3.156,  $P = 0.007$ ), antipsychotic drug use (OR = 1.886, 95% CI = 1.312–2.711,  $P = 0.001$ ), unmarried status (OR = 1.720, 95% CI = 1.164–2.541,  $P = 0.006$ ) and junior high school education (OR = 1.591, 95% CI = 1.010–2.508,  $P = 0.045$ ) were independent risk factors for CAP in inpatients with mental disorders.

**Conclusion:** CAP was common in inpatients with mental disorders. Patients with mental disorders have unique risk factors for CAP. Further research is required to explore the relationship and mechanism between different mental disorders, antipsychotic drugs and CAP.

## KEYWORDS

mental disorders, community-acquired pneumonia, general hospitals, inpatients, risk factors

## Introduction

Mental disorders are a group of diseases that manifest as cognitive, emotional, and behavioral disturbances. The global burden of mental disorders has increased in recent years (1). Mental disorders account for 14.3% of all deaths worldwide, and around 8 million people with mental disorders die each year (2). Most of the reductions in life expectancy in people with mental disorders appear to be due to somatic comorbidities or other natural causes of death such as cardiovascular disease (CVD) and pneumonia (3).

Community-acquired pneumonia (CAP), which develops in people outside of healthcare settings, is a serious disease with a potentially poor long-term prognosis. CAP is particularly prevalent in developing countries and is associated with high morbidity, hospitalization, and mortality rates (4). Epidemiological studies have found that patients with mental disorders have a significantly increased risk of developing CAP (5). CAP is an important cause of hospitalization and death in patients with mental disorders (6). Patients with mental disorders such as schizophrenia and depression have a generally poorer prognosis after developing CAP, such as higher occupancy rates in the intensive care unit (ICU) (7).

Risk factors for CAP in the general population include advanced age, male gender, smoking, alcoholism, respiratory disease, dementia, and various comorbidities (8). People with mental disorders are more likely to use antipsychotic drugs, have unhealthy lifestyles, show poor adherence to treatment, and have poor access to medical services (3). All of these factors may affect the occurrence of CAP. To date, few published studies have evaluated the epidemiology of CAP and the risk factors for CAP in inpatients with mental disorders. A retrospective analysis of 2,209 patients with schizophrenia hospitalized in Tokyo, Japan, found that 101 patients (4.6%) were diagnosed with pneumonia on admission (9). Furthermore, advanced age ( $\geq 50$  years-old), body mass index (BMI)  $< 18.5$  kg/m<sup>2</sup>, smoking, use of atypical antipsychotic drugs, and high-dose antipsychotic drugs were risk factors for pneumonia on admission in patients with schizophrenia (9). The above study mainly focused on patients in specialized psychiatric hospitals and on schizophrenia. There are few reports describing the epidemiological characteristics of CAP among inpatients with mental disorders in general hospitals.

Our hospital is a tertiary general hospital with the largest number of psychiatric beds in China (350 beds, including 225 beds on open wards and 125 beds on closed wards). Our hospital also has high-level respiratory, infectious disease, intensive care medicine, and radiology departments, which allows patients with suspected CAP to be diagnosed and treated in a timely manner. The aim of this cross-sectional study was to investigate the epidemiological characteristics of CAP among inpatients with mental disorders admitted to a general hospital in China.

## Methods

### Study design and patients

This retrospective study included inpatients diagnosed with mental disorders at Renmin Hospital of Wuhan University between January 2017 and July 2021. The Ethics Committee of Renmin Hospital of Wuhan University approved this study (WDRY2021-KS069) and waived the requirement for informed consent due to the retrospective nature of the analysis.

The inclusion criteria were as follows: (1) admitted to the hospital with a primary diagnosis of a mental disorder or a mental disorder with pneumonia/pulmonary infection; (2) hospitalized for  $>48$  h; and (3) aged  $\geq 18$  years-old. The diagnoses of the mental disorders were made in accordance with the tenth revision of the International Classification of Mental Disorders (ICD-10, codes F00–F99) (WHO, 1992). Patients were excluded from the final analysis if any of the following criteria were met: (1) hospital-acquired pneumonia (HAP); (2) died or discharged from the hospital within 48 h of admission; (3) admitted during the COVID-19 pandemic (January 2020–May 2020); (4) readmitted after a first admission during the study period; and (5) incomplete data.

### Data collection and definition

The following baseline data were extracted from the medical records: age, gender, education level, marital status, smoking history, history of alcohol consumption, history of mental disorder (including type, age at onset, disease course, and current treatment strategy), BMI, comorbidities, type of ward admitted to (closed or open), the requirement for ICU admission, the requirement for mechanical ventilation, duration of hospitalization and survival.

The inpatients with mental disorders were divided into a CAP group and a non-CAP group according to whether comorbid CAP was present. The diagnosis of CAP was made if the patient met all three of the following criteria (10): (1) onset in the community; (2) any one of the following pneumonia-related clinical manifestations: (i) newly developed cough or expectoration or exacerbation of existing respiratory disease symptoms with or without purulent sputum, chest pain, dyspnea, or hemoptysis; (ii) fever; (iii) signs of pulmonary consolidation and/or moist rales; (iv) peripheral blood leukocytes  $> 10 \times 10^9/L$  or  $< 4 \times 10^9/L$  with or without a left shift; (3) chest imaging demonstrated new patchy infiltrates, lobar or segmental consolidation, ground-glass opacities, or interstitial changes with or without pleural effusion. They were excluded if other lung diseases (such as pulmonary tuberculosis, lung tumor, non-infectious pulmonary interstitial

disease, pulmonary edema, atelectasis, pulmonary embolism, pulmonary eosinophilic infiltration, or pulmonary vasculitis) were present.

## Statistical analysis

The data were analyzed using SPSS 22.0 (IBM Corp., Armonk, NY, USA). Measurement data were tested for normality using the Kolmogorov-Smirnov method (sample size  $\geq 50$ ) or the Shapiro-Wilk method (sample size  $< 50$ ). Normally-distributed measurement data are presented as the mean  $\pm$  standard deviation (SD) and were compared between groups using the *t*-test for independent samples. Non-normally-distributed measurement data are shown as median [interquartile range (IQR)] and were compared between groups using the Mann-Whitney U test. Non-normally-distributed data were compared between multiple groups using the Kruskal-Wallis test. Count data are presented as frequency (percentage) and were analyzed using the chi-squared test or Fisher's exact test. Propensity score matching (PSM) was carried out using R 4.1.1 software (R Foundation for Statistical Computing, Vienna, Austria), and 1:4 matching was performed using variables such as age, gender, and BMI. Factors associated with CAP in patients with mental disorders were explored using univariate and multivariable logistic regression analyses. The presence or absence of CAP was used as the outcome variable, and the demographic/laboratory indicators were used as the independent variables. Variables with a  $p < 0.05$  in the univariate analysis were entered into the multivariate analysis (enter method). Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated. Multicollinearity was considered if Tolerance was  $< 0.2$  or the variance inflation factor (VIF) was  $> 10$ . No multicollinearity was observed in the multivariable model.  $P < 0.05$  was considered statistically significant.

## Results

### Baseline characteristics of the study participants

A total of 25,891 patients with mental disorders were admitted during the study period. After the exclusion of patients under the age of 18 years-old ( $n = 3,853$ ), patients with a hospital stay of  $< 48$  h ( $n = 449$ ), patients with HAP ( $n = 194$ ), repeat admissions ( $n = 4,419$ ) and patients with incomplete pre-admission clinical data ( $n = 42$ ), the final analysis included 16,934 patients. The baseline clinical characteristics of the study participants before PSM are shown in [Supplementary Table 1](#). The 301 patients (168 men, 55.81%) in the CAP group had a median age of 50.00 (IQR, 33.00–62.00) years, and the 16,633

patients (7,063 men, 42.46%) in the non-CAP group had a median age of 31.00 (IQR, 24.00–48.00) years.

### Incidence of CAP

The incidence rate of CAP was 1.78% overall, 8.44% in patients with organic mental disorders, 2.80% in patients with schizophrenia spectrum disorders, 1.04% in patients with mood-affective disorders, and 1.28% in patients with other mental disorders. The incidence rate of CAP increased with age (1.06% for those aged 18–44 years-old, 2.68% for those aged 45–64 years old, and 6.86% for those aged  $\geq 65$  years-old), was higher in men than in women (2.32 vs. 1.37%) and higher in patients with a BMI  $\leq 18.5$  kg/m<sup>2</sup> than in those with a BMI  $> 18.5$  kg/m<sup>2</sup> (3.90 vs. 1.65%).

### Baseline characteristics of the study participants after PSM

The propensity score-matched data consisted of 1,495 patients and included 299 patients with CAP and 1,196 patients without CAP. There were significant differences in education, smoking, alcohol consumption, type of mental disorder, age at onset of the mental disorder, duration of the mental disorder, duration of treatment for the mental disorder, duration of treatment with antipsychotic drugs, use of antipsychotic drugs, use of clozapine, use of cholinesterase inhibitors, CCI and incidences of comorbid diseases (cerebrovascular disease, CVD, diabetes mellitus) between the CAP group and non-CAP group after PSM ([Table 1](#)).

### Outcomes of inpatients with mental disorders who had comorbid CAP

The patient outcomes were analyzed after PSM. Inpatients with mental disorders who had comorbid CAP had a significantly prolonged hospital stay, were more often admitted to a closed ward or the ICU, and were more often treated with mechanical ventilation than those without CAP ( $P < 0.001$  for all parameters). However, there was no significant difference in mortality rate between the two groups ([Table 2](#)).

Among the patients with CAP, hospital stay was significantly longer in those with schizophrenia or mood-affective disorder than in those with organic mental disorders or other types of mental illness ( $P = 0.039$ ) ([Table 3](#)). Prognosis and length of hospital stay were comparable between patients admitted to open wards, closed wards, and the ICU. However, only patients admitted to the ICU received mechanical ventilation ([Table 4](#)).

TABLE 1 Baseline characteristics of the study participants after propensity score matching.

Characteristic	CAP group ( <i>n</i> = 299)	Non-CAP group ( <i>n</i> = 1,196)	<i>P</i>
Age (years), median (IQR)	50.00 (33.00, 62.00)	50.00 (33.00, 62.00)	0.967
Gender, Male, <i>n</i> (%)	166 (55.52%)	665 (55.60%)	0.979
Education, <i>n</i> (%)			0.014
Undergraduate and above	41(13.71%)	250(20.90%)	
College	9 (3.01%)	62 (5.18%)	
High school or secondary school	93 (31.10%)	361 (30.18%)	
Junior high school	87 (29.10%)	291 (24.33%)	
Primary school/illiterate	69 (23.08%)	232 (19.40%)	
Marital status, <i>n</i> (%)			0.068
Unmarried	83 (27.76%)	267 (22.32%)	
Married	181 (60.54%)	808 (67.56%)	
Widowed or divorced	35 (11.71%)	121 (10.12%)	
Body mass index, $\leq 18.5$ kg/m <sup>2</sup> , <i>n</i> (%)	35 (11.71%)	134 (11.20%)	0.806
Smoking, <i>n</i> (%)	75 (25.08%)	229 (19.15%)	0.023
Alcohol consumption, <i>n</i> (%)	53 (17.73%)	114 (9.53%)	<0.001
Type of mental disorders, <i>n</i> (%)			<0.001
Organic mental disorder	59 (19.73%)	131 (10.95%)	
Schizophrenia spectrum disorder	100 (33.44%)	192 (16.05%)	
Mood affective disorder	97 (32.44%)	586 (49.00%)	
Other	43 (14.38%)	287 (24.00%)	
Age at mental disorder onset (years), median (IQR)	36.00 (24.00, 57.00)	41.00 (27.00, 58.00)	0.028
Duration of mental disorder (years), median (IQR)	4.00 (0.30, 10.00)	2.00 (0.20, 8.00)	0.002
Family history of mental disorder, <i>n</i> (%)	36 (12.04%)	155 (12.96%)	0.670
Duration of treatment (years), median (IQR)	1.00 (0.00, 7.00)	0.50 (0.00, 3.00)	<0.001
Duration of antipsychotic drug use (years), median (IQR)	0.20 (0.00, 5.00)	0.00 (0.00, 1.00)	<0.001
Poor adherence to recent therapy <sup>a</sup> , <i>n</i> (%)	37 (12.37%)	147 (12.29%)	0.969
Number of antipsychotic drugs currently used, <i>n</i> (%)			<0.001
0	159 (53.18%)	881 (73.66%)	
1	79 (26.42%)	213 (17.81%)	
2/3/4	61 (20.40%)	102 (8.53%)	
Current use of clozapine, <i>n</i> (%)	64 (21.40%)	56 (4.68%)	<0.001
Cholinesterase inhibitor use, <i>n</i> (%)	23 (7.69%)	50 (4.18%)	0.012
Charlson comorbidity index, <i>n</i> (%)			<0.001
0–1 points	145 (48.49%)	758 (63.38%)	
2 points	38 (12.71%)	172 (14.38%)	
3 points and above	116 (38.80%)	266 (22.24%)	
Cerebrovascular disease, <i>n</i> (%)	86 (28.76%)	195 (16.30%)	<0.001
Cardiovascular disease, <i>n</i> (%)	41 (13.71%)	47 (3.93%)	<0.001
Diabetes mellitus, <i>n</i> (%)	39 (13.04%)	65 (5.43%)	<0.001

<sup>a</sup> Failure to take the medication regularly or medication discontinued without authorization during the past 1 month.  
CAP, community-acquired pneumonia; IQR, interquartile range.

## Logistic regression analyses of factors associated with CAP in inpatients with mental disorders

The multivariable analysis revealed that clozapine use, schizophrenia spectrum disorder, alcohol consumption, CVD, CCI  $\geq 3$  points, organic mental disorder, use of an antipsychotic drug, unmarried status, and junior high school education were

independently associated with CAP in hospitalized patients with mental disorders (Table 5).

## Discussion

As far as we know, this is the first study to investigate the occurrence, risk factor analysis, and prognosis of CAP



TABLE 2 Ward of admission and outcomes of inpatients with mental disorders stratified according to the presence/absence of comorbid community-acquired pneumonia.

Parameter	CAP group ( <i>n</i> = 299)	Non-CAP group ( <i>n</i> = 1,196)	<i>P</i>
Ward admitted to, <i>n</i> (%)			<0.001
Open ward	149 (49.83%)	952 (79.60%)	
Closed ward	110 (36.79%)	239 (19.98%)	
Intensive care unit	40 (13.38%)	5 (0.42%)	
Outcome, <i>n</i> (%)			0.114 <sup>a</sup>
Clinical improvement	295 (98.66%)	1,191 (99.58%)	
No clinical change	2 (0.67%)	2 (0.17%)	
Death	2 (0.67%)	3 (0.25%)	
Mechanical ventilation, <i>n</i> (%)			<0.001 <sup>a</sup>
No	294 (98.33%)	1,196 (100.00%)	
Yes	5 (1.67%)	0 (0.00%)	
Hospital stay (days), median (IQR)	15.00 (10.00, 24.00)	13.00 (9.00, 19.00)	<0.001

<sup>a</sup>Fisher's exact probability method.

CAP, community-acquired pneumonia; IQR, interquartile range.

TABLE 3 Ward of admission and outcomes of inpatients with mental disorders and community-acquired pneumonia stratified according to the type of mental disorder.

Parameter	Organic mental disorder ( <i>n</i> = 59)	Schizophrenia spectrum disorder ( <i>n</i> = 100)	Mood affective disorder ( <i>n</i> = 97)	Other ( <i>n</i> = 43)	<i>P</i>
Ward admitted to, <i>n</i> (%)					0.141
Open ward	31 (52.54%)	42 (42.00%)	55 (56.70%)	21 (48.84%)	
Closed ward	23 (38.98%)	38 (38.00%)	30 (30.93%)	19 (44.19%)	
Intensive care unit	5 (8.47%)	20 (20.00%)	12 (12.37%)	3 (6.98%)	
Outcome, <i>n</i> (%)					0.663 <sup>a</sup>
Clinical improvement	57 (96.61%)	98 (98.00%)	97 (100.00%)	43 (100.00%)	
No clinical change	1 (1.69%)	1 (1.00%)	0 (0.00%)	0 (0.00%)	
Death	1 (1.69%)	1 (1.00%)	0 (0.00%)	0 (0.00%)	
Mechanical ventilation, <i>n</i> (%)					0.576 <sup>a</sup>
No	59 (100.00%)	97 (97.00%)	95 (97.94%)	43 (100.00%)	
Yes	0 (0.00%)	3 (3.00%)	2 (2.06%)	0 (0.00%)	
Hospital stay (days), median (IQR)	14.00 (10.00, 18.00)	16.50 (11.00, 29.75)	17.00 (10.50, 28.00)	14.00 (10.00, 18.00)	0.039

<sup>a</sup>Fisher's exact probability method.

IQR, interquartile range.

in hospitalized patients with mental disorders in a large general hospital.

The overall incidence of CAP in the patients with mental disorders admitted to this tertiary general hospital was 1.78%, which was higher than that reported for inpatients without mental disorders (11) but lower than that in a psychiatric hospital (9). The present study found that CAP significantly increased the length of hospital stay for inpatients with mental disorders. Comorbid CAP also increased the probability of the patient being admitted to a closed ward or the ICU, as well as the probability of the patient requiring mechanical ventilation

during treatment. However, comorbid CAP didn't increase the mortality rate of patients with mental disorders in this general hospital, which was different from the previous reports of psychiatric hospitals (6).

The incidence of CAP among the patients with mental disorders in this study was higher in those aged  $\geq 65$  years-old, males, and those with a BMI  $\leq 18.5$  kg/m<sup>2</sup>, which agrees well with previous findings in the general population (8). Therefore, the main analyses were performed following PSM for gender, age, and BMI. After PSM, it was found that the risk factors for CAP in patients with mental disorders admitted to this

TABLE 4 Outcomes of inpatients with mental disorders and community-acquired pneumonia stratified according to ward of admission.

Parameter	Admission to open ward ( <i>n</i> = 149)	Admission to closed ward ( <i>n</i> = 110)	Admission to intensive care unit ( <i>n</i> = 40)	<i>P</i>
Outcome, <i>n</i> (%)				0.218 <sup>a</sup>
Clinical improvement	147 (98.66%)	109 (99.09%)	39 (97.50%)	
No clinical change	0 (0.00%)	1 (0.91%)	1 (2.50%)	
Death	2 (1.34%)	0 (0.00%)	0 (0.00%)	
Mechanical ventilation, <i>n</i> (%)				<0.001 <sup>a</sup>
No	149 (100.00%)	110 (100.00%)	35 (87.50%)	
Yes	0 (0.00%)	0 (0.00%)	5 (12.50%)	
Hospital stay (days), median (IQR)	16.00 (11.00, 23.50)	16.00 (10.75, 26.50)	13.00 (9.00, 25.75)	0.788

<sup>a</sup>Fisher's exact probability method.

IQR, interquartile range.

general hospital were the use of anti-psychotic drugs, especially clozapine, schizophrenia spectrum disorder, organic mental disorder, alcohol consumption, CVD, CCI index  $\geq 3$ , unmarried status and low education level.

The observation that anti-psychotic drug use was associated with increased odds of CAP in inpatients with mental disorders is consistent with previous studies (12). Typical anti-psychotics may enhance the risk of aspiration pneumonia by causing extra-pyramidal side effects such as dyskinesia. Although atypical anti-psychotics are associated with a lower risk of extra-pyramidal side effects, they can cause dry mouth and dysphagia (due to anticholinergic effects) as well as sedation (caused by central nervous system H1 receptor blockade), which are also risk factors for pneumonia. This study found that clozapine, an atypical anti-psychotic drug, was associated with an elevated risk of CAP in inpatients with mental disorders (OR = 3.212). Several previous large-scale investigations have reported that treatment with clozapine is associated with an increased risk of pneumonia (13). Clozapine may be more likely to induce sedation and salivation (14). Clozapine is the antipsychotic drug of choice for the treatment of refractory schizophrenia (15). However, clozapine-treated patients should be monitored carefully.

This study found that inpatients with organic mental disorders or schizophrenia spectrum disorder had a higher incidence of CAP than those with other types of mental disorder. Schizophrenia is a common, chronic, and disabling mental illness (16). A 9-year follow-up study in Taiwan determined that the incidence of pneumonia in patients with schizophrenia was 10.26% and that the incidence density was 11.4/1,000 person-years (17). Many patients with schizophrenia exhibit impairments in social functioning, self-care, and self-control, which may increase the risk of pneumonia. In addition, dysphagia is common in patients with schizophrenia, and this can lead to aspiration pneumonia. Organic mental disorders may have an inherent “organic

basis” and hence be associated with physical comorbidities (1), and many patients with organic mental disorders are elderly and have comorbid dementia and cerebrovascular disease, which may increase the risk of pneumonia. Dementia, in particular, is thought to elevate the risk of pneumonia (18).

Previous research showed that polymorbidity (two or more physical comorbidities) was more common in people with mental disorders than in those without mental illness (19). Compared with the general population, patients with mental disorders have a 6–8-fold increase in medical comorbidity, a shorter life expectancy, and a higher mortality (20). The present study found that a CCI index  $\geq 3$  was a risk factor for CAP in inpatients with mental disorders. The age- and sex-standardized incidence of CVD was found to be higher in patients with mental disorders than in those without mental illnesses (13.5/1,000 person-years vs. 6.3/1,000 person-years), and the highest CVD incidence rates were in patients with bipolar disorder and schizophrenia (21). CVD is a known risk factor for CAP (22). Thus, it is important that clinicians are aware that inpatients with mental disorders and multiple comorbidities are at particular risk of CAP.

This study found that unmarried status was closely related to CAP in inpatients with mental disorders. A population-based case-control study found that the odds of pneumonia-related hospitalization were 33% higher for unmarried people than for married people, and alcoholism-related disorders and other comorbidities appeared to explain the increased risk of pneumonia-related hospitalization in unmarried people (23). Junior high school education was also associated with CAP in inpatients with mental disorders. Prior research has yielded evidence that a higher level of education is associated with a lower risk of major psychiatric disorders and most physical disorders, independent of intelligence (24). In China, low education and being unmarried are both associated with an increased risk of

**TABLE 5** Logistic regression analyses of factors associated with community-acquired pneumonia in inpatients with mental disorders.

Variable	Multivariate analysis	
	OR (95% CI)	P
Education		
Undergraduate and above	Reference	
College	0.829 (0.364, 1.888)	0.656
High school or secondary school	1.541 (0.992, 2.392)	0.054
Junior high school	1.591 (1.010, 2.508)	0.045
Primary school/illiterate	1.505 (0.927, 2.443)	0.099
Marital status		
Married	Reference	
Unmarried	1.720 (1.164, 2.541)	0.006
Widowed or divorced	1.109 (0.706, 1.743)	0.652
Smoking	0.984 (0.660, 1.468)	0.939
Alcohol consumption	2.549 (1.586, 4.096)	<0.001
Type of mental disorders		
Organic mental disorder	1.941 (1.194, 3.156)	0.007
Schizophrenia spectrum disorder	2.785 (1.684, 4.607)	<0.001
Mood-affective disorder	1.384 (0.906, 2.113)	0.133
Other	Reference	
Duration of mental disorder (years)	1.002 (0.982, 1.023)	0.837
Duration of treatment (years)	1.003 (0.958, 1.050)	0.894
Duration of antipsychotic drug use (years)	0.990 (0.944, 1.038)	0.684
Number of antipsychotic drugs currently used		
0	Reference	
1	1.886 (1.312, 2.711)	0.001
2/3/4	1.641 (0.913, 2.948)	0.098
Current use of clozapine	3.212 (1.744, 5.915)	<0.001
Cholinesterase inhibitor use	0.773 (0.416, 1.435)	0.414
Charlson comorbidity index		
0–1 points	Reference	
2 points	1.471 (0.928, 2.332)	0.101
3 points and above	2.092 (1.342, 3.260)	0.001
Cerebrovascular disease	1.336 (0.883, 2.021)	0.170
Cardiovascular disease	2.299 (1.362, 3.879)	0.002
Diabetes mellitus	1.533 (0.939, 2.503)	0.087

OR, odds ratio; 95% CI, 95% confidence interval. All the variables listed in the table were the ones that were significant in the univariable analyses and entered the model. Otherwise, age, gender, body mass index, age at mental disorder onset, family history of mental disorder, and poor recent adherence to therapy did not enter the model.

serious mental illness (25). This study found that 6.03% of the inpatients with mental disorders had alcohol misuse disorder, and the consumption of alcohol was identified as a risk factor for CAP in patients with mental disorders. The sedative effects of prolonged alcohol consumption can impair cough and vomiting responses and thereby increase the risk of aspiration.

## Conclusions

The incidence rate of CAP was 1.78% in inpatients with mental disorders. Clozapine, schizophrenia spectrum disorder, alcohol consumption, CVD, CCI index  $\geq 3$ , organic mental disorder, use of antipsychotic drugs, unmarried status, and lower level of education were identified as independent risk factors for CAP in hospitalized patients with mental disorders. These findings provide baseline data for establishing effective prevention strategies of CAP in people with mental disorders.

## Limitations

First, this was a cross-sectional study, and subsequent readmissions and deaths after discharge were not tracked. Second, this study involved only one general hospital, so the findings will need to be further evaluated in a stratified analysis of data from multiple centers of different sizes. Third, the severity of mental disorders on admission could not be assessed in all patients due to the retrospective study design.

## Data availability statement

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

## Author contributions

JH and GW conceived and designed the experiment. JH performed the research, analyzed the results, wrote the manuscript, analyzed the data, and carried out a literature search. JH, QW, LX, and GW contributed to revising the manuscript. JH and MS collected data. JH and ZL submitted the article. All authors read and approved the final manuscript.

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## Conflict of interest

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

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyt.2022.941198/full#supplementary-material>

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# Gamification-based intervention for enhancing team effectiveness and coping flexibility: Randomized controlled trial

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This study aimed to evaluate a newly developed gamification-based intervention of serious play training (SPT). A randomized controlled trial was conducted to assess the efficacy of the new intervention program in comparison with a widely adopted cognitive-behavioral training (CBT) program. Real-life work teams were recruited to enhance the ecological validity of outcome evaluation. The participants comprised 250 Chinese working adults (68% men; median age = 25 years, range: 18–40) who took part voluntarily. They were randomly assigned to the SPT, CBT, and waitlist conditions. For outcome evaluation, team effectiveness was the primary outcome, whereas coping flexibility was the secondary outcome. For explanation of outcome changes, group cohesion and discriminative thinking were tested as the hypothesized learning mechanisms. The results revealed that the SPT group alone reported greater team effectiveness over time, with an increase in group cohesion found to explain the improvement. Both the SPT and CBT groups reported greater coping flexibility over time, with discriminative thinking found to account for the beneficial changes. These findings provide initial evidence indicating the efficacy of utilizing the gamification approach in corporate training for team-building and personal coping.

## KEYWORDS

coping, stress, intervention, serious game, mental health, psychological well-being, group cohesion, team building

## Introduction

The rapidly evolving nature of the work environment and contemporary organizational adaptations are intrinsically entwined with the multiple challenges of daily life faced by many employees today (1, 2). The 2008 global economic crisis and the ongoing COVID-19 pandemic have imposed immense amounts of stress on employees amid widespread concerns about job insecurity and layoffs (3, 4). A recent meta-analysis indicates that coping flexibility is the cornerstone of psychological adjustment to stressful life changes, as demonstrated by the positive associations between this coping



skill and multiple mental health indicators such as subjective well-being and quality of life (5).

To tackle the issues arising from the ever-changing work and economic environments, many organizations provide their employees with training to improve their coping skills, with many corporate training workshops emphasizing the importance of flexible coping in mitigating work stress. Cognitive-behavioral training (CBT) is currently one of the most common approaches to stress management intervention (6, 7). Several review studies have documented the efficacy of workshops adopting cognitive-behavioral approaches in strengthening discriminative thinking skills that equip individuals to deploy flexible strategies for coping with an array of stressors, thus mitigating the risks of developing mental health problems such as psychological distress and psychosomatic symptoms (8, 9).

Systematic reviews also indicate that CBT generally focuses on the person, and is highly prescriptive, non-interactive, product-oriented, skill-based, and instructor-centered (10). Participants taking part in CBT acquire an array of cognitive-behavioral skills (e.g., problem-solving, relaxation) that help them to expand their personal resources and mitigate psychological distress experienced during stressful encounters (6, 11). However, both the socio-cultural constructivist theory of learning (12) and cognitive flexibility theory (13) postulate that knowledge constitutes both the derivation of a learner's interpretations of his or her personal experiences and the process of meaning-making through active interactions with others. Accordingly, learners tend to actively "construct" their knowledge, with such construction consolidating their cognitive flexibility and problem-solving skills (14, 15). More broadly, most person-oriented CBT workshops fail to implement intervention strategies that promote group cohesion, which is highly valued in work settings in many collectivistic societies (16).

To address these important but unexplored issues, an alternative approach—serious play training (SPT)—was adopted in the present study. Serious play is a novel intervention technique that refers to the use of games to educate, train, and inform workshop participants; and serious games have been shown to be successful as a learning method for building skills to tackle real-life complex issues or tasks, such as change management (17). It could therefore be expected that serious games would play an important role within corporate training. The efficacy of this newly developed workshop was evaluated by comparing it with the widely adopted CBT approach in a Chinese setting.

SPT differs from CBT in two major ways. First, SPT was developed according to the principles of gamification, which refers to the utilization of game design elements in daily life contexts to enhance the motivation and engagement of workshop participants (18, 19). The gamification approach has been found to incentivize active engagement in the given

intervention, as participants are immersed in the training process and find it to be enjoyable and intrinsically rewarding (20, 21). It has also been found effective in reinforcing collective problem-solving skills and promoting active learning (18) as well as improving health and bolstering mental wellness (22, 23).

Second, a theoretical approach underpinning the SPT intervention design is collectivism-oriented human resource management (24), whereas CBT programs are "imported" from the West with different extents of cultural adaptations. For SPT, the cultural management strategy highlights the collective generation of creative solutions and ideas through team-based structures, which aligns with the socio-cultural values (e.g., collectivism) and institutional context of many Chinese organizations. Implementing the principles of a culturally relevant strategy has been found to promote team reflexivity in Chinese teams, which in turn bolsters their innovation and job performance (25).

Applying the principles of collectivism-oriented human resource management, SPT's gamification design and practices focus on (a) treating employee training and development as team endeavors; (b) foregrounding teamwork and group cohesion rather than individual performance; and (c) rewarding teams of individuals (24). SPT thus involves a range of group-based activities aimed at facilitating social engagement among participants, with such engagement bolstering effective communication, collaboration, and relational quality among team members (18). Adopting the gamification approach in a work setting, Luu and Narayan (26) reported stronger communication skills to be associated with higher degrees of both individual and group task satisfaction. Moreover, another gamification-based intervention fosters a more collaborative learning environment and more favorable evaluations among team members (27). Taken together, these findings suggest that the proposed SPT is likely to provide workshop participants with ample opportunities for intensive collaboration, thereby consolidating teamwork as the basis for effective job performance (25, 28).

The structure and modules of both the proposed SPT and the existing CBT are summarized in [Table 1](#). As shown in this table, SPT aims at mitigating stressors specifically related to the work setting through gaming activities that facilitate collective decision-making and social resource accrual. Both of these team-based activities have been found to increase group cohesion among team members, which in turn improve team effectiveness and reduce work stress (29, 30).

Despite the aforementioned differences in their program structure and focus, SPT and CBT were both designed to strengthen discriminative thinking, an essential skill for flexible adjustment to stressful life changes (31). Discriminative thinking refers to an individual's ability to recognize a unique set of situational features characterizing a specific stressful event (i.e., cognitive flexibility); that is, the ability to determine, for example, whether the outcome of a given stressor is amenable

to change through his or her own effort or whether the stressor will exert an undesirable impact on his or her long-term life goals (32, 33). After recognizing the unique features of a variety of stressors, discriminative thinking further enables a person to discern and differentiate among the demands of multiple stressors (i.e., response flexibility), resulting in the deployment of appropriate strategies that meet the specific situational demands (31).

Through training in discriminative thinking in both SPT and CBT, workshop participants are temporarily drawn away from the conscious processing of their work, endowing them with an opportunity to “incubate,” to allow the unconscious processing of work to take place (34). Unconscious work and task switching during the incubation stage is conducive to creative problem-solving and reduced mental fixation (35, 36), the latter of which is key to promoting cognitive and response flexibility (37). To evaluate the hypothesized efficacy of both SPT and CBT, the following hypotheses were tested.

*Hypothesis 1:* Participants who took part in SPT (vs. CBT and no skill training) will have higher levels of team effectiveness over time.

*Hypothesis 2:* The positive association between SPT (vs. CBT and no skill training) and team effectiveness over time will be explained by an increase in group cohesion.

*Hypothesis 3:* Participants who took part in SPT or CBT (vs. no skill training) will display higher levels of coping flexibility over time.

*Hypothesis 4:* The positive association between skill training (vs. no skill training) and coping flexibility over time will be accounted for by an increase in discriminative thinking.

In summary, this study contributed to the literature by adopting an integrative approach to the design of SPT, a novel gamification-based intervention. Instead of focusing on personal skill development *per se* as in the widely adopted CBT, SPT comprises an array of modules designed for strengthening both personal skills (i.e., discriminative thinking) and interpersonal skills (i.e., collective decision-making and social resource accrual) over time. A longitudinal research design was adopted to test the effectiveness of the newly developed SPT. More importantly, a randomized controlled trial was conducted to compare the hypothesized benefits of SPT with two control conditions: existing training control (CBT) and no training control (waitlist). Compared with the participants who were assigned to the waitlist control condition,

the participants who took part in the SPT were predicted to experience desirable changes in both team effectiveness and coping flexibility, whereas those who took part in the CBT were predicted to experience desirable changes in coping flexibility only.

## Materials and methods

### Research design

The present study took the form of a randomized controlled trial that adhered to the Consolidated Standards of Reporting Trials (CONSORT). The aim of the trial was to compare the learning mechanisms and outcomes of the newly developed SPT program versus a current CBT program among working adults. Randomized controlled trials are widely regarded as the gold standard for program evaluation (38).

Program effectiveness was assessed using a longitudinal design comprising three time points. Before training began (Time 1/T1), all participants completed the baseline questionnaires at their own work sites after being given instructions by a trained research assistant. Immediately (Time 2/T2) and three months (Time 3/T3) after the training, they completed the follow-up questionnaires on their own.

### Sampling procedures

Employees of our organizational partners in southern China were recruited through a standardized advertisement distributed by the human resource or administration department of each private organization. These departments then submitted lists of the teams who had expressed an interest in taking part.

Eligible participants were full-time employees aged between 18- and 40-years-old who had served in the company for at least six months and could read and communicate in Chinese. Participants were excluded if they reported any psychological illness or medical problems or if they were unwilling to give informed consent or follow the study procedures.

After eligibility screening, an independent research assistant created an allocation schedule using the “random sample of cases” function in SPSS version 26.0 (39), (RRID:SCR\_002865). When using this function, the research assistant first entered into the software program the number of teams planned for each of the conditions, and then the software program randomly selected the specified number of teams and assigned them to a skill training program (SPT or CBT) or waitlist.

The study was conducted in accordance with the ethical standards outlined by the American Psychological Association. The research was conducted after obtaining institutional review board approval from the authors’ university. The participants

TABLE 1 Descriptions of stress management modules of serious play training and cognitive-behavioral training programs.

Serious play training		Cognitive-behavioral training	
Aim of module	Content	Aim of module	Content
1. Orientation and understand mechanisms of stress	Psychoeducation: nature and mechanisms of stress, transactional stress model, and links between stressors and stress reactions	1. Orientation and understand mechanisms of stress	Psychoeducation: nature and mechanisms of stress, transactional stress model, and links between stressors and stress reactions
2. Develop cognitive flexibility skills	Identification of personal signs of stress and stress triggers, reflection of stressful experience, development of discriminative thinking skills to distinguish among the nature and demands of diverse stressors, development of cognitive restructuring skills to challenge automatic irrational thoughts and replace them with more realistic flexible ones	2. Develop cognitive flexibility skills	Identification of personal signs of stress and stress triggers, reflection of stressful experience, development of discriminative thinking skills to distinguish among the nature and demands of diverse stressors, development of cognitive restructuring skills to challenge automatic irrational thoughts and replace them with more realistic flexible ones
3. Develop response flexibility skills	Identification of personal coping style and its limitations, reflection of coping experience, importance of expanding coping repertoire, development of discriminative thinking skills to recognize differential coping effectiveness across stressful situations, acquisition of good-fit principle for effective strategy deployment	3. Develop response flexibility skills	Identification of personal coping style and its limitations, reflection of coping experience, importance of expanding coping repertoire, development of discriminative thinking skills to recognize differential coping effectiveness across stressful situations, acquisition of good-fit principle for effective strategy deployment
4. Develop collective problem-solving skills	Team building process and group dynamics: team knowledge formation and evolution, strategic planning and group support tools, creation of a diverse and inclusive work culture, conflict management, the art of giving constructive feedback, group reflection, outcome review	4. Develop problem-solving skills	Systematic problem-solving and solution-oriented coping activities: problems finding, problems shaping, listing of possible solutions, making choices and back-up plans, action execution, progress monitoring and reflection, outcome review
5. Manage stress together and accrue social resources	Role of a supportive social environment, importance of expanding social network and social capital, communication skill training for identifying and activating coping resources	5. Practice behavioral activation and relaxation skills	Behavioral activation skills to increase pleasant and reinforcing daily activities, practice of mindfulness and breathing techniques for relaxation
6. Review and devise plans for action and maintenance	Summary of intervention components, review of team and personal performance, importance of skill integration and transfer to daily life, and creation of plans for daily action and maintenance	6. Review and devise plans for action and maintenance	Summary of intervention components, review of personal performance, importance of skill integration and transfer to daily life, and creation of plans for daily action and maintenance

were assured that their participation was entirely voluntary and that their data and performance during the training sessions would be kept strictly confidential and would not be communicated to their employers. Participants assigned to the waitlist control group were told they would be invited to attend SPT sessions if the findings demonstrated the training's effectiveness. Participants in all three conditions received a souvenir (a pen or towel) for returning their questionnaires at T2 and T3.

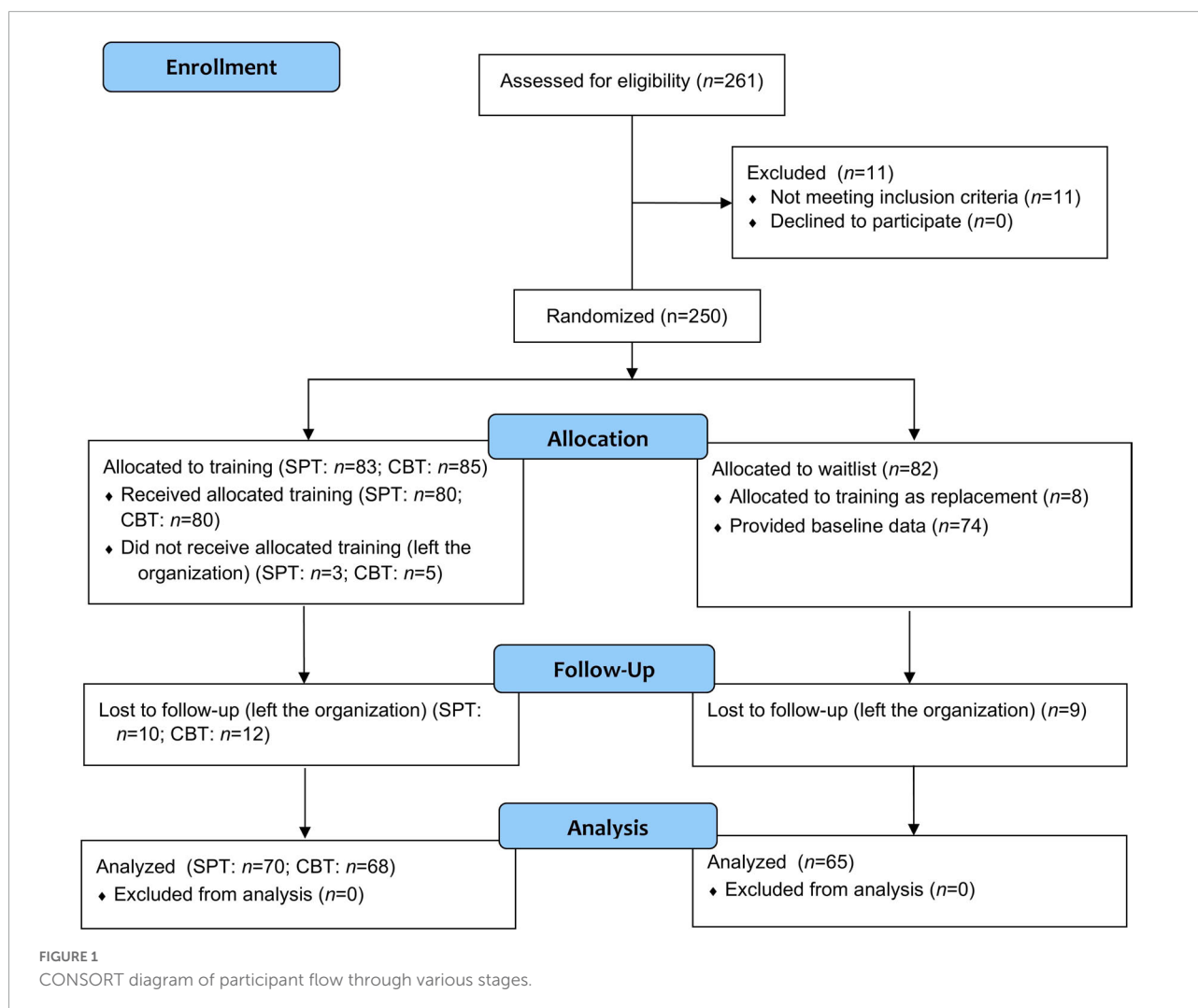
## Sample size and statistical power

*A priori* power analysis was performed using G\*Power version 3.1 (40), (RRID:SCR\_013726) based on the estimated effect size (0.21) obtained in our pilot study [citation redacted for masked review]. The results revealed that a minimum sample

size of 54 per condition was sufficient to attain statistical power of at least 90% and to detect significant group differences at a significance level of  $\alpha = 0.05$ . Considering the possible attrition rate for a three-phase longitudinal design (41), the target sample size was set at 80 participants per training condition.

## Participants

A total of 234 Chinese working adults were enrolled, with 160 receiving SBT or CBT, but 10, 12, and 9 subsequently dropped out of the SPT, CBT, and waitlist conditions, respectively. Figure 1 depicts the CONSORT flow diagram that summarizes the enrollment and allocation processes. The sample consisted of 68% men, with a median age of 25 years (age range: 18–40). The demographic characteristics of the sample are shown in Table 2. The participants who dropped out and



those who took part in all three time points did not differ in any demographic characteristics,  $ps > 0.17$ .

## Intervention fidelity

Multiple practices and strategies were undertaken for monitoring and enhancing intervention fidelity in this study. Specifically, the implementation of both SPT and CBT was standardized through the adoption of a manual. Each intervention program had its own manual, which contained comprehensive instructions and thorough descriptions of the content (i.e., goals and objectives, timeframe, scripted text, planned activities, and worksheets) for each of the program sessions.

All the intervention sessions were delivered by an experienced facilitator who was a holder of certificates in both Play Therapy and the LEGO SERIOUS PLAY method. Before the study began, the facilitator received extensive training

on the delivery of protocolized procedures for implementing each training program. The facilitator was instructed to closely follow a series of steps outlined in the respective manual of each program.

Implementation fidelity was monitored by two observers, each of whom made the assessment using a checklist adapted from the Implementation Fidelity Checklist constructed by Swain, Finney (42). Each observer gave independent ratings to five categories: program differentiation (SPT vs. CBT), adherence, exposure (planned vs. actual time), quality, and engagement. The inter-observer reliability in the assessment was high across the categories (77% to 97%).

## Skill training programs

Two skill training programs—SPT and CBT—were delivered and compared. Each program involved six bi-weekly two-hour sessions. The two programs were conducted at the

TABLE 2 Descriptive statistics of demographic and study variables by condition.

	Condition					
	SPT ( <i>n</i> = 70)		CBT ( <i>n</i> = 68)		Waitlist ( <i>n</i> = 65)	
	<i>M</i> (%)	<i>SD</i>	<i>M</i> (%)	<i>SD</i>	<i>M</i> (%)	<i>SD</i>
Gender (% of men)	67%		65%		71%	
<b>Education level</b>						
Junior secondary education or below	13%		9%		11%	
Senior secondary/vocational education	81%		84%		83%	
Tertiary/university education	6%		7%		6%	
Age	24.93 <sub>a</sub>	5.47	25.16 <sub>a</sub>	4.51	25.18 <sub>a</sub>	4.86
Months of service in the organization	11.58 <sub>a</sub>	5.75	11.22 <sub>a</sub>	4.66	11.47 <sub>a</sub>	5.66
Years of employment	8.22 <sub>a</sub>	6.08	7.74 <sub>a</sub>	5.02	7.84 <sub>a</sub>	5.22
<b>Team effectiveness</b>						
T1 self-ratings	15.80 <sub>a</sub>	3.88	15.74 <sub>a</sub>	3.12	15.52 <sub>a</sub>	3.76
T2 self-ratings	17.81 <sub>b</sub>	3.04	16.37 <sub>a</sub>	3.06	15.75 <sub>a</sub>	3.36
T3 self-ratings	18.19 <sub>b</sub>	3.56	15.40 <sub>a</sub>	2.83	15.28 <sub>a</sub>	3.60
T2 actual task performance†	59.34 <sub>a</sub>	19.48	63.53 <sub>a</sub>	20.32	n/a	
T2 behavioral coding	61.50 <sub>b</sub>	19.63	48.37 <sub>a</sub>	17.64	n/a	
T3 supervisor-ratings	18.87 <sub>b</sub>	2.63	16.63 <sub>a</sub>	2.49	16.40 <sub>a</sub>	2.83
T1 Coping flexibility	2.68 <sub>a</sub>	0.55	2.66 <sub>a</sub>	0.54	2.52 <sub>a</sub>	0.47
T2 Coping flexibility	2.87 <sub>b</sub>	0.48	2.92 <sub>b</sub>	0.54	2.62 <sub>a</sub>	0.46
T3 Coping flexibility	2.99 <sub>b</sub>	0.49	2.83 <sub>b</sub>	0.50	2.55 <sub>a</sub>	0.48
T1 Group cohesion	8.07 <sub>a</sub>	2.68	8.19 <sub>a</sub>	2.66	8.15 <sub>a</sub>	2.56
T2 Group cohesion	9.83 <sub>b</sub>	2.69	8.12 <sub>a</sub>	2.73	8.54 <sub>a</sub>	2.63
T3 Group cohesion	9.20 <sub>b</sub>	2.48	8.19 <sub>a</sub>	2.38	8.35 <sub>a</sub>	2.48
T1 Discriminative thinking	3.86 <sub>a</sub>	1.44	3.66 <sub>a</sub>	1.59	3.63 <sub>a</sub>	1.66
T2 Discriminative thinking	5.71 <sub>c</sub>	1.63	4.75 <sub>b</sub>	1.93	3.68 <sub>a</sub>	1.76
T3 Discriminative thinking	5.37 <sub>b</sub>	1.50	4.99 <sub>b</sub>	1.85	3.49 <sub>a</sub>	1.63

CBT = cognitive-behavioral training; n/a = not available; SPT = serious play training, T1 = Time 1; T2 = Time 2; T3 = Time 3. †Higher scores indicate greater ineffectiveness in team performance. Means that do not share the same subscripts differ from each other at  $p < 0.05$ .

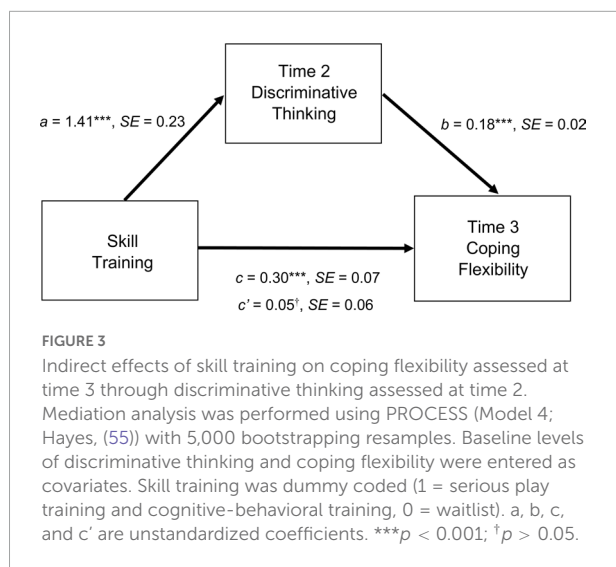
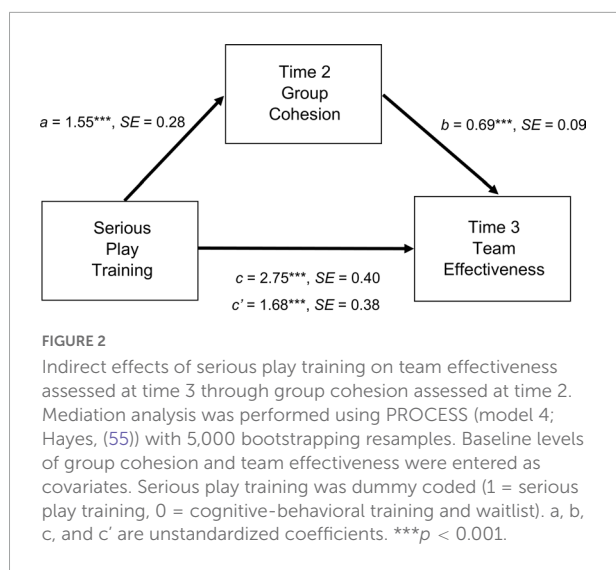
organizations from which the participants had been recruited. The newly developed SPT was first piloted on 30 working adults, with the pilot data demonstrating the program's implementation feasibility and acceptability among participants [citation redacted for masked review].

In both the gamification and instruction conditions, the sessions were delivered to teams of six to eight members. The overarching goal in both conditions was to develop skills that facilitate flexible deployment of coping strategies across the changing environment. The first three modules were psychoeducational, focusing on helping participants to understand the sources of their stress and their own distinct coping styles and then strengthening their discriminative thinking skills to increase coping effectiveness (43).

The three remaining sessions focused on real-life applications, although the delivery mode and context of training differed for the two conditions. A specific feature

of the SPT condition was that the modules were delivered to real-life work teams via group games, which combined interactive learning with the LEGO® SERIOUS PLAY® method (44). Active participation in these group games allowed the participants to acquire knowledge and communicate with their real-life team members effectively through immersion in an enjoyable, playful environment (17). Each group game involved three learning phases: LEGO® model building, storytelling, and reflection for learning. Specifically, within a group session, each team was first given a series of stressful vignettes (e.g., conflict with colleagues, reporting a work problem to the supervisor) constructed based on their life stories. In the model building phase, members were instructed to express their solutions through the use of LEGO® bricks to create a model as representations of metaphors. In the storytelling phase, the team conveyed their ideas through presenting their LEGO model and stories to the entire group. In the reflection phase, the entire group discussed their ideas and gave feedback to the





presenting team to help the team reflected on their own work. These activities were designed to strengthen the participants' skills for effective group decision-making and social resource accrual. Through such game engagement, greater cohesion among team members was expected to equip them to deal with work stress effectively.

For the CBT condition, the facilitator provided real-case demonstrations to show the participants how to deploy flexible coping to handle stressful life changes in the same series of vignettes. These activities were designed to strengthen the participants' skills for effective decision-making and the development of both problem-focused and emotion-focused coping skills (i.e., behavioral activation and relaxation). The content of these modules was designed according to the cognitive-behavioral approach (45). In the final session of both conditions, all the participants were asked to devise their own

action plan for future stress management at work and in their daily life.

## Measures

A battery of standardized questionnaires was administered to assess the learning mechanisms and outcome parameters for program evaluation. Specifically, the primary outcome was team effectiveness, whereas the secondary outcomes were coping flexibility. Two learning mechanisms—group cohesion and discriminative thinking—were also assessed.

For all these outcomes and learning mechanisms, self-ratings were obtained from the participants in all three conditions at all three time points. In addition, the primary outcome of team effectiveness was thoroughly evaluated using four methods: self-ratings, supervisor-ratings, actual task performance, and observation (behavioral coding). Data derived from actual task performance and observation were collected during discussions held in the final training session for both the SPT and CBT conditions. Supervisor-ratings were collected for the participants after the training at T3.

## Team effectiveness

Both the self- and supervisor-ratings of team effectiveness were measured using the Behaviorally Anchored Rating Scale version of the Comprehensive Assessment of Team Member Effectiveness measure (46). Each of the five domains of team effectiveness was evaluated by a 5-point rating, with each rating point anchored by a set of behavioral indicators. The raters were instructed to read all the behavioral indicators and then choose the response option that best reflected the actual team behaviors. The composite scores ranged from 5 to 25. The translated measure has been validated for the assessment of both self- and other-ratings in Chinese samples (47).

Team (vs. individual) performance during the training sessions was evaluated by a decision-making task entitled "Winter survival" (48). The task presented a stressful vignette regarding a group of people who survived from a plane crash but encountered a dire situation in a wilderness area under a severely cold weather. The group managed to salvage 12 items when escaped from the plane, and the task was to rank the set of items to indicate the importance of each item to their survival in the dire situation. Team members first gave their own sets of rankings independently, and then engaged in discussion to generate final team decisions. Team performance was computed by the absolute sum differences between a team's group rankings and the expert rankings. As lower difference scores indicated greater accuracy, a higher discrepancy score indicated less effective team performance. This task was administered in the final session of the SPT and CBT conditions at T2.

Each team member's effective (vs. ineffective) teamwork behavior during the decision-making process at T2 was recorded and coded by two independent observers. These extensively trained observers coded the team behaviors exhibited by all team members while they engaged in the "Winter survival" task using the Behavioral Observation Scale (49). The observers adopted a 7-point scale (1 = almost never, 7 = almost always) to rate 16 teamwork categories. The ratings for two ineffective behavioral markers were reverse scored, with higher composite scores indicating a team member's greater display of effective teamwork behavior. The level of inter-observer reliability was high (Krippendorff's  $\alpha \geq 0.70$ ).

### Coping flexibility

The Coping Flexibility Questionnaire (50) was adopted as an indicator of flexible coping. The inventory comprised two sections. In the first section, respondents were asked to list two controllable and two uncontrollable stressful events. In the second section, they reported up to four coping strategies and their corresponding goals for coping with each event. The respondents' coping goals were scored according to a validated scoring scheme based on the transactional theory of coping (51). The final codings ranged from 0 to 4, with higher scores indicating greater coping flexibility. This coping measure is found reliable and valid in Chinese samples (50).

### Group cohesion

The Group Cohesion Scale (52) was employed to assess group cohesion perceptions. Respondents rated each of the scale's three items on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicated stronger perceptions of cohesion among team members. The composite scores ranged from 3 to 15. The translated measure has been validated in Chinese settings (53).

### Discriminative thinking

The Extended Miller Behavioral Style Scale (37) was used as a measure of discriminative thinking. The brief version of the scale comprises two hypothetical stressful vignettes, each with eight coping responses. Respondents were instructed to endorse the deployment of each coping response in each vignette (0 = no, 1 = yes). The items were scored by a scheme derived by experts (37). The final codings ranged from 0 to 16, with higher values indicating a greater tendency toward discriminative thinking. This scale has good psychometric properties in Chinese samples (37).

### Manipulation checks

The participants were asked to guess the purpose of the study and to report whether they had previously seen any

decision-making tasks similar to that used in the present study. None of the participants could provide a correct guess of the study aims, and none had seen this type of task before.

## Masking

Participants' personal data and the condition to which they were assigned were concealed by arbitrary codes. The randomized controlled trial involved single masking, because the facilitator needed to administer different intervention programs to participants of various skill training conditions. Nevertheless, partial masking was adopted for different research teams to maximize the level of masking. Specifically, the supervisors who gave ratings, the observers who conducted behavioral codings, and the research assistants who administered the study and input data were unaware of the allocation schedule, randomization procedures, and research hypotheses. Moreover, the investigators were unaware of the allocation schedule and randomization procedures during their interpretation of the findings.

## Analytical strategy

Before hypothesis testing, outlier analysis was performed. Multiple outlier identification methods—boxplot, quantile-quantile plot, and stem-and-leaf plot—were employed to detect as many outliers as possible. Outliers identified by the three methods were removed. If the results obtained after outlier removal differed from those derived from the full sample, both sets of results are reported herein. If no substantial differences in the pattern of findings were found, the full results would be reported.

For outcome evaluations, the hypothetical longitudinal changes in the primary (team effectiveness) and secondary (coping flexibility) outcomes among the participants of the three conditions were tested by linear mixed effects modeling using analysis of covariance with three fixed factors (condition, time, and condition by time) and the baseline value as covariate. The missing data for the analysis of covariance modeling neither were imputed nor were they carried forward.

To unveil the hypothetical mechanisms underlying outcome changes, mediation analysis was performed using PROCESS macro version 3.5 (54), (RRID:SCR\_021369). Model 4 with the widely adopted, standard procedure of 5,000 bootstrap simulations was executed (55). In each mediation model, training condition (SPT, CBT, and waitlist) was entered as the antecedent, the hypothesized mechanisms (group cohesion and discriminative thinking) assessed at T2 were the mediator, and the primary and secondary outcomes assessed at T3 were included as the outcome. The baseline levels of both the mediator and outcome variables were controlled. The

significance of indirect effects was assessed by 95% bias-corrected and accelerated bootstrap (BCa) confidence intervals (CIs). To test the antecedent of training condition, the three-level categorical variable was coded into two dummy variables: SPT (1 = SPT, 0 = CBT/waitlist) and skill training (1 = SPT/CBT, 0 = waitlist). All analyzes were conducted using SPSS 26.0 (39), (RRID:SCR\_002865).

## Results

### Preliminary analyzes

Outliers detected by all three outlier identification methods were checked, and none were found to be error outliers. To further identify influential outliers, all outliers were omitted, with the same set of main analyzes conducted again. The pattern and interpretation of the findings yielded from the full sample and the trimmed sample with all outliers removed did not differ substantially, indicating that none of the suspected cases was an influential outlier.

**Table 2** presents the descriptive statistics of both the demographic and study variables for the three conditions. No significant differences were found for any of the demographic variables ( $ps > 0.09$ ), with the exception of a significant positive association between length of service in the organization and self-ratings of team effectiveness reported at T1,  $r(203) = 0.14$ ,  $p = 0.04$ . The analyzes were thus conducted with the pooled sample, with no demographic variables included as covariates.

### Evaluations of program effectiveness

The efficacy of SPT (vs. CBT and waitlist conditions) was evaluated in terms of changes in both team effectiveness and coping flexibility over time. For the participants' self-ratings of team effectiveness, the hypothesized Condition  $\times$  Time interaction was significant,  $F(4, 600) = 3.75$ ,  $p = 0.005$ , Cohen's  $f = 0.13$ . The participants of the three conditions did not differ in their ratings of team effectiveness at T1, but those assigned to the SPT condition gave higher team effectiveness ratings at T2 and T3 than those assigned to the other two conditions ( $ps < 0.02$ ).

For the supervisors' ratings of team effectiveness at T3, significant differences among the three conditions were also found,  $F(2, 200) = 18.19$ ,  $p < 0.001$ , Cohen's  $f = 0.41$ . The supervisors gave higher ratings of team effectiveness for the participants in the SPT condition than for those in the two other conditions.

For the observer-coding of actual team behavior at T2, the observers gave higher scores for the effective team behaviors of the participants taking part in SPT (vs. CBT),  $t(136) = 4.14$ ,  $p < 0.001$ , Hedges'  $g = 0.70$ ; but no such differences in task performance scores were found between the two conditions,

$t(136) = -1.24$ ,  $p = 0.22$ , Hedges'  $g = -0.21$ . Taken together, all these findings derived from multiple methods were largely consistent with Hypothesis 1.

The efficacy of both skill training programs (i.e., both SPT and CBT) was assessed in terms of changes in coping flexibility over time. A linear mixed effect model revealed that the hypothesized Condition  $\times$  Time interaction was not significant,  $F(4, 600) = 1.60$ ,  $p = 0.17$ , Cohen's  $f = 0.06$ . However, significant main effects were found for condition,  $F(2, 600) = 18.31$ ,  $p < 0.001$ , Cohen's  $f = 0.24$ ; and for time,  $F(2, 600) = 8.46$ ,  $p < 0.001$ , Cohen's  $f = 0.16$ . There were no differences among the participants of the three conditions at T1, but those assigned to the SPT and CBT conditions exhibited greater coping flexibility at T2 and T3 than those assigned to the CBT or waitlist conditions ( $ps < 0.001$ ). Such findings provided partial support for Hypothesis 2.

### Mechanisms for explaining program effectiveness

To test the hypothesized mechanisms underlying the beneficial changes in the acquisition of flexible coping skills after attending SPT, mediation analysis was conducted. The results are summarized in **Figures 2** and **3**. Referring to **Figure 2**, the hypothesized indirect effect of SPT (vs. CBT and waitlist) on T3 self-ratings of team effectiveness through T2 group cohesion was significant, but no such mediation effects were found for T2 discriminative thinking. The direct effect remained significant after controlling for the effect of T2 group cohesion, indicating the presence of a partial mediation. The results thus supported Hypothesis 3.

Finally, the hypothesized mechanisms underlying the beneficial changes in coping flexibility after attending SPT or CBT were also tested. The findings are shown in **Figure 3**. Referring to this figure, the hypothesized indirect effect of skill training on T3 coping flexibility through T2 discriminative thinking was significant. The direct effect (path  $c'$ ) became non-significant after controlling for the effect of the mediator, thus indicating complete mediation. These findings provided support for Hypothesis 4.

## Discussion

This study introduced a newly designed SPT program as an alternative approach to staff development that strengthens Chinese workers' personal and interpersonal skills, both of which are beneficial to team building and flexible coping with life stress. Through examining the learning mechanisms underlying program participation, the findings demonstrate that SPT has the advantage over CBT in strengthening team effectiveness, with such a desirable change explained by an

increase in group cohesion. In addition, the findings further provide evidence suggesting that SPT is as effective as existing CBT programs in enhancing coping flexibility over time, with the strengthening of discriminative thinking skills found to explain this positive change.

For team building, only SPT is found to enhance team effectiveness. Such encouraging findings provide support for the use of serious play as an adult learning tool in team building, one of the most popular employee development themes in corporate training. The serious play method is grounded in theories of play, imagination, and complexity; aiming to uncover and create new insights by using toy materials (e.g., LEGO bricks, doll house) as a medium for visualizing, communicating, understanding, and tackling challenges (56). The major advantage is the method's playful, hands-on approach, which turns a work setting into a constructive playground. The fun and relaxing environment gently pushes team members to think "outside the box," facilitating them to brainstorm more unusual ideas and speak their minds effectively to an audience (57).

The findings also support the hypothesized mediating role of group cohesion in the link between SPT participation and self-rated team effectiveness. However, it is noteworthy that this mediation effect is only partial. This result may be attributable to the highly complex nature of team effectiveness, which is a multifaceted construct (58). Previous work has indicated that team effectiveness comprises a variety of domains, including both task-oriented (e.g., leadership, coordination) and social-oriented (e.g., communication, conflict management) domains (59). Future program evaluation studies should adopt a more nuanced approach to identify the specific domains and psychological mechanisms that account for greater variances in outcome changes resulting from SPT participation. Nevertheless, nuanced approaches can have shortcomings because many learning processes involve the simultaneous occurrence of multiple psychological mechanisms that are practically difficult to dissect for separate analyses.

For stress management, the newly introduced SPT approach is found to be as effective as the existing, popular method of CBT in fostering coping flexibility, demonstrating that SPT is an effective tool for building not only team but also personal skills. In corporate training, the serious play intervention has been adopted for change management so as to improve the company and promote its future development. It is important to note that the aim of the intervention is not just to foster creativity and flexibility among company staff, but ultimately to help transform the staff and their company (60). The creative and flexible thinking skills acquired from SPT enable the participants not only to spot new opportunities in the business environment, but more importantly, to change strategies, structures, products, business models, and systems. In the same vein, our study

further shows that the SPT is also efficacious for facilitating coping flexibility, an essential skill for handling stressful life transitions and vicissitudes (5). Workshop participants acquire cognitive astuteness and sensitivity to environmental cues (i.e., cognitive flexibility) through constant shifting of their constructed models from one context to another, and their acquired astuteness facilitates the choice of the most situation-appropriate strategy from their coping repertoire (i.e., behavioral flexibility) (61).

Our study further unveils discriminative thinking as a cognitive mechanism underlying the building of flexible coping skills. In SPT sessions, toy materials (i.e., LEGO bricks) are used as a major tool for supporting flexible thinking, developing a creative culture, and contributing to learning processes through storytelling and reflection (17). The bricks are flexible for building symbolic and metaphorical models. When completing a single task in a training session, participants can easily build and rebuild their models by removing the bricks and placing the bricks in other locations. They are also asked to switch contexts by creating new stories and building new models. Such frequent task switching enables the participants to acquire discriminative thinking, which fosters deployment of a coping strategy that best meets the demands of a particular stressful encounter (62, 63).

The novel findings presented herein have practical implications for corporate training with a special focus on personal development. Most existing intervention programs in this area adopt an individual-oriented approach aimed at building cognitive-behavioral skills that can facilitate the effective handling of stressful events (64). This widely adopted approach has been criticized for largely neglecting a crucial dimension of the occupational environment, such as the organizational and interpersonal elements at play (11).

To address this important but unexplored dimension, we recommend a paradigmatic shift toward an integrative, ecologically relevant approach that broadens the scope of skill development to both personal and interpersonal realms in real-life work teams. The aim of this alternative novel approach is to attain the goal of skill acquisition through real-life social engagement. Our proposed SPT expands upon the often-demarcated designs that are targeted primarily at the individual level, thereby acknowledging the need to concurrently attend to workshop participants' interactions with their actual surroundings and immediate contextual characteristics (e.g., peer relations, institutional demands, cultural orientation), which constitute ever-evolving psychosocial stressors inherent to the work environment.

The major advantage of this novel approach is that SPT training activities are designed based on the real-life work problems reported by employees with the same work and cultural backgrounds, and thus are of direct relevance to the

participants' interests that increase their motivation for active participation and engagement. Despite the workshop setting, participants have already been practicing their acquired skills through interacting with members of their real-life work teams. Under the guidance of a qualified facilitator, participants can further polish their coping skills through reflection on their dynamic exchanges during the sessions and collaborations with their fellow team members in serious games, as well as meaning-making through social interactions, thereby facilitating the active construction and consolidation of knowledge acquired in the training sessions (14, 15).

Although the present study contributes to the literature by providing evidence supporting the efficacy of a new intervention approach to corporate training, several limitations suggest that broader generalizations of the findings should be made with caution. First, SPT in this study focuses solely on the cultivation of coping skills. The gamification approach may not be equally effective for the acquisition of other personal development skills such as leadership and assertiveness. The scope of SPT should be expanded to an array of skills to allow a more thorough evaluation of its usefulness in corporate training.

Moreover, as the study targeted the training of actual teams within real organizations, participant recruitment was arranged by the administrative staff of the participating organizations. The sample was thus relatively homogeneous, constituting mainly young men who had attained a senior secondary level of education or received vocational education. Hence, the present findings may not be generalizable to employees with dissimilar demographic characteristics.

## Conclusion

The present study is the first to test the efficacy of the newly introduced SPT intervention approach and compare it with the existing CBT approach in terms of both team and personal skill training. As expected, only SPT is found to strengthen team building skills over time, and group cohesion is identified as the underlying learning mechanism that explains this positive change. In addition, SPT is found to be as beneficial as the existing CBT in sharpening flexible coping skills, and discriminative thinking is identified as the learning mechanism underlying the positive change. Such promising results encourage future researchers and practitioners to draw more attention and resources to utilize SPT for developing a broader array of skills in both corporate and public wellness promotion programs.

## Data availability statement

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

## Ethics statement

The studies involving human participants were reviewed and approved by Human Research Ethics Committee (HREC) of the University of Hong Kong. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

CC contributed to the conception and design of the study, coordinated the data collection process, performed the statistical analysis, and wrote the first draft of the manuscript. C-LC wrote sections of the manuscript. Both authors conducted the literature review, contributed to the editing and revision of the manuscript, 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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# Depression, anxiety and stress, during COVID-19 pandemic among midwives in Ethiopia: A nationwide cross-sectional survey

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**Introduction:** COVID-19 has rapidly crossed borders, infecting people throughout the whole world, and has led to a wide range of psychological sequelae. Midwives who come close in contact with women while providing care are often left stricken with inadequate protection from contamination with COVID-19. Therefore, this study aimed to assess the level of depression, anxiety, and stress (DASS) among midwives in Ethiopia.

**Methods:** A cross-sectional study was conducted from 20 June to 20 August 2020, among 1,691 practicing midwives in Ethiopia. A simple random sampling technique was used to select study participants. Data were collected through a structured telephone interview. A 21-item depression, anxiety, and stress scale (DASS-21) was used. Data were entered using the Google forms platform and were analyzed with SPSS version 24. Both bivariate and multivariable logistic regression analyses were employed. Variables with a  $p$ -value  $< 0.05$  in the final model were declared statistically significant. Adjusted odds ratio (AOR) with the corresponding 95% confidence interval (95% CI) was used to determine independent predictors.

**Results:** The prevalence of DASS among midwives in Ethiopia was 41.1, 29.6, and 19.0%, respectively. Being female [AOR = 1.35; 95% CI: 1.08, 1.69], working in rural areas [AOR = 1.39; 95% CI: 1.06, 1.82], having poor knowledge of COVID-19 [AOR = 1.40; 95% CI: 1.12, 1.75], having poor preventive practice [AOR = 1.83; 95% CI: 1.47, 2.28], and substance use [AOR = 0.31; 95% CI: 0.17, 0.56] were significantly associated with depression; while, working in the governmental health facility [AOR = 2.44; 95% CI: 1.24, 4.78], having poor preventive practice [AOR = 1.47; 95% CI: 1.16, 1.85], and having poor attitude [AOR = 2.22; 95% CI: 1.04, 1.66] were significantly associated with anxiety. Furthermore, working in rural areas [AOR = 0.57; 95% CI: 0.39, 0.83], substance use [AOR = 2.06; 95% CI: 1.51, 2.81], having poor knowledge [AOR = 1.44; 95%

CI: 1.20, 1.90], and having poor preventive practice [AOR = 1.60; 95% CI: 1.23, 2.10] were associated with stress.

**Conclusion:** In this study, the overall magnitude of depression, anxiety, and stress were high. Addressing knowledge gaps through information, training, and safety protocols on COVID-19 and the provision of adequate personal protective equipment (PPE) is essential to preserve the mental health of Midwives during COVID-19.

#### KEYWORDS

anxiety, depression, stress, COVID-19, midwives, Ethiopia

## Introduction

COVID-19 is an infectious disease that is caused by a new strain of novel coronavirus and is known to cause illnesses ranging from the common cold to severe acute respiratory syndrome (SARS). It was first confirmed in December 2019 in Wuhan, Hubei Province, China (1). In January 2020, the World Health Organization (WHO) declared that COVID-19 is a Public Health Emergency of International Concern (2). Patients with COVID-19 either have an asymptomatic disease or are present with symptoms, such as fever, cough, or shortness of breath (3).

COVID-19 has rapidly crossed borders, infecting people throughout the whole world. Its emergence and spread cause confusion, anxiety, and fear among the general public (4). As research into COVID-19 continues, a lot of the facts keep on changing and many myths are also prevalent in the general population regarding the prevention and management of the infection. In the time of widespread use of social media, these myths along with fake news about corona are also spreading rapidly, which causes feelings of stress, anxiety, and depression (5).

Depression, anxiety, and stress (DASS) are globally affecting every individual to variable extents. Recent evidence suggests that individuals who are kept in isolation and quarantine experience significant distress in the form of anxiety, anger, confusion, and post-traumatic stress symptoms (6). With this mode of transmission, healthcare workers are among the highest risk of being infected. The highly contagious COVID-19 virus is an additional hazard for the healthcare system apart from the burden of extended work hours, physical and psychological stress, burnout, and fatigue. Midwives are essential in reducing maternal and perinatal morbidity and mortality but are an

all-too-often forgotten human resource in healthcare systems (7, 8).

Due to their direct contact with patients, healthcare workers are among the highest risk of being infected by COVID-19 (9) and suffering psychological exhaustion (10) after working in an extremely stressful environment. The United Nations (UN) body reported that more than 1.4 million infections of COVID-19 in the world are accounted for by health workers, at least 10% of all cases (11). In Africa, the information on health worker infections is still limited, but preliminary data reported that over 10,000 health workers in Africa were infected with COVID-19 (12).

In Ethiopia, during the emergence of the pandemic outbreak, healthcare services were partially closed and focused on the prevention and treatment of COVID-19. However, midwifery services were among the services that continued as usual. Midwives, who come close and prolonged contact with women when providing care, are often left stricken with inadequate protections from contamination, high risks of infection, working burnout, fear, anxiety, and depression. Furthermore, the limited availability of adequate personal protective equipment (PPE) has raised concerns and worries about the risk of COVID-19 infection. However, there is no known information on the psychological impact of COVID-19 among midwives. Therefore, this study aimed to assess the prevalence of DASS during the COVID-19 pandemic among midwives in Ethiopia in 2020.

## Materials and methods

### Study setting, design, and period

A web-based quantitative cross-sectional study was conducted among midwives who are providing maternal health services in Ethiopia from 20 May to 20 August 2020. According to the Ethiopian Midwives Association (EMA) database in 2020, there are 16,925 midwives in Ethiopia.

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**Abbreviations:** AOR, Adjusted Odds Ratio; COVID-19, Coronavirus Disease 2019; CI, Confidence Interval; COR, Crude Odds Ratio; MERS-CoV, Middle East Respiratory Syndrome; EMWA, Ethiopian Midwives Association; SARS, Severe Acute Respiratory Syndrome; and WHO, World Health Organization.

## Source and study population

All midwives currently providing clinical care in Ethiopia were the source population, and randomly selected midwives were the study population. All midwives providing clinical care for reproductive, maternal, neonatal, child, and adolescent health were included.

## Sample size determination and sampling procedure

The sample size was determined using the single population proportion formula, taking the following assumptions: 20.1% depression symptoms in China due to COVID-19 outbreak (13), 95% confidence interval (CI),  $Z$  as 1.96, 2% margin of error, and adding 10% non-response rate. Finally, 1,691 was the final sample size considered in the current study.

The total sample was proportionally allocated for all administrative regional states and two city administrations based on their number of midwives according to the EMA national census database. Then, a simple random sampling technique was used to select study participants. Then, data were collected through a telephone interview and each response was entered in the prepared Google forms platform data collection tool.

## Data collection tools and measurement

Due to the COVID-19 contagious pandemic outbreak, the team opted to collect the data through telephone interviews. A pretested and structured telephone interviewer-administered questionnaire was used to collect the data. For those study participants who did not pick up their phones, whose phones were not working, and who were not ready to talk by the time, and then our data collectors called them on another day during the data collection period.

The questionnaire consisted of three parts, such as socio-demographic characteristics, COVID-19-related knowledge, attitude, and practice, and depression, anxiety, and stress scale (DASS-21). Depression, anxiety, and stress have 7 scales, with a 4-point Likert scale from 0 to 3, where 0 stands for “never-did not apply to me at all,” 1 stands for “sometimes-applied to me to some degree, or some of the times,” 2 stands for “often, i.e., applied to me to a considerable degree or a good part of the time,” and 3 stands for “almost always applied to me very much or most of the time,” and the final score of each part was obtained by adding the scores of the related questions and finally

multiplied by 2, thus arriving at three separate scores for all three subscales (14).

### Depression, anxiety, and stress

A respondent who scored below 10, 8, and 15 for each of the respective questions on the DASS-21 scale was considered as having no DASS and a respondent who scored  $\geq 10$ ,  $\geq 8$ , and  $\geq 15$  was considered as having DASS, respectively (14).

### Good knowledge of COVID-19

A respondent who answered the mean and above score (9.91) among sixteen item knowledge questions was considered as having “good knowledge” of COVID-19.

### Favorable attitude toward COVID-19

A respondent who answered the mean and above score (3.25) among seven-item attitude questions was considered as having a “favorable attitude” toward COVID-19.

### Good COVID-19 prevention practices

A respondent who answered the mean and above score (3.62) among five-item prevention practice questions was considered as having “good preventive practice” on COVID-19 prevention.

The questionnaire was pretested among midwives working in academic institutions to ensure the validity of the tool, and then the correction was made before the actual data collection started. The training was given to data collectors and supervisors on the data collection procedures. In total, fifteen multilingual BSc nurses collected the data through a telephone interview and the data were supervised by two masters of public health holders. Proper coding and categorization of data were maintained for the quality of the data to be analyzed. Double data entry was done and any inconsistency was managed accordingly.

## Data analysis procedure

The collected data were extracted from Google forms and exported to Microsoft Excel for cleaning and coding. The data were analyzed using SPSS version 24 software (IBM Corp., Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.). Frequencies and cross-tabulations were used to summarize descriptive statistics of the data. Tables and graphs were used for data presentation. Binary logistic regression analysis was primarily used to establish an association between dependent and independent variables. Then, variables with a  $p$ -value of less than 0.2 fitted into multiple logistic regression models and variables having a  $p$ -value less than 0.05 in the multivariable logistic regression analysis were considered to declare the statistical significance. The strength of association was interpreted using the adjusted odds ratio (OR) and 95% CI.



## Ethics statement

The study was approved by the Institutional Review Boards of Woldia University (Ref: WDU/986/RCS/2020). Informed consent was obtained from participants after providing all the necessary information on the study, informing them of the purpose, benefit, risk, and confidentiality of the information and the voluntary nature of the participation in the study. Participants were informed that all data obtained from them were kept confidential and no identifying information was collected from them.

## Results

### Socio-demographic characteristics

A total of 1,498 participants were included in the study, which makes a response rate of 88.6%. The study participants with symptoms and signs of COVID-19 were referred to nearby isolation centers. The median age of the participants was 27.0 ( $\pm$  4.3) years. The majority (93.3%) of participants were in the age range of 16–34 years, 781 (52.1%) were men and 769 (51.3%) were married. Moreover, more than four-fifths (81.4%) are working in an urban area. The mean ( $\pm$  SD) work experience of participants was 5.72 ( $\pm$  4.1) years with nearly three-fifths (58.3%) having less than 5 years of work experience (Table 1).

### Knowledge, attitude, and preventive practices toward COVID-19

In this study, 876 (58.5%) midwives had good knowledge of COVID-19. Regarding attitude and preventive practices of COVID-19, 590 (39.4%) of midwives had a favorable attitude and 854 (57.0%) had good preventive practices toward COVID-19.

### Prevalence of depression, anxiety, and stress

The overall prevalence of DASS among midwives was found to be 41.1% [95% CI: 38.6, 43.7], 29.6% [95% CI: 27.3, 31.8], and 19.0% [95% CI: 17.0, 20.8], respectively (Figure 1).

### Factors associated with depression

In the bivariable analysis: age, sex, marital status, residence, educational level, type of working facility, substance use (tobacco, khat, or alcohol), knowledge of COVID-19, attitude

toward COVID-19, and preventive practice toward COVID-19 were found to be significantly associated with depression. After controlling confounders through the multivariable analysis, sex, residence, types of working health facility, knowledge, preventive practice on COVID-19 pandemic prevention and substance use were significantly associated with depression among midwives in Ethiopia.

Female midwives were 1.35 times more likely to develop depression as compared with men [adjusted odds ratio [AOR] = 1.35; 95% CI: 1.08, 1.69]. Those midwives who are working in the rural area were 1.39 times more likely to develop depression as compared with midwives working in the urban areas [AOR = 1.39; 95% CI: 1.06, 1.82]. The odds of developing depression among midwives with the poor knowledge of COVID-19 were 1.40 times higher compared with their counterparts [AOR = 1.40; 95% CI: 1.12, 1.75]. Those midwives with a poor COVID-19 prevention practice were 1.83 times more likely to develop depression as compared with their counterparts [AOR = 1.83; 95% CI: 1.47, 2.28]. The odds of depression were 1.69 times higher among midwives who were exposed to substances than non-users [AOR = 1.69; 95% CI: 1.27, 2.25]. However, the odds of having depression were decreased by 69% among midwives working in governmental

TABLE 1 Socio-demographic characteristics of midwives working in Ethiopia in 2020 ( $n = 1,498$ ).

Variables	Category	Frequency (n)	Percent (%)
Age	16–34	1,398	93.3
	35–62	100	6.7
Sex	Male	781	52.1
	Female	717	47.9
Marital status	Married	769	51.3
	Single	729	48.7
Resident	Urban	1,219	81.4
	Rural	279	18.6
Religious status	Orthodox	964	64.3
	Muslim	308	20.6
	Protestant	210	14.0
	Others*	16	1.1
Educational level	Diploma	539	36.0
	Bachelor degree	837	55.9
	Master's degree	122	8.1
Work experience	$\leq 5$ years	874	58.3
	5–10 years	506	33.8
	> 10 years	118	7.9
Type of health facility	Governmental	1,427	95.3
	Private	71	4.7
Health facility ( $n = 1,427$ )	Hospital	778	54.5
	Health center	649	45.5

Others\*, Apostolic, Catholic, Adventist 7th day.

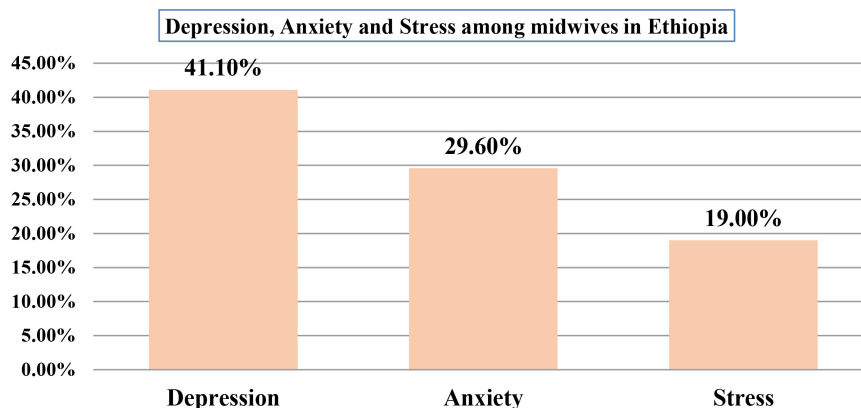


FIGURE 1

The level of depression, anxiety, and stress among midwives in Ethiopia in 2020.

TABLE 2 Bivariable and multivariable logistic regression analysis for factors associated with depression among midwives in Ethiopia in 2020 ( $n = 1,498$ ).

Variables	Category	Depression		COR (95%CI)	AOR (95%CI)
		Yes (%)	No (%)		
Sex	Male	293 (37.5)	488 (62.5)	1	1
	Female	323 (45.0)	394 (55.0)	1.37 (1.11, 1.68)	1.35 (1.08, 1.69) *
Residence	Urban	484 (39.7)	735 (60.3)	1	1
	Rural	132 (47.3)	147 (52.7)	1.36 (1.05, 1.77)	1.39 (1.06, 1.83)
Working facility	Government	562 (39.4)	865 (60.6)	0.21 (0.12, 0.36)	0.31 (0.17, 0.56) **
	Private	54 (76.1)	17 (23.9)	1	1
Knowledge on COVID-19	Good	315 (36.0)	561 (64.0)	1	1
	Poor	301 (48.4)	321 (51.6)	1.67 (1.35, 2.06)	1.40 (1.12, 1.75) *
COVID-19 prevention practice	Good	288 (33.7)	566 (66.3)	1	1
	Poor	328 (50.9)	316 (49.1)	2.04 (1.65, 2.52)	1.83 (1.47, 2.28) **
Substance use	Yes	142 (53.4)	124 (46.6)	1.83 (1.40, 2.39)	1.69 (1.27, 2.25) **
	No	474 (38.5)	758 (61.5)	1	1

\* $p < 0.005$ , \*\* $p < 0.001$ , and 1: constant.

health facilities than midwives working in private health facilities [ $AOR = 0.31$ ; 95%  $CI$ : 0.17, 0.56] (Table 2).

among midwives with an unfavorable attitude toward COVID-19 compared with those with a poor attitude [ $AOR = 1.31$ ; 95%  $CI$ : 1.04, 1.66] (Table 3).

## Factors associated with anxiety

In the bivariable analysis, the type of working facility, COVID-19 preventive practice, and attitude toward COVID-19 were significantly associated with anxiety among midwives. The odds of anxiety were 2.44 times higher among midwives who are working in government health facilities as compared with midwives working in private health facilities [ $AOR = 2.44$ ; 95%  $CI$ : 1.24, 4.78]. The odds of anxiety were 1.47 times higher among midwives who had a poor COVID-19 preventive practice as compared with their counterparts [ $AOR = 1.47$ ; 95%  $CI$ : 1.16, 1.85]. Moreover, the odds of anxiety were 1.31 times higher

## Factors associated with stress

In multivariable logistic regression analysis: residence, substance use, knowledge of midwives toward COVID-19, and COVID-19 pandemic prevention practices were significantly associated with depression among midwives in Ethiopia. Unlike depression, those midwives who are working in rural areas have decreased the odds of stress by 43% as compared with midwives working in the urban area [ $AOR = 0.57$ ; 95%  $CI$ : 0.39, 0.83]. The odds of stress were 2.06 times more likely among midwives who use substances than their counterparts [ $AOR = 2.06$ ; 95%  $CI$ :

TABLE 3 Bivariable and multivariable logistic regression analysis for factors associated with anxiety among midwives in Ethiopia in 2020 ( $n = 1,498$ ).

Variable	Categories	Anxiety		COR (95% CI)	AOR (95% CI)
		Yes (%)	No (%)		
Educational level	Diploma	142 (26.3)	397 (73.7)	1.25 (0.98, 1.59)	
	BSc degree	258 (30.8)	579 (69.2)	1.52 (1.00, 2.31)	
	MSc degree	43 (35.2)	79 (64.8)	1	1
Marital status	Single	197 (27.4)	523 (72.6)	1	1
	Married	246 (31.6)	532 (68.4)	1.27 (1.02, 1.59)	
Working facility	Government	432 (30.3)	995 (69.7)	2.37 (1.23, 4.55)	2.44 (1.24, 4.78)*
	Private	11 (15.5)	60 (84.5)	1	1
Substance use	Yes	93 (35.0)	173 (65.0)	1.36 (1.02, 1.79)	
	No	350 (28.4)	882 (71.6)	1	1
COVID-19 prevention practice	Poor	218 (33.9)	426 (66.1)	1.43 (1.14, 1.79)	1.47 (1.16, 1.85)*
	Good	255 (28.8)	629 (71.2)	1	1
COVID-19 attitude	Unfavorable	290 (31.9)	618 (68.1)	1.34 (1.10, 1.69)	1.31 (1.04, 1.66)*
	Favorable	153 (25.9)	437 (64.1)	1	1

\* $p < 0.005$ , and 1: constant.

1.51, 2.81]. The odds of stress were 1.44 times more likely among midwives who had poor knowledge than their counterparts [ $AOR = 1.44$ ; 95%  $CI$ : 1.20, 1.90]. Those midwives who had poor COVID-19 prevention practice were 1.60 times more likely to develop stress as compared with those who had good preventive practice [ $AOR = 1.60$ ; 95%  $CI$ : 1.23, 2.10] (Table 4).

## Discussion

To the best of our knowledge, this work is the first nationwide survey on the prevalence of DASS among midwives working in clinical practice following the COVID-19 pandemic. The overall prevalence of DASS among midwives in Ethiopia was found to be 41.1, 29.6, and 19.0%, respectively. This finding is lower than another study conducted in Ethiopia; depression (60.3%), anxiety (78%), and stress (33.8%) (15); in northwest Ethiopia, depression (55.3%), anxiety (69.6%), and stress (79.5%) (16); in Turkey, depression (64.7%), anxiety (51.6%), and stress (41.2%) among the health workers (17); in New York, depression (48%), anxiety (33%), and stress (57%) (18), and in China, depression (50.4%), anxiety (44.6%), and stress (71.5%) (19). This might be due to the fact that those studies were done during the early stage of COVID-19, at which the outbreak was severe and caused fear and frustration among the healthcare providers and the general public. In addition, little is known about the virus, including prevention and transmission means, clinical presentation, and personal protective equipment during the initial period of the pandemic.

However, the finding of this study was higher than that of the study conducted in Singapore among healthcare workers,

in which 14.5% of participants screened positive for anxiety, 8.9% for depression, and 6.6% for stress (16). The possible reason could be the difference in perceived exposure among healthcare providers; midwives cannot keep their physical distance during antenatal care (ANC), labor, and delivery, because of the nature of services that require close and prolonged contact with women. Additionally, it is difficult to wear a face mask during labor and delivery the whole day, which creates discomfort. Furthermore, there has been a scarcity of personal protective equipment to fight COVID-19, and this situation entails an increased probability of suffering different mental health consequences.

In this study, female midwives were more likely to develop depression as compared with men. This result was in line with the study done in China and Turkey (20, 21), this could be due to the intersect effect of genetic, biological, hormonal, social, and psychological factors. The second reason could be that the presence of androgen receptors in men may give protection, and since testosterone hormone does not cycle as estrogen in women, it also has protection in men. Because of the above reasons, women experience a high prevalence of mood and anxiety disorders (22). Moreover, in the Ethiopian context, women are responsible to take care of family and control their household activities in addition to their professional work, which makes them anxious and more stressed.

Those midwives working in rural areas were more likely to develop depression as compared with their counterparts. This finding is supported by a study done in China (23). This might be due to a lack of personal protective equipment in health facilities or poor knowledge and practice of the rural community toward COVID-19, which put midwives at an increased risk of developing depression.

TABLE 4 Bivariable and multivariable logistic regression analysis for factors associated with stress among midwives in Ethiopia in 2020 ( $n = 1,498$ ).

Variables	Categories	Stress		COR (95% CI)	AOR (95% CI)
		Yes (%)	No (%)		
Marital status	Single	128 (17.6)	601 (82.4)	1	1
	Married	156 (20.3)	613 (79.7)	1.20 (0.92, 1.55)	
Residence	Urban	248 (20.3)	971 (79.7)	1	1
	Rural	36 (12.9)	243 (87.1)	0.58 (0.40, 0.85)	0.57 (0.39, 0.83)*
Working facility	Government	258 (18.1)	1,169 (71.9)	1	1
	Private	26 (36.6)	45 (63.4)	2.62 (1.59, 4.32)	
Substance use	Yes	83 (31.2)	183 (69.8)	2.33 (1.72, 3.14)	2.06 (1.51, 2.81)**
	No	201 (16.3)	1,031 (83.7)	1	1
COVID-19 knowledge	Poor	141 (22.7)	481 (77.3)	1.50 (1.16, 1.95)	1.44 (1.20, 1.90)*
	Good	143 (16.3)	733 (83.7)	1	1
COVID-19 prevention practice	Poor	158 (24.5)	486 (75.5)	1.88 (1.45, 2.44)	1.60 (1.23, 2.10)*
	Good	126 (14.8)	728 (85.2)	1	1

\* $p < 0.005$ , \*\* $p < 0.001$ , and 1: constant.

Unlike depression, those midwives working in rural areas are less likely to develop stress compared with their counterparts. The possible reason might be that the burden of infection is highly prevalent in the urban area. Another possible reason could be isolation, quarantine, and treatment centers for COVID-19 are located in urban areas, so health professionals, such as midwives, who are working in urban health facilities, are worried about the risk of acquiring the infection.

Our study showed that midwives working in government health institutions have a higher prevalence of depression and anxiety as compared with those midwives working in private ones. This finding is in line with a systematic and meta-analysis study (24). This could be due to a critical shortage of PPEs in government health facilities where they are under the continuous threat of acquiring the infection.

Midwives who had poor knowledge of COVID-19 were more likely to develop depression and stress as compared with their counterparts. This is in line with studies done in China (25–27). This might be due to that health providers with a good knowledge of the COVID-19 outbreak are crucial in reducing the rate of infection and protecting from infection (28), which helps to avoid adverse psychological distress. Additionally, having a good knowledge of prevention and method of transmission of the novel virus would help the healthcare providers in engaging mindfully in activities, such as hand washing, wearing a mask, and keeping physical distancing, which minimizes the level of depression and stress (29).

The poor preventive practice of COVID-19 among providers had a significant association with DASS. This is supported by a study done in Saudi Arabia (28). This is due to the fact that respondents who practiced preventive measures for

COVID-19 are less likely to acquire the infection, so they are less likely to develop stress, anxiety, and depression symptoms (30). Moreover, this could be due to the fact that taking care of and complying with the disease prevention strategies could give a sense of protection, and as a frontline cadre to care for patients; good prevention practice may reduce frustration and worry related to acquiring and transmitting the disease which leads to develop good mental health and wellbeing.

Midwives who had a poor attitude toward COVID-19 were more likely to develop anxiety than their counterparts. This finding is supported by a review article done among nurses and healthcare professionals (31). This might be because those people who are not confident that the disease can finally be controlled and have a higher perception of susceptibility and severity may feel more anxious.

Furthermore, exposure to substances was significantly and positively associated with depression and stress. This finding is in agreement with the study done in India (32). According to the World Health Organization (WHO) recommendation, alcohol consumption can increase the risk of catching COVID-19 (33). This might be also due to the triggering effect of substance, which impairs the decision-making and judgment ability of workers and reduce the preventive measures for COVID-19 infection. Moreover, poor COVID-19 preventive practice resulted in worry and fear that might be putative factors for the impairment of mental health and wellbeing.

The study has some limitations that need to be acknowledged. The study did not include those midwives who had no mobile network access. As the study findings are based on self-report using a subjective scale, there might be reporting bias among study participants. Due to the cross-sectional nature of the study, it does not show the cause and effect relationship.

## Conclusion

We found high rates of negative mental health outcomes among midwifery professionals in Ethiopia. The findings of this study have paramount importance to the public and clinical setups, and the findings of the study highlights the need for addressing knowledge and preventive practice gaps through information, training, and safety protocols on the COVID-19 modes of transmission, and prevention-related precautions as well as the provision of adequate personal protective equipment is essential to preserve the mental health of midwives during the COVID-19 pandemic. Moreover, the relative contribution of COVID-19 on the psychological disorders among midwives needs to be evaluated using a longitudinal study design.

## Data availability statement

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

## Ethics statement

This study was approved by the Institutional Review Boards of Woldia University (Ref: WDU/986/RCS/2020). Informed consent was obtained from participants after providing all necessary information on the study, informing them all the purpose, benefit, risk, and confidentiality of the information and the voluntary nature of the participation in the study. Participants were informed that all data obtained from them were kept confidential and no identifying information was collected from them.

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## Author contributions

EK: writing—original draft, data curation, investigation, methodology, and formal analysis. BK: data curation, investigation, methodology, formal analysis, and supervision. ST: data curation, investigation, and methodology. AB: funding acquisition, investigation, supervision, methodology, formal analysis, and writing—review and editing. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

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

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# Adult attachment and trait anxiety among Chinese college students: A multiple mediation model

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The present study discusses the relationship between adult attachment and trait anxiety of Chinese college students based on the “internal working models” theory. Six hundred and seventy-two valid data were collected using a self-reported questionnaire. The mediating roles of self-esteem, perceived social support, and security in the relationship between adult attachment orientations (anxiety and avoidance) and trait anxiety were investigated using the structural equation model and bootstrap methods. The results showed that: self-esteem and security play mediating roles in the relationship between attachment anxiety and trait anxiety. self-esteem, perceived social support, and security play mediating roles in the relationship between attachment avoidance and trait anxiety. In addition, there were different mediation mechanisms in the correlation between different attachment dimensions and trait anxiety. This study provided empirical data for exploring the formation and maintenance of trait anxiety in college students and had a specific significance for the early prevention and clinical intervention of anxiety-related disorders.

## KEYWORDS

adult attachment, self-esteem, perceived social support, security, trait anxiety

## Introduction

The further development of COVID-19 has hurt people's mental health, leading to anxiety and depression among some college students (1). Trait anxiety reflects the relatively persistent and stable differences in individual anxiety tendencies and is a critical predisposition factor for anxiety-related disorders (2). College students leave their families of origin, come to the university campus, and establish an attachment mode dominated by adult attachment. Therefore, exploring the relationship and mediating mechanism between adult attachment and trait anxiety in the COVID-19 pandemic is essential. The results of this study had implications for the prevention and intervention of anxiety-related disorders among college students.

Attachment, an intimate relationship between individuals and caregivers formed in the early years, is significant to individual psychological development and emotional regulation. The internal work model (IWMs) is an individual's internal mental representation and cognitive schema about self and others formed in early parent-child interaction (3). This cognitive schema works on an individual's early attachment objects and can extend to new interpersonal relationships with age growth (4). With age, the individual's different cognitive schemata about self and others develop into different adult attachment orientations and become an essential basis of individual psychological security (5). Brennan et al. (6) divided adult attachment orientations into two dimensions of "attachment anxiety" and "attachment avoidance" based on the differences between self-representation and other-representation in IWMs. Individuals with higher levels of attachment anxiety adopt "hyperactivating strategy," while individuals with higher levels of attachment avoidance adopt "deactivating strategy" (7). "Hyperactivating strategy" is a kind of emotion regulation strategy to obtain security by constantly trying to establish relationships with others. "Deactivating strategy" is a kind of emotion regulation strategy to avoid emotional investment by suppressing the need for attachment through self-protection.

Emotional dysregulation is an important factor affecting individuals' trait anxiety (8). A few studies on the relationship between adult attachment and anxiety levels have also proved that emotional dysregulation was a key mechanism linking attachment and state anxiety [e.g., (9)]. However, there are few studies on the effect of adult attachment on individual trait anxiety. Therefore, this study intends to establish the following hypotheses based on IWMs and adult attachment emotion regulation strategies: attachment anxiety and avoidance correlated with trait anxiety (H1a); Attachment anxiety and attachment avoidance have different mechanisms in predicting trait anxiety (H1b).

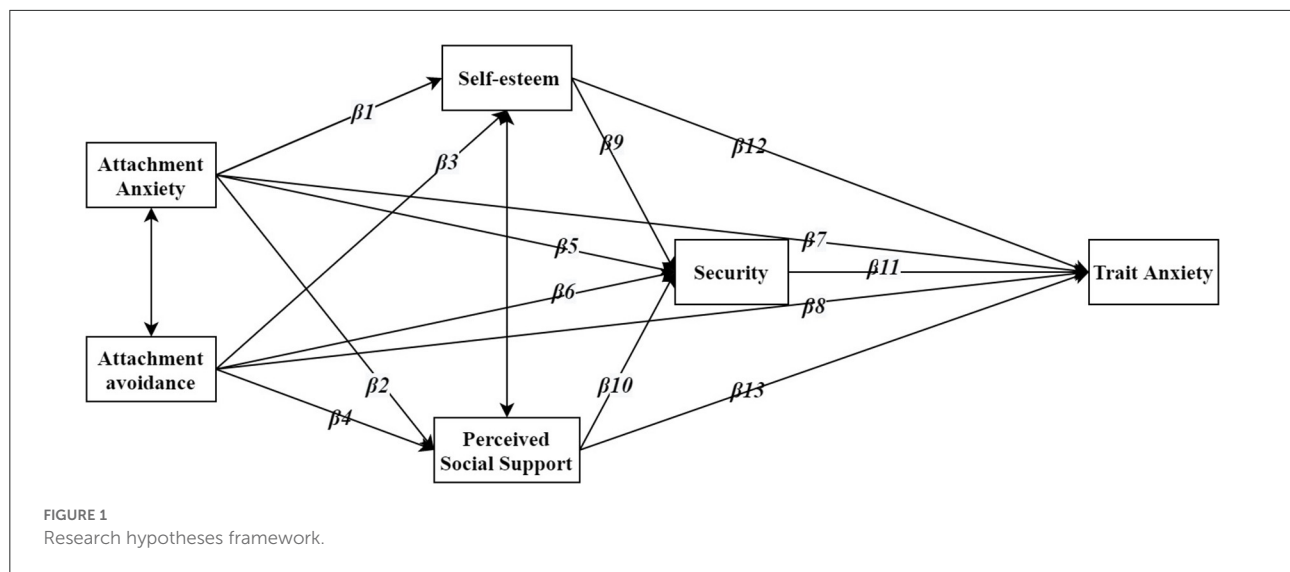
Self-esteem is the core self-evaluation and emotional experience of individuals. Greenberg et al. (10) terror Management theory regards self-esteem as a universal buffer for dealing with stress and fear in human evolution. The self-representation formed by individuals in interacting with the attachment object is the basis for developing individual self-esteem (11). Individuals with secure attachment have the highest level of self-esteem compared to insecure attachment (12), but research on the relationship between insecure attachment and self-esteem has been inconsistent. A study based on a sample of American college students found that attachment anxiety was negatively correlated with self-esteem after controlling for relevant variables. Still, attachment avoidance was not significantly correlated with self-esteem (13). This result is inconsistent with the study of Li and Zheng (14), who found that attachment anxiety and avoidance are negatively correlated with self-esteem in Chinese culture. In addition, it has been

found that self-esteem is an essential factor affecting trait anxiety, and childhood parental bondings can affect trait anxiety in adulthood through individual self-esteem (15). Therefore, this study proposed the hypothesis: self-esteem mediates the relationship between attachment anxiety and trait anxiety (H2a). In addition, considering that this study was conducted in Chinese culture, we also hypothesized that self-esteem does not mediate the relationship between attachment avoidance and trait anxiety (H2b).

As an essential psychological resource possessed by individuals, social support plays a buffering effect between external pressure and individual mental health (16). Perceived social support refers to an individual's expectation and evaluation of social support or belief that it is possible to obtain it (17). Previous studies have shown that perceived social support, as a stable feature with individual differences, is closely related to personal subjective feelings and emotional satisfaction and affects the mental health level of college students (18). Furthermore, Calvo et al. (19) found that attachment anxiety and avoidance may negatively influence perceived social support. Therefore, this study proposed that perceived social support mediates the relationship between attachment orientations (anxiety and avoidance) and trait anxiety (H3a and H3b).

According to attachment theory, the acquisition and satisfaction of security is a critical threshold to trigger individual emotion regulation behavior (5). Security is an individual's strong sense of coping with all kinds of possible dangers, expressed as the sense of prediction, determination, and control of life (20). Insecurity is the typical personality basis of various neuroses, and many neurotic behaviors of human beings are caused by the excessive compensatory pursuit of security (21). When the level of security is reduced, individuals feel that they are facing more significant risks and may be unable to cope with them, resulting in worry and nervousness. Attachment is the basis for individual security formation and change (22). Meanwhile, existing studies have shown that self-identification (22) and perception of external support (23) are important sources of individual security. Therefore, we propose the following hypotheses: security mediates the relationship between attachment orientations (anxiety and avoidance) and trait anxiety (H4a and H4b); self-esteem and security play serial roles in the relationship between attachment orientations (anxiety and avoidance) and trait anxiety (H4c and H4d); perceived social support and security play serial roles in the relationship between attachment orientations (anxiety and avoidance) and trait anxiety (H4e and H4f).

Based on the review of existing research and IWMs theory, this study established a multi-mediating model based on these assumptions to investigate the relationship between adult attachment orientations (anxiety or avoidance) and trait anxiety. The hypothesis model is as follows (see Figure 1).



## Materials and methods

### Participants

During the COVID-19 pandemic, we recruited 693 undergraduates from two universities in Jiangsu and Guangdong province using a cluster random sampling method. Participants voluntarily completed the paper-and-pencil version during the class break. This study was conducted under applicable ethics regulations. Participants signed the informed consent and were given gifts to those who completed the survey. After removing 15 uncompleted and six regular questionnaires, 672 valid questionnaires were collected, with an effective rate of 97%. The distribution of the subjects was as follows: 360 male and 312 female; Age ranged from 17 to 23 years ( $M = 19.39$ ;  $SD = 1.05$ ). Among them, 326 freshmen (48.5%), 231 sophomores (34.40%), and 115 juniors (17.10%).

### Measures

#### Adult attachment

Adult attachment was measured using the revised version of the Experiences in Close Relationships Scale (ECR-R) developed by Fraley et al. (24). The ECR-R has 36 items and uses a 7-point Likert scale (1 = “strongly disagree,” 7 = “strongly agree”) to measure the two dimensions of “attachment anxiety” (e.g., “I worry that I won’t measure up to other people.”) and “attachment avoidance” (e.g., “I tell my partner just about everything.”). This scale has been widely adopted and has demonstrated good reliability in Chinese participants (25). In this study, the internal consistency coefficients of the Chinese version were 0.89 (attachment anxiety) and 0.87 (attachment avoidance), respectively.

#### Self-esteem

Self-esteem was measured using the self-esteem Scale (SES) developed by Rosenberg (26). The scale is a single-dimensional self-rating scale, consisting of 10 items (e.g., “I take a positive attitude toward myself.”), using Likert scale 4 (1 = “strongly disagree,” 4 = “strongly agree”). This scale has been widely adopted and has demonstrated good reliability in Chinese participants (27). In this study, the internal consistency coefficient was 0.86.

#### Perceived social support

Perceived social support was measured using the published Perceived Social Support Scale (PSSS) (17). The scale consists of 12 self-rated items on a 7-Likert scale (1 = “strongly disagree,” 7 = “strongly agree”). The Chinese version is divided into three subscales of family support (e.g., “My family really tries to help me.”), friend support (e.g., “My friends really try to help me.”), and other support (e.g., “There is a special person with whom I can share my joys and sorrows.”). The Chinese version demonstrated good reliability in Chinese participants (28). In this study, the  $\alpha$  coefficients of “family support,” “friend support,” and “other support” subscales were 0.84, 0.87, and 0.86, respectively.

#### Security

The security questionnaire (SQ) prepared by Cong and An (20) was used to evaluate the safety score of neurotic patients and normal people. The scale has 16 items, using a 5-point Likert scale (1 = “very consistent,” 5 = “very inconsistent”), including two dimensions of “interpersonal security” (eight items; e.g., “I never dare to volunteer my opinion”) and “sense of definite control” (eight items; e.g., “I always worry that something bad

will happen”). In this study, the internal consistency coefficients of the “interpersonal security” and “sense of definite control” were 0.77 and 0.78, respectively.

### Trait anxiety

Trait anxiety was measured using the trait anxiety subscale (TAI) of the State-Trait Anxiety Scale (STAI) developed and revised by Spielberger (29). The TAI subscale includes 11 items of negative emotion and nine items of positive emotion (e.g., “I feel pleasant”), using a 4-point Likert scale (1 = “almost never”, 4 = “almost always”). TAI subscale is mainly used to evaluate stable personality traits such as anxiety and tension. This TAI scale has been widely adopted and has demonstrated good reliability in Chinese participants (30). In this study, the internal consistency coefficient of the revised Chinese version was 0.84.

### Procedures

The data analysis of this study was carried out in two steps. The first step was to conduct a descriptive statistical analysis of variables and test the correlation between variables and gender differences. Second, structural equation modeling was used to examine further the relationship between adult attachment dimensions and trait anxiety and the mediating roles of self-esteem, perceived social support, and security. Maximum likelihood estimation (ML) and bootstrap method with bias correction were used to establish the structural equation model and evaluate the mediating effects. Item parceling method was used to solve the problem of too many observation indicators of individual latent variables. R 4.0 and *Mplus*8.0 were used for all statistical processing in this study.

## Results

### Descriptive statistics

The means, standard deviations, and correlations of all variables are presented in Table 1. The skewness coefficient of the data is between  $-0.59$  and  $0.50$ , and the kurtosis coefficient is between  $-0.58$  and  $0.61$ , indicating that the data meet the normality requirement for structural equation analysis (31). The variance inflation factor (VIF) is between  $1.40$  and  $1.90$ , indicating no multicollinearity problem in the data. Independent sample *T*-test results showed that there were gender differences in attachment avoidance [ $t_{(670)} = 3.80, p < 0.001$ ] and perceived social support [ $t_{(670)} = -3.23, p < 0.005$ ]. These differences indicated that women have higher attachment avoidance levels and lower social support than men. Therefore, gender as the control variable is included in the model analysis in the following mediation effect analysis.

### Common method biases test

Exploratory factor analysis without rotation was performed using Harman single factor test on all measurement items. The results showed that there were six factors with characteristic roots  $>1$ , among which the first factor accounted for 19.15% of the total variation, far less than the critical value of 40%, indicating that there was no serious common method bias in this study (32).

### Mediation analyses

The results of mediation analysis show that the model fits well ( $\chi^2 = 289.89, df = 117, \chi^2/df = 2.48, p \leq 0.001$ ; RMSEA = 0.05; CFI = 0.98; TLI = 0.97; SRMR = 0.04). As shown in Figure 2, factor loads of each measurement model range from 0.78 to 0.89, and all are significant at 0.001 level.

As shown in Table 2 and Figure 2, the direct effect of attachment anxiety on trait anxiety is significant ( $\beta_7$ ), and the total mediating effects in the relationship between attachment anxiety and trait anxiety are significant ( $\beta_1\beta_{12} + \beta_2\beta_{13} + \beta_5\beta_{11} + \beta_1\beta_9\beta_{11} + \beta_2\beta_{10}\beta_{11}$ ). Self-esteem ( $\beta_1\beta_{12}$ ) and security ( $\beta_5\beta_{11}$ ) play mediating roles in the relationship between attachment anxiety and trait anxiety, respectively. Self-esteem and security play serial mediating roles in the relationship between attachment anxiety and trait anxiety ( $\beta_1\beta_9\beta_{11}$ ). The direct effect of attachment avoidance on trait anxiety was not significant, but the total mediating effects in the relationship between attachment avoidance and trait anxiety are significant ( $\beta_3\beta_{12} + \beta_4\beta_{13} + \beta_6\beta_{11} + \beta_3\beta_9\beta_{11} + \beta_4\beta_{10}\beta_{11}$ ) are significant. Self-esteem ( $\beta_3\beta_{12}$ ) plays mediating role in the relationship between attachment avoidance and trait anxiety. Self-esteem and security play serial mediating roles in the relationship between attachment avoidance and trait anxiety ( $\beta_3\beta_9\beta_{11}$ ). Perceived social support and security play serial mediating roles in the relationship between attachment avoidance and trait anxiety ( $\beta_4\beta_{10}\beta_{11}$ ).

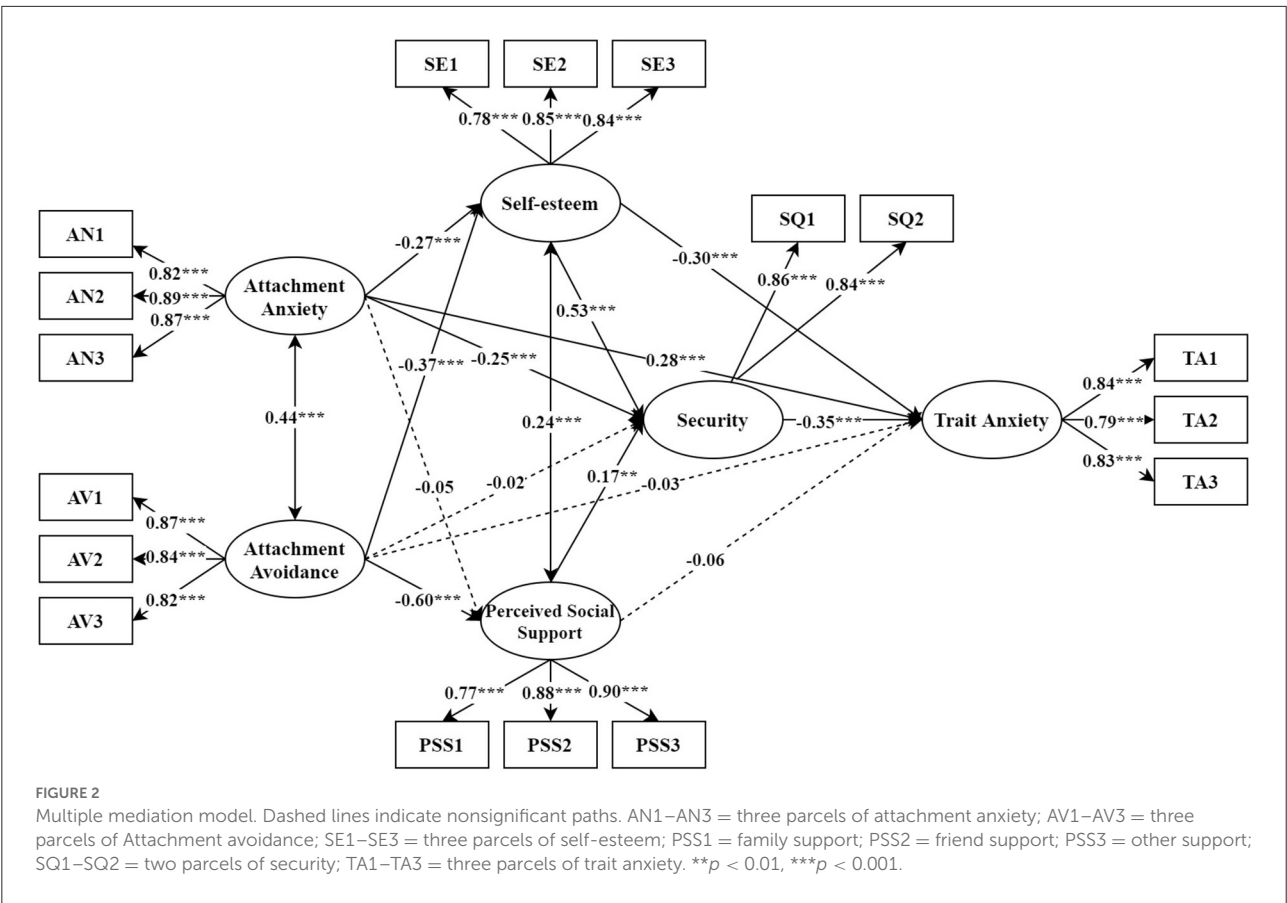
By setting up auxiliary variables in the model, we investigated the different internal mechanism of adult attachment predicting trait anxiety. The results show that (non-standard results): attachment anxiety and attachment avoidance have significant differences to predict trait anxiety ( $(\beta_7 + \beta_1\beta_{12} + \beta_2\beta_{13} + \beta_5\beta_{11} + \beta_1\beta_9\beta_{11} + \beta_2\beta_{10}\beta_{11}) - (\beta_8 + \beta_3\beta_{12} + \beta_4\beta_{13} + \beta_6\beta_{11} + \beta_3\beta_9\beta_{11} + \beta_4\beta_{10}\beta_{11}) = 0.11, 95\% \text{ CI} = [0.05, 0.17]$ ); there is no significant difference in the serial mediating effects of self-esteem via security ( $(\beta_1\beta_9\beta_{11} - \beta_3\beta_9\beta_{11}) = -0.01, 95\% \text{ CI} = [-0.03, 0.00]$ ); the serial mediating effects of perceived social support via security are significantly different ( $(\beta_2\beta_{10}\beta_{11}) - (\beta_4\beta_{10}\beta_{11}) = -0.02, 95\% \text{ CI} = [-0.03, -0.01]$ ).



TABLE 1 Descriptive statistics and correlations among the variables.

Variables	1	2	3	4	5	6
Attachment anxiety						
Attachment avoidance	0.39***					
Self-esteem	−0.38***	−0.42***				
Perceived social support	−0.28***	−0.56***	0.42***			
Security	−0.47***	−0.41***	0.61***	0.43***		
Trait anxiety	0.53***	0.37***	−0.59***	−0.39***	−0.62***	
<i>M ± SD</i>	61.32 (18.85)	51.57 (15.80)	30.62 (4.89)	62.50 (13.44)	55.39 (10.42)	42.14 (7.96)

*N* = 672.  
\*\*\**p* < 0.001.



## Discussion

This study's descriptive statistical results showed that both attachment anxiety and avoidance positively correlated with trait anxiety. At the same time, effect comparison results showed that the total effect of attachment anxiety predicts trait anxiety is significantly greater than that of attachment avoidance. These results verified H1a and H1b and suggest that there may be different mediating pathways or effects between attachment orientations and relationships. In the following analysis, we

further analyzed the mechanism of the difference between attachment anxiety and avoidance and trait anxiety.

Mediating effect analysis found that self-esteem plays mediating role between attachment anxiety and trait anxiety. This result verified H2a and indicated that college students with higher attachment anxiety negatively evaluated themselves. The lower levels of self-esteem were also associated with trait anxiety. In addition, self-esteem also plays mediating role between attachment avoidance and trait anxiety. This result verified H2b and indicated that individuals with higher scores

TABLE 2 Direct and indirect effects of adult attachment on trait anxiety.

Adult attachment	Parameter estimate	Bias-corrected CI (95%)	
	Effects (SE)	Lower	Upper
<b>Attachment anxiety (Total effects1; H1a)</b>	0.22 (0.04)***	0.17	0.29
AN→ SE→ TA ( $\beta_1\beta_{12}$ ; H2a)	0.08 (0.02)***	0.05	0.12
AN→ PSS→ TA ( $\beta_2\beta_{13}$ ; H3a)	0.003 (0.004)	−0.00	0.01
AN→ Security→ SAS ( $\beta_5\beta_{11}$ ; H4a)	0.09 (0.03)**	0.04	0.14
AN→ SE4→ Security→ TA ( $\beta_1\beta_9\beta_{11}$ ; H4c)	0.05 (0.01)***	0.03	0.08
AN→ PSS→ Security→ TA ( $\beta_2\beta_{10}\beta_{11}$ ; H4e)	0.003 (0.003)	0.00	0.01
AN→ TA ( $\beta_7$ )	0.28 (0.02)	0.21	0.36
<b>Attachment avoidance (Total effects2)</b>	0.26 (0.04)***	0.20	0.33
AV→ SE→ TA ( $\beta_3\beta_{12}$ ; H2b)	0.11 (0.03)***	0.07	0.17
AN→ PSS→ TA ( $\beta_4\beta_{13}$ ; H3b)	0.03 (0.03)	−0.02	0.09
AV→ Security→ TA ( $\beta_6\beta_{11}$ ; H4b)	0.01 (0.02)	−0.02	0.04
AV→ SE→ Security→ TA ( $\beta_3\beta_9\beta_{11}$ ; H4d)	0.07 (0.02)***	0.04	0.10
AN→ PSS→ Security→ TA ( $\beta_4\beta_{10}\beta_{11}$ ; H4f)	0.04 (0.01)**	0.02	0.06
AV→ TA ( $\beta_8$ )	−0.03 (0.05)	−0.11	0.05
<b>Total effects1 – Total effects2 (H1b)</b>	0.11 (0.04)	0.05	0.17

The total effect size is nonstandardized, and the rest is standardized.

AN, attachment anxiety; AV, attachment avoidance; SE, self-esteem; PSS, perceived social support; TA, trait anxiety.

\*\* $p < 0.01$ .

\*\*\* $p < 0.001$ .

in attachment avoidance might suppress and isolate negative self-cognition by a “defensive mechanism” (33). This result was inconsistent with previous studies with U.S. samples. They found that attachment avoidance was not associated with self-esteem [e.g., (13)]. It was a puzzling and meaningful result that we suspect may be related to differences in the samples collected in the study. It needs to be further deepened and clarified in future studies.

At the same time, we found that perceived social support mediates attachment avoidance and trait anxiety but not between attachment anxiety and trait anxiety. These results verified the H3b, but it was inconsistent with H3a. On the one hand, these results indicated that although college students with high attachment anxiety obtain security by constantly seeking others to establish intimacy, they do not experience the corresponding care and support during this process. These results also explained the intrinsic motivation that leads individuals with high attachment anxiety to adopt a “hyperactivating strategy” (34). Individuals with high attachment anxiety expect to gain support and care through establishing intimate relationships with others, but they do not experience adequate outside support during this process (35). On the other hand, These results indicated that college students with higher scores in attachment avoidance adopt “deactivation strategy” to selectively filter external support and care from others (36). This

isolation strategy of intimate relationships leads to higher trait anxiety.

This study found that the mediating effect of security and the serial mediating effect of self-esteem *via* security in the relationship between attachment anxiety and trait anxiety were significant. These results supported H4a and H4c and suggest security plays a critical mediating role in the relationship between attachment anxiety and trait anxiety. In other words, individuals with high attachment anxiety generally lack a sense of security (37), so they easily become a susceptible group to anxiety disorder. At the same time, the serial mediating effect of self-esteem *via* security and the serial mediating effect of perceived social support *via* security in the relationship between attachment avoidance and trait anxiety are significant. These results supported H4D and H4F and indicated that although individuals with high attachment avoidance adopt interpersonal withdrawal strategies (38), they also have a lower sense of security, which explains the core mediating factor of high trait anxiety levels of individuals with attachment avoidance.

## Conclusion

This study reveals the relationship and mediating mechanism between adult attachment and trait anxiety in college students and guided the prevention and intervention

of anxiety-related disorders. Specifically, individuals with higher scores in attachment anxiety need to improve their social support skills in interaction with attachment objects while enhancing their self-positive evaluation. While providing adequate social support for individuals with high scores in the attachment avoidance dimension, self-worth training should also be strengthened.

Of course, there are still many deficiencies in this study. First of all, although the mediation model established in this study systematically reveals the relationship between adult attachment and trait anxiety and its internal mediation mechanism, the mediation model fits well. However, the model has many variables and complex relationships, which leads to an insufficient discussion of the relationship between some variables. Secondly, since the structural equation model was built by collecting cross-sectional data in this study, the model results cannot directly support causal inferences. Further analysis can use the longitudinal mediation model to verify and explore the conclusion of this study. In addition, the influence of attachment avoidance on self-representation in the context of Chinese culture needs further research. Thirdly, the relationship between attachment avoidance and self-representation in the context of Chinese culture needs further investigation.

## Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author/s.

## Ethics statement

The studies involving human participants were reviewed and approved by Academic Ethics Review Committee of Guangdong University of Petrochemical Technology. The patients/participants provided their written informed consent to participate in this study.

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## Author contributions

XL designed, wrote, and approved all contributions to the study. PS helped to design the study and edit the manuscript. LL participated in collecting the data. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

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

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2022.912128/full#supplementary-material>

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# Visual responses of patients with generalized anxiety disorder who cycling in the virtual sportscares with different tree cover densities

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The tree density of virtual sportscape is the main factor that determines the benefits that generalized anxiety disorder (GAD) patients can obtain when they exercise with virtual environment. By using pupil size, fixation count and time as metrics, this research aimed to clarify the relationship between tree cover density and stress in the virtual environment. Ninety GAD patients were randomly grouped into the 36–60% tree density (high tree density, HTDS), 20–35% tree density (medium tree density, MTDS), or control groups ( $n = 30$ ). Researchers used eye-tracking technology to analyze fixation time, fixation count and changes in pupil size to evaluate the stress changes of participants after 20 min of aerobic exercise in a virtual environment. The results showed that pupil size expanded in GAD patients after exercising in the virtual environment. Furthermore, GAD patient cycling in the MTDS group can show smaller pupil size than those in HTDS. Those results suggest that GAD patient cycling 20 min in the MTDS group can perceived lower stress. The results of eye tracking analysis showed that GAD patients spend more time and counts observing tree elements in HTDS and MTDS sportscares. Specifically, they spent more 48% and 27% time on tree and green plants in the HTDS condition and MTDS condition, respectively, than in non-natural sportscares. Although 36–60% tree density of virtual natural sportscape can get more visual attention from GAD patients, 20–35% tree density of virtual natural sportscape is more capable of reducing their stress.

## KEYWORDS

tree cover density, virtual sportscares, pupil size, fixation time, fixation count

## Introduction

Patients with generalized anxiety disorder (GAD) are unwilling to interact with others (1) and avoid outdoor exercise (2), resulting in increasingly poor psychological and physiological health (1, 2). Adults with GAD excessively and persistently worry about many events or activities, causing them to feel immense stress and difficulty in relaxing (3, 4) which even causes daily life to become difficult. Adults with GAD will



experience a series of psychological and physiological symptoms, such as feeling tense or fear, tachycardia, tachypnea, and hyperventilation (5). GAD greatly impacts the quality of life of patients (1, 6) and will increase usage of medical services and direct and indirect medical costs (7, 8).

Virtual exercises that promote psychological and physiological health in patients with psychological disorders had attracted the attention of practitioners and researchers. Exercising in a virtual environment solves a key clinical problem: enabling adults with GAD to improve their psychological and physiological health without having to interact with others (2). Virtual reality (VR) is regarded to be a new method for promoting physical activities and has great potential for improving individual health and lifestyle habits (9). In particular, air pollution in cities and even suburbs has roused concern that outdoor exercise may have adverse health effects (10). Studies proved that outdoor exercise in environments with poor air quality may have negative effects on cognitive function (11) and blood pressure (10). Therefore, engaging in virtual sports at home is a good choice to promote health. Furthermore, simulation of a sportscape that enables adults with GAD not to interact with others is a key factor for promoting exercise in these patients. In order to simulate a realistic exercise environment, we examined the contributions of characteristics of a virtual exercise environment (such as tree density) to obtaining visual attention of cycling subjects.

Stress reduction theory is an important framework that explains why contact with nature may promote stress reduction through relaxation of the parasympathetic nervous system (12, 13). This theory states that stress is produced when an individual encounter an event or situation that is unfavorable, threatening, or challenging (14). Several studies have found that the natural environment can induce alpha waves that represent relaxation, and the lower blood flow in the pre-frontal cortex may represent the physiological characteristics of this process (15–17). In addition, people in an urban environment were found to have activated the cingulate gyrus of their brains, which reflects the effort of attention that consumes cognitive resources (16–19).

However, Martens, Gutscher and Bauer (20) found that not all forest environments have the same effect. The reason for this phenomenon is related to tree density in the environment (21). investigated the correlation curve between tree density and physiological stress, and they particularly examined tree density from 1.7 to 62.0%. There is an inverted U-shaped curve between tree density and physiological stress, and the greatest effect of tree density on stress reduction was within 24 to 34%. Similarly, the vegetation density of the community also has a significant effect on reducing anxiety. Higher vegetation density will not lead to a higher anxiety-reducing effect. Moderate vegetation density can achieve the best effect of reducing anxiety (22). Especially, Cox et al. (22) found that the probability of mild

or severe depression is significantly decreased when vegetation cover in a neighborhood is 20%.

In certain environments, such as medium depth and complexity, presence of visual focus, and environments with plants and water, attention will be attracted to these environmental elements, which may even block pessimistic thoughts (21). These thoughts are replaced by positive emotions and induce recovery of depressed cognitive behavior and dysregulated physiology (23). The results of many studies based on the stress reduction theory by Ulrich (24) also showed that natural environments (environments with higher restorative potential) can decrease stress-related physiological markers compared with urban environments (environments with lower restorative potential) (18, 19, 21, 25).

Previous studies have confirmed that the natural environment can reduce people's perceived anxiety compared with the built environment [i.e., (26)]. However, Researchers still don't understand the characteristics of the natural environment (for example: how much tree cover density) can promote people's anxiety reduction (27). Tree cover density is considered to be a main characteristic in the virtual environment that will affect the experience and exercise performance of adults during exercise (21, 28). As tree density increases, the view of the sky will be blocked. Excessively high tree density may have different effects on psychological health. For example, Jiang et al. (21) found that speed for reducing stress is slower in adults under high tree density, which may be due to decreased openness under high tree density. Therefore, humans may have similar preference for openness and greenness (29). A place with appropriate tree density may be more suitable for recreational activities than a scenario with high tree density. However, previous studies did not examine the psychological effects of tree density on people who exercise. Based on the study results on vegetation cover by Cox et al. (22) and tree density by Jiang et al. (21), tree density classified into high tree density (36–60%) and medium tree density (20–35%) in this study.

As eye movement tracking technology can obtain objective psychological response data, it has broad application prospects in environmental psychology. Previous psychological recovery studies also encourage the use of eye movement tracking technology to examine the effects of the environment on emotions and cognition (30, 31). When the eye receives different visual stimuli, the pupil will dilate or constrict (32). Accordingly, researchers can record and analyze eye movement data to determine the cognitive experience of the subject in a virtual exercise environment.

People use pupils to perceive external environmental stimuli and pay attention to targets of interest. Several findings confirm that people's viewing natural visual experiences are important in triggering restorative responses (31), however, systematic studies on the characteristics of visual patterns (fixation and pupil size) associated with people's observing of restorative

environments are still lacking (25). Previous research used eye movement trackers to investigate the type of eye movement when subjects were asked to assess the possibility of rest and recovery in the presented environment (i.e., (27, 30)). When adults observe a city park image, previous research found that benches, shrubs, and trees are objects with the longest fixation duration, showing that adults are observing objects that are more likely to induce relaxation (i.e., (27, 30)). On the other hand, changes in pupil size can reflect the level of perceived stress in an individual (25, 30). Martínez-Soto et al. (25) employed eye movement tracking technology to determine the differences in pupil size and visual behavior in scenarios with high restorative potential (HRP, such as natural environments) and low restorative potential (LRP, such as cities without natural environments). They found that, relative to low restorative potential environmental perception, restorative environmental observation was associated with decreased eye movement activity (include fixations and pupil dilatation), which may reflect a decrease in cognitive effort when dealing with natural scenes. In the context of restorative sportscares research, however, there are very few studies that examined the relationship between pupil size and stress.

Individuals may simultaneously prefer openness and greenness (29). A place with appropriate tree density may be more suitable for recreational activities than a scene with high tree density. As tree density increases, the view of the sky will be blocked. High tree density may decrease overall openness, thereby decreasing the stress reduction speed. Jiang et al. (21) investigated the correlation curve between tree density and physiological stress, and they particularly examined tree density from 1.7 to 62.0%. This was an inverted U-shaped curve and tree density that has the greatest effect on stress reduction was from 24 to 34%. Jiang et al. (21) were surprised to find that the inverted U-shape can best describe the data relationship between tree density and physiological stress. This may be because dense vegetation causes discomfort in people. When vegetation is sufficiently dense to obstruct vision, it usually results in discomfort or even fear (33). Under medium tree density sportscares (MTDS), adults with GAD will feel less stress than high tree density sportscares (HTDS).

In addition, the immersion effects of a virtual environment (34) enable users to experience a forest- or green space-like environment indoors and allows them to exercise in that immersive environment (30). When individuals see images that invoke pleasure, their pupils will dilate (35, 36). When an individual cycle outdoors, he/she will browse the surrounding landscape. While cycling in a natural environment, the adults will be attracted by the surrounding natural environment and continuously sees a green landscape (24, 37). Further, these green landscapes will cause the individuals to relieve stress through visual perception (24). Adults with GAD only need passive observing the surrounding environment and

allow natural scenery to be perceived by their eyes during cycling, and they can experience a sense of psychological freedom (38, 39) and then reduce anxiety sensitivity (40, 41). The smaller the pupil size, the higher the value of recovery possibility (25). However, too much dense vegetation will consume more cognitive effort from adults (25). Specially, high-density vegetation cannot produce more peace. The relationship between vegetation density and stress reduction is inverted U-shaped, and stress reduction will weaken as the number of vegetation increases (19, 21). Thus, during aerobic exercise in a virtual natural environment, the relationship between pupil size and stress should be non-linear. Rather, a moderate pupil size can reflect the low-level stress of adults with GAD.

## Objectives and research hypotheses

Current research still does not have a clear understanding of the characteristics of the virtual sportscares that enables adults with GAD to ride in a low-stress indoor environment. Therefore, the aim of this study was to examine the effect of virtual natural landscapes with high or moderate tree cover density in a cave virtual environment (VE) system on reducing stress in adults with GAD. Combining immerse VR, and eye-tracking, a VR exercise intervention was designed to examine their responses to different tree cover densities (high tree density, HTDS, and medium tree density, MTDS) in natural sportscares. In addition to physiological measurements of stress reaction, visual attention was also measured. The hypotheses of this study were that cycling in a VE with medium tree density will lower (1) pupil size, (2) increase fixation count and (3) fixation time comparably when cycling in a VE with high tree cover density compared with medium tree cover density. In order to validate the proposed hypotheses, a randomized controlled trial was conducted.

## Methods

To examine the effects of tree density in sportscares on visual and stress in adults with GAD, we recruited adults with GAD as participants. This study was performed at National Cheng Kung University, Taiwan. We constructed 2 types of virtual sportscares and 1 control condition for the experiment (Figure 1). We asked these participants to cycle at different tree densities and recorded their pupil size, fixation count and fixation time using the eye-tracking equipment.



FIGURE 1

Experimental images. (A) high tree density sportscape (HTDS); (B) medium tree density sportscape (MTDS); (C) control condition. (Experimental images from evening\_tao / Freepik).

## Participants

The authors attended an older adult's meeting in Tainan, Taiwan, and invited older adult with GAD tendencies to fill out the GAD-7 scale first. The authors formally invited each older adult to join the study after physicians assessed that the older adult met the criteria for GAD. Participants were selected for this study based on the following inclusion criteria: (a) People between the ages of 50 and 75 have relatively more stress and may get more benefits from physical activity. People aged 50–59 (compared to  $\geq 80$  years) have a higher rate of GAD (42), and the risk of anxiety decreases by 40% after 75 years of age, and 47% after 80 years of age (43). Thus, age between 50 and 75 years as exercise has many benefits for middle-aged and elderly individuals (such as decreasing mortality rate, delaying cognitive aging, and decreasing medical costs) (44, 45); (b) A score above 5 on the GAD-7 scale, representing participants have at least mild anxiety symptoms; (b) Normal body mass index (BMI) defined by the Taiwan Ministry of Health and Welfare based on relevant disease incidence data and risk of death in Asian populations ( $18.5 \leq \text{BMI} < 24 \text{ kg/m}^2$ ) (46). The exclusion criteria are participants with the following: (a) obsessive compulsive disorder or other anxiety disorder; (b) a mini mental state examination (MMSE) score of  $< 24$ , representing cognitive impairment; and (c) claustrophobia, as this experiment was performed in an indoor immersive surrounding sound system. Ninety eight participants were contacted and 8 participants were excluded as they suffer from other psychiatric disorders or were unable to complete the entire experiment due to physical reasons.

Power analysis (G\*Power 3.1.9.4) was used to calculate the sample size required to obtain at least small-to-medium results ( $r = 0.20$ ) at an alpha of 0.05 (two-tailed) (47). Power was set as 0.80 (48). G\*Power analysis showed that the sample size required was  $N = 54$ . Therefore, the sample size used in this study ( $n = 90$ ) conforms to the test hypotheses.

## Ethical consideration

Participants participated in this study entirely voluntarily. All participants had to read the instructions and provide informed consent before starting the investigation according to the Declaration of Helsinki. The researchers informed the participants that they could discontinue the investigation at any time for any reason. This study was approved by the institutional review board of National Cheng Kung University (B-ER-107-150). The confidentiality of personal data was protected under the Taiwan Data Protection Law.

## Experimental procedure

This experiment requires participants to focus their attention for around 1 h. To decrease the potential risk of interfering psychological and physiological responses and complicating factors, the researchers called the subjects with GAD 24 h before the experiment to remind them to abstain from certain behaviors (such as pulling all-nighters, drinking caffeinated beverages, and taking medications).

Ninety adults with GAD were randomly grouped into the high tree density sportscape (HTDS,  $n = 30$ ), medium tree density sportscape (MTDS,  $n = 30$ ), or control groups (non-virtual environment,  $n = 30$ ). Every participant was required to arrive at the laboratory at 8:30–9:30 a.m. to control for the effects of the circadian rhythm. After the participant has arrived at the laboratory, the research assistant explained the experimental procedure and requested that the participant completed the informed consent form, demographic survey form, and MMSE and GAD-7 questionnaires. In addition, their height and weight were measured to calculate the BMI. Following that, eye movements, and heart rate (HR) were measured to ensure that there is no difference in relaxation status and emotional status before the experimental intervention.

Participants from the HTDS and MTDS groups cycled for 20 min in Cave VE (Figure 1). Participants wore the Polar optical HR sensor on their wrists to monitor their HR during cycling. All participants were required to carry out moderate intensity exercise (50–60% HRmax). In the HTDS and MTDS groups, machine-simulated forests, parks, trees, rivers, and other landscapes were projected in Cave and moved as the participant cycled. In the HTDS, trees accounted for 36–60% of the entire sportscape. In the MTDS, trees accounted for 20–35% of the entire sportscape. After exercise intervention, HR, and eye movements were measured (see Figure 2).

## Exercise duration

With regards to the duration of exercise required to have positive psychological effects, existing papers mostly found that longer exercise duration such as 20 min or more seems to have the greatest psychological benefit (49). Therefore, this study adopted a 20 min cycling exercise as the duration for a single exercise intervention.

## Virtual environment

The researcher constructed a CAVE VE around the participants so that the participants can exercise in that surround environment. The Cave VE system was installed in a dimly-lit soundproof room and mainly projects the sportscape around the participant to enhance immersion and presence so that the participants felt that they were cycling outdoor (34, 50). The VE was presented in images within the visual field of the participants. The VE surround screens were at the front, left, right, and bottom of the participants. The bicycle was 2 meters away from the front screen. Several screens surround the participants to create a surround scenario. Surround 3D projection technology was used to project images on the screen to create a complete surround experimental scenario for the participants (26, 34). The CAVE virtual reality system hardware consists mainly of projectors and screens. For surround VR projection, 2 projectors were used to project images at 270 degrees and participants can view the cycling track images used in the 3D experiment with the naked eye. This system employs wireless streaming technique so that the participants' cycling speed and the image movement speed are synchronized in the VE (combined virtual reality equipment, Taiwan patent no. I67522). Virtual reality systems similar to Cave were successfully used in previous studies (26, 50)]. All experimental steps were performed in the VE laboratory of National Cheng Kung University. During the experiment, temperature was controlled at 24–25°C and relative humidity was controlled at 50–60%.

## Tree density calculations

A 20 min virtual cycling track was employed and images were extracted once every 2 min. Ten images each were extracted in the high and medium tree density environments. Following that, the researcher calculated the tree density of each image. The recommendations of Jiang et al. (21) were used to measure tree density using the Adobe Photoshop software to calculate the total pixels in green areas on trees, which was used to calculate the pixel percentage of trees in the entire photograph. The images were classified as high tree density (tree density accounted for 36–60% of the entire image) and medium tree density (tree density accounted for 20–35% of the entire image) (51) (see Figure 3).

## Instruments

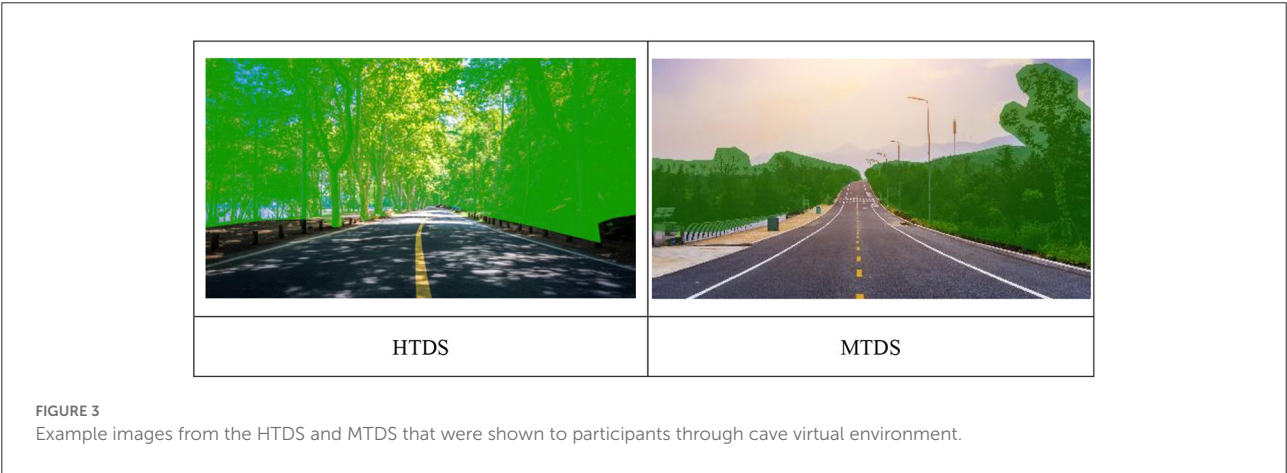
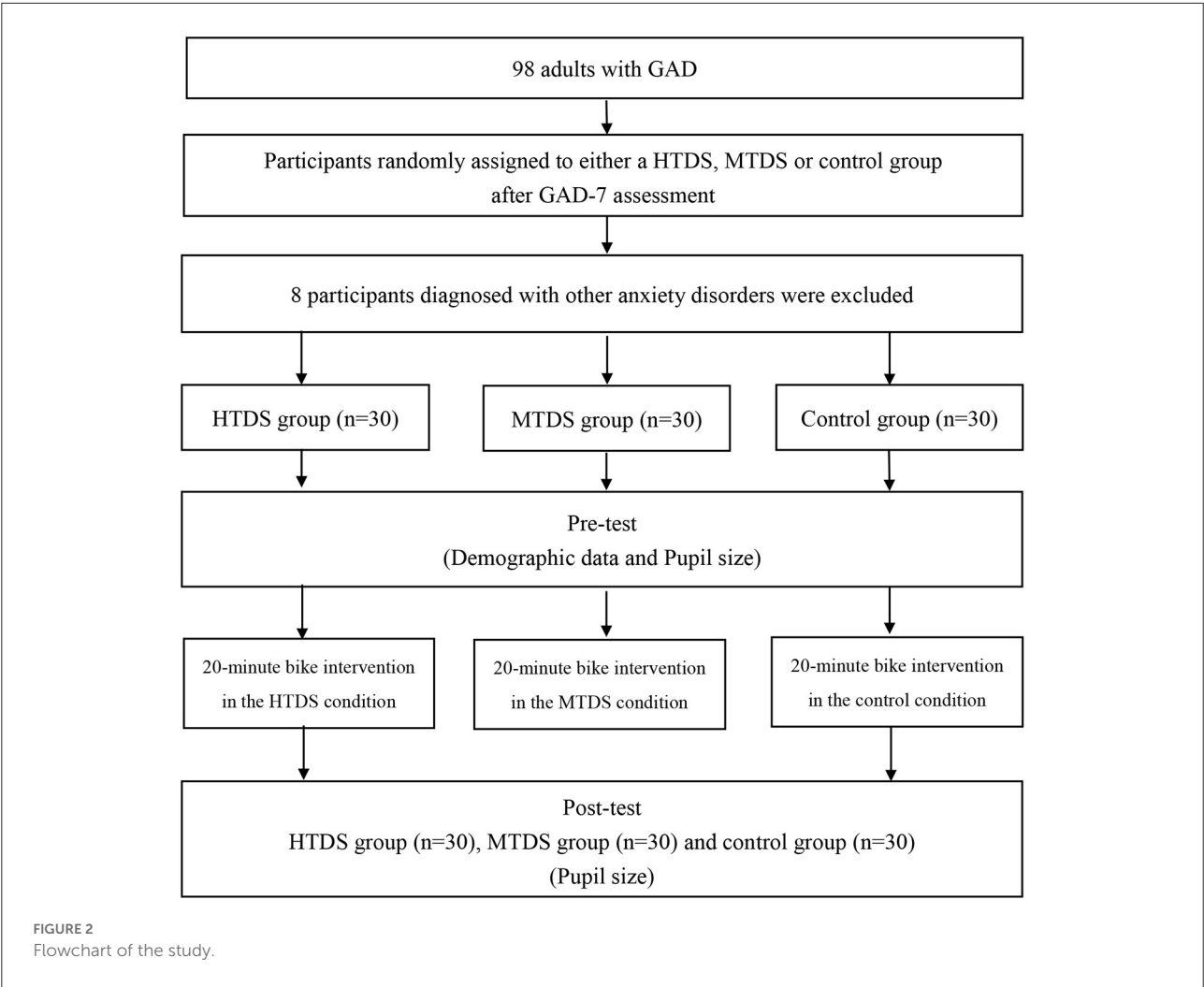
The Tobii T/X eye tracker (Tobii G2; Tobii Pro Glasses2-50, Danderyd, Sweden) was used to track the eye movement of participants. The data (include the fixation counts, fixation time and pupil dimension) were collected using specialized eye movement analysis software (Tobii Studio).

The initial diagnosis of GAD based on the generalized anxiety disorder 7-item (GAD-7) scale as this has high sensitivity and specificity for GAD detection (52, 53). GAD-7 is a reliable self-report measure with high internal consistency and good test-retest reliability (54–57).

Participants were asked to rate how they felt in their lives: “In the past 2 weeks, how often have you been bothered by the following 7 items?” Each item was measured on a four-point Likert scale (0 = not at all sure, 1 = several days, 2 = over half the days, and 3 = nearly every day). The total score (ranges from 0 to 21) is divided into four different levels of severity: asymptomatic (0 to 4); mild anxiety symptoms (5 to 9); moderate anxiety symptoms (10 to 14) or severe anxiety symptoms (15 to 21). Older adults with a score of 5 or higher were selected for this study. A higher score means a higher severity.

## Visual attention

To measure visual attention, the authors divided the sportsapes image into 2 areas of interest (AOI), including 1. trees, and 2. road. This method is used to confirm which part of the sportsapes image the observer is most interested in. Eye tracking technology visualizes visual attention in the form of a gaze plot, allowing researchers to explore visual attention. The key indicators used to assess individual's visual attention were the average fixation count and the total fixation time (58). The average fixation count is the number of times that the individual interacts with the stimuli, with higher total fixation counts indicating that



individuals felt the observed stimulus more attractive to them (26, 59). The total fixation time is the processing time when the individual to observe the stimuli, with longer total fixation time implying that individuals spent more time exploring the information or the relationships between the internal and external representations (59, 60). The phenomenon suggests



that the individual's visual attention was more attracted during that time (59, 61). Previous neuroscience visuo-cognitive research usually uses a threshold of 200 ms (62, 63). Therefore, values below 200 ms were excluded from subsequent analyses (64).

## Pupil size

The definition of pupil size in this study was based on the actual external physical dimensions of the pupils. Pupils will constrict or dilate with light, illumination, and stimulation and pupil diameter ranges from 1.3 to 10 mm (65, 66). Pupil size is considered a reliable parameter for identifying an individual's stress state (67). The amount of pupil diameter decreases to represent stress reduction and emotional relaxation (67). This study used the amount of change in pupil size as an indicator of stress.

## Data analysis

All statistical analysis was carried out using SPSS 21.0 (SPSS Inc, IBM Chicago, IL, USA). Descriptive statistical data were expressed as mean  $\pm$  SD (Table 1). One way ANOVA was used for inter-group comparison of demographic data. Values of pupil size, fixation time and fixation count were used for a 3 (groups: HTDS, MTDS, and control)  $\times$  3 (time points: before intervention, during intervention, and after intervention) one way ANOVA. Bonferroni correction was used for paired multiple posterior comparisons of mean values to determine if there are significant differences. A difference of  $p < 0.05$  was considered to be statistically significant. Cohen's  $d$  was used for estimation of effect size for significant  $t$ -test results (68) and effect sizes were classified as low, medium, and high based on values of 0–0.2, 0.2–0.5, and 0.5–0.8, respectively (48).

## Results

### Demographic characteristics

No participant reported any discomfort throughout the 20 min experiment. There were no significant differences in demographic variables between the HTDS, MTDS and control groups before the intervention (Table 1). In this study, 41 men and 39 women were included. The overall mean age was  $59.86 \pm 7.46$  years.

### Pupil size

As shown in Figure 4, the RM ANOVA on the pupil size revealed a significant main effect of *Time*

**TABLE 1** Baseline demographic characteristics of the participants [mean (SD)].

Variables	HTDS group ( <i>n</i> = 30)	MTDS group ( <i>n</i> = 30)	Control group ( <i>n</i> = 30)	<i>p</i> -value
Age (year)	58.43 (7.37)	59.87 (6.99)	60.85	0.25
Gender (M/F)	13/17	14/16	14/16	0.47
Height (m)	1.60 (0.08)	1.60 (0.09)	1.62 (0.09)	0.91
Weight (kg)	60.22 (10.93)	61.97 (13.28)	61.11 (12.78)	0.53
BMI (kg/m <sup>2</sup> )	21.54 (1.25)	21.56 (1.77)	21.82 (1.34)	0.88
GAD levels (Medium/low)	18/12	18/12	17/13	0.47
MMSE (score)	28.81 (1.44)	29.13 (1.11)	28.81 (1.44)	0.29
GAD-7 (score)	12.43 (2.73)	12.73 (3.52)	12.43 (2.73)	0.78
Resting HR (count/minute)	77.91 (6.84)	79.83 (6.60)	78.17 (6.65)	0.46

SD, standard deviation; BMI, body mass index; GAD, generalized anxiety disorder; MMSE, mini-mental state examination; HR, heart rate; HTDS, high tree density sportscape; MTDS, Medium tree density sportscape; HR, heart rate.

[ $F_{(2,89)} = 128.36, p < 0.001, \eta_p^2 = 0.30$ ] and *Group* [ $F_{(2,89)} = 3.34, p < 0.01, \eta_p^2 = 0.15$ ], showing that the during-exercise pupil size ( $4.28 \pm 0.08$ ) were higher than the pre-exercise values ( $3.54 \pm 0.07$ ) and post-exercise ( $3.43 \pm 0.07$ ) across the three groups, and the pupil size for the HTDS group ( $3.97 \pm 0.09$ ) were higher than those for the MTDS group ( $3.71 \pm 0.10$ ) and control group ( $3.57 \pm 0.15$ ) across the three time points (See Figure 4). The main effect was superseded by the *Time*  $\times$  *Group* [ $F_{(4,89)} = 16.94, p < 0.001, \eta_p^2 = 0.15$ ] interaction. The *post-hoc* analyses indicated that the during-exercise pupil size were lower than the pre-exercise values and post-exercise values for the MTDS (pre-exercise vs. during-exercise vs. post-exercise:  $4.82 \pm 0.58$  mm vs.  $4.13 \pm 0.5$  mm vs.  $4.43 \pm 0.67$  mm;  $p < 0.01$ ) (See Figure 5), showing that pupil size in the MTDS group were smaller than those in the HTDS and control group. Thus, the hypothesis 1 was supported.

### Average total fixation count and fixation time

As shown in Figures 6A,B, a one-way ANOVA analysis showed significant differences in total fixation count ( $F_{(2,87)} = 4.8, p = 0.02$ ) and total fixation time ( $F_{(2,87)} = 5.32, p = 0.01$ ) across the three groups during cycling. *Post-hoc* pairwise comparisons showed that the HTDS group's total fixation count was significantly higher than the MTDS group ( $2885284.75 \pm 1497042.52$  vs.  $2331572.33 \pm 1593762.72, p = 0.67$ ) and control group ( $2885284.75 \pm 1497042.52$  vs.  $1935592.6 \pm 632001.02, p = 0.01$ ). *Post-hoc* pairwise

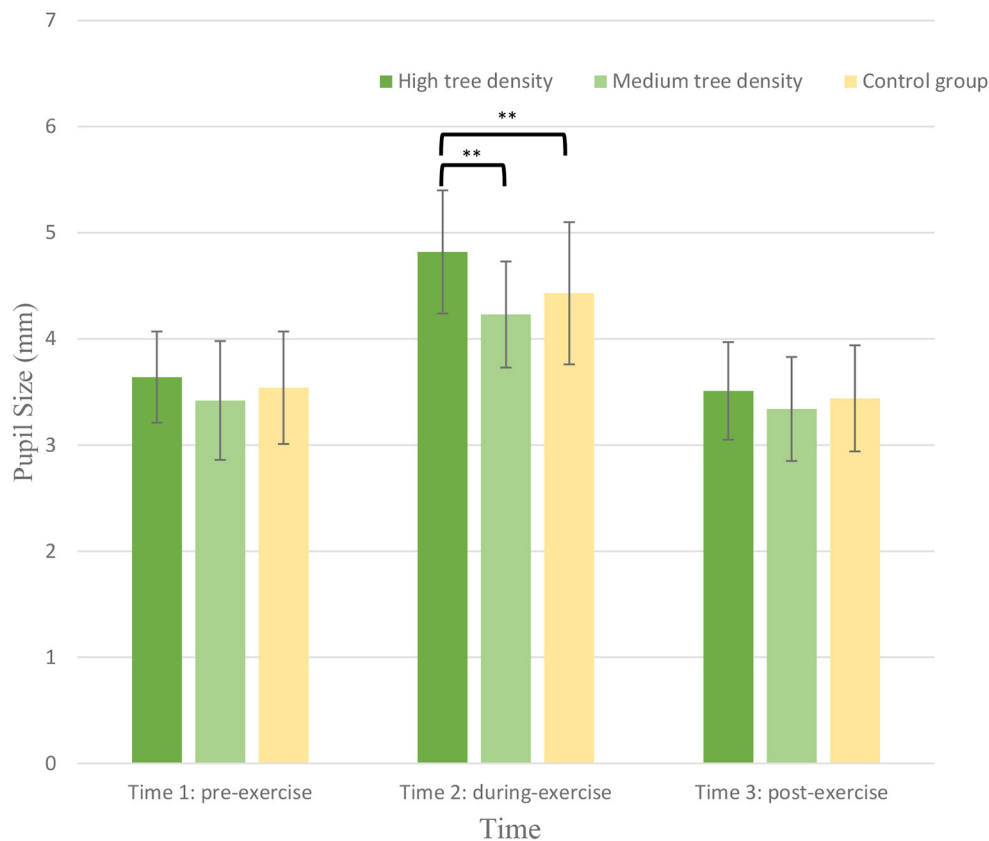


FIGURE 4

Pupil size for the high tree density sportscape (HTDS) and the medium tree density sportscape (MTDS) groups at 3 different time points. (\*\* $p < 0.01$ ).

comparisons also showed that the HTDS group's total fixation time was significantly higher than the MTDS group ( $790.22 \pm 204.97$  vs.  $680.89 \pm 299.46$ ,  $p = 0.43$ ) and control group ( $790.22 \pm 204.97$  vs.  $434.48 \pm 155.32$ ,  $p = 0.01$ ), showing that the HTDS group have higher visual attention (average total fixation count and the total fixation time) compared to the control group. There is no significant difference between MTDS and Control group for average total fixation count and fixation time. The hypotheses 2 and 3 were supported.

## Discussion

This study examined the effects of different tree densities on visual behavior in adults with GAD and found that the tree density of simulated sportscape is a key factor that affects their exercise experience. Pupil diameter was the largest when adults with GAD exercise in a high tree density environment, followed by control group. In contrast, pupil dilation was the lowest in adults with GAD who exercised in the medium tree density

group. Those results imply that exercising under medium tree density can best lower stress.

This research contributes to the research on promoting adults with GAD to exercise at home has the following contributions in the following ways: First, the tree density of the virtual sportscape is a key factor that determines the degree of stress during exercise. Shanahan et al. (69) argued that the interaction between the natural environment and physical activity can enhance the benefits of physical activity. The results of this study further point out that not all exercises in the natural environment can obtain the same benefits, but depend on the tree density. Compared with a high tree density environment, exercise in a medium tree density environment can bring lower stress to adults with GAD. Thus, exercise with VE could be a suitable stress reduction technique in adults with GAD regardless of the environment introduced (2). Therefore, VE with a medium tree density sportsapes can help adults with GAD who are afraid of interacting with others or the outside world to be not feel stressed, and thus willing to ride bicycles with VE in their homes.

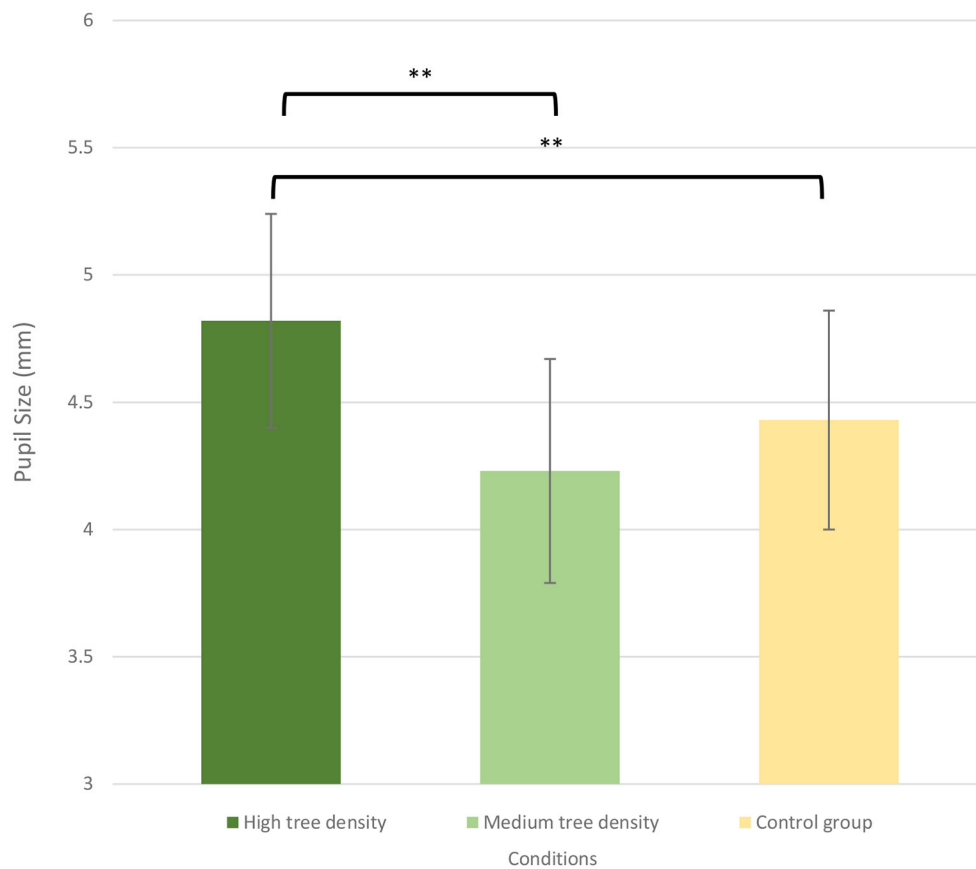


FIGURE 5

Pupil size for the high tree density sportscape (HTDS) and the medium tree density sportscape (MTDS) groups during exercise. (\*\* $p < 0.01$ ).

Previous studies on the relationship between tree density and stress recovery also found similar results. For example, Jiang et al. (21) examined the tree density of urban landscapes and found that observed recovery is decreased (self-reported stress recovery) when tree density in the residential area exceeds the medium level (34–62% of the visual field). Even though they did not specifically measure perceived safety but they deduced that “when tree density is sufficient to block the line of sight”, it usually leads to discomfort or even fear [(21). p. 34]. These findings mean that perceived security may have a mediating role in the relationship between the closeness of green space and perceived recovery. Therefore, perceived negative emotions and perceived lack of security may be one of the causes of lack of relaxation when adults with GAD perform aerobic exercise in a high tree density setting.

Second, in the advertisement image, the type of servicescape may affect the eye movement pattern of the individual extracting information from it. The data of eye movement analysis shows that there are fewer fixations in the homogeneous servicescape. This result means that, compared with the diversified servicescape, the homogeneous servicescape has simple characteristics (25) and does not need to be explored

intensively (70). Furthermore, the longer fixation time of an object is considered to represent more interest or liking (71, 72) and more likely to induce emotional arousal (73). The data of eye tracking analysis shows that HTDS will have more fixation time than MTDS. This result implies that the individual is more interested in HTDS and perceives higher stress. This result is consistent with the previous description of the affective valence of HRP and LRP photos (25, 74).

Third, the high tree density of virtual sportsapes will over-attract the visual attention (pupil size becomes larger) of adults with GAD during exercise. The ANOVA results of the relationship between pupil size and tree density show that HTDS makes the pupil size of adults with GAD larger than the pupil size of their cycling under MTDS, and control conditions. Also, the pupil size of adults with GAD cycling in a medium density sportsapes was smaller than that of a high density sportsapes and the control group. This may be because adults with GAD cycling in HTDS will increase the visual attention to the surrounding environment and then cause pupil dilation.

Gavas et al. (75) found that the same pupil dilation may represent different meanings, depending on the situation. For

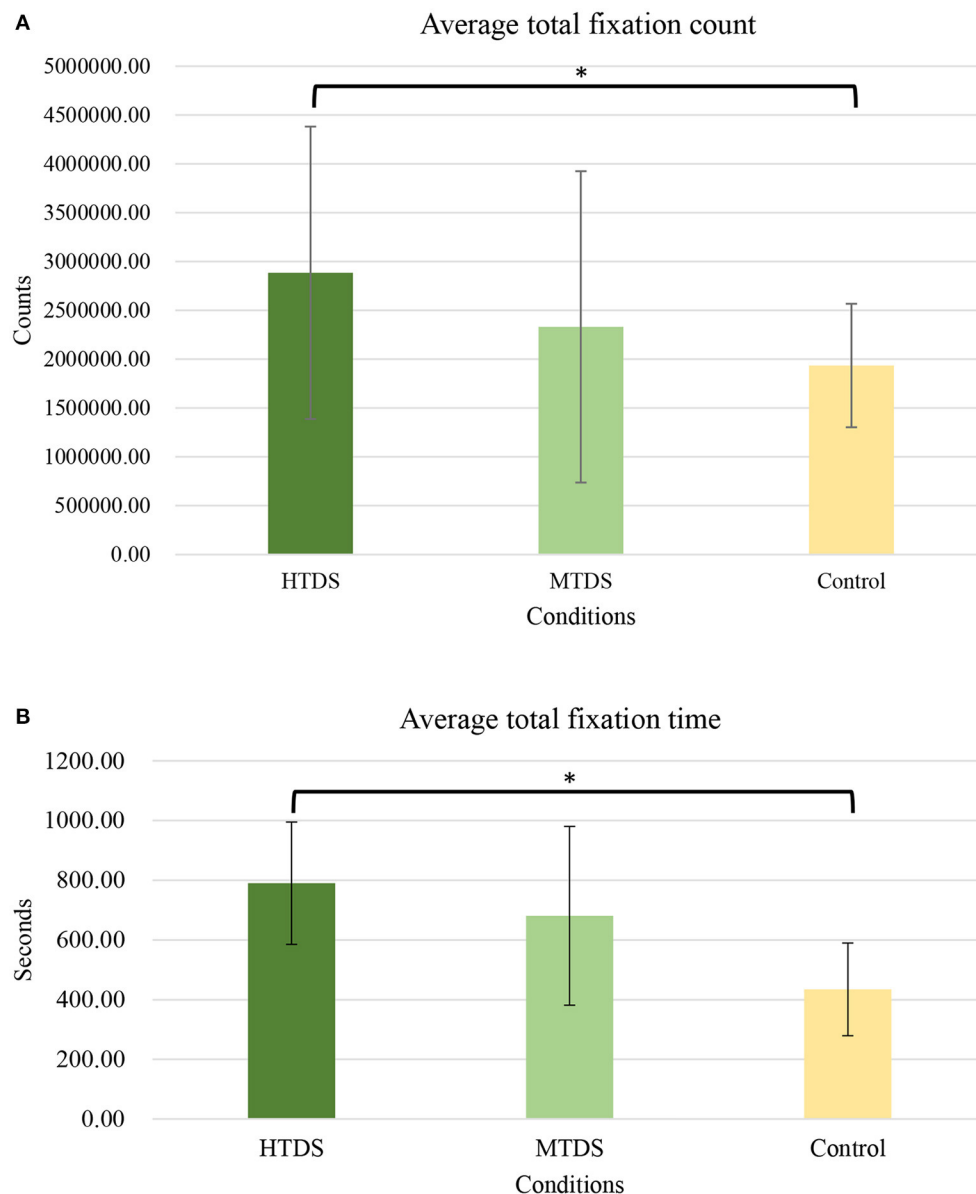


FIGURE 6

(A) Average total fixation count for the high tree density sportscape (HTDS) and the medium tree density sportscape (MTDS) groups during exercise. (\* $p < 0.05$ ). (B) Average total fixation time for the high tree density sportscape (HTDS) and the medium tree density sportscape (MTDS) groups during exercise. (\* $p < 0.05$ ).

example, pupil dilation will be greater if the natural environment is more interesting or invokes negative emotions. Too dense forest might cause adults with GAD to be unable to obtain the benefits of relaxation. High tree density (36–60%) will cause people who exercise to pay more attention to search for potential dangers (76, 77) or even feel frightened (21, 78). Therefore, their pupils will be more dilated, which decreases the level of relaxation. These results may mean that medium tree density can cause people who exercise to feel the least stressful and do not invoke negative emotions (such as fear and terror) due to overly

dense tree landscapes, which consumes their visual attention (lead to pupil dilation).

## Research limitations and future research suggestions

There were some limitations in this study. Due to the limitations of current machine learning techniques, tree coverage density of virtual sportsapes cannot be evaluated

automatically. Method development with this capability is needed to advance the virtual sportsfields field in the future. Furthermore, the relationship between tree cover density and pupil size may be a complex curve relationship and future studies can further examine the correlation between tree density and pupil size.

## Conclusion

The results of this study found that the green coverage rate in the sportsfields can affect the visual and psychological responses of adults with GAD. Especially, 36–60% tree density of virtual natural sportsfield can get more visual attention from adults with GAD, 20–35% tree density of virtual natural sportsfield can reduce their stress more.

To meet the needs of adults with GAD to engage in physical activity indoors. Virtual sports equipment companies can design virtual sportsfields with different functions for GAD to choose. For example: design a sportsfield with 20–35% tree coverage to meet the needs of adults with GAD who want to relax through exercise. In addition, a sportsfield with 36–60% tree coverage can also be constructed, so that adults with GAD can feel interesting and not boring during exercise, and promote the formation of their long-term physical activity habits.

## Data availability statement

The datasets presented in this article are not readily available because the author does not own the datasets. Requests to access the datasets should be directed to Chen, [fongjihchen@gmail.com](mailto:fongjihchen@gmail.com).

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## Ethics statement

The studies involving human participants were reviewed and approved by National Cheng Kung University. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

T-CW and T-WT wrote the first draft. C-LT collected and analyzed the 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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# How does mindfulness relate to benign/malicious envy? The mediating role of resilience, internal locus of control and self-esteem

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The present study aimed to explore the roles of resilience, internal locus of control, and self-esteem in the link between mindfulness and benign/malicious envy (BE/ME). Nine hundred ninety-one participants (299 males, 692 females; mean age =  $19.05 \pm 1.54$ ) completed a survey that assessed mindfulness, internal locus of control, resilience, self-esteem, and BE/ME. The results suggest that resilience, internal locus of control, and self-esteem independently mediate the relationship between mindfulness and BE/ME. Additionally, "internal locus of control → resilience" and "self-esteem → resilience" play chain mediating roles in the relationship between mindfulness and BE/ME. Namely, mindfulness is positively associated with resilience *via* improving internal control and self-esteem, thereby inhibiting malicious envy and promoting benign envy. The present study advances our knowledge of the mindfulness re-perceiving theory, and thus provides a new explanation for the inhibition of negative emotions from the perspective of resilience, internal locus of control, and self-esteem.

## KEYWORDS

mindfulness, internal locus of control, resilience, self-esteem, benign/malicious envy

## Introduction

Mindfulness is generally defined as an individual's purposeful and uncritical focus on their current internal and external experiences, including emotions, cognition, physical feelings, and sensory stimuli (1). The tendency to experience an internal state of mindfulness is called trait mindfulness (2), and it is often measured using self-reported methods such as the Mindful Attention Awareness Scale (MAAS) (3). Several studies have also used the MAAS to explore the relationship between mindfulness and negative emotions (4–6). Mindfulness is linked with a lessening of envy (7). Envy consists of the negative emotions that occur when people realize that they lack the advantages, achievements, and properties of others (8). It has two forms that differ in their motivational nature: benign/malicious envy (BE/ME) (9). Of these, BE elicits self-elevating motivation

and can be a positive phenomenon (10, 11), while ME elicits a motivation to destroy the advantages of others (10, 12, 13). Envy, particularly ME, may trigger social violence and criminal behavior (14, 15), and it is, therefore, important to further discuss mechanisms that may effectively inhibit the negative effects of envy. Prior research has provided preliminary evidence that mindfulness is positively associated with BE, but negatively with ME (6). Therefore, based on the mindfulness reperceiving theory, this article intends to replicate and expand the results of the prior literature by confirming the association between mindfulness and BE/ME and investigating the mediating roles of resilience, internal locus of control, and self-esteem.

Resilience is an ability or trait by which people effectively adapt to adversity (16, 17). As a trait, it explains why some people are more courageous in the face of adversity, while others are overwhelmed by it and even develop serious psychological problems (18). Prior studies have indicated that the mediating link between mindfulness and both BE/ME is resilience (7). This means that resilience acts as a positive psychological resource for effectively coping with envy. Importantly, resilience is composed of protective factors originating from the individual, their family, and society (19). Internal locus of control and self-esteem are typical protective factors of resilience that arise from the individual (20). The present study further explored the mediating role of resilience, internal locus of control, and self-esteem in the link between mindfulness and BE/ME.

Internal locus of control is defined as a person's belief that they control their own life (21). People with internal locus of control feel that their life outcomes are determined by their own actions and personal characteristics (22). Mindfulness is positively related to internal locus of control. Some theorists have proposed the mindfulness reperceiving theory: reperceiving has been found to help people choose behaviors that are consistent with their needs, interests, and values and to make them more likely to believe in their abilities (23). Internal locus of control helps people have confidence in their behavior, abilities, and attributes and make choices that meet their needs (22). Therefore, mindfulness is linked with a higher internal locus of control, and this relationship has been borne out by empirical research (20, 24).

Some studies have also proposed that the internal locus of control should be understood to consist of perceived control (25). Perceived control is the belief that an individual determines their own internal state and behavior (26). Perceived control is also one of the conditions for envy differentiation (11, 27). The higher an individual's perceived level of control, the easier it feels for them to change their disadvantageous situation, and the more likely they are to experience BE rather than ME (28). Therefore, internal locus of control may be associated with a tendency toward BE/ME. Specifically, internal locus of control may be a mediating mechanism between mindfulness and BE/ME. Additionally, internal locus of control is a protective factor of resilience (29, 30). This implies that mindfulness may

also be positively associated with resilience by improving the internal locus of control, thereby indirectly impacting envy in either its benign or malicious form.

Furthermore, self-esteem is defined as an individual's general sense of their own value (31). According to the mindfulness reperceiving theory, reperceiving is a change in perspective that encourages people to keep an open and objective attitude toward their current experience (23). This means that people with higher mindfulness are less concentrated on negative feelings and thoughts; reperceiving is thus associated with high self-esteem (32). A majority of studies have also suggested that mindfulness is positively linked to self-esteem (33–35).

Additionally, research has demonstrated a link between self-esteem and BE/ME (36). People with low self-esteem have cognitive biases and often have a negative view of self (37). Thus, to avoid losing their valuable self-esteem resources after a negative upward social comparison, they may be particularly prone to use hostile strategies, and therefore more inclined to experience ME (36). Therefore, we inferred that self-esteem is negatively linked with BE/ME. Self-esteem, too, is a protective factor of resilience (29). Mindfulness may, therefore, also positively link resilience to BE/ME by promoting self-esteem.

Based on the above literature and the mindfulness reperceiving theory, we proposed four hypotheses: (1) Mindfulness is indirectly related to BE/ME through the mediating role of internal locus of control. (2) Mindfulness is related to BE/ME through the chain mediating mechanism of "internal locus of control → resilience". (3) Mindfulness is indirectly related to BE/ME through the mediating role of self-esteem. (4) Mindfulness is related to BE/ME through the chain mediating mechanism of "self-esteem → resilience".

## Methods

### Participants and procedures

Nine hundred ninety-one participants (299 males and 692 females) were selected from the eastern and coastal regions of China by random sampling and cluster sampling. Participants' ages ranged from 17 to 26 ( $M = 19.05$ ,  $SD = \pm 1.54$ ). They completed hardcopy informed consent forms and received compensation of 30 yuan after completing all questionnaires. This study was approved by the ethics committee of the author's university. Two exclusion criteria were used. First, a survey was excluded if more than 2/3 of the questions were not filled out. Second, a questionnaire was excluded if all the questions had the same answer, as this indicated that the participant did not answer them carefully. Based on these two exclusion criteria, 64 questionnaires were excluded. Moreover, for  $power = 0.95$ , the required sample size for this study is 400. The sample size of this study was 991 (i.e., >400) meeting the requirement. It should be noted that the data for the current study were from an ongoing

project named “Philosophy and Social Science Project of Hunan Province of China”, some of the data have been used in previous studies (6, 7, 11, 13, 38).

The questionnaires included a short demographic survey and the MAAS, the Locus of Control Scale (LCS), the Connor-Davidson Resilience Scale (CD-RISC), the Rosenberg Self-Esteem Scale (RSES), and the Benign and Malicious Envy Scale (BEMAS). The participants completed all the questionnaires in about 40 min. Numerous studies have proven the effectiveness of this procedure (38–40).

## Measures

Brown and Ryan (1) devised the MAAS to measure mindfulness. It consists of 15 items (e.g., “I forget a person’s name almost as soon as I’ve been told it for the first time.”). All items are answered on 6-point scale (1 = *almost always*, 6 = *almost never*), with higher scores meaning higher levels of mindfulness. Studies have shown this scale to be highly reliable with Chinese participants (41) (Cronbach’s  $\alpha = 0.86$ ). Cronbach’s  $\alpha = 0.79$  for this scale in the current study.

The BEMAS was devised by Lange and Crusius (10). It consists of 10 items, with 5 items for each of the 2 subscales (BE/ME). A representative item from the BE subscale is, “Envyng others motivates me to accomplish my goals.” Meanwhile, the ME subscale included items such as, “I feel ill will toward people I envy.” Participants indicated their agreement on a 6-point Likert-type scale (1 = *almost disagree*, 6 = *almost agree*). Higher scores indicate higher levels of BE/ME. Many studies have demonstrated the validity of this scale for Chinese participants (6, 13, 39). Cronbach’s  $\alpha = 0.81$  for the BE scale and 0.85 for the ME scale in the current study.

The CD-RISC was developed and revised by Campbell-Sills and Stein (17). It is composed of 10 items (e.g., “Tries to see the humorous side of problems”) and is a 6-point scale (1 = *almost disagree*, 6 = *almost agree*). Higher scores indicate stronger resilience. Xiang et al. (38) have confirmed its reliability with Chinese participants. Cronbach’s  $\alpha = 0.89$  for this scale in the current study.

The LCS was compiled by Levenson (21) and divided into three dimensions, namely Internal Locus of Control, Powerful Others, and Chance. It has 24 items, 8 items of which measure internal locus of control. A representative item is, “Whether I can be a leader mainly depends on my ability.” Participants rated each item on a 6-point scale (1 = *almost disagree*, 6 = *almost agree*). Higher scores indicate a higher internal locus of control. Studies have confirmed its reliability with Chinese participants (42) (Cronbach’s  $\alpha = 0.71$ ). The Cronbach’s  $\alpha$  of this dimension was 0.77 in the current study.

The RSES was compiled by Rosenberg (31) and includes 10 items. A sample item is “I take a positive attitude toward myself.” The scale uses a 4-point scale (1 = *strongly disagree*, 4

= *strongly agree*). Higher scores indicate higher levels of self-esteem. Kong and You (43) have confirmed its reliability with Chinese participants. Cronbach’s  $\alpha = 0.89$  in this study.

## Data analysis

First, the possibility of common method bias (CMB) was analyzed. Second, a measurement model was established to determine whether the observed variables represent the latent variables well. Prior studies have shown that when using a structural equation model to construct a measurement model, the items can be packaged to divide the factor loadings (44). Specifically, the inter-item balance method was used to divide mindfulness and resilience into three parcels, and to separate internal locus of control, self-esteem, and BE/ME into two parcels. The effectiveness of this method has been verified in previous studies (39, 40, 43). Third, according to the good fit of the measurement model, the structure model was established, and some indexes (e.g., the Chi-Square Statistics) were adopted as indicators to evaluate goodness of fit (42–44). The bootstrapping method was then used to test the mediating role of resilience, internal locus of control, and self-esteem. Finally, a cross-gender stability analysis was used to examine gender differences.

## Results

### Common method biases

Given that this study was based on a questionnaire survey method, Harman’s single factor test was used to measure CMB (45). The common factor was set to 1 for confirmatory factor analysis. The results indicated that the fitting index was not ideal ( $\chi^2_{/df} = 8.015$ , RMSEA = 0.084, NFI = 0.451, GFI = 0.608, CFI = 0.483, SRMR = 0.089), demonstrating that there was no serious CMB in the data.

### Measurement model

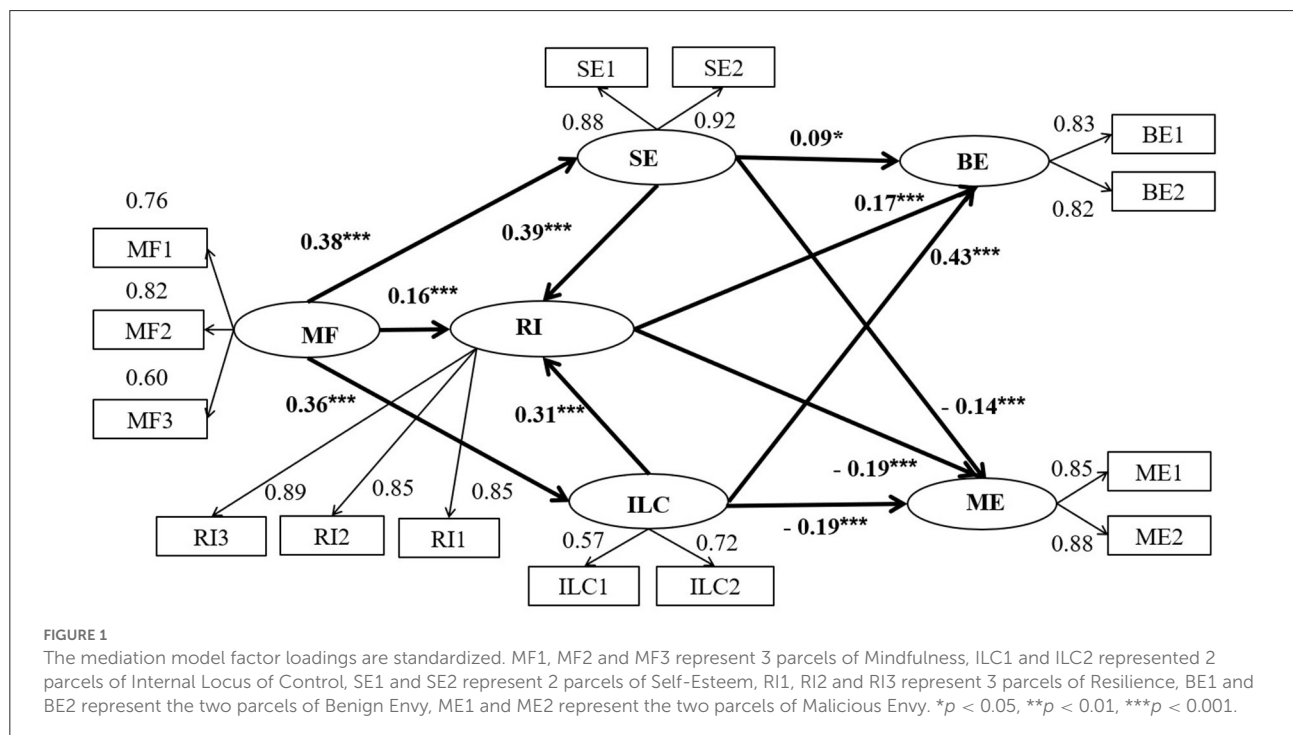
Latent variables in the measurement model included mindfulness, resilience, internal locus of control, self-esteem, and BE/ME; there were 14 observed variables. The results showed that the data were suitable for the established models [ $\chi^2_{(62,991)} = 157.950$ ,  $p < 0.001$ ; RMSEA = 0.040; SRMR = 0.028; CFI = 0.985; AIC = 243.950; ECVI = 0.246]. Furthermore, all variables were significantly related; Table 1 includes the *M* (mean), *SD* (standard deviation), and correlations of mindfulness, resilience, internal locus of control, self-esteem, and BE/ME.



TABLE 1 Descriptive statistics and correlations for major measures.

	<i>M</i>	<i>SD</i>	1	2	3	4	5
1 MF	60.91	9.08	1.000				
2 RI	34.74	5.53	0.326***	1.000			
3 SE	29.38	4.63	0.300***	0.498***	1.000		
4 ILC	31.76	3.85	0.204***	0.400***	0.368***	1.000	
5 BE	23.35	3.59	0.122***	0.369***	0.292***	0.388***	1.000
6 ME	11.01	4.49	−0.281***	−0.308***	−0.274***	−0.266***	−0.205***

MF, Mindfulness; RI, Resilience; SE, Self-Esteem; ILC, Internal Locus of Control; BE, Benign Envy; ME, Malicious Envy; \*\*\*  $p < 0.001$ .



## Structure model

Once it was shown that the measurement model fit well, Structure **Model 1** was established to consistent with the hypotheses (see Figure 1). **Model 1** results indicated that each indicator matched well (see Table 2) [**Model 1**:  $\chi^2_{(66,991)} = 340.310$ ;  $p < 0.001$ ; RMSEA = 0.065; SRMR = 0.069; CFI = 0.958; AIC = 418.310; ECVI = 0.423]. Therefore, **Model 1** was chosen as the final structural model.

## Testing of mediating variables

Bootstrap estimation was used to test the validity of the mediating variables (i.e., resilience, internal locus of control, and self-esteem). 1,000 bootstrap samples ( $N = 991$ ) were selected from the raw data by random sampling. The results indicated that all the mediating variables played a significant role, with

95% CIs (see Table 3). Among them [95% CIs (0.004, 0.037)/95% CIs (−0.040 to −0.006)], internal locus of control [95% CIs (0.070, 0.159)/95% CIs (−0.096 to −0.011)], and self-esteem [95% CIs (0.001, 0.049)/95% CIs (−0.062 to −0.007)] played significant mediating roles in the link between mindfulness and BE/ME. Importantly, mindfulness had an indirect and significant effect on BE/ME through the chain mediating paths of “internal locus of control → resilience” [95% CIs (0.005, 0.025)/95% CIs (−0.024 to −0.006)] and “self-esteem → resilience” [95% CIs (0.005, 0.031)/95% CIs (−0.028 to −0.006)].

## Gender differences

The independent sample *T*-test was used to determine whether there were differences in gender between the six latent variables. The results showed that there were no significant gender differences in mindfulness [ $t_{(991)} = 0.192$ ,  $p = 0.848$ ],

TABLE 2 Fit indices of structure Model 1.

	$\chi^2$	df	RMSEA	SRMR	CFI	AIC	ECVI
Model 1	340.310	66	0.065	0.069	0.958	418.310	0.423

RMSEA, Root-Mean-Square Error of Approximation; SRMR, Standardized Root-Mean-Square Residual; CFI, Comparative Fit Index; AIC, Akaike Information Criterion; ECVI, Expected Cross-Validation Index; the same below.

TABLE 3 Standardized indirect effects and 95% CIs.

Model pathways	Estimated	Lower	Upper
MF → RI → BE	0.018**	0.004	0.037
MF → RI → ME	−0.019**	−0.040	−0.006
MF → ILC → BE	0.103***	0.070	0.159
MF → ILC → ME	−0.042**	−0.096	−0.011
MF → SE → BE	0.022*	0.001	0.049
MF → SE → ME	−0.032**	−0.062	−0.007
MF → ILC → RI → BE	0.013**	0.005	0.025
MF → ILC → RI → ME	−0.013**	−0.024	−0.006
MF → SE → RI → BE	0.016**	0.005	0.031
MF → SE → RI → ME	−0.017**	−0.028	−0.006

MF, Mindfulness; RI, Resilience; BE, Benign Envy; ME, Malicious Envy; ILC, Internal Locus of Control; SE, Self-Esteem. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

self-esteem [ $t_{(991)} = 1.162, p = 0.246$ ], internal locus of control [ $t_{(991)} = 0.907, p = 0.365$ ], or BE [ $t_{(991)} = -1.77, p = 0.077$ ]/ME [ $t_{(991)} = -0.671, p = 0.502$ ]. The gender difference in resilience was significant [ $t_{(991)} = 2.999, p = 0.003$ ], with men scoring higher than women.

To test the gender stability of the structural model, a cross-gender stability analysis was performed. According to the basic constraint that factor loadings, error variances, and structure variances should be kept unchanged, two models were established, one of which allowed for an unconstrained structure path, while the other restricted the structure coefficients of the two genders to be equal (46). The model results indicated that there was a significant difference between the two [ $\Delta \chi^2_{(31,991)} = 68.728, p < 0.001$ ]. Meanwhile, all fitting indicators of the model reached the standard of fitness (see Table 4). Furthermore, the CRD (absolute value range:  $>1.96$ ) was used as an indicator to further explore the structural cross-gender stability (47).

The results showed that there was a significant gender difference in the structure paths of mindfulness → resilience (CRD  $MF \rightarrow RI = -2.233; \beta_{men} = 0.291, p < 0.001; \beta_{women} = 0.101, p = 0.031$ ) and internal locus of control → resilience (CRD  $ILC \rightarrow RI = -2.174; \beta_{men} = 0.189, p = 0.013; \beta_{women} = 0.373, p < 0.001$ ). Meanwhile, there were no significant differences in the structural paths of all other variables (CRD  $MF \rightarrow SE = 0.423$ , CRD  $MF \rightarrow ILC = -0.738$ , CRD  $RI \rightarrow BE = -0.306$ , CRD  $SE \rightarrow BE = 1.249$ , CRD  $ILC \rightarrow BE = -0.608$ , CRD  $SE \rightarrow RI = 1.326$ , CRD  $RI \rightarrow ME = 0.001$ , CRD  $SE \rightarrow ME = 0.778$ , CRD  $ILC \rightarrow ME = -0.259$ ).

## Discussion

This article aimed to reveal the mechanisms by which resilience, internal locus of control, and self-esteem mediate the association between mindfulness and BE/ME. The results suggest that mindfulness effectively promotes the occurrence of BE and inhibits the occurrence of ME through resilience, internal locus of control, and self-esteem. Thus, this study further expands the theoretical basis of the mindfulness re-perceiving theory. Interestingly, the comparison of cross-gender models found that there are gender differences in the path of “mindfulness → resilience” and “internal locus of control → resilience”.

First, unlike previous studies, our results reveal that mindfulness is positively correlated with BE. A possible reason for this relationship is that BE has a positive side. Prior studies have found that BE motivates people to narrow the gap between themselves and the envied (48, 49). In addition, the mindfulness re-perceiving theory posits that mindfulness helps people focus more on their current experience and can break rigid responses (23), thus improving cognitive flexibility (50, 51). Therefore, mindfulness gives people strong cognitive flexibility, leading to less resentment and less sense of inferiority, making the individual more prone to experience BE. However, although our research shows that there is a positive side to BE, it must be acknowledged that BE is still a negative emotion. BE is also correlated with undesirable psychological outcomes in terms of personality. For example, Lange et al. (12) have found that

TABLE 4 Comparison of unconstrained and constrained structural path models.

	$\chi^2$	df	CFI	RMSEA	SRMR	AIC	ECVI
Unconstrained SP	434.950	140	0.955	0.046	0.074	574.950	0.581
Constraint SP	503.678	171	0.949	0.044	0.075	581.618	0.588

BE is linked with the Dark Triad of personality. Therefore, future research needs to further explore the relationship between mindfulness and BE.

Second, the mediation analysis results reveal that mindfulness promotes BE and inhibits ME by strengthening the internal locus of control, validating **hypothesis 1**. One possible explanation is that mindfulness helps people make choices that meet their own needs (23) and makes them more confident in their own abilities (20, 24), thereby causing them to experience a greater sense of internal locus of control. Therefore, such people are more likely to experience BE than ME. Moreover, this finding indirectly suggests that internal locus of control is indeed equivalent to perceived control to some extent (25), thus influencing BE/ME.

In addition, the results also indicate that mindfulness relates to BE/ME through the chain mediating mechanism of “internal locus of control → resilience,” supporting **hypothesis 2**. This is probably because internal locus of control is linked to positive adaptation to adversity (20). Mindfulness motivates people to be more confident in their abilities (23), and thus enables them to actively adjust to adversity (52). As a result, they are more likely to experience BE than ME.

The mediation analysis results reveal that mindfulness indirectly predicts BE/ME through self-esteem, validating **hypothesis 3** and the mindfulness re-perceiving theory. This is consistent with the fact that mindfulness increases self-esteem, thereby inhibiting negative emotions (34). Mindfulness is linked with greater cognitive flexibility and a lessened focus on negative thoughts (23), leading to higher self-esteem (53). Additionally, our research supports a positive link between self-esteem and BE. This finding is also consistent with that of Li and Xiang (13). Therefore, people with low self-esteem are more likely to experience ME rather than BE.

Importantly, mindfulness relates to BE/ME through the chain mediating mechanism of “self-esteem → resilience,” supporting **hypothesis 4**. That is to say, mindfulness improves an individual's self-esteem, thereby enhancing their resilience, and thereby promoting BE and reducing ME. One reason for this is that mindfulness helps people adjust their perceptions of negative experiences through re-perceiving (23), thereby increasing self-esteem. Meanwhile, mindfulness is associated with positive self-assessment (54), and therefore with higher self-esteem (35, 55), and thus mindful individuals tend to positively adjust and adapt to adversity (33, 34), promoting their resilience

(35, 55–57). Therefore, such individuals are more likely to experience BE than ME.

Interestingly, the cross-gender model analysis results showed that men have higher mindfulness, and thus more resilience, than women. This is consistent with prior studies, which have shown that men are more resilient than women in the face of adversity (58, 59). Men with higher levels of mindfulness are better able to actively adapt to adversity, and therefore are more resilient than women. However, women have higher internal locus of control, and thus more resilience. This supports previous studies that showed that women have a higher internal locus of control than men (60), and thus have higher resilience.

This article has some limitations. First, the participants were all Chinese youths. Future research should examine the mechanisms of mindfulness and BE/ME in groups of different ages and cultural backgrounds. Second, the structural equation model can only infer possible causal relationships between variables. Future research should adopt longitudinal research and experimental methods to explore more deeply the causality linking mindfulness and BE/ME. Third, the gender ratio of this study was unbalanced, and future studies should use samples that are more gender-balanced.

Despite the above limitations, this study still has some practical implications. First, this study shows that the further development of malicious envy can be avoided by using mindfulness to enhance resilience, internal control, and self-esteem. This finding might be useful for educators and employers to improve group performance in classrooms or workplaces. For example, educators can teach their students a mindful approach that increases their positive resources (i.e., resilience, internal locus of control, and self-esteem), so that they can avoid the painful experience of envy, especially malicious envy, and feel more satisfied with their lives (6). Meanwhile, in order to avoid malicious envy among employees, employers can also carry out proper training activities and use mindfulness to improve employees' resilience, internal locus of control, and self-esteem, thereby stimulating better work performance. Second, this study also found that mindfulness improves resilience through positive associations between internal locus of control and self-esteem, and helps to prevent individuals from developing malicious envy. This indicates that resilience, internal locus of control, and self-esteem are not completely independent, and they forestall the development of malicious envy through positive interactions with each other. Thus,

educators and employers should focus on the development of the individual's overall positive resources (i.e., resilience, internal locus of control, and self-esteem) in the process of education or training, which can improve resilience and thereby avoid the negative effects of malicious envy.

## Conclusion

This research investigated the underlying mechanisms by which mindfulness is linked to BE/ME from the perspective of the mindfulness reperceiving theory. Why does mindfulness effectively inhibit ME and promote BE? A possible explanation is that mindful reperceiving enhances resilience, internal locus of control, and self-esteem. Future research can design mindfulness interventions and improve resilience from the view of internal locus of control and self-esteem to inhibit ME and promote BE.

## Data availability statement

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

## Ethics statement

The studies involving human participants were reviewed and approved by the paper was Ethics Committee of the Hunan Normal University. All procedures carried out in this study involving human participants were in accordance with the ethical standards of the Helsinki Declaration. All participants provided informed consents before completing the questionnaires, and were paid after completing the whole questionnaires. The patients/participants provided their written informed consent to participate in this study.

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## Author contributions

XD: paper writing, paper revising, and data analysis. XL and XJ: paper revising. YX: study design and paper revising. 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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# The efficacy and safety of Jin's three-needle therapy vs. placebo acupuncture on anxiety symptoms in patients with post-stroke anxiety: A study protocol for a randomized controlled trial

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**Background:** A large number of clinical RCTs have verified that Jin's three-needle therapy (JTNT) has a great contribution to promoting the function of paralyzed limbs and relieving anxiety disorders for patients with post-stroke anxiety (PSA). However, there is still a lack of sham needle control, and its placebo effect cannot be ruled out. This study firstly verifies the real effectiveness of JTNT. Besides, the changes in serum indexes on the hypothalamic-pituitary-adrenal axis (HPA axis) are observed dynamically by the Enzyme-Linked Immunosorbent Assay (ELISA). The activation of different brain regions by JTNT is recorded using resting functional magnetic resonance imaging (rs-fMRI). Therefore, we can provide more practical and powerful evidence-based medical evidence for clinical decisions.

**Method:** This is a 16 week parallel, single-blind, random, controlled trial, including baseline, 4 weeks of treatment, and 12 weeks of follow-up. A total of 114 participants will be randomly divided into three groups in the proportion of 1:1:1. Participants will receive Jin's three-needle therapy in the active acupuncture group and accept sham needle treatment in the sham acupuncture group. In the waitlist control group, patients will not receive any acupuncture treatment. Outcomes cover three types of indicators, including scale indicators, serum indicators, and imaging indicators. The primary outcome is the change in the performance of anxiety symptoms, which is estimated by the 14-item Hamilton Anxiety Rating Scale (HAMA-14) and the 7-item Generalized Anxiety Disorder scale (GAD-7). Secondary outcomes are physical recovery and daily quality of life, which are evaluated by the National Institute of Health stroke scale (NIHSS) and the Modified Barthel Index Score (MBI Scale). Therefore, the assessment of the scale is carried out at baseline, 2nd, 4th, 8, 12, and 16 weeks. Adrenocorticotropin and cortisol will

be quantitatively detected by ELISA at baseline and 4 weeks after treatment. In addition, regional homogeneity analysis (ReHo) will be used to record the activity of brain regions at baseline and 4 weeks after intervention.

**Discussion:** The study aims to provide high-quality clinical evidence on the effectiveness and safety of JTNT for patients with PSA. In addition, this trial explores a possible mechanism of JTNT for patients with PSA.

**Clinical trial registration:** Chinese Clinical Trial Registry, identifier [ChiCTR2200058992].

#### KEYWORDS

post-stroke anxiety (PSA), Jin's three-needle therapy, sham acupuncture, CORT, ACTH, fMRI, randomized controlled trial, protocol

## Introduction

Stroke is the leading cause of permanent disability and death (1). Globally, more than 25 million people are diagnosed with stroke and 6.5 million people die from stroke each year, which aggravates the disease burden (2–4). Despite the existence of global policies and guidelines for stroke implementation, many challenges remain in establishing stroke services (5). In addition to residual physical disability, post-stroke anxiety (PSA) is one of the common neuropsychiatric comorbidities with a high incidence. The reported prevalence of PSA ranges from 20 to 25 percent (6–8). During COVID-19, PSA showed a noticeable peak, which is related significantly to social deprivation and the lack of rehabilitation (9). Compared to non-anxious patients, the patients with PSA are usually in more severe condition at presentation and sustain a long rehabilitation process, resulting in stroke recurrence and death (10–12). It suggests the importance of assessing anxiety and designing effective interventions in chronic stroke survivors. Unfortunately, existing stroke guidelines do not propose the best way to identify and guide the clinical treatment for PSA. Research on PSA is still in its early stages (13). A Cochrane review confirmed that current evidence is insufficient to guide the clinical treatment for PSA (14). Commonly used drugs such as selective serotonin reuptake inhibitors (SSRIs) have poor patient compliance due to their side effects (15). Therefore, more adjuvant therapy methods need to be developed.

Traditional Chinese medicine (TCM) has been used to treat cerebral apoplexy since 3,000 years ago and accumulated abundant and robust evidence (16). Acupuncture, as an important part of TCM, has a solid foundation in China to be applied to improve neurological impairment and complications induced by stroke (17). Jin's three-needle therapy (JTNT), established by Jin Rui, was standardized in one of the National research projects and promoted as the popular acupuncture method in Southern China (18–20). A large number of RCTs have confirmed the efficacy of JTNT in treating mental diseases

such as PSA (21, 22). However, there is no placebo-controlled evidence to support it. The real efficacy of JTNT for patients with PSA remains to be proven, and its mechanism has not been fully elucidated.

It is indispensable to identify the cause and pathogenesis of PSA for targeted therapies. According to the available research results, PSA is multifactorial, involving biological and neurophysiological factors. The hypothalamic-pituitary-adrenal (HPA) axis is one of the neuroendocrine systems in the brain that controls the release of glucocorticoids from the adrenocortical glands (23). As well as being a component of the stress response, it also mediates additional downstream pathophysiological changes (24). Hypothalamic hormones stimulate corticotroph cells in the anterior pituitary to secrete adrenocorticotropin (ACTH) (25, 26). ACTH activates the synthesis and secretion of glucocorticoid cortisol (CORT) by the human adrenal cortex (27, 28). As a result of the variety of releasing factors, the HPA axis is expected to respond to stimulation quickly and dynamically. Clinical studies suggest that immediately after stroke onset, a massive release of pro-inflammatory cytokines activates the HPA axis (29, 30). The activated HPA axis promoted a “systemic anti-inflammatory response” that negatively affects function recovery and anxiety generation (31). Besides, anxiety and depression are recognized to be associated with dysregulation of the HPA axis, which accentuates inflammation, consequently increasing the risk of stroke recurrence (32). Dysfunction of the HPA axis is suspected to be one of the main mechanisms connecting stroke with anxiety (33). This study provides preliminary biological evidence for the potential efficacy effect of acupuncture on PSA.

Resting-state functional magnetic resonance imaging (rs-fMRI) is an effective and non-invasive technique to record the activity of the brain in various neuropsychiatric disorders including PSA (34–36). It is revealed that the main regions related to anxiety effects are hippocampus, thalamus, frontal lobe, amygdala, insular cortex, and prefrontal cortex (37–40).

The hypothesis of our study is to explore the underlying neural mechanisms of PSA through blood-oxygen-level-dependent effects (41). Regional homogeneity (ReHo) is used to process the fMRI images (42). To evaluate resting-state brain activity effectively, Kendall's coefficient of concordance (KCC) is used to compare a given voxel's time series with its nearest neighbors (43). ReHo theory states that in an area where ReHo is increased, the connections between neurons are strengthened. Conversely, the presence of reduced ReHo indicates a weakening of local connections between neurons. ReHo has shown to be a highly sensitive and reliable method for determining the regional activity level of each voxel in the brain of a single individual (44). Yet, few studies have investigated how acupuncture modulates brain regions in patients with PSA using fMRI. As a result, we use rs-fMRI to explore the possible changes in brain activity and try to find the associations among brain activity, disease activity, and anxiety statuses. This study provides preliminary neurophysiological evidence for the potential efficacy effect of acupuncture on PSA.

In recent years, JTNT has increasingly attracted the attention of clinicians and researchers. However, there is insufficient evidence about the real effects of JTNT on PSA patients. Therefore, we hypothesize that acupuncture will have better clinical efficacy than sham acupuncture in clinical symptoms, anxiety degree, and quality of life. We try to investigate the potential mechanism by enzyme-linked immunosorbent assay (ELISA) and rs-fMRI.

## Methods and analysis

### Ethical standard and study registration

The protocol was registered with the China Clinical Trial Registry (item number: ChiCTR2200058992), and this study protocol has been approved by the Ethics Committee of the First Affiliated Hospital of Guangzhou University of TCM (item number: K2022-02).

### Informed consent

Participants will have sufficient time to decide whether to participate in this trial. Before this trial, patients will have the right to obtain all relevant information about the trial including the benefits and risks, and they will have the right to withdraw from it if needed. As part of the recruitment process, all participants will be required to provide written informed consent before the trial. All participant records will be kept confidential.

## Study design

A single-center, prospective, randomized controlled trial (RCT) will be conducted at the First Affiliated Hospital of Guangzhou University of TCM. A total of 114 participants with PSA will be recruited and randomly assigned to conventional therapy plus JTNT, conventional therapy plus sham acupuncture, or conventional therapy only. Both JTNT and sham acupuncture are provided five times per week for 4 weeks. Outcomes cover three types of indicators, including scale indicators, serum indicators, and imaging indicators. The primary outcome is the change in the performance of anxiety symptoms, which is estimated by the 14-item Hamilton Anxiety Rating Scale (HAMA-14) and the 7-item Generalized Anxiety Disorder scale (GAD-7). Secondary outcomes are the physical recovery and daily quality of life for patients with PSA, which are evaluated by the National Institute of Health Stroke Scale (NIHSS) and the Modified Barthel Index Scale (MBI). The evaluator will evaluate and analyze the results at six points (baseline, 2nd, 4th, 8, 12, and 16 weeks). ACTH and CORT will be quantitatively detected by ELISA at baseline and 4 weeks of treatment. In addition, ReHo will be used to record the brain regions activity at baseline and 4 weeks after intervention. The flow chart of the trial is illustrated in [Figure 1](#), while [Table 1](#) shows the schedule of measurements.

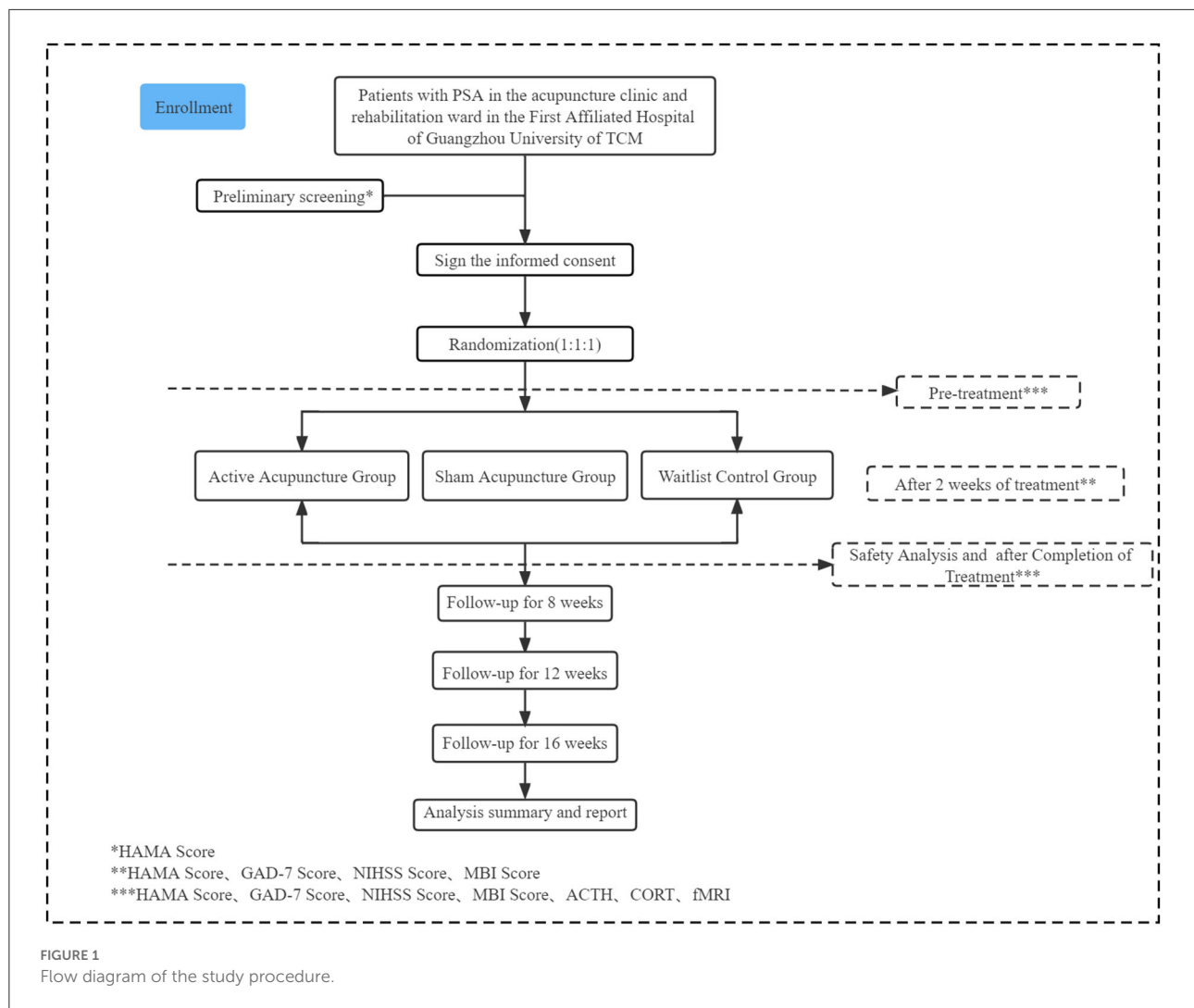
## Participant recruitment

Those who occur anxiety more than 1 week after a stroke are diagnosed with PSA according to guidelines customized by The American Psychiatric Association. A target sample of 114 participants will be recruited in the acupuncture outpatient and inpatient systems at the First Affiliated Hospital of Guangzhou University of TCM. The trial will start in May 2022 and run until December 2024. To recruit potential patients, recruitment advertisements will be posted on WeChat, acupuncture outpatient, inpatient systems, and other official platforms. Brief introductions about inclusion criteria, possible benefits for patients, and contact information for the researcher will be provided in the advertisements.

## Inclusion criteria

Participants with the following conditions are included:

- (1) The age is between 30 and 75, and gender is not limited.
- (2) Diagnosed with stroke (cerebral infarction) within 2 weeks to 3 months and patients who have not had a previous stroke.
- (3) Met the diagnostic criteria for "Anxiety disorder due to another medical condition" in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V) (45).



- (4) The HAMA score  $\geq 14$  points, and  $< 29$  points.
- (5) Clear consciousness, stable vital signs, no cognitive impairment, and ability to cooperate with the scale assessment.
- (6) Have not taken anti-anxiety drugs systematically.
- (7) An informed consent is signed by patients or their immediate family members.

## Exclusion criteria

Participants with the following conditions are excluded:

- (1) Transient ischemic attack, reversible neurological deficit.
- (2) Diagnosed with depression, cognitive impairment, schizophrenia, bipolar disorder, substance abuse, or other mental disorders before stroke.

- (3) Those who have been confirmed by examination that the neurological deficit is caused by diseases such as brain tumor, brain trauma, cerebral vascular malformation, and brain parasites.
- (4) Patients with severe forms of heart disease, liver disease, kidney disease, or tumors.
- (5) Contraindication to an MRI examination.
- (6) Participating in any other clinical trials.
- (7) During pregnancy or lactation.
- (8) Patients who suffer from bleeding disorders, coagulation dysfunction, and skin infections that are not suitable for acupuncture.

## Randomization

The randomization sequence will be generated by an independent statistician, who will not participate in other



TABLE 1 Study schedule showing the time points for enrollment and assessment.

Study period							
Timepoint	Enrollment	Baseline	Treatment phase (4 weeks)		Follow-up phase (12weeks)		
	(1 week)	0 week	Week 2	Week 4	Week 8	Week 12	Week 16
Enrollment							
Informed consent	×						
Eligibility screen	×						
Medical history	×						
Merger disease	×						
Randomization		×					
Allocation		×					
Interventions							
Intervention group		←————→					
Control group		←————→					
Assessments							
HAMA-14		×	×	×	×	×	×
GAD-7		×	×	×	×	×	×
NIHSS		×	×	×	×	×	×
MBI		×	×	×	×	×	×
CORT		×		×	×	×	×
ACTH		×		×	×	×	×
fMRI		×		×			
Safety							
Safety evaluation		×		×			
Adverse events		←————→			←————→		

×, required; HAMA, 14-item Hamilton Anxiety Scale; GAD-7, 7-item Generalized Anxiety Disorder-7 Scale; NIHSS, National Institute of Health stroke scale; MBI, the Modified Barthel Index Scale.

procedures of the trial, using the SAS 9.3 statistical analysis system (SAS Institute Inc., Cary, NC, USA). To guarantee allocation concealment, the generated list of random numbers will be placed into sequentially numbered, opaque, sealed envelopes. A special information manager will be designated to keep information secure. Researchers need to contact the designated information manager to get a random number and group information for each participant included in the study.

## Blinding

Following the information from the envelope, each participant will be randomly assigned in a 1:1:1 ratio to active acupuncture group, the sham acupuncture group or the waitlist group. Acupuncturists, who had received the prepared standard operating procedure guidance for 2 weeks, will be appointed to perform the acupuncture treatment for both groups separately. The blinding acupuncture device has obtained the national utility model patent certificate (patent number: ZL 202121352221.7). It is a validated device that consists of one tube, one needle base with multiple angle openings, one open

or sealing adhesive base, and a pointy or flat acupuncture needle. Figure 2 details the blinding device. The customized blinding needles are produced by a manufacturer with relevant qualifications (Guangzhou Suixin Medical Equipment Co., Ltd.). Before our research, patients will be informed that they may have either “less painful acupuncture” (sham needles) or “traditional Chinese acupuncture” (real needles). As the sham acupuncture in this study can create similar pain to acupuncture without penetrating the skin, it can serve as an effective blinding tool. To maximize blinding effect, both groups will be given identical blindfolds during the treatment. Even so, it is impractical to blind the acupuncture operators due to the acupuncture procedure. In an attempt to minimize the subjective influence, statisticians and data managers, as independent three-party to the research, will also be blinded to the group information.

## Interventions and comparison

All groups of patients with PSA will receive routine drugs and rehabilitation treatment during the whole 4-week study,



**FIGURE 2**  
Schematic diagram of the new acupuncture equipment.

implemented by clinicians and rehabilitation therapists with more than 5 years of clinical experience. All the researchers in this study had received the prepared standard operating procedure (SOP) guidance for 2 weeks before the trial. According to the Guidelines for the Prevention and Treatment of Cerebrovascular Diseases in China (46), basic therapeutic drugs with nutritional support, neuroprotection, and secondary prevention drugs will be provided. Additionally, rehabilitation exercises targeting different functions of the subject will be implemented. However, Chinese herbal medicine will be prohibited during the trial. The active and sham acupuncture groups will receive acupuncture treatment five times per week for 4 weeks. The waitlist group will not receive any acupuncture treatment. The specific operations are as follows:

### Active acupuncture group

Jin's three-needle therapy is performed by professional acupuncturists. After the acupoint is positioned precisely and the skin to be punctured is disinfected, the needle will be inserted quickly. The location of acupoints is based on the guidelines issued by the World Health Organization (WHO) (47). The subject is asked to take a supine position and wear an eye patch after fully exposing the site to be punctured. Before the intervention, the acupuncturists assemble the tube into the needle base and put the open adhesive base stacking on the target acupoint after skin disinfection with an iodophor cotton swab. The pointy acupuncture needle is passed through the tube into the skin of the subject. Figure 3 shows the acupuncture points, and Table 2 details the locations. Acupoints will be stimulated manually with the depth of insertion varies from 0.5 to 1.5 cun until operating the sense of "De Qi" (48). The reactions of "De Qi" make patients feel soreness, distension, or heaviness, which are vital for acupuncture to react to different nerve conduction (49, 50). After "De Qi" happens, the needles are kept in the acupoints for 30 min without electricity applied. After the needle is removed, the needle hole will be pressed with a sterile dry cotton swab for a while. It must be ensured that the patient

is not allowed to remove the eye patch from the start of the acupuncture to the end of the needle withdrawal procedure.

### Sham acupuncture group

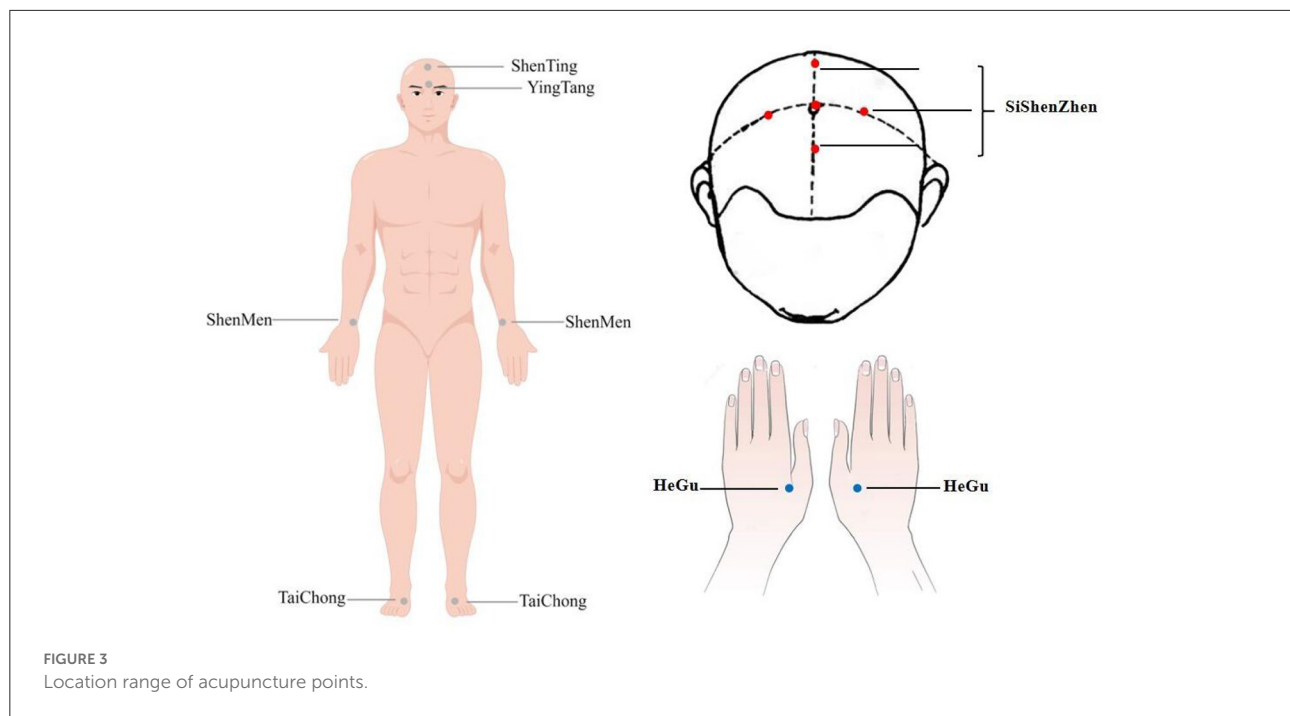
Before the intervention, the acupuncturists assemble the tube into the needle hub and put the sealing adhesive base stacking on the target acupoint after skin disinfection. However, the flat acupuncture needle is passed through the tube into the adhesive sealing base, and the peak of the flat needle can touch the surface skin of the subject to create similar pain as real acupuncture without penetrating the skin. Therefore, it can serve as an effective blinding tool. In both groups, the number of needles inserted, needle retention time, and treatment frequency are the same.

### Waitlist control group

During the first 4 weeks, participants in the waitlist group will not receive any acupuncture intervention but will be given compensatory needle therapy after follow-up phase finished.

### Sample size

The sample size was calculated by the primary outcome. According to the results of preliminary pre-experiment, the Mean  $\pm$  SD of HAMA score in patients who received conventional therapy plus JTNT was  $14.25 \pm 7.10$ , while it was  $19.46 \pm 4.80$  in patients who received conventional therapy plus sham acupuncture. Statistical power is set at 0.90, alpha is set at 0.05, and two-sided tests are performed. After calculations performed by PASS 15.0 (NCSS LLC, Kaysville, Utah, USA) software, 30 people are estimated for each group. The estimated loss to follow-up rate is 20%, so each group will eventually need to include 38 people. The formula for sample size calculation is as follow. Therefore, to verify the placebo effect of sham acupuncture, a waiting group was recruited. The number of



participants in the waitlist control group is equal as the sham acupuncture group. Finally, a total of 114 participants will be randomly divided into three groups in the proportion of 1:1:1.

$$N = \frac{(Z_{\alpha} + Z_{\beta})^2 * 2\sigma^2}{\delta^2} \quad (1)$$

## Outcome measures

Outcomes cover three types of indicators, including scale indicators, serum indicators, and imaging indicators. The assessment of the scale is carried out at baseline, 2nd, 4th, 8, 12, and 16 weeks. CORT and ACTH will be quantitatively detected by ELISA at baseline and 4 weeks of treatment. In addition, ReHo will be used to record the activity of the brain at the baseline and 4 weeks after intervention. All evaluations are conducted by researchers who are blinded to the treatment allocation.

## The primary outcome

The primary outcome is the change in the performance of anxiety symptoms, which is estimated by the 14-item Hamilton Anxiety Rating Scale (HAMA-14) and the 7-item Generalized Anxiety Disorder scale (GAD-7).

## Hamilton anxiety rating scale

The severity of anxiety is often determined by psychological scales. The Hamilton Anxiety Scale (HAMA) is one of the first rating scales to measure the severity of perceived anxiety symptoms. It is considered one of the most widely used rating scales and has been translated into Cantonese (51). A structured interview guide contains a 14-item Hamilton Anxiety Rating Scale of general anxiety, which is rated on a 5-point scale and ranged from 0 (none) to 4 (very severe) by the interviewer.

## Generalized anxiety disorder scale

Several different types of anxiety disorders have been found in PSA. GAD seems to be the most common type (11). The 7-item Generalized Anxiety Disorder Scale (GAD-7) is commonly used to monitor anxiety symptoms. The reliability and validity of GAD-7 have been well-documented (52). A diagnostic meta-analysis in East Asian samples concluded that given the brevity, sensitivity, and specificity of the questionnaire reported, GAD-7 can be well-utilized to identify people with GAD (53).

## The secondly outcome

The secondary outcomes are the physical recovery and daily quality of life for patients with PSA, which are evaluated by the National Institute of Health stroke scale (NIHSS) and the Modified Barthel Index Scale (MBI). Besides, secondary outcomes will be obtained using ELISA and fMRI scanning.

TABLE 2 Specific acupoint location and angle requirements.

Acupoints	Location	Insert angle	Insert depth
BaiHui (GV20)	on the head, 5 cun directly above the midpoint of the anterior hairline, or at the midpoint of the line connecting the apexes of the two auricles.		
SiShenZhen	On the head, a total of 4 acupoints are distributed in the front, back, left and right sides of the Baihui acupoint, with 1.5 cun each above BaiHui.	15°	0.5 cun
ShenTing (GV24)	on the head, 0.5 cun directly above the midpoint of the anterior hairline.	15°	0.5 cun
YinTang (GV29)	On the forehead, at the midpoint between the two medial ends of the eyebrow.	15°	0.5 cun
ShenMen (HT7) (bilateral)	On the wrist, in the ulnar depression of the transverse wrist crease, the radial border of the flexor carpi ulnaris tendon.	90°	0.5 cun
SanYinJiao ( SP6) (bilateral)	On the inner side of the calf, 3 cun above the tip of the medial malleolus, along the medial border of the tibia.	90°	1.5 cun
HeGu (LI4) (bilateral)	On the dorsum of the hand, approximately on the radial side of the second metacarpal bone, between the first and second metacarpal bones of the hand.	90°	0.5 cun
TaiChong (LR3) (bilateral)	On the dorsal side of the foot, in the subdigital depression to the first metatarsal space.	90°	0.5 cun

1 cun is equal to the width of the interphalangeal joint on the middle finger.

ELISA will be used for quantitative analysis of the content of CORT and ACTH in serum.

National institute of health stroke scale

Stroke severity is measured using the National Institute of Health Stroke Scale (NIHSS) (54). There is a 15-item neurologic examination in the NIHSS that is used to assess stroke symptoms. The items are graded from 0 to 42 on an ordinal scale, with higher scores indicating greater severity.

Modified barthel index scale

The Modified Barthel Index (MBI) contains ten basic aspects assessing functional independence related to self-care and mobility (55). Each item is divided into five levels, and the level represents different degrees of independence. The lowest level is 1 and the highest is 5, while the higher the level, the greater the independence. The normal score is 100.

Enzyme-linked immunosorbent assay

The concentration of ACTH and CORT levels in plasma are measured with commercially immunosorbent assay (ELISA) kits (56). All procedure is conducted according to the manufacturer’s instructions. We first measure the absorbance of each sample at 450 nm. Then, a standard curve will be drawn, with the absorbance as the ordinate and the corresponding standard

concentration as the abscissa. A regression equation from the standard curve will be used to calculate the concentration of CORT and ACTH in each sample.

Functional-MRI

Each subject underwent an fMRI scanner with a head orthogonal coil for fMRI data acquisition before and after acupuncture treatment. Before the scanning, participants should adjust the environment on the bed for at least 5 min to help calm down. The subject must hold still and not think systematically or fall asleep. To keep away from the scanner noise and optical disturbance, eyeshades and earplugs are put on. To keep the head from moving, foam pads are used. The scan will be performed in the following order. The position of the image involving the entire brain is structurally acquired by resting-state blood oxygenation level-dependent (BOLD) imaging and echo-planar imaging sequence (57). Then, a three-dimensional (3D) structure is included in the brain volume imaging sequences by capturing a high-resolution image of the entire brain scan (58). The parameters of each sequence scan are listed in Table 3.

Incidence of adverse events

Although acupuncture is a relatively safe treatment with a low risk of adverse events (AEs), at each acupuncture treatment,

TABLE 3 Scanning parameters.

Sequence	TE (ms)	TR (ms)	Depth (mm)	Interval (mm)	Vision (mm <sup>2</sup> )	Matrix
Bold	30	2000	4	0	240 × 240	64 × 64
3D-BRAVO	3.1	8.1	1	0	256 × 256	256 × 256

TE, time of echo; TR, time of repetition; BOLD, blood oxygenation level-dependent; 3D-BRAVO, three-dimensional brain volume imaging.

study acupuncturists will enquire about AEs. While patients receive acupuncture, AEs still may occur, such as pain, bleeding, fainting, infection, and hematoma. The rate of incidence will be carefully recorded in the case report forms, and the causality with acupuncture therapy will be analyzed.

## Data collection and management

Case report forms (CRFs) are designed to make data entry and export more convenient (55). Evaluators will record the detailed personal information and classify the research data of the subject in the CRFs. After the observed recourse end, CRFs will be sorted out in time and imported into the electronic database. To ensure the security and accuracy of databases, the completed paper CRFs will be collected into locked cabinets uniformly. In addition, the electronic database is managed by a third-party person who does not involve in the research process, so the researcher cannot modify the data content. Participants will be identified by a code and their personal information will be hidden and kept strictly confidential. The Data Monitoring Committee of the Rehabilitation Center of the First Affiliated Hospital of Guangzhou University of TCM aims to monitor the trial progress regularly, make sure the safety of the trial, and verify the completeness of the CRFs.

## Statistical analysis

### Clinical data analysis

Third-party statisticians who do not involve in the whole assignment process and implementation of the trial will be invited to conduct statistical analysis. The data will be analyzed using SPSS 26.0 software (SPSS, Inc., Chicago, IL, USA) according to the intention-to-treat principle. The multiple imputation-expectation maximization algorithms are conducted to impute missing data. Continuous variables are summarized as mean  $\pm$  standard deviation (SD) and tested using a *t*-test or Wilcoxon rank-sum test analysis. Categorical variables are reported in percentage (%) and compared using Pearson's  $\chi^2$  test or Fisher's exact test. The groups' comparisons are analyzed by *t*-test (independent *t*-test for comparison between

the groups; paired *t*-test for comparison within the same group). The non-parametric Wilcoxon rank-sum test or the Mann-Whitney U test will be conducted for the measurement data without a normal distribution or homogeneous variance. All bilateral hypothesis tests with a significance level  $<0.05$  will be considered statistically significant.

### MRI data analysis

The DPARSF software platform (DPARSF, Data Processing Assistant for rs-fMRI, GNU GENERAL PUBLIC LICENSE, Beijing, China) is used to preprocess the MRI data, based on the Resting-State fMRI Data Analysis Toolkit (REST; <http://www.restfmri.net>) and the statistical parametric mapping (SPM8; <http://www.fil.ion.ucl.ac.uk/spm>). Then, the rs-fMRI data corrections are performed on the images such as slice timing and realignment for intra-volume acquisition delay. To minimize the influence of head movement, subject with head motion (maximum displacement  $> 2.5$  mm or angle movement  $> 2^\circ$ ) during the whole fMRI scan will be excluded. Stabilization of the magnetization and adaptation of the participants to the fMRI environment will take time. For each time series, the first 10 time points will be deleted to exclude non-neuronal BOLD noise signals (59). In spatial normalization, the whole brain template of the Montreal Neurological Institute (MNI) standard space is normalized in all data spaces (isotropic voxel size =  $3 \times 3 \times 3$  mm) (60). By calculating Kendall's coefficient of concordance (KCC), a voxel-by-voxel basis of a given voxel time series with its neighboring 26 voxels is generated to obtain a separate ReHo map. Finally, a spatially smoothed function with  $4 \times 4 \times 4$  mm (full width at half maximum) Gaussian kernel is applied to reduce the noise and residual in the gyrus anatomy. The statistical analysis tool of REST is performed for independent *t*-tests to identify the ReHo patterns of the three groups (61). Besides, a paired *t*-test is applied to compare the changes in the brain before and after the treatment in each group. Covariates, such as age and education, are considered by the Pearson correlation coefficient to analyze the relationship between the improvement scores of the correlation scales and the brain regions of fMRI image data.



## Quality control

To improve quality control during the trial process, several measures will be taken. (1) Before clinical research, we will conduct a unified training for all researchers about the trial protocol, operating standard procedures, and personnel deployment. (2) To ensure the feasibility of the research operation, all the acupuncturists involved have obtained the qualification certificate for more than 5 years, and have grasped the operating specifications of the new needle equipment. (3) Instruments, equipment, and reagents to be used have strict quality standards to ensure that they work under normal conditions. (4) To ensure the reliability of the research conclusions, information feedback is carried out at the beginning and mid-term of the project, and we will solve various problems in the course of the project research promptly.

## Discussion

The individual's social role is always changed as a result of sudden neurological impairment after stroke, which requires a psychological transition and adjustment to a new definition of self (62–65). The self-acceptance process causes a high incidence of anxiety. The incidence of anxiety did not decrease significantly over time during 24 months after stroke (66). During COVID-19, PSA showed a noticeable peak (9). It has been pointed out by two comprehensive reviews that loss, social isolation, uncertainty, and physical dependence as factors that might contribute to negative psychological outcomes (67). Emotional resistance and self-acceptance are associated with poorer recovery outcomes and reduced life engagement. Since the long-term anxiety exerts a negative effect on the quality of life for the stroke survivors, which has become a worldwide phenomenon (68), it deserves more attention than it has so far received.

There has been a large number of studies showing that acupuncture is effective in the treatment of stroke and its complications. Acupuncture interventions are various, and a unified acupuncture protocol is still on the way (69). Jin's three-needle therapy (JTNT), invented by Professor Jin Rui, is famous for using three silver needles to cure diseases. JTNT is representative and has been widely used in public hospitals around Southern China. Its real clinical efficacy is worthy of study (70). Despite the high number of clinical trials about stroke, the focus of most existing research is limited to motor symptoms rather than complications after stroke (20). Besides, there is few sham control to observe the real effect of acupuncture. Investigators focus on efficacy rather than exploring pathogenesis. Given this, this study selected the sham needle equipment invented by members of our research team as the control interventions. We formulated a standard operating

procedure protocol to further expound the mechanism of acupuncture through ELISA and rs-fMRI.

The clinical effect of JTNT on both motor and anxiety symptoms for PSA has been verified in the previous clinical trial carried out in the First Affiliated Hospital of Guangzhou University of TCM. To further explore the mechanism of JTNT, we completed the first draft of this research protocol. After discussion and revision of the draft by the hospital ethics committee, the final protocol was unanimously approved.

This trial attempted to assess possible mechanisms of JTNT for PSA by the HPA axis. To dynamically observe the therapeutic effect of acupuncture on PSA, we detected the key factors of the HPA axis—the changes in ACTH and CORT before and after treatment. The action mechanism of JTNT is investigated by functional magnetic resonance imaging (fMRI) to observe whether JTNT can relieve anxiety symptoms by activating the core brain regions associated with emotion regulation.

However, this study still has limitations. First, this is a single-center study, because of the COVID-19 outbreak, we cannot conduct trials in multiple centers. Secondly, due to the use of a new type of acupuncture equipment in this study, it is necessary to explain to the patient well in exchange for greater compliance. In addition, we are still working hard to standardize the process of this study to provide high-quality medical evidence for JTNT so that it can be used as an optimized plan for PSA supplementation therapy.

## Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the First Affiliated Hospital of Guangzhou University of Traditional Chinese Medicine. 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

Study design: ML. Study conduct: ML and YW. Drafting manuscript and approving the final version of the manuscript: all authors.

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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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# Association between migration paths and mental health of new-generation migrants in China: The mediating effect of social integration

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**Background:** The new-generation migrants born in 1980 and later are large and vulnerable internal migrants in China. Migration paths and social integration are important factors to explain for their mental health. However, they faced difficulties in social integration varying from migration paths. We aimed to explore the mediating role of social integration between migration paths and the mental health of new-generation migrants.

**Methods:** The migration paths included urban-to-urban, urban-to-rural, rural-to-urban and rural-to-rural. Mental health was assessed by the Kessler Screening Scale for Psychological Distress (K6) and the Perceived Stress Scales (PSS-4). Social integration was measured by economic integration, life integration, maintenance of the local culture, acceptance of the host culture and psychological integration. Multiple linear regressions with bootstrapping were used to examine the mediating effect.

**Results:** A total of 9,830 new-generation migrants were included in this study. The mean age was 26.92 ( $SD = 4.47$ ) years and the proportion of rural-to-urban migrants was 63.7%. Compared with the new generation of rural-to-rural migrants, rural-to-urban migrants had higher psychological distress ( $\beta = 0.305$ , 95% CI: 0.152–0.458) and perceived stress ( $\beta = 0.328$ , 95% CI: 0.199–0.456). The bootstrapping test found that two dimensions (“life integration” and “acceptance of the host culture”) of social integration as a mediator weakened the negative effect of the rural-to-urban migration path on the mental health of new-generation migrants.



**Conclusion:** Rural-to-urban migrants had poorer mental health, and the association was mediated by their poorer social integration. The migration policies developed to enhance social integration could effectively improve the mental health of new-generation migrants.

#### KEYWORDS

mental health, new-generation migrants, migration paths, social integration, urban, rural, China

## Introduction

By the end of 2018, there were 241 million internal migrants (IMs) in China, accounting for 17.3% of the overall population according to China Statistical Yearbook 2019 (1). The emergence of IMs in China could be linked to the Hukou system. Since the 1980s, because of the high demand for labor in urban areas, the Chinese government has loosened its control over Hukou management, and allowed the rural Hukou population to work and do business in urban areas (2, 3). In China, this migrant population is defined as IMs. The definition of the generation of IMs was based on the date of birth. According to the definition of Chinese National Bureau of Statistics, those born in January 1980 and later were classified as the “new generation,” while people born before 1980 were classified as the “old generation” (4, 5). The year 1980 was chosen because it was the year that China began comprehensive social and economic reforms (6, 7). Based on the Report on Chinese Migrant Population Development in 2018, the population size of new-generation migrants who were born in 1980 and later continuously increases rapidly, accounting for 65.1% of the IMs (8). Compared with the old-generation migrants, new-generation migrants have higher professional ambitions and higher urban lifestyle preferences (9).

Social integration is a multi-dimension concept used to explain the behavior, adaptation, acculturation process and self-identity of migrants (10), without clear and unified definition among transdisciplinarity (11). Some studies use multi-dimensional indexes, covering cultural, economic and psychological dimensions, while others use one-dimensional indicators of economic conditions. Multi-dimensional indicators may deviate from the overall evaluation of social integration of migrants; one-dimensional indicators often ignore the complexity of social integration. For example, Wu chose an urban household registration index as a measure of social integration (12). The theory of social integration was developed to understand the behavior, adaptation, cultural integration, and acculturation processes of migrants, although most have been applied in Western societies (10, 13). Thus, the measurement network of social integration

is uncertain, and the typical operational definition is a scale based on individual summary scores of different types of social roles or social networks (14). However, social integration was not only related to individual characteristics but also the characteristics of “the place of origin” and “the host cities” (15).

Evidence from previous studies suggested that during the process of migration, the new-generation migrants were also confronted with social integration challenges (16). The greater the changes in the socio-economic environment resulting from the migration paths (i.e., migration from the place of origin to the host city), the greater the social integration difficulties faced by the new-generation migrants (17). Migration paths were reported to be important predictive factors of common mental disorders among migrants across the world (18). Furthermore, with migration paths classified as urban-to-urban, urban-to-rural, rural-to-urban and rural-to-rural, previous studies found that rural-to-urban migrants had higher psychological distress among the IMs (19). The stress from social integration might negatively affect the mental health of new-generation migrants (20–23), which may endanger their family relationships and even pose a serious threat to the economic development of the place of origin and the host city (2, 24–26).

The new-generation migrants are high-risk groups facing mental health problems. Migration paths and social integration have been identified as the important factors affecting the mental health of migrants. However, there is little research on the relationship between social integration and mental health based on different migration paths, especially for the new-generation migrants. The present study was aimed to explore the mediating effect of social integration on the relationship between migration paths and mental health among the new-generation migrants by using the secondary public database of the National Internal Migrant Dynamic Monitoring Survey in 2014, which would help identify the vulnerable groups and provide more effective interventions according to the mediator.

There are two hypotheses in this study: (1) Migration paths are associated with mental health. (2) After the adjustment of social integration, the above correlation might be weakened, and it is speculated that migration paths could affect the



mental health among new-generation migrants mediated by social integration.

## Materials and methods

### Study design and participants

The data was extracted from the National Internal Migrant Dynamic Monitoring Survey in 2014. This survey was a cross-sectional survey conducted by the National Population and Family Planning Commission of China in May 2014, which included a thematic survey on the social integration and health status of internal migrants (IMs). Because NIMDMS changed the survey theme every year, the data in 2014 was the most comprehensive thematic survey on the social integration of China's migrant population (27). The thematic survey was carried out in eight "demonstration pilot cities" with different degrees of migration and social integration programs, including Beijing (the capital of China), Zhengzhou and Chengdu (two provincial capitals), Xiamen, Jiaxing, Qingdao, Shenzhen and Zhongshan (five economic centers in eastern and southern coastal regions), which throughout the eastern, central, and western areas of China.

A stratified multi-stage probability proportional to size (PPS) sampling method was used to sample the respondents from eight "demonstration pilot cities." First, taking the annual report data in 2013 as the basic sampling frame, the sub-districts or townships within each district or county were selected. Second, depending on the size of the IMs, neighborhoods or villages were drawn from the selected sub-districts or townships. Finally, in each neighborhood or village, 20 respondents between the ages of 15 and 59 who had lived locally for at least 1 month were selected. A total of 15,999 respondents were included. A face-to-face interview questionnaire survey was conducted among the respondents. Interviewers from eight "demonstration pilot cities" have received standardized training from the National Population and Family Planning Commission. At the same time, quality control was implemented in the process of data collection (28).

After removing 12 IMs with incomplete questionnaire information, 2,325 IMs who had not lived in "demonstration pilot cities" for 6 months and 3,832 IMs born before January 1980, there were 9,830 new-generation migrants who were born in January 1980 or later in our study (4).

### Assessment of mental health

Mental health was assessed by psychological distress and perceived stress over the past 30 days. Psychological distress was measured by the 6-item Kessler Scale (K6) (29). The values for each item range from 0 (none of the time) to 4

(all of the time). On a scale of 0 to 24, higher scores indicate worse mental health. It has been proved that K6 has good psychometric properties in the Chinese population (Cronbach's  $\alpha = 0.84$ ) (30).

Perceived stress was measured with the 4-item Perceived Stress Scales (PSS-4), which is a brief and effective stress scale for different groups of people (16). PSS-4 values range from 0 to 16, and the higher the score, the higher the perceived stress level. Previous studies have confirmed the satisfactory psychometric properties of the Chinese version of PSS-4 (Cronbach's  $\alpha = 0.67$ ) (31).

### Assessment of migration paths and social integration

According to the participants' Hukou system (registered permanent residence located in a county or a district) and current residence (a county or a district) of the respondents, migration paths were divided into four groups, including rural-to-rural, urban-to-rural, ur-ban-to-rural and rural-to-urban (32).

In this study, social integration consisted of five dimensions and was measured using 27 items (33), referred to Yang's theoretical framework for social integration (34). There was economic integration (five items), life integration (four items), maintenance of original culture (four items), acceptance of the host culture (four items) and psychological integration (ten items). Reliability analyses found strong internal consistency in 27 items (Cronbach's  $\alpha = 0.70$ ). Questions about the dimensions of social integration and the results of reliability analyses were summarized in [Supplementary Table 1](#). Factor analysis was used to calculate the scores of each dimension, and these scores were further converted into a range of 0–100 by the min-max normalization and percentage method. The values of social integration ranged from 0 to 100 for each dimension, with a higher score indicating a higher level of social integration.

### Potential confounding variables

A series of demographics related to mental health reported in previous studies were adjusted in the current study, including age, sex, marital status, nationality, education level, occupation, and Hukou status (35, 36). Due to the various obstacles migrants encountered in the process of migration and the post-migration period, migration characteristics have become the cause of mental illnesses (37). Migration characteristics included the scope of migration, length of residence in the host cities, reasons for migrating and whether people migrate with their families (38). Two other variables were also included in the study, establishing health records and receiving health education,

which might be associated with the social integration and mental health of the IMs (39). The variables of establishing health records and receiving health education were both measured by the question contained in the NIMDMS.

## Statistical analysis

Descriptive analysis was conducted for all variables. The continuous variables were expressed in mean (SD) or median (IQR). The categorical variables were reported by numbers and percentages. Analysis of variance, rank-sum test and chi-square test were used to compare the differences of factors in the four migration paths.

Before the establishment of the multivariable linear regression model, bivariate linear regression analysis was used to examine the relationship between mental health and migration paths. In bivariate analysis, considering that the relationship between independent and dependent variables may be masked by potential confounders, in order to avoid overly strict criteria leading to the omission of some meaningful variables,  $P < 0.1$  was therefore used as the selection criterion (40). Migration paths, social integration, statistically significant confounding factors ( $P < 0.1$ ) and theoretically proven influencing factors were included in the multivariable linear regression model.

The  $-2$  log likelihood ratio ( $-2$  LLR) test was used to determine whether the mediating effect improved the goodness-of-fit of the model (41). The  $-2$  LLR decreases by 3.84 or more (Chi-square limit of 1 degree of freedom is 0.05), indicating that one model is superior to the other. The mediator was examined by using mediation analysis with PROCESS macro, which was based on the path analytic framework of ordinary least square (OLS) regression (42). The multiple linear regression model 1(not including the mediator) and model 2 (including the mediator) were established, and the coefficients of regression and its 95% confidence interval (CI) were calculated by the bootstrapping method (43). If the value of the mediating effect was greater than zero and the bootstrapping 95% CI did not contain zero, the mediating effect would play a role. Conversely, if the value of the mediating effect was less than zero, it could only be explained by the “suppressing effects” (44). All statistical analyses were conducted using IBM SPSS 26.0.

## Results

### Characteristics of the study sample

The demographic characteristics and migration characteristics of the 9,830 new-generation migrants were

presented in Table 1. Overall, the mean age of new-generation migrants was 26.92 ( $SD = 4.47$ ) years old, 53.4% of new-generation migrants were male and 59.9% of them were married. Nearly half of them had a secondary school of education level. 86.5% of the respondents had a rural Hukou. More respondents migrated across provinces, and 48.3% of respondents have lived in the host city for 1–5 years. There were 94.4% and 64.1% of respondents migrated for business and migrated with their families, respectively. The new-generation migrants were divided into four migration paths. Most of them migrated from rural to urban (63.7%), followed by rural-to-rural (23.8%), urban-to-urban (11.2%) and urban-to-rural (1.3%), respectively.

### Mediation effect of social integration on the relationship between migration paths and mental health

The results of multiple linear regression models (including social integration or not) were shown in Table 2. Compared with the new generation of rural-to-rural migrants, rural-to-urban migrants had higher scores of psychological distress (0.305, 95% CI: 0.152–0.458) and perceived stress (0.328, 95% CI: 0.199–0.456). When social integration was considered, the relationships between migration paths and psychological distress and perceived stress were weakened. Social integration generally improved the mental health of new-generation migrants, in which economic integration, acceptance of the host culture and psychological integration were negatively associated with both psychological distress and perceived stress scores.

The results of bootstrapping test for mediating effect were shown in Tables 3, 4. It was found that two dimensions of social integration, namely life integration and acceptance of the host culture, mediated the relationship between the rural-to-urban migration path and the psychological distress of new-generation migrants by 0.022 (95% CI: 0.010–0.036) and 0.069 (95% CI: 0.047–0.094), respectively. Furthermore, in one dimension of social integration, the mediating effect of acceptance of the host culture on the relationship between the rural-to-urban migration path and perceived stress of new-generation migrants was 0.062 (95% CI: 0.043–0.082).

## Discussion

Under the background of Chinese migrants, this study used the mediation analysis to explore the relationship between migration paths and the mental health of new-generation migrants through the five dimensions of social integration. The results showed that the mental health of the rural-to-urban

TABLE 1 Characteristics of 9,830 new-generation migrants from Internal Migrant Dynamic Monitoring Survey in China, 2014.

Variables	Migration paths					P-value <sup>a</sup>
	Total (N = 9,830) N(%) / M ± SD	Rural-to- Rural (N = 2,339) N(%) / M ± SD	Urban-to- Urban (N = 1,101) N(%) / M ± SD	Urban-to- Rural (N = 129) N(%) / M ± SD	Rural-to- Urban (N = 6,261) N(%) / M ± SD	
Age (years)	26.92 ± 4.47	26.76 ± 4.54	28.34 ± 3.91	28.05 ± 3.90	26.72 ± 4.51	<0.001
<b>Sex</b>						0.944
Female	4577 (46.6)	1099 (47.0)	513 (46.6)	62 (48.1)	2903 (46.4)	
Male	5253 (53.4)	1240 (53.0)	588 (53.4)	67 (51.9)	3358 (53.6)	
<b>Marital status</b>						<0.001
Single	3943 (40.1)	821 (35.1)	420 (38.1)	42 (32.6)	2660 (42.5)	
Married	5887 (59.9)	1518 (64.9)	681 (61.9)	87 (67.4)	3601 (57.5)	
<b>Nationality</b>						<0.001
Han	9480 (96.4)	2221 (95.0)	1063 (96.5)	127 (98.4)	6069 (96.9)	
Other	350 (3.6)	118 (5.0)	38 (3.5)	2 (1.6)	192 (3.1)	
<b>Education level</b>						<0.001
Primary school and less	307 (3.1)	123 (5.3)	9 (0.8)	1 (0.8)	174 (2.8)	
Secondary school	4685 (47.7)	1462 (62.5)	118 (10.7)	29 (22.5)	3076 (49.1)	
High school	2889 (29.4)	571 (24.4)	268 (24.3)	44 (34.1)	2006 (32.0)	
College and above	1949 (19.8)	183 (7.8)	706 (64.1)	55 (42.6)	1005 (16.1)	
<b>Hukou</b>						<0.001
Rural	8501 (86.5)	2324 (99.4)	0 (0.0)	0 (0.0)	6177 (98.7)	
Urban	1329 (13.5)	15 (0.6)	1101 (100.0)	129 (100.0)	84 (1.3)	
<b>Range of migration</b>						<0.001
Across the province	5312 (54.0)	1714 (73.3)	683 (62.0)	93 (72.1)	2822 (45.1)	
Within the province	4518 (46.0)	625 (26.7)	418 (38.0)	36 (27.9)	3439 (54.9)	
<b>Duration of residence in the host city (years)</b>						<0.001
<1	3074 (31.3)	750 (32.1)	269 (24.4)	31 (24.0)	2024 (32.3)	
1 ~ 5	4745 (48.3)	1143 (48.9)	554 (50.3)	64 (49.6)	2984 (47.7)	
5 ~ 10	1521 (15.5)	336 (14.4)	208 (18.9)	28 (21.7)	949 (15.2)	
≥10	490 (5.0)	110 (4.7)	70 (6.4)	6 (4.7)	304 (4.9)	
<b>Reasons for migration</b>						0.168
Business	9276 (94.4)	2205 (94.3)	1042 (94.6)	116 (89.9)	5913 (94.4)	
Others	554 (5.6)	134 (5.7)	59 (5.4)	13 (10.1)	348 (5.6)	
<b>Migrating with families</b>						<0.001
Yes	6300 (64.1)	1609 (68.8)	715 (64.9)	90 (69.8)	3886 (62.1)	
No	3530 (35.9)	730 (31.2)	386 (35.1)	39 (30.2)	2375 (37.9)	
<b>Establishment of health records</b>						<0.001
Yes	2266 (23.1)	318 (13.6)	278 (25.2)	16 (12.4)	1654 (26.4)	
No	7563 (76.9)	2021 (86.4)	823 (74.8)	113 (87.6)	4606 (73.6)	
<b>Receiving health education</b>						<0.001
Yes	6604 (67.2)	1319 (56.4)	809 (73.5)	78 (60.5)	4398 (70.2)	
No	3226 (32.8)	1020 (43.6)	292 (26.5)	51 (39.5)	1863 (29.8)	
<b>Social integration</b>						
Economic integration	44.68 ± 11.51	44.04 ± 10.52	48.65 ± 13.13	47.33 ± 11.63	44.16 ± 11.41	<0.001
Life integration	20.75 ± 15.70	15.41 ± 11.58	29.16 ± 17.83	19.90 ± 15.01	21.28 ± 15.91	<0.001
Maintenance of original culture	65.45 ± 16.53	67.03 ± 16.18	61.31 ± 16.88	65.82 ± 18.61	65.59 ± 16.43	<0.001
Acceptance of the host culture	65.77 ± 17.92	65.77 ± 17.53	69.15 ± 18.08	66.31 ± 17.73	65.17 ± 17.98	<0.001
Psychological integration	79.07 ± 15.58	77.23 ± 14.61	81.43 ± 15.87	78.80 ± 15.50	79.36 ± 15.81	<0.001
<b>Mental health</b>						
Psychological distress	3.52 ± 3.09	3.25 ± 2.81	3.77 ± 3.40	3.49 ± 3.12	3.58 ± 3.13	<0.001
Perceived stress	5.39 ± 2.61	5.22 ± 2.58	5.37 ± 2.66	5.18 ± 2.82	5.46 ± 2.60	0.002

<sup>a</sup> Analysis of variance, rank-sum test or chi-square test.

M, mean; SD, standard deviation.

**TABLE 2** The relationship between migration paths, social integration and the mental health of new-generation migrants with multiple linear regression.

Variables	Psychological distress		Perceived stress	
	$\beta$ (95% CI)	$\beta$ (95% CI)	$\beta$ (95% CI)	$\beta$ (95% CI)
<b>Migration path</b>				
Urban-to-Urban	0.630 (−0.018,1.278)	0.624 (−0.002,1.250)	0.365 (−0.181,0.911)	0.410 (−0.117,0.932)
Urban-to-Rural	0.385 (−0.432,1.202)	0.312 (−0.475,1.099)	0.080 (−0.608,0.768)	0.044 (−0.612,0.701)
Rural-to-Urban	0.305 (0.152,0.458)**	0.235 (0.087,0.384)*	0.328 (0.199,0.456)**	0.286 (0.162,0.409)**
Rural-to-Rural	Ref.	Ref.	Ref.	Ref.
<b>Social integration</b>				
Economic integration	–	−0.044 (−0.050, −0.038)**	–	−0.045 (−0.050, −0.041)**
Life integration	–	0.008 (0.004, 0.012)**	–	−0.001 (−0.005, 0.003)
Maintenance of original culture	–	−0.001 (−0.005, 0.002)	–	−0.007 (−0.010, −0.004)**
Acceptance of the host culture	–	−0.024 (−0.027, −0.020)**	–	−0.021 (−0.024, −0.018)**
Psychological integration	–	−0.026 (−0.030, −0.022)**	–	−0.022 (−0.026, −0.019)**

\* $P < 0.05$ , \*\* $P < 0.001$ .

CI, confidence interval; Ref, reference group.

**TABLE 3** The mediating effect of social integration on the association between migration paths and psychological distress of new-generation migrants.

Mediator	Migration paths (Ref = Rural-to-Rural)	Mediating effect	Bootstrap 95% CI	
			LL	UL
Economic integration	Urban-to-Urban	−0.078	−0.177	0.018
	Urban-to-Rural	−0.034	−0.166	0.096
	Rural-to-Urban	−0.014	−0.037	0.008
Life integration	Urban-to-Urban	0.057**	0.022	0.101
	Urban-to-Rural	0.014	−0.016	0.049
	Rural-to-Urban	0.022**	0.010	0.036
Maintenance of original culture	Urban-to-Urban	0.005	−0.008	0.021
	Urban-to-Rural	−0.002	−0.015	0.009
	Rural-to-Urban	0.001	−0.002	0.005
Acceptance of the host culture	Urban-to-Urban	−0.015	−0.106	0.076
	Urban-to-Rural	0.014	−0.098	0.126
	Rural-to-Urban	0.069**	0.048	0.093
Psychological integration	Urban-to-Urban	0.038	−0.039	0.113
	Urban-to-Rural	0.080	−0.021	0.187
	Rural-to-Urban	−0.009	−0.028	0.011

\* $P < 0.05$ , \*\* $P < 0.001$ .

CI, confidence interval; LL, lower limit; UL, upper limit; Ref, reference group.

migrants was worse than that of the rural-to-rural migrants, and social integration could improve the mental health of new-generation migrants. Furthermore, the relationship between the rural-to-urban migration path and the mental health of new-generation migrants was mediated by the two dimensions of social integration: life integration and acceptance of the host culture.

This study found that the new-generation migrants from rural to urban areas had worse mental health measured by psychological distress and perceived stress scores, which was

consistent with evidence from previous studies (45, 46). The new-generation migrants tended to be more educated and more likely to develop in cities, but the income inequality caused by the registered permanent residence could lead to great stress and subsequent psychological distress (9, 47). Moreover, the differences between urban and rural areas would bring great difficulties to new-generation migrants when they came to the host city, which would affect their mental health (48). Unlike rural-to-urban migrants, urban-to-urban generation migrants were more likely to be the

TABLE 4 The mediating effect of social integration on the association between migration paths and perceived stress of new-generation migrants.

Mediator	Migration paths (Ref = Rural-to-Rural)	Mediating effect	Bootstrap 95% CI	
			LL	UL
Economic integration	Urban-to-Urban	−0.080	−0.180	0.015
	Urban-to-Rural	−0.035	−0.172	0.098
	Rural-to-Urban	−0.015	−0.038	0.008
Life integration	Urban-to-Urban	−0.007	−0.034	0.018
	Urban-to-Rural	−0.002	−0.014	0.007
	Rural-to-Urban	−0.003	−0.013	0.007
Maintenance of original culture	Urban-to-Urban	0.023**	0.002	0.050
	Urban-to-Rural	−0.009	−0.042	0.023
	Rural-to-Urban	0.005	−0.001	0.012
Acceptance of the host culture	Urban-to-Urban	−0.013	−0.097	0.065
	Urban-to-Rural	0.012	−0.090	0.115
	Rural-to-Urban	0.062**	0.043	0.082
Psychological integration	Urban-to-Urban	0.032	−0.032	0.095
	Urban-to-Rural	0.069	−0.018	0.154
	Rural-to-Urban	−0.007	−0.025	0.009

\* $P < 0.05$ ; \*\* $P < 0.001$ .

CI, confidence interval; LL, lower limit; UL, upper limit; Ref, reference group.

only child in a family, which means they would have more family expectations and responsibilities. Because of the deep-rooted belief in filial piety in Chinese society, Chinese only-child migrants experience a range of dilemmas, from personal development in a receptive society to caring for elderly parents (49). Similarly, urban-to-urban new-generation migrants were more motivated to pursue personal development in metropolitan areas than their rural-to-urban counterparts, and the longer they stayed in these areas, the less likely they were to return (19). The gap between expectations and reality could also lead to significant stress and subsequent mental health problems. The results of the study underscore the importance of providing mental health services to new-generation migrants.

Social integration was described by five dimensions (50, 51), and was found to improve the mental health of new-generation migrants, similar to previous research (52). During the process of migration, new-generation migrants would encounter various obstacles which may cause psychological pressure (53–55). However, the improvement of social integration might overcome these barriers, relieve these pressures and ultimately promote the mental health of new-generation migrants (56). In addition, resettlement-related stressors were important factors affecting the mental health of migrants, and strengthening social integration is the key to improving the mental health of new-generation migrants (57, 58).

This study observed that life integration and acceptance of host culture played a mediating role between the rural-to-urban migration path and the mental health of new-generation migrants. As a mediator, life integration weakened the negative

effects of rural-to-urban migration on mental health. It may be that improved social insurance and active participation in society could help migrants obtain medical resources and health information, thus contributing to the mental health of new-generation migrants from rural to urban areas (59, 60). Acceptance of host culture as a mediator also weakened the negative impact of the rural-to-urban migration path on mental health. This was inconsistent with some previous studies, possibly because original and host cultures were not considered together in other studies (61). Cultural differences in migration paths could create psychological stress for rural-to-urban migrants (62). However, new-generation migrants from rural to urban areas were more likely to pursue an urbanized lifestyle, and greater acceptance of the host culture could alleviate these pressures and improve their mental health, as well as to urban-to-urban (63). Therefore, the government should attach great importance to the role of local culture and values for new-generation migrants and guide the local people to treat them with an open mind (64). Furthermore, the stressors after resettlement are the most important factors affecting the mental health of migrants. Targeting the sources of stress associated with resettlement through enhanced psychosocial care programs and social integration would be a key way to improve the mental health of migrants (58).

Some limitations of this study should be recognized. First, the Chinese version of migrants, which may not be fully applicable to reflect the real situation. But we calculated the Cronbach coefficients of K6 and PSS-4 were 0.83 and 0.61, respectively, which generally had good psychometric properties. Furthermore, due to the availability of data, migration paths



were classified based on participants' Hukou status using rural and urban areas rather than the level of economic development. And it was a limitation of our study that we could not meaningfully reflect the complexity of migration paths without considering the migration path from small towns to mega cities, so it is hard to comprehensively evaluate migration paths in a more detailed unit. However, most Chinese urban residents enjoy more advantages in income, education and employment than rural residents (65–67). Chinese medical resources are also concentrated in urban areas (68, 69). In 2020, for instance, the number of medical practitioners in urban China was 4.25 per 1,000 persons, compared with 2.56 per 1,000 persons in rural China (70). In addition, the rates of all-cause mortality and cancer mortality among rural residents were higher and increased faster than that of urban residents (71). Therefore, it could basically capture the economic-driven migration path trends in a rough way and this classification method has been verified in other studies (72, 73). Lastly, because this study was a cross-sectional design, it could not support the causal relationship between migration paths and the mental health of new-generation migrants, but only the correlation between them. Further longitudinal research may be required to verify in the future.

Despite these limitations, this study further added evidence of the effects of migration paths on the mental health of new-generation migrants and indicated the mediating role of social integration. In particular, the study relied on a large population sample covering a representative new-generation migrants in a developing country. The findings inform public policy makers that more migration-related policies are needed to promote the social integration of new-generation migrants and to make efforts to protect their mental health.

## Conclusion

This study highlighted that the rural-to-urban migration path had negative effects on the mental health of new-generation migrants. Furthermore, life integration and acceptance of the host culture as a mediator could weaken the impact. These findings suggested that migration policies should be developed to enhance the life integration and acceptance of the host culture and improve the mental health of new-generation migrants. At the same time, addressing the sources of stress associated with resettlement through enhanced psychosocial care programs and social integration would be a key way to improve the mental health of migrants.

## Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories

and accession number(s) can be found below: <https://chinaldrk.org.cn/wjw/#/application/index>.

## Ethics statement

This study was a secondary analysis of a public access dataset of the National Internal Migrant Dynamic Monitoring Survey (NIMDMS) 2014. No identifiable private information of the participants was contained. This study was approved by the Ethics Committee of the School of Public Health, Sun Yat-sen University. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

FZ, MC, BP, and LL: conceptualization. FZ, MC, and BP: data curation. FZ, MC, BP, and LS: formal analysis. FZ, MC, BP, LL, and HZ: funding acquisition. LL: resources. FZ and MC: writing—original draft preparation. FZ, MC, BP, HZ, LS, and LL: writing—review and editing. All authors have contributed to the data interpretation and have read and agreed to the published version of the manuscript.

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## Conflict of interest

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

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsy.2022.967291/full#supplementary-material>

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# Relationship between Chinese middle-aged and old couples' Confucian coping thinking and marital quality

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**Objective:** Drawing on the actor-partner interdependence model (APIM), the present study investigated the relationship between Chinese middle-aged and old couples' Confucian coping thinking and their marital quality in the hope to provide a theoretical basis for ameliorating marital quality.

**Methods:** With 744 middle-aged and old couples as participants, the Confucian Coping Questionnaire (CCQ) and the Quality of Marriage Index (QMI) were employed to probe the relationship between responsibility thinking (RT), pro-setback thinking (PT), fate thinking (FT), and marital quality.

**Results:** Husbands' and wives' scores in responsibility thinking and pro-setback thinking had significantly positive correlations with their own and their spouses' scores in marital quality, respectively, and husbands' and wives' scores in fate thinking had significantly negative correlations with their own and their spouses' marital quality, respectively. Husbands' responsibility thinking, pro-setback thinking, and fate thinking had a significant actor effect. Husbands' responsibility thinking and fate thinking had a significant partner effect. Wives' responsibility thinking, pro-setback thinking, and fate thinking had a significant actor effect. Wives' responsibility thinking and pro-setback thinking had a significant partner effect.

**Conclusion:** From the perspective of dyadic relationships, the present study found that responsibility thinking and pro-setback thinking could positively predict marital quality, while pro-setback thinking could negatively predict marital quality.

## KEYWORDS

middle-aged and old couples, responsibility thinking, pro-setback thinking, fate thinking, marital quality, the actor-partner interdependence model

## Introduction

For most people, establishing and maintaining a meaningful and positive marital relationship is an indispensable experience in their lives. Marital quality is regarded as the main indicator of marital harmony and marital stability (1). How to improve marital quality is always one of the hotspots in the marriage and family field. Marital quality



is couples' subjective evaluation of their marital satisfaction and marital harmony (2). Inferior marital quality not only can negatively predict individuals' psychological health (3) but also can impair physical health (4). On the contrary, superior marital quality can be beneficial to improving marital stability (5), reducing psychological distress (6), mitigating loneliness (7), and buffering negative emotions' adverse effects (8). Besides, related to individuals' physical activity and health behaviors, marital quality can also predict one's physical health (9). In general, individuals with higher marital quality have higher cognitive health (10), better sleep quality (11), less pain (12), and fewer disease risks (13). Moreover, low parental marital quality can also lower adolescent psychological wellbeing (14).

Coping approaches are a key predictor of marital quality (15). There might be stress, divergence, arguments, and even fights in any marriage, although a great marital relationship is expected by couples (16). The vulnerability-stress-adaptation (VSA) model assumes that the coping approaches adopted by couples in the face of daily life events and marital stress are directly associated with their subjective perception and evaluation of marriage (17). Positive emotional expressions and search for solutions can positively predict marital quality, while negative emotional expressions and avoidance of problems can negatively predict marital quality (18). On balance, coping approaches in marriage can be divided into positive and negative ones. Positive coping approaches are conducive to mitigating emotional distress between couples and enhancing the level of perceived social support for couples (19) and ameliorating marital quality (20). By contrast, negative coping approaches can be destructive to marital quality (21), and even negatively impact individuals' marital quality in a long run (22).

Coping approaches clearly show cultural characteristics, since individuals in different cultural contexts have different perceptions, evaluations, and selection of coping objectives and approaches (23). Chinese traditional culture is a composite of multiple cultures represented by Confucianism, Taoism, and Buddhism. As the mainstream culture, Confucianism has greatly contributed to Chinese people's ideology, behavioral patterns, and psychological health (24). Confucianism has a rich discussion of how individuals deal with stress and setbacks. Different from the western culture, which assumes that stress derives from external or specific life events, Confucianism regards stress as the corollary of insufficient self-cultivation and emphasizes that the ideal coping approaches should be "unity of knowledge and action," namely, individuals constantly improve their ability to cope with stress through moral cultivation, meanwhile cultivating their morality through specific practice (25). Furthermore, cultural differences may also be shown in the outcome of coping in the Chinese and Western contexts (26).

Confucian coping thinking refers to Chinese people's mindset in coping with difficulties and setbacks under the influence of Confucian culture, which mainly comprises responsibility thinking, pro-setback thinking, and fate

thinking (27). As an important component of Confucianism, responsibility thinking assumes that individuals have responsibility for themselves, others, society, and all things in the world (28). "Cultivating the self, regulating the family, governing the country, and pacifying the world" are the crucial political ideals of Confucianism. Accordingly, a person's responsibility extends from himself to the family, the country, and even the world. Family is not only the basic unit of social organization but also the hub connecting individuals and countries. Responsibility for the family is often regarded as one's most important responsibility (29). Individuals with high responsibility thinking, whether in good or bad times, tend to voluntarily take responsibility and actively handle and solve a variety of negative events. Although Confucianism agrees that setbacks can bring pain and tension, it also believes that setbacks can effectively hone oneself and benefits one's growth (30). Individuals with high pro-setback thinking pay more attention to the positive aspects of hardship and believe that the key to success is to accept, face and overcome setbacks through their own efforts (31). Moreover, fate thinking plays a vital role in Confucian culture and greatly contributes to the coping approaches of Chinese people. Individuals with high fate thinking think that their fate is predetermined so that when encountering difficulties, they have a stronger sense of powerlessness and are less likely to seek solutions to problems (27).

Although the relationship between coping approaches and marital quality has been widely demonstrated, few studies have investigated the effect of coping approaches on marital quality from the cultural perspective (32). Since individuals' coping approaches are closely associated with their cultural contexts (33), Chinese couples would inevitably show certain coping characteristics in conformity with Chinese culture. In most cases, responsibility thinking and pro-setback thinking are connected to positive psychological and behavioral outcomes, while fate thinking is connected to negative outcomes (31). According to previous studies, individuals' responsibility thinking and pro-setback thinking are positively correlated with psychological resilience and negatively correlated with anxiety and depression (26, 27). Besides, psychological resilience is considered to increase marital quality (34), whereas anxiety and depression are regarded to decrease marital quality (35). In addition, responsibility thinking and pro-setback thinking are the major constituents of positive Confucian ideology. Confucianism believes that the happiness brought by fulfilled personal needs is based on voluntarily taking responsibility and strenuously surmounting difficulties (30). Hence, individuals with high responsibility thinking and pro-setback thinking can face frustrations with more equanimity and handle the problems in marriage with more optimism, which can improve marital quality. Therefore, it seems reasonable to postulate that responsibility thinking and pro-setback thinking can positively



predict marital quality, whereas fate thinking could negatively predict marital quality.

Dyadic relationships are the basic unit of interpersonal interaction (36). Since marital relationships are the closest interpersonal relationship, one party's notions and behaviors indispensably have effects on another party, which is particularly remarkable in China where interpersonal connections are highly emphasized (37). Self includes independent self and interdependent self, and Chinese people prioritize society-oriented interdependent self (38). Individuals with high interdependent self tend to regard themselves as a part of relationships, expect more to gain recognition from others, and consider the needs of others (39). Family systems theory assumes that the family can be divided into three subsystems of marital, parent-child, and sibling relationships. The same and different subsystems are interrelated and interacted (40). Since marital relationships are the most crucial subsystem, couples have strong interdependence in cognition, emotion, and behavior (41). Hence, it seems advisable to presume that husbands' or wives' Confucian coping thinking not only can affect their own marital quality but also likely affect their spouses' marital quality.

The APIM is widely employed in the analysis of dyadic data. The actor effect refers to the effect of individuals' predictor variables on their own outcome variables, while the partner effect comes to the effect of individuals' predictor variables on their partner's outcome variables (42). Unfortunately, although a multitude of studies have indicated that couples' coping approaches can predict both their own and their spouses' marital quality (32, 43), so far, no study has probed the relationship between Confucian coping thinking and marital quality using the APIM. It's noteworthy that several studies found that gender differences may exist in the partner effect of coping approaches on marital quality (44). Brandão et al. found that both husbands' and wives' dyadic coping had an actor effect on marital quality, but only husbands had a partner effect on marital quality (45). The longitudinal research also demonstrated that couples' coping approaches have different effects on their spouses' marital quality (46). Hence, it can be extrapolated that Confucian coping thinking is probably related to both one's own (the actor effect) and their spouses' marital quality (the partner effect).

According to the above analysis, several gaps in the extant literature can be crystallized. First, a paucity of studies has explored the relationship between Confucian coping approaches and marital quality, notwithstanding its cultural significance. Second, few studies have applied the APIM to probe this relationship, although it offers an effective framework. Given the existing gaps in research, we aimed to culturally investigate this relationship using the APIM. More specifically, we hypothesized that individuals' responsibility thinking and pro-setback thinking were positively correlated with their own and their spouses' marital quality, and fate thinking was negatively correlated with their own and their spouses' marital quality.

## Materials and methods

### Study design and participants

The inclusion criteria for participants are: (1) Marital length  $\geq 15$  years, (2) Age  $\geq 40$  (both husbands and wives) (47), and (3) Couples who volunteered for the survey and signed the informed consent. The present study was approved by the Ethics Committee of Jilin International Studies University.

A household survey was conducted by systematically trained college students among middle-aged and old couples in their hometowns. Participants were from eight provinces of China, namely, Jilin, Heilongjiang, Hebei, Henan, Shandong, Inner Mongolia, Sichuan, and Gansu. Data collection was based on convenient sampling and snowball sampling. More specifically, researchers first had a survey on their acquaintances like relatives, friends, and neighbors. Afterward, researchers requested these acquaintances to recommend new participants meeting the inclusion criteria. By the same token, these new participants were requested to provide other new participants. In this way, sample sizes were continuously expanded. It should be noted that the survey was conducted face to face.

Before the survey, participants were informed of the purpose, the way to complete the questionnaire, confidentiality, and anonymity. Besides, participants' questions about the survey were answered, and their permission was obtained. After the paper informed consent was signed, each couple got a code for matching the data. After that, participants were sent a link for the survey from researchers to complete the online questionnaire. The questionnaire was administered separately to husbands and wives in case they influence each other. If participants had difficulties in reading the questionnaire due to their low educational level or poor eyesight, researchers would read and fill out the questionnaire for them. After the survey, researchers checked the data and removed invalid questionnaires. The criteria for removal are as follows: (1) The response time of husbands/wives was too short ( $<120$  s). (2) Both positive and negative items were responded to the same. (3) The data could not be matched.

A total of 813 husband-reported questionnaires were collected, of which, 13 questionnaires were dropped for both positive and negative items being responded to the same, 28 questionnaires were removed for response time being too short ( $<120$  s), and then 769 questionnaires were retained. A total of 821 mother-reported questionnaires were collected, of which, 17 questionnaires were dropped for both positive and negative items being responded to the same, 37 questionnaires were removed for response time being too short ( $<120$  s), and then 783 questionnaires were retained. Finally, 744 sets of valid data were collected. Regarding residence, 414 (55.65%) couples lived in the city, and 330 (44.35%) couples lived in the countryside. Concerning marital length, it ranged from 15 to 59 years (Mean  $\pm$  SD = 29.77  $\pm$  12.99). Regarding annual family income,

74 couples earned <10,000 yuan (9.95%), 159 couples earned between 10,000 and 30,000 yuan (21.37%), 158 earned between 30,000 and 50,000 yuan (21.24%), 181 couples earned between 50,000 and 100,000 yuan (24.33%), 90 couples earned between 100,000 and 150,000 yuan (12.10%), 55 couples earned between 160,000 and 250,000 yuan (7.39%), 22 couples earned between 250,000 and 500,000 yuan (2.95%), and 5 couples earned more than 500,000 yuan (0.67%). Regarding age, husbands aged from 40 to 79 (Mean  $\pm$  SD = 55.14  $\pm$  11.67) and wives aged from 40 to 77 (Mean  $\pm$  SD = 53.65  $\pm$  12.12).

## Measures

### Confucian coping questionnaire

The Confucian Coping Questionnaire (CCQ) was first developed by Jing Huaibin and then revised by Yang Muzi (27). The scale consists of 11 items divided into three dimensions of responsibility thinking, pro-setback thinking, and fate thinking, scored on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Among them, items 3, 4, 7, 8, and 9 come to responsibility thinking, items 1, 5, and 11 belong to pro-setback thinking, and items 2, 6, and 10 refer to fate thinking. The sum of all item scores is the total scores. The higher scores in responsibility thinking, the more recognition of taking responsibility. The higher scores in pro-setback thinking, the more positive attitude toward setbacks, and the more identification with setbacks' benefits on one's growth. The higher scores in fate thinking, the more approval for fate thinking. Item examples in each dimension: "People should naturally take social responsibility," "Only those experiencing many setbacks can be successful," and "A good or bad life is determined by external and mysterious fate." In the present study, Cronbach's alpha coefficients of responsibility thinking, pro-setback thinking, and fate thinking were 0.795, 0.718, and 0.704 for husbands, respectively, and 0.789, 0.707, and 0.705 for wives, respectively.

### Quality of marriage index

Developed by Norton in 1983, the Chinese version of the Quality of Marriage Index (QMI) was employed (48, 49). The scale with one dimension is composed of six items. Participants answer the first five items on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). The sixth item is answered on a 10-point scale ranging from 1 (extremely low) to 10 (extremely high). The sum of all item scores is the total scores, with higher scores indicating higher marital quality. Item examples: "My relationship with my partner is very stable" and "My relationship with my partner makes me happy." In the present study, Cronbach's alpha coefficients were 0.929 for husbands and 0.927 for wives.

## Statistical analysis

Descriptive statistics and item analysis were performed using SPSS 26.0. The correlation between the variables between husbands and wives was tested using Pearson's correlation coefficient. The APIM was tested using an online free web application called APIM\_SEM (50). With maximum likelihood estimation (MLE), the analyses used structural equation modeling (SEM) using the program R package lavaan (51). Three APIMs were constructed to test the effect of couples' responsibility thinking, pro-setback thinking, and fate thinking on their own and their spouses' marital quality, respectively. When examining the APIM, we set marital length, annual family income, and residence as the control variables. The actor effect refers to the effect of individuals' predictor variables on their own outcome variables, while the partner effect comes to the effect of individuals' predictor variables on their partner's outcome variables. For instance, in the present study, the husbands' actor effect refers to the predictive effect of husbands' Confucian coping thinking on their own perceived marital quality, whereas the husbands' partner effect comes to the predictive effect of wives' Confucian coping thinking on husbands' marital quality. The standard model of the APIM was saturated and just-identified. Four general dyadic patterns include the actor-only, the couple, the contrast, and the mixed patterns. In the analysis of dyadic patterns, *k*-values, used to measure dyadic patterns, are the ratio of the partner effect to the actor effect. Only when the standardized absolute values of the actor effect are higher than 0.10 and statistically significant, *k*-values can be computed. With 5,000 bootstrap iterations, the confidence interval (CI) for *k*-values was computed, and if 1, 0, or  $-1$  was in the CI was evaluated. If 0 is in the CI, the model is the actor-only pattern; if 1 is in the CI, the model is the couple pattern; if  $-1$  is in the CI, the model is the contrast pattern (52); if the CI is between 0 and 1, it suggests that the APIM is between the couple pattern and the actor-only pattern, called the mixed pattern (53). Although dyadic relationships are distinguished by the role (husband vs. wife), their actor and partner effects probably cannot be distinguished (54). Two steps are needed to examine whether dyad members are distinguishable or indistinguishable. First, test if the actor and partner effects can be set equal. In this step, the actor and partner effects of the dyadic data are set equal to test whether the chi-square value significantly changes. The insignificant change in the chi-square value ( $p > 0.05$ ) indicates that the actor and partner effects as the dyad numbers are probably indistinguishable (52). Second test indistinguishable dyad members. In this step, a model with complete indistinguishability is constructed by setting equal means and variances of the causal variables, intercepts of the outcome variables, error variances, actor effects, and partner effects (55). To test if gender makes a statistically significant difference, model comparison is performed by a chi-square test between a model with distinguishable members and a model

TABLE 1 Descriptive characteristics of the CCQ and the QMI.

Items	Husband		Wife	
	M	SD	M	SD
Without suffering, there will be no sheer tenacity.	3.92	1.01	3.79	1.06
Fate is a random result of various external factors.	2.78	1.31	2.74	1.19
I still feel hopeful for future even in confronting my biggest failure.	3.98	1.06	3.94	1.06
I can control how the thing is going on.	3.46	0.96	3.37	0.94
People with a smooth life won't have great success.	2.94	1.01	2.80	1.02
A good or bad life is determined by external and mysterious fate.	2.21	1.27	2.25	1.23
I always try to learn something from setbacks.	3.96	1.05	3.94	1.03
I still try to improve myself to prepare for future in the time of bad luck.	4.15	1.01	4.10	1.03
People should naturally take social responsibility.	3.99	1.08	3.93	1.09
Fate is mysterious and predetermined.	2.32	1.27	2.35	1.21
Only those experiencing many setbacks can be successful.	3.37	1.02	3.25	1.03
RT	19.53	3.83	34.92	7.44
PT	10.26	2.40	9.85	2.48
FT	7.34	2.88	7.30	3.05
We have a good marriage.	5.36	1.41	5.23	1.42
My relationship with my partner is very stable.	5.37	1.40	5.29	1.36
Our marriage is strong.	5.42	1.40	5.32	1.39
My relationship with my partner makes me happy.	5.43	1.40	5.30	1.40
I really feel like part of a team with my partner.	5.40	1.43	5.32	1.35
The degree of happiness, everything considered, in your marriage?	8.74	1.54	8.46	1.74
QMI	35.71	7.38	34.92	7.44

M, mean; SD, standard deviation; RT, responsibility thinking; PT, pro-setback thinking; FT, fate thinking; QMI, quality of marriage index.

with indistinguishable members. If  $p < 0.05$ , it suggests that members can be statistically distinguished by gender.

## Results

### Preliminary analyses

Table 1 lists the mean and standard deviation of the scores of husbands and wives in the CCQ and the QMI. As illustrated in Table 2, the scores of husbands and wives in responsibility thinking and pro-setback thinking were significantly positively correlated with their own and their spouses' marital quality, respectively. The scores of husbands and wives in fate thinking were significantly negatively correlated with their own and their spouses' marital quality, respectively.

### Testing for APIM

Three APIMs for the predictive effect of responsibility thinking, pro-setback thinking, and fate thinking on marital quality were constructed, respectively (see Table 3). Specifically, the APIM for the predictive effect of couples' responsibility thinking on marital quality is illustrated in Figure 1, and the

actor and partner effects for husbands and wives are presented in Table 2. When tested if the two actor effects were equal, the difference was found not to be statistically significant [ $p = 0.070$ , 95%CI (−0.02, 0.39)]. Additionally, when tested if the two partner effects were equal, the difference was found not to be statistically significant [ $p = 0.152$ , 95% CI (−0.34, 0.05)]. Husbands'  $k$ -value was 0.313 with a 95% CI between 0.110 and 0.571 (the CI was between 0 and 1), suggesting that the pattern was a mixed pattern. The wives'  $k$ -value was 0.734 with a 95% CI between 0.401 and 1.263 (1 was in the CI), suggesting the couple pattern. Besides, the two  $k$ -values showed no significant difference [ $p = 0.132$ , 95% CI (−1.04, 0.07)]. Whether the pattern was with distinguishable dyad members was further tested. According to the results,  $\chi^2(15)$  was equal to 192.21 and  $p$  was lower than 0.001, suggesting that the predictive effect of husbands' and wives' responsibility thinking on marital quality was statistically distinguishable dyad members by gender.

The APIM for the predictive effect of couples' pro-setback thinking on marital quality is shown in Figure 2, and the actor and partner effects for husbands and wives are presented in Table 2. When tested if the two actor effects were equal, the difference was found not to be statistically significant [ $p = 0.823$ , 95% CI (−0.27, 0.34)]. In addition, when tested if the

TABLE 2 Descriptive statistics and correlations of all variables.

Variables	RT	PT	FT	QMI	H-M	H-SD
RT	0.30***	0.41***	−0.09*	0.32***	19.53	3.83
PT	0.43***	0.24***	0.29***	0.17***	10.26	2.40
FT	−0.12**	0.20***	0.37***	−0.21***	7.30	3.05
QMI	0.40***	0.18***	−0.20***	0.46***	35.71	7.38
W-M	19.29	9.85	7.34	34.92		
W-SD	3.80	2.48	2.88	7.44		

H, husband; W, wife; M, mean; SD, standard deviation; RT, responsibility thinking; PT, pro-setback thinking; FT, fate thinking; QMI, quality of marriage index; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . Below the diagonal are the ones for husbands, above the diagonal for wives, and the correlations between husbands and wives are on the diagonal.

two partner effects were equal, the difference was found not to be statistically significant [ $p = 0.186$ , 95% CI (−0.48, 0.09)]. Husbands'  $k$ -value was 0.227 with a 95% CI between −0.181 and 0.853 (0 was in the CI), suggesting the actor-only pattern. Wives'  $k$ -value was 0.686 with a 95% CI between 0.191 and 1.778 (1 was in the CI), suggesting the couple pattern. In addition, the two  $k$ -values showed no significant difference [ $p = 0.426$ , 95% CI (−1.71, 0.44)]. Whether the model was with distinguishable dyad members was further tested. Based on the results,  $\chi^2(15)$  was equal to 156.15 and  $p$  was lower than 0.001, suggesting that the predictive effect of husbands' and wives' pro-setback thinking on marital quality was statistically distinguishable dyad members by gender.

The APIM for the predictive effect of couples' fate thinking on marital quality is shown in Figure 3, and the actor and partner effects for husbands and wives are presented in Table 2. When tested if the two actor effects were equal, the difference was found not to be statistically significant [ $p = 0.489$ , 95% CI (−0.19, 0.40)]. Besides, when tested if the two partner effects were equal, the difference was found not to be statistically significant [ $p = 0.407$ , 95% CI (−0.41, 0.16)]. Husbands'  $k$ -value was 0.621 with a 95% CI between 0.090 and 2.021 (1 was in the CI), suggesting the couple pattern. Wives'  $k$ -value was 0.229 with a 95% CI between −0.149 and 0.822 (0 was in the CI), suggesting the actor-only pattern. In addition, the two  $k$ -values showed no significant difference [ $p = 0.672$ , 95% CI (−0.54, 1.93)]. Whether the model was with distinguishable dyad members was further tested. According to the results,  $\chi^2(15)$  was equal to 174.92 and  $p$  was lower than 0.001, suggesting that the predictive effect of husbands' and wives' fate thinking on marital quality was statistically distinguishable dyad members by gender.

## Discussion

The studies pertaining to coping approaches and marital quality have always been the hotspot of marriage and family fields. Marital quality, as individuals' subjective feelings, is not

static. Influenced by social culture, personality traits, interaction modes, attachment styles, and so forth, marital quality is always a dynamic process. Among a variety of factors, coping approaches play a vital role in affecting marital quality (56). People in the same cultural context may show certain common characteristics (15). As the mainstream culture of China, Confucianism has shaped the value judgment and behavioral patterns of Chinese people. Although an increasing number of scholars have realized that coping approaches have clear cultural characteristics (57), hitherto, no study has probed the relationship between Confucian coping approaches and marital quality. Particularly, no study has used dyadic data to investigate the relationship between the actor and partner effects of husbands' and wives' responsibility thinking, pro-setback thinking, and fate thinking on marital quality. Based on the APIM, the present study, with middle-aged and old couples as participants, investigated the predictive effect of Confucian coping thinking on individuals' own and their spouses' marital quality. At present, China has been facing the social problem of a rising divorce rate (58). Marital quality has been considered the most important predictor of marital stability (59). The results of the present study can be conducive to deepening the understanding of the relationship between Confucian coping thinking and marital quality, so as to provide theoretical reference for improving marital quality and reducing the divorce rate.

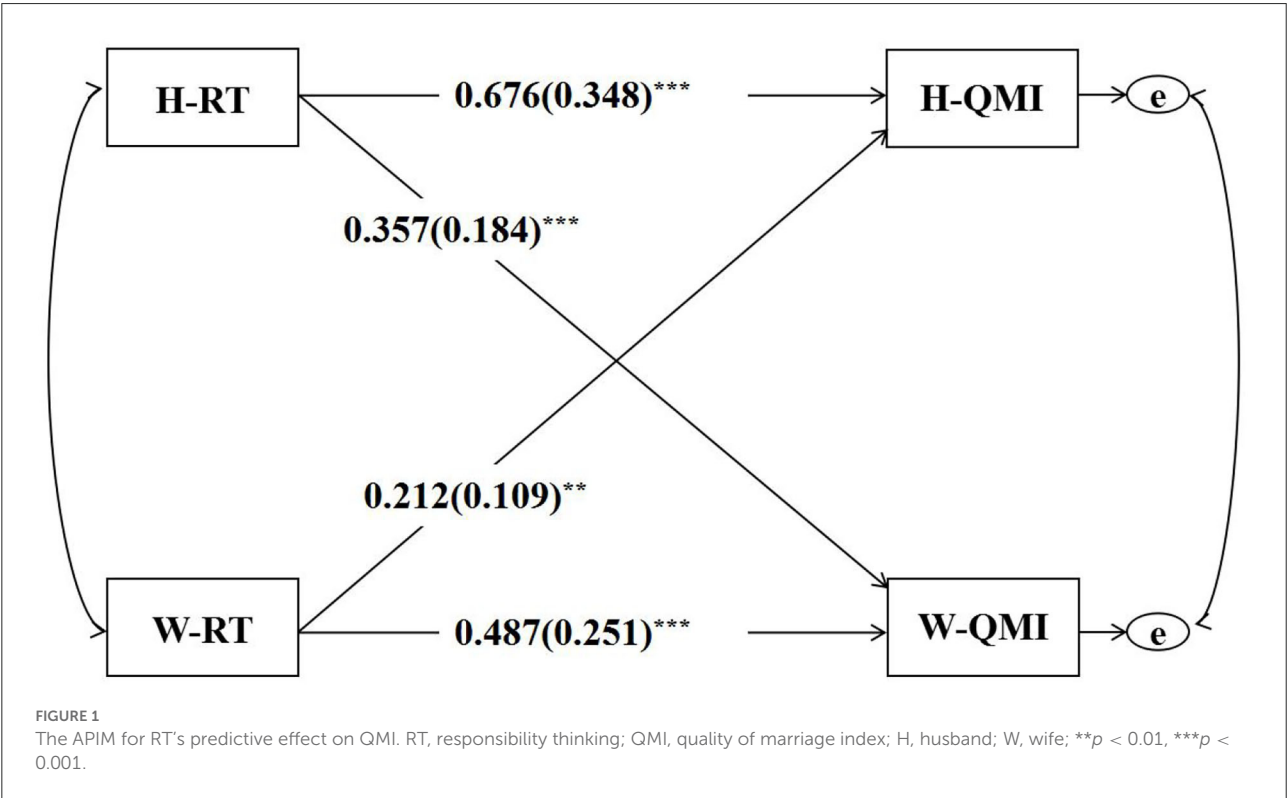
In the APIM for the predictive effect of responsibility thinking on marital quality, both husbands' and wives' responsibility thinking could significantly positively predict their own and their spouses' marital quality. Responsibility thinking is the premise of developing and maintaining interpersonal relationships. According to previous studies, responsibility can improve marital quality (60). To the authors' knowledge, the present study is the first one that investigated the relationship between responsibility thinking and marital quality and drew a similar conclusion. Responsibility's contribution to a marriage has been identified in both Chinese and western cultures, although in the two cultures, the emphasis and view on responsibility are not identical, and the connotation and manifestation of responsibility are also different. Confucianism regards the self as a kind of "relational self," and believes that everyone should be responsible for others in a relationship, which requires individuals to actively improve their self-cultivation in order to better take their responsibility (61). As the most basic social relationship, marital relationships are considered a person's main responsibility (62). Both husbands and wives have the responsibility to jointly maintain the stability, sustainability, and harmony of marriage. Influenced by Confucianism's view on family, individuals attaching importance to marital harmony tend to voluntarily take family responsibility and even sacrifice their own interests (63).

In the APIM of the predictive effect of pro-setback thinking on marital quality, both husbands' and wives' pro-setback thinking could significantly positively predict their own marital

TABLE 3 Parameter estimates for paths of the APIM.

	Effect	Estimate	Standardized effect	95% CI	<i>p</i>
RT	H-Actor	0.676	0.348	[0.533, 0.824]	<0.001
	H-Partner	0.212	0.109	[0.079, 0.343]	0.002
	H- <i>k</i>	0.313		[0.110, 0.571]	
	W-Actor	0.487	0.251	[0.352, 0.626]	<0.001
	W-Partner	0.357	0.184	[0.220, 0.500]	<0.001
	W- <i>k</i>	0.734		[0.401, 1.263]	
PT	H-Actor	0.476	0.157	[0.256, 0.699]	<0.001
	H-Partner	0.108	0.036	[−0.089, 0.306]	0.285
	H- <i>k</i>	0.227		[−0.181, 0.853]	
	W-Actor	0.441	0.145	[0.236, 0.644]	<0.001
	W-Partner	0.303	0.100	[0.102, 0.511]	0.004
	W- <i>k</i>	0.686		[0.191, 1.778]	
FT	H-Actor	−0.362	−0.145	[−0.560, −0.165]	<0.001
	H-Partner	−0.225	−0.090	[−0.414, −0.041]	0.018
	H- <i>k</i>	0.621		[0.090, 2.021]	
	W-Actor	−0.465	−0.186	[−0.656, −0.273]	<0.001
	W-Partner	−0.106	−0.043	[−0.285, 0.077]	0.246
	W- <i>k</i>	0.229		[−0.149, 0.822]	

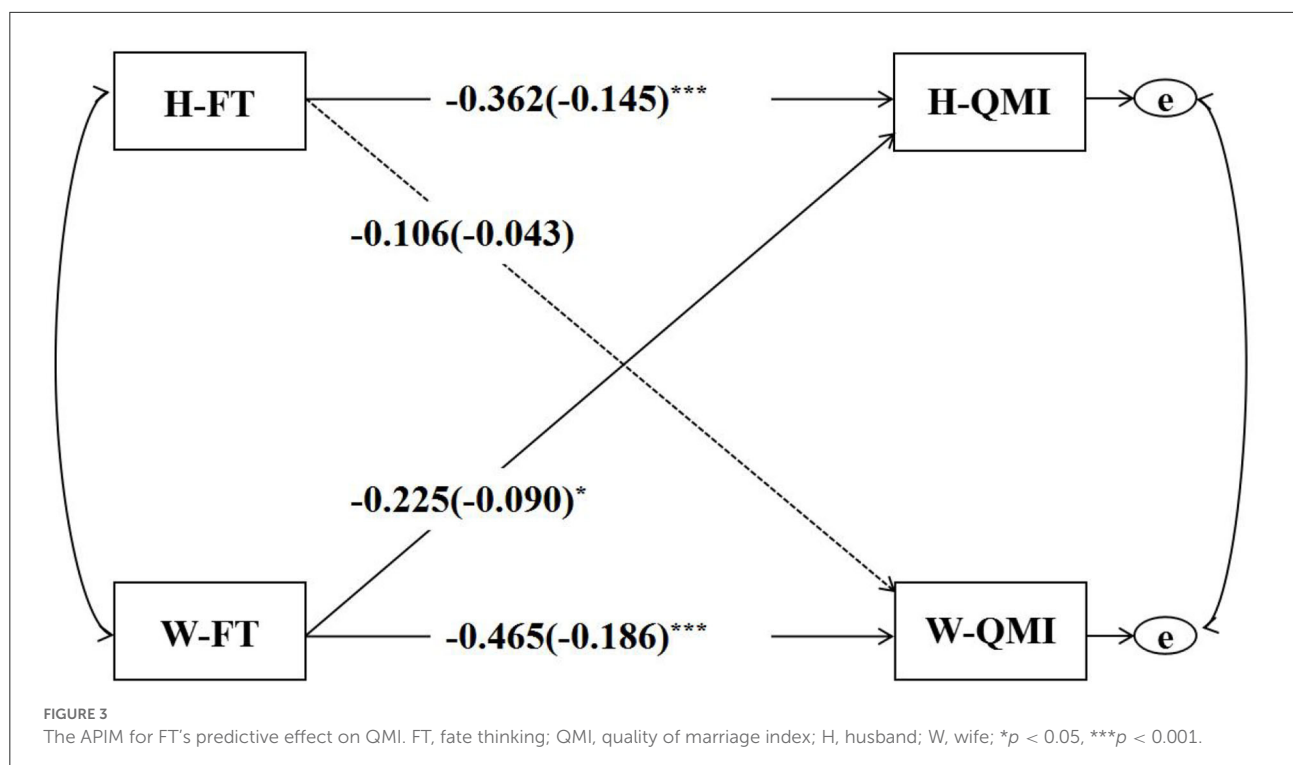
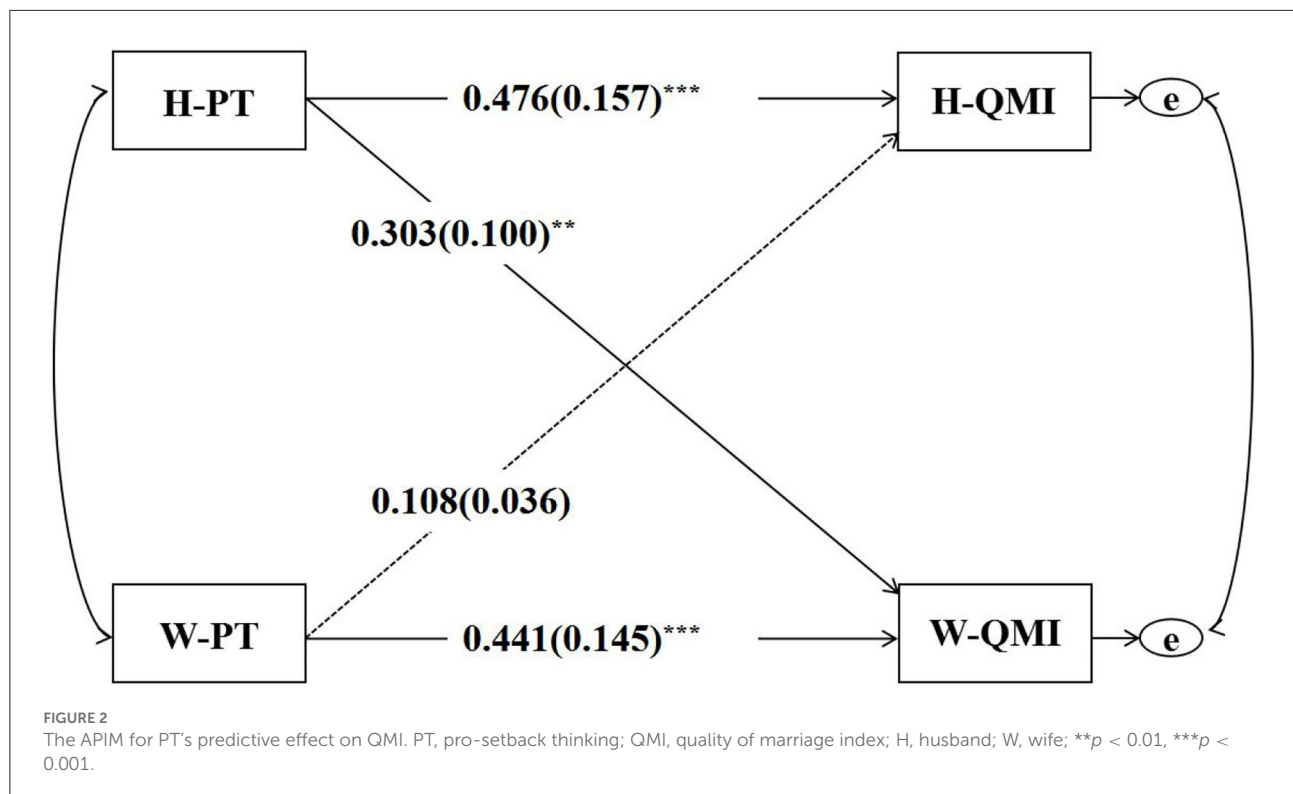
H, husband; W, wife; RT, responsibility thinking; PT, pro-setback thinking; FT, fate thinking; QMI, quality of marriage index.



quality, which was consistent with the hypothesis. However, only husbands' pro-setback thinking could positively wives'

marital quality, which was not in line with the hypothesis. Based on previous studies, the predictive effect of couples' coping





approaches on marital satisfaction is not identical (56). For instance, Bodmann et al. found that husbands' positive coping approaches were positively correlated with couples' marital

quality, while wives' positive approaches were only correlated with their own marital quality and were not correlated with their husbands' marital quality (46). Pro-setback thinking, as a

sort of positive coping thinking, also shares the same predictive effect. Confucianism assumes that both men and women should take responsibility in line with their gender, identity, and status, and act accordingly. On the contrary, the cultivation of pro-setback thinking is more aimed at men. Confucianism regards “improving oneself,” “striving for progress,” and “daring to take responsibility” as important spiritual characteristics of a “gentleman” personality (64). Confucianism insists that men should hold a positive attitude toward the setbacks and hardships encountered in their careers and growth. In addition, Confucianism’s concept of hierarchy is also reflected in marital relationships, assuming that women should be subordinate and obedient to men (65). Women’s happiness is largely dependent on men’s career achievements. Setbacks are considered the key to self-transcendence and success (31). Therefore, husbands’ optimistic attitude in handling and overcoming setbacks means that they are more likely to succeed in the future, which can enhance the wife’s evaluation of marital quality.

In the APIM of the predictive effect of fate thinking on marital quality, both husbands and wives had actor and partner effects, namely, both husbands’ and wives’ fate thinking could significantly negatively predict their own marital quality, which was consistent with the hypothesis. According to previous studies, fate thinking, different from responsibility thinking and pro-setback thinking, can negatively predict individuals’ psychological health, emotional experience, and psychological resilience (27, 31). The present study also demonstrated in the marital relationship field that fate thinking was negative. Fate thinking shows individuals’ inclination of attributing it to external uncontrollable factors when encountering stress. Individuals with higher fate thinking are more inclined to attribute the good or bad results to “fate,” and passively accept and comply with the “predetermined” results (66). The idea of “obeying fate” can cause uncontrollability and powerlessness. Individuals with high fate thinking usually take tolerant and passive approaches in coping with the confrontation and dissatisfaction in marriage, which may cause a decline in marital quality.

In the analysis of the partner effect, the present study only found that wives’ fate thinking could negatively predict their husbands’ marital quality, while husbands’ fate thinking could not significantly predict their wives’ marital quality, which was not completely consistent with the hypothesis. Fate is a complicated concept, comprising three dimensions: “fearing fate,” “obeying fate” and “utilizing fate.” Among them, “fearing fate” is the most negative attitude toward fate. Individuals fearing fate tend to believe that everyday issues have already been ordained by fate, and then passively accept them. In Confucianism’s view on marriage, women have no free choice of their husbands, so their perceived marital quality is completely dependent on their predetermined husbands, which manifests in “fearing fate” (67). In other words, women would blame their marital miseries on the fate of failing to

marry a good husband (68). Women’s complaints about their husbands and marriage could negatively affect their own and their husbands’ marital quality. In addition, different from the view of women, Confucianism emphasizes that “Junzi” (gentlemen) should “obey fate.” With the prerequisite of fate being unchangeable, “obeying fate” assumes that personal morality could be strengthened to realize, understand, and obey fate (69). Confucianism believes that a “Junzi” should always strengthen his self-cultivation, although it is a very difficult and long process from “fearing fate” to “obeying fate.” Therefore, men are more inclined to ascribe the negative effect of fate to their lack of self-cultivation, which properly justifies husbands’ FT only negatively predicting their own perceived marital quality but failing to significantly predict their wives’ marital quality.

Adopting the APIM, the present study investigated the relationship between Confucian coping thinking and marital quality. The present study has certain theoretical significance, as it is an expansion and supplement to the Vulnerability-Stress-Adaptation (VSA) Model and the family systems theory. In addition, the present study also has certain practical significance, as it can serve as a reference for marriage therapy and family intervention. From the perspective of culture, different and targeted measures can be developed to improve marital quality. Moreover, marital quality can also be enhanced by cultivating couples’ responsibility thinking and pro-setback thinking and reducing their fate thinking. It is noteworthy that although Confucian coping thinking is relatively stable and significantly correlated with marital quality, individuals’ coping approaches are by no means invariable, and the specific strategies shown in a specific context of stress are affected by internal and external factors (70). More specifically, the coping approaches adopted by couples in handling and solving various problems or stress in marriage are also related to both the thinking and context at that time (71). Hence, in the intervention of marital quality, the psychological features, interaction modes, family of origin, economic status, and other factors of couples also need to be investigated comprehensively, in addition to the role of Confucian coping thinking.

The present study also has some limitations. First, a cross-sectional survey was used in the present study, so the causality between Confucian coping thinking and marital quality is hard to be explained. A longitudinal survey needs to be conducted in future work to probe how Confucian coping thinking affects marital quality as time rolls on. Second, the data were collected by self-report measures, which may cause recall bias. Besides, China has the concept of “don’t wash your dirty linen in public,” which possibly leads to the inaccuracy of the results under the Social Desirability Effect. Third, in the process of China’s modernization, Chinese culture is characterized by diversity. Especially, younger people are deeply influenced by western culture (72). Consequently, in terms of Confucian coping thinking, as well as the attitude and

evaluation of marital quality, young couples may show relatively huge differences from their middle-aged and old counterparts. Therefore, whether the results in the present study are applicable to young couples still needs more empirical evidence. Fourth, the sample was insufficient in representativeness, since participants were all recruited from college students' acquaintances based on convenient sampling and snowball sampling. Therefore, random sampling can be adopted in future work to further examine the relationship between Confucian coping thinking and marital quality.

## Data availability statement

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

## Ethics statement

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

## Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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## 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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# Resilience resources and coping strategies of COVID-19 female long haulers: A qualitative study

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**Background:** Female long haulers deal with persistent post-acute COVID-19 symptoms that have serious health implications. This study aimed to identify resilience resources at multiple socio-ecological levels for female long haulers and describe how resilience resources affect their responses to long COVID.

**Methods:** Purposive sampling was adopted to recruit participants through social media from April to June 2021 followed by 15 semi-structured interviews. An inductive analytical approach was adopted to categorize themes by open and axial coding that were verified by peer review.

**Results:** Female long haulers relied on resources at various socio-ecological levels to foster their resilience in response to long COVID. At the individual level, they utilized cognitive and emotional resources to increase knowledge, learn new skills, set goals, and manage emotions; behavioral resources (e.g., internal motivation and executive functioning) to perform physical, creative, and recreational activities, and adopt healthier eating habits; and spiritual resources to perform spiritual rituals and connect with God. At the social level, the support from existing relationships and/or online social support groups enhanced their social identity and provided material and informational resources. At the health systems level, the guidance from counselors and physicians and availability of clinics, medicines, and health equipment assisted them in symptom management and medication adherence.

**Conclusion:** The resilience of female long haulers can be enhanced through (1) offering financial and health-related resources, (2) developing online social-support groups, (3) counseling and care service training for healthcare professionals, and (4) implementing more psychosocial interventions by labor organizations.

## KEYWORDS

long COVID, female long haulers, persistent COVID-19 symptoms, resilience, coping, qualitative study

## Introduction

Today, contagious infectious diseases are one of the main threats to global public health (1). The emergence of the COVID-19 pandemic 2 years ago has affected many human lives. According to the World Health Organization (WHO) data, more than 520 million people have been infected with the novel coronavirus, with more than 6 million lives lost by May, 2022 (2). The COVID-19 pandemic also caused numerous psychological issues (3). Based on a systematic review reporting the average prevalence of COVID-19-related psychological issues on a global scale, the general public has experienced anxiety (33%), depression (28%), distress (35%), stress (40%), insomnia (32%), PTSD (3–16%), and psychological disturbance (14–72%) during the pandemic (4). Most coronavirus patients experience short-term symptoms; however, 10–15% of the patients, also known as “long-haulers,” deal with post-acute COVID-19 syndrome (PACS) (5–8). Based on the Center for Disease Control’s (CDC) definition, PACS is known as post-COVID conditions (PCC), long COVID, or post-acute sequelae of SARS CoV-2 infection (PASC) and constitutes a range of new, returning, or ongoing symptoms that develop during or after COVID-19, persist for more than 12 weeks, and cannot be explained by an alternative diagnosis (9).

Long haulers suffer from serious health complications, including (1) mental health issues (10–14) such as post-traumatic stress disorder (PTSD) (15), neurological disorders and cognitive dysfunction (16, 17), attention deficit, and depression (18, 19); and (2) physical health issues such as fatigue, body aches, and difficulties in breathing (20). In addition, they also experience social and economic problems such as reduction of the social sphere, unemployment, and decreased income experienced (21, 22). Based on recent studies (9, 23–26), the risk of long COVID is approximately twice in females as compared to men. In fact, the U.S. Department of Health and Human Services (HHS) reported that females comprise up to 80% of the patient population suffering from long-lasting symptoms following infection with the virus (27, 28). The unique circumstances of females, such as intimate partner violence (IPV) (interpersonal level), caregiver roles (social level), and resource insecurity (systems level), might make them vulnerable to multi-level adversities (29–31). Intimate partner violence, i.e., psychological, physical, sexual, or economic violence, has significantly increased in quantity (35%) and severity (30%) since the start of the COVID-19 pandemic (32). Intimate partner violence had significant negative implications on females’ physical and mental health due to the restrictive measures of the COVID-19 pandemic (lockdown, social isolation, social distancing). Furthermore, since women were more likely to perform “family duties” around the clock, they had lesser time for

economic and work opportunities (33). The fewer economic and working opportunities not only resulted in experiencing higher IPV (33, 34), but also led in relatively poorer socioeconomic status such as lesser financial, informational, social, and emotional resources (34, 35). This multi-dimensional lack of resources can be associated with females’ resource insecurity, especially the essential family expenditure for health care services.

Regarding the response of female long haulers to long COVID, resilience could play a decisive role by helping them to deal with long COVID symptoms more effectively. Resilience can be defined as the function of a person’s strengths and challenges dependent on the available and accessible meaningful opportunity structure (36). The opportunity is defined as the capacity of the social and physical ecology to provide accessible resources for internal integration and external adaptation. Therefore, a person’s capacity to successfully adapt to adversities that threaten health functioning is a socio-ecological process rather than an individual trait (36, 37).

Since the beginning of the COVID-19 pandemic, many empirical studies have evaluated the interplay between COVID-19 related adversities and resilience processes for different population groups. In a study on children and adolescents (38), authors found that high rates of life satisfaction (80%) among children and adolescents were due to the co-existence of psychological distress and resilience when faced with change or adversity in the pandemic. In another study on college students (39), authors showed resilience’s protective role against a high loneliness rate among students during the pandemic. During the pandemic, higher levels of depression and anxiety were observed in healthcare professionals with non-resilient personality prototypes indicating the role of resilience in preserving psychological health. In this regard, appropriate information delivery, psychosocial support, treatment, and monitoring of professionals’ health status were suggested to enhance resilience among healthcare professionals (40–42). Among COVID-19 patients with mild symptoms, greater levels of resilience were associated with lower depression and anxiety (43). For office workers, higher levels of resilience and positive coping strategies enhanced personal growth (44). The quarantined elders (45), similar to adults in the early months of the pandemic (46), showed higher levels of depression, anxiety, and stress when they had lower resilience levels. However, to the best of our knowledge, none of the studies have assessed coping experiences of “female-long-haulers” through the lens of a resilience framework. Thus, in this study, we aimed to identify resilience resources facilitating coping strategies used by female long haulers at multiple socio-ecological levels to mitigate the adverse impact of long COVID and describe how resilience resources affect female long haulers’ response to long COVID.

## Methods

### Study design

The interview data utilized in this study were derived from an online health promotion intervention for COVID-19 female long haulers. We recruited the participants primarily by using social media, especially Facebook, through snowball and purposive sampling. In total, we recruited the participants from 16 Facebook groups, websites of two organizations related to female-long-haulers, and a Slack group. Female-long-haulers that lived in the United States and were 18 years of age or older and could speak and understand English were eligible for this study. In terms of COVID-19 experience, they should have been infected with COVID-19 with at least a persistent COVID-19 symptom for 4 weeks or longer.

After getting approval from social media groups and organizations' administrators, we posted study descriptions, the contact information of interviewers, and a recruitment flier to their websites or groups. The whole recruitment process was conducted in two and a half months, from the last week of March 2021 to mid-June 2021. We conducted semi-structured interviews with 15 out of 17 participants who completed written informed consent based on their eligibility for this study. Two independent research team members verified the eligibility of participants. The clinical diagnosis of COVID-19 and having PACS for 4 weeks or longer were checked verbally. The recruitment process continued until data saturation, when no new codes were identified from the analysis of interview data. Two researchers discussed data saturation. The sample of 15 in our study seemed sufficient for the qualitative analysis considering the recommended minimum sample size of 12 for qualitative studies (47–49). The University of South Carolina Institutional Review Board (Pro00109358) reviewed and approved the study protocol. We conducted semi-structured interviews by video conferencing software Zoom (2022). We scheduled the interviews based on the availability of interviewees and conducted them in a one-on-one online meeting including the interviewer and participant. The interviews were conducted from early April 2021 to mid-June 2021. Demographic characteristics of participants are shown in Table 1.

### Data collection

We gathered information on the influence of persistent COVID-19 symptoms on female-long-haulers' lives and the coping strategies utilized by them. The interview guide (see Supplementary Data 1), developed for a larger study, investigates different aspects of long COVID and lived experiences of female long haulers (50). The open-ended interview questions were derived based on the literature to find

TABLE 1 Demographic characteristics of female-long-haulers.

Variable	n (Total = 15)	Percent
<b>Age</b>		
20–35	2	13.33
36–50	6	40.00
51–65	6	40.00
>65	1	6.67
<b>Occupation</b>		
Health care provider	5	33.33
Educator	4	26.67
Business owner	4	26.67
Student	1	6.67
Retired	1	6.67
<b>Living situation</b>		
Live with others	13	86.67
Live alone	2	13.33
<b>Location</b>		
East	10	66.67
Central	3	20
West	2	13.33

similar questions that have been asked in studies of similar topics and questions theory indicates might be important. In this study, we used participants' answers to sections addressing (1) Background of COVID-19 infection and its related symptoms, (2) Psychological influences of COVID-19, (3) Coping with COVID-19 symptoms, and (4) Social support and resilience. To compensate for the time of participants, we gave a \$30 Amazon e-gift card to each participant. After each interview, the interviewers wrote the field notes. The total number of interviews was mutually agreed by two researchers regarding reaching data saturation. We recorded all interviews with verbal permission from participants. The Otter.ai (2022) was employed to transcribe the recordings, and then the interviewer reviewed and verified the final texts after transcription.

### Data analysis

We utilized an inductive approach for the thematic analysis of the interviews (49, 51, 52). Our analysis comprised six stages from becoming familiar with data, constructing preliminary codes to obtaining, revising, labeling, and reporting themes (53). We used MAXQDA (2022) for analyzing the interview transcripts. For accuracy, we initially reviewed all transcripts multiple times (54, 55), and then identified the emergent themes (open coding) (56). In the next stage, we categorized identified subthemes into five main themes (axial coding). We also held team meetings to discuss the initial codes and then reorganized

them to obtain the final codebook. The codebook included themes' definitions, exemplar quotes, and even quote samples not fitting into the categorization. By comparing themes, we identified differences, similarities, and interactions between themes. To check the reliability of our analysis, inter-coder agreement and peer debriefing techniques were utilized (57–59). To examine themes and outcomes, we presented final codes and findings to two team members not involved in the data analysis (57, 58). Direct quotes representing the themes were selected to explain the key findings.

## Results

### Resilience resources and coping strategies at the individual level

#### Cognitive and emotional coping strategy

Less than half of the female long haulers used their “knowledge,” “skills,” “growth mindset,” and “emotional regulation skills” to use four types of cognitive coping strategies against the PACS challenges: (1) increasing knowledge, (2) planning, (3) learning new skills, (4) realistic goal setting, and (5) emotions management.

Participants increased their knowledge on COVID-19 symptoms, treatments, and healthy behaviors through different online platforms. This information helped them reduce uncertainty about their symptoms, adopt timely and scientifically validated health-promoting actions to manage symptoms, and find resources to return to normal. One of the participants (ID#8) expressed, *“Sometimes the doctors don't know how to make you better or whatever...I tried to search to find the answer, so I've always been more research-based”* (reduce uncertainty) and the other one (ID#13) said, *“If I would have known this information about nutrition three months ago, I probably wouldn't have relapsed”* (manage symptoms).

Participants planned new ways of living post-pandemic to enhance their well-being. They planned on “forming new relationships” and “finding new jobs.” One of female long haulers (ID#2) pointed out, *“I'm hoping to maybe open myself up to dating when the pandemic kind of dies down a little bit”* and the other one (ID#11) said *“apply for jobs...I am busy with that...participated in many interviews.”* Participants learned new skills to heal themselves and others. One of the participants (ID#9) said, *“I would like to get certified in mind-body medicine...so I think that is helping also keep my own anxiety down”* and another participant (ID#14) asserted, *“I started to learn tapping freedom technique, and that has helped and improved my health.”*

Participants engaged in setting specific and achievable goals to prioritize and tackle symptoms, and managed responsibilities based on their physical abilities. One of female long haulers (ID#5) explained, *“I try to fix one aspect of the symptoms at a*

*time...before moving on to the next aspect”*; Similarly, one of participant (ID#12) pointed out *“I made a list of duties to do one by one.”* Additionally, they managed their physical limitations as one of the participants (ID#10) said *“I just kind of decide for each day what I'm willing to deal with and then I'm done...if I set my expectations lower... it's better.”*

All participants engaged in emotional management through engaging in sensory healing, altering their physical environments, accomplishing small tasks, becoming emotionally self-dependent, and enhancing their self-image. One of female long haulers (ID#11) mentioned, *“I started taking baths, having music in the background, lighting, candles, just being with myself. And my goal is to take care of me”* and other participant (ID#12) emphasized *“do little things to feel accomplished in self-time.”* Also, one of participant (ID#6) expressed, *“I would just need to be more emotionally secure with myself, and like, not being so hard on myself with how I'm handling it,”* and the other one (ID#3) said *“I try to just being the best version of myself... being the best mom, being the best wife.”*

#### Behavioral coping strategy

More than half of the female-long-haulers used “internal motivation” and “executive functioning skills” to adopt five types of behavioral coping strategies against the PACS challenges: (1) physical activity, (2) creative activities, (3) recreational activities, (4) healthier eating habits, and (5) volunteering.

Participants performed moderate-level mindful physical activities to regain physical fitness, improve mental health, and productively engage themselves. They engaged in swimming, walking, and yoga. One of participant (ID#4) said, *“Swimming in the pool, like was soothing to me”* and mentioned, *“I started walking...it helps lift my mood.”* Likewise, participant (ID#8) said, *“the only thing that I know, like that's helped in the past is like working out...So, I take my dog on a walk, and I love that and that kind of helps me.”* Among these activities, Yoga was the most popular relaxation technique because 13 female-long-haulers reported an increase in well-being through practice of Yoga. One of participant (ID#3) mentioned, *“It (Yoga) is therapeutic...make you feel better about yourself”* and the other one (ID#1) expressed, *“Yoga has helped me stay fluid and guided to self-awareness and rebuilding some strength in a delicate way.”*

Participants engaged in indoor and outdoor creative activities to experience immersive engagement, a state of flow, and a sense of “accomplishment.” They engaged in visual arts such as decoration, painting, and photography, and performing arts such as singing or music. One of female long haulers (ID#7) expressed, *“when my mental status or whatever is not good, and the insomnia is really bad, my release is taking pictures.”* Participants engaged in recreational activities to uplift their moods and to temporarily divert their attention from risks by watching entertaining movies and reading books. Also, one of



participant (ID#2) said, “*getting lost in a book sometimes just kind of distract me.*”

Participants altered their eating habits by shifting to a healthier diet, practicing mindful eating, and eating slowly. One of female long haulers (ID#8) asserted, “*I made sure that I mindfully ate... nourish my body and helped me get better*” and the other one (ID#9) explained, “*the main thing that I’ve started doing now is eating less to breathing better.*” Participants adopted a new social role of “volunteering” that gave them a sense of higher purpose, meaning, and fostered their mental well-being. One of participant (ID#2) explained the “*therapeutic influence*” of volunteering, and said, “*I think that (volunteering) is helping also keep my own anxiety down.*” Also, other participant (ID#15) said, “*I participated in donating my blood so they can monitor how long the antibodies last. So, you know, and I’m interested in doing other research and helping out in other ways that I can.*”

### Spiritual coping strategy

Half of the female-long-haulers benefitted from spiritual resources such as “spiritual rituals,” and “spiritual beliefs” to adopt three types of coping strategies: (1) performing spiritual rituals, and (2) connection with God.

Participants attended and engaged in spiritual rituals online or offline to manage stress and enhance their well-being. One of female long haulers (ID#1) asserted, “*I go to church... I feel like emotionally I’m needing more, like, soul nourishment*” and the other one (ID#15) said, “*I’ll listen to one of my favorite pastors on YouTube to have peace.*” Through the spiritual beliefs, participants experienced a close connection with God that gave them a sense of protection, meaning and purpose, and induced resilience to face unpleasant situations. One of participant (ID#2) said, “*I always say prayer is when I speak to God.....God’s intentions are good for me, for just my life in general,*” and the other one (ID#15) mentioned, “*I just laid in bed and prayed... no worries for anything.*”

## Resilience resources and coping strategies at the social level

### Seeking social support coping strategy

Most female-long-haulers received support from “family and friends,” “co-workers,” “therapists and counselors,” “online support groups with other patients,” “spiritual leaders and community” in the form of (1) emotional and material support, (2) informational support, and (3) stronger social identity.

The accessibility and availability of “friends and family” and “coworkers” acted as an emotional and material support system for the participants. One of female long haulers (ID#1) said, “*My friends and family have helped emotionally, physically, with food, with love, with support, with coming to clean my*

*house, bringing flowers.*” Participants’ co-workers offered a non-judgmental and a relatively “non-attached” setting to “share concerns.” One of participant (ID#8) explained, “*I feel more comfortable talking with my co-workers and supervisors than with family and friends... because my family is overprotective.*”

The healthcare providers such as therapists and counselors offered a safe space for the participants to share their concerns and enabled the participants to “learn coping skills.” One of female long haulers (ID#9) explained, “*I have probably more coping skills than most just because I had a really good therapist.*” Likewise, participants connected with other patients through online support groups, wherein, they comfortably expressed their feelings, gained meaningful information, communicated empathetically with other patients as they felt a “the sense of belongingness,” and gained access to an “advocacy group” for their rights. One of participants (ID#10) expressed, “*companionship of other patients in a similar situation made them feel that they are not alone,*” another participants (ID#6) explained, “*online support groups provide helpful information or training like belly breathing,*” and “*sharing and connecting with other patients kept me motivated.*”

Participants expressed the importance of prayer groups (spiritual community) in providing emotional and social support. One of them (ID#4) expressed, “*praying with other people help feeling not alone and to be positive.*” Another participant (ID#6) also said, “*I usually like to go to church... a lot of my friends from inside the church. We always feel like a team and support each other.*”

## Resilience resources and coping strategies at the health systems level

Half of the female-long-haulers used resources at the health-systems level such as “counselors,” “physicians,” “clinics,” “medicines,” and “health equipment’s” to adopt three types of health management strategies: (1) symptom management, (2) medication adherence, (3) realistic social responsibilities, and (4) stress reduction by health care providers.

Participants, especially the ones with pre-existing health conditions such as pneumonia, heart disease, and geriatric conditions, consistently and actively monitored their symptoms to take preventive actions, track health progress, and improve recovery strategies. One of the participants (ID#7) asserted that “*It helps me to know when it’s time to go to the E.R.,*” and the other one (ID#4) said, “*When I get short of breath, I get really anxious... a pulse ox... it’s really helped my anxiety.*”

Participants reported an increase in medication adherence because they understood the severity of COVID-19 and desired a “normal” lifestyle. One of them (ID#7) asserted “*we’ve tried a couple of different medications...and I haven’t had a headache since... that’s to me is a quick win,*” and the other one (ID#5)



highlighted the significant influence of medicine on enabling her to fulfill the duties and said, *“when I take medicine, then it helps me like work throughout the day and stay like focused and be able to not feel the fatigue.”*

Participants also decreased social responsibilities by presenting their true situation to friends or family. One of them (ID#8) said, *“there’s something called the Spoon Theory...just so my family can kind of see where I am for the day...then I think it would have been easier for my son to understand why mom couldn’t take him out.”*

Female long haulers also highlighted the role of health care providers in helping them to cope with their new health conditions. A participant (ID#10) mentioned *“I’m talking with my counselor today, you know, because we have to see our counselor, and she had a really good idea for me because I can’t think for myself, you know, and diagnose myself.”* One of participants (ID#7) explained the way her therapist encouraged her to be more resilient and said *“my counselor released me from week to week. Now we’re doing every three weeks - And I shared with her, I was like, ‘Victoria, this is really scary for me...and she said,’ you know, you need to depend on yourself because you are in a place where you have grown so much.”* Some of the female long haulers mentioned the stress reduction aspect of the health care providers roles. One of participants (ID#9) asserted that *“my counselor really spoke with me about one of the things that I was doing at work is when I get upset and I felt like I just needed to step away because the environment was very fast-paced.”* Also, a female long hauler (ID#7) said, *“I have a really, really good physician, that is our family physician... I do feel so comfortable with him, and he’s been with me through everything. And that conversation was extremely comforting.”*

## Challenges in coping

Although female-long-haulers utilized multi-level resilience resources to cope against PCAS, they faced some challenges through the coping process, which could be new risks for their recovering from long COVID and maintaining psychosocial well-being: (1) insufficient financial resources, (2) perceived stigma against COVID survivors, (3) fear of deteriorating physical health, (4) unpleasant healthcare experiences in dealing with long COVID, (5) misinformation of long COVID, (6) overwhelming social interaction and burnout.

Most female long haulers faced shortage of money in financing treatment bills, visiting a counselor, accessing health care services, and engaging with recreational activities. The lack of sufficient finances impacted behavioral, emotional, and health management coping strategies. A participant (ID#2) asserted that *“I had counseling in my plan..., but basically stopped! Some issue is about the billing.”* Participants’ perceived stigma toward their “persistent” symptoms acted as a significant barrier to adopt the social-support coping strategy. One of them (ID#8)

explained *“I don’t want to show that when I’m around other people because of their reactions, so I try and act like I feel good even though I may just be like short of breath and feeling absolutely crappy.”*

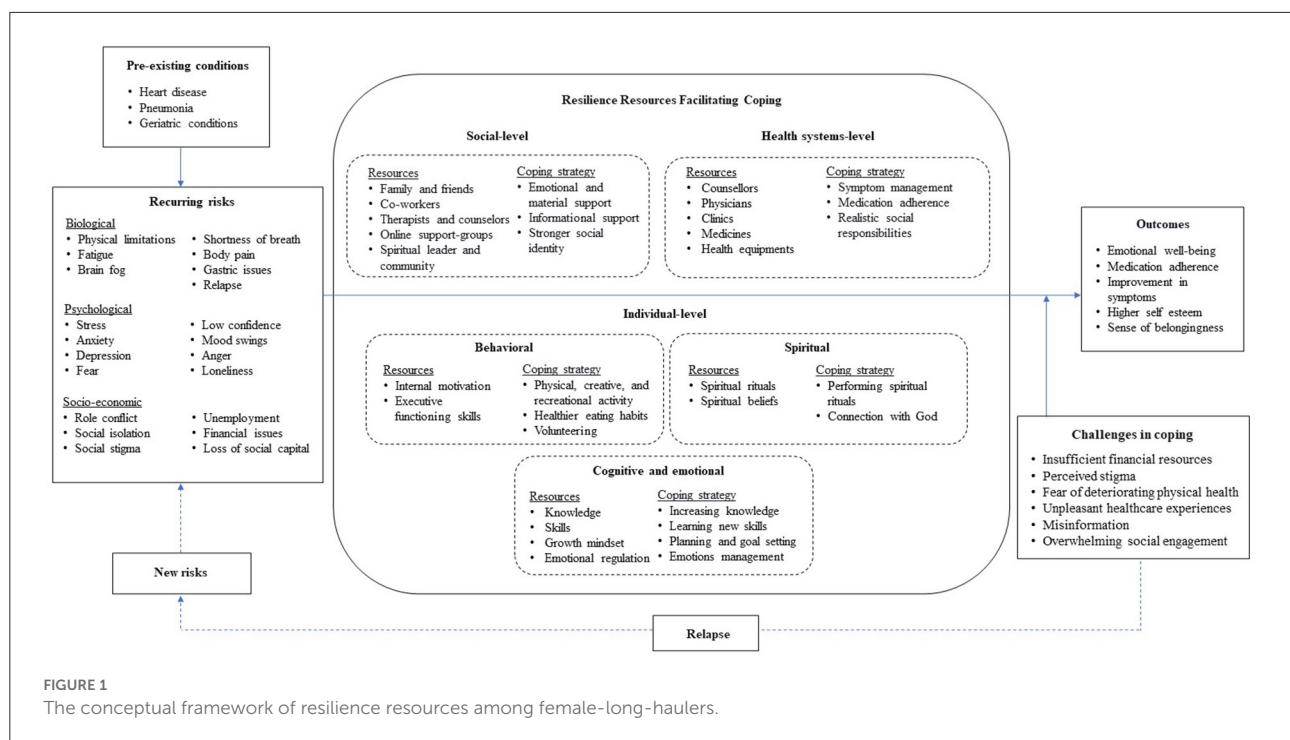
For more than half of the participants, the fear of deteriorating physical health acted as a barrier to adopt behavioral coping strategies such as exercising and social-coping strategies such as gathering with other people in a common place. One of the participants (ID#6) explained that *“I walk away from things, I lost a lot of friends, because I just couldn’t deal with these symptoms. I had to just step back. Now I have all of these irrational fears and irrational anxiety.”*

More than half of the participants mentioned challenges in utilizing health management strategies, including “lack of access to health care services,” “lack of knowledge among doctors about COVID,” “uncertainty about treatment,” “being tired of consuming various medicine,” and “being frustrated of visiting different physician.” The challenge of identifying credible or scientifically valid information acted as a barrier for participants in “increasing their knowledge” or adopting cognitive coping strategy. Participants sometimes preferred isolation and avoiding excessive social interaction because they felt overwhelmed listening to other’s issues. One of them (ID#5) asserted that *“I can’t deal with other people’s problems anymore because I’m almost over-empathetic now.”*

## Discussion

This study identifies and describes the coping processes and resilience resources of female long haulers. The resilience resources that facilitated coping were categorized into individual level, social level, and health systems level. The results demonstrated an interactive relationship among the multilevel resilience resources to cope with persistent COVID-19 symptoms.

The compensatory and protective models of resilience (60, 61) were adapted to connect key themes that appeared in data analysis through inductive approach. This model demonstrates resilience resources and coping strategies among female-long-haulers, and show an interactive relationship among risks, resources, and outcomes (Figure 1). In general, good outcomes refer to improvement in physical and mental health. The function of risks is negative. They may have a direct negative effect on the good outcomes and/or an indirect negative effect on the good outcomes by hampering the functioning of resources in the system. On the other hand, the function of resources is positive. A greater number of resources is positively correlated with the system’s capacity to cope with adversity (62). They may have a direct positive effect on the good outcomes and/or an indirect positive effect on the good outcomes by moderating the negative impact of risks. The resilience resources of an individual, distributed across the bio-psycho-social system,



facilitate coping against risks. Based on coping theory, when people encounter risks, they can use multi-level resilience resources to employ different coping strategies against risks (12). These coping strategies help to overcome, endure, or lessen the negative impact of risks (63).

In the context of long COVID, risks toward outcomes were at three levels i.e., biological, psychological, and socio-economic in addition to the pre-existing conditions (e.g., various chronic diseases). The resilience resources at multiple socioecological levels could mitigate the influence of risk factors on mental health outcomes of female-long-haulers through promoting adaptive and positive coping strategies. However, the performance of these resources could change in the process of psychosocial adaptation to chronic illness (64, 65). The common individual-level resilience resources include self-efficacy (mastery motivation) (66–68), self-regulation skills (emotional regulation) (69–71), cognitive abilities (72, 73), hope and meaning (74), religious faith (75), and personality trait (76). An individual's inner strengths and resilience always interact with external factors within a particular social-ecological context. For example, interpersonal resilience resource may include family support (77), peer group and social network (78), neighborhood (79, 80), and structural level factors include policies and institutions (81, 82), and culture (83).

Other studies also used compensatory and protective models of resilience to study resilience in the context of COVID-19. The compensatory model of resilience has been used to understand the relationship between resilience and anxiety among pregnant women during the COVID-19 pandemic (84). Consistent with

our results, the authors showed that pregnant women with adaptive profiles could better adapt to changes in their social life and often have higher self-efficacy and coping abilities. They demonstrated that these individual-level factors might develop resilience in pregnant women by providing more resources to cope with stressors. In another study based on protective model of resilience, in line with our study, authors found that enacting the two coping mechanisms (Problem-focused and Emotion-focused strategies) and resilience resources is essential to achieve an adaptive effect on health practitioners' mental health (85).

As stated by participants, relapse of symptoms could occur in long Covid. Given that long Covid includes various symptoms across organ systems, such as shortness of breath, fatigue, and cognitive impairment, we observed cycles of wellness followed by relapse in long haulers (86). Davis et al. (87) reported that 86% of people with long COVID could experience relapses that often occur in an irregular pattern or in response to triggers like stress, physical or mental activity, heat, menstruation, or alcohol (87).

As stated in our results, participants reported various types of coping strategies. They tapped on their internal resources (intrinsic motivation, executive functioning skills, knowledge, skills, and positive attitude) to adopt new behaviors, emotionally regulate themselves, and seek social support. These findings are consistent with other studies which identified that meditation (88, 89), dietary changes, recreational activities, and physical activity were associated with distress reduction (90) and had antidepressant properties (91) and improved symptoms among COVID-19 patients (92). Emotional regulation reduced anxiety (93), depression (11), and emotional distress (94) during the

COVID-19 pandemic. People in other disasters, like SARS, also used this coping strategy (74, 95, 96). Seeking and accessing to social support from others, especially from healthcare workers and other patients could also act as adaptive coping strategies during the COVID-19 outbreak. It is notable that participants reported taking on new social roles (e.g., volunteers to support other patients) as a unique coping strategy. Volunteer work has been shown to have the potential to facilitate the recovery of psychological well-being and allow individuals to enhance their social lives (97). Although this coping strategy is recognized as a new one among female-long-haulers, it has been employed among some populations, like nurses dealing with COVID-19 patients, whose occupation requires care for others. Helping others, in general, can be regarded as a form of self-help, leading to higher levels of confidence and self-awareness, with a decrease in depression (98).

Though common coping strategies were embedded at the individual level, the resilience resources that facilitated this coping went beyond the individual. Many participants reported the use of resilience resources at the social and systems level to cope with long COVID similar to other studies (99, 100). At the health-systems level, the affordability, availability, and accessibility to physical and mental health care providers, along with trustworthy medical equipment and resources, acted as a resilience resource for the participants. The health care providers not only contributed to symptom management and treatment, but offered emotional, cognitive, social, and behavioral support (101, 102). Participants reported an increase in medication adherence, symptom management, knowledge about long COVID, hope for better physical health, and better management of social responsibilities.

At the social-level, apart from the support of close friends, family, and co-workers, participants reported the online or social-media based support groups as an important resilience resource. Our findings showed that participants discussed their symptoms, potential treatments, and other COVID-related information with other long haulers through online support groups. The right amount of privacy and anonymity enabled participants to share freely. Participants highlighted that although they faced physical or mental limitations for socializing with different people, the online social support groups enabled them to tackle loneliness. Additionally, participants experienced emotional comfort as someone else was experiencing similar issues. Some participants also reported gaining access to material resources through the online support groups. Some studies mentioned that some patients checked their health status during their infection and shared some of their symptoms on social media in order to raise awareness or find a solution to their problem (103). Although other studies highlighted the role of online support for educating students (104, 105) or searching for information about COVID-19 (106, 107), the use of online

support groups for multi-level coping with persistent COVID-19 symptoms is a new finding represented in this study.

Certain factors limited this study results. The small sample size of participants i.e., 15 participants, did not allow for investigating the role of key demographic variables, which would have allowed us to assess the potential influence of race or ethnicity on social life of female-long-haulers. However, this type of qualitative research that is typically based on small samples, seek to provide trustworthiness and sufficient context to a greater extent to allow readers to make their own judgment regarding transferability (108). Like all other qualitative research, our study may have also been influenced by the researchers' subjective bias during the process of guide development, transcription coding, and result interpretation. Furthermore, this study was part of an online health intervention among long haulers and recruited all potential participants online, particularly from Facebook groups. Hence, members of our sample were the individuals already interested in online intervention and had access to social media which limited their ability to be a representative of the general population. Also, not obtaining the proof required to verify the clinical diagnosis of COVID-19 and PACS for participants may limit our results' applicability for future clinical studies.

Despite these limitations, our findings demonstrate the importance of resilience resources for female-long-haulers' coping process. It is critical to identify and capitalize the fundamental resilience resources of female-long-haulers as they persistently impact the health outcomes over a long period of time through dynamic channels (109). This study also shows a demand for work organizations to plan for and implement more psychosocial measures to provide their staff a healthy coping with COVID-19. Healthcare professionals and social workers can capitalize on social and system level resilience resources to facilitate coping against long COVID among female-long-haulers. First, there is a need to develop and regulate online support groups to allow female-long-haulers to share health-related information and express their feelings freely. Second, at the policy-level, financial interventions for facilitating access to healthcare services and insurance is necessary as many female-long-haulers reported the lack of finances as a major barrier to cope with long COVID. Third, as the study indicated the important role of healthcare provider in offering multi-level coping strategies, the healthcare providers can offer a pool of resources to female-long-haulers such as information on online support groups, techniques for managing social responsibilities, and online channels to gather trusted information when required. Overall, the healthcare professionals need to facilitate coping in female long haulers from the intersectionality lens, adopting policies to balance job/family roles to promote gender equality in healthcare services and the job market for COVID-19 female-long-haulers.

## Conclusion

This study identified and described the resilience resources and coping strategies for female-long-haulers in the United States to mitigate the detrimental effects of long COVID on their mental health. Although some coping strategies such as physical and recreational activity, emotional management, social support, and shifting to a healthier diet were common among female-long-haulers, some others, like cognitive and spiritual coping strategies, were rarely considered. Our findings confirmed the prominent role of family, friends, and support groups as powerful resilience resources. Moreover, the current study revealed some novel resilience resources and related coping strategies among female-long-haulers, including health management, taking social roles, and online social support. Health care providers and counselors had a unique position since their roles may promote resilience among female-long-haulers by providing more positive orientation and helping to practice new stress reduction techniques.

## 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 methods were carried out in accordance with guidelines of qualitative study. This study was reviewed and approved by the University of South Carolina Institutional Review Board (Pro00109358). The informed consent was obtained from all the participants prior to the interview.

## Author contributions

SQ contributed to the study conception and design. Material preparation and data analysis were performed by AAgh and AAgg. The first draft of the manuscript was written by AAgh, and AAgg. RZ and SQ also made major contribution in manuscript writing. SQ and XL have reviewed

and revised the manuscript. All authors read and approved the final manuscript.

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## Conflict of interest

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

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2022.970378/full#supplementary-material>

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# Perceived stress and symptoms of post-traumatic stress disorder in nurses: A moderated mediation model of maladaptive cognitive emotional regulation and psychological capital

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Nurses often face a variety of work-related and life-related stresses that make them more prone to symptoms of post-traumatic stress disorder (PTSD), yet the underlying mechanism of this association is poorly understood. To address this research gap, we investigated the mediating role of maladaptive cognitive emotion regulation strategies in the relationship between perceived stress and PTSD symptoms, and explored whether psychological capital could moderate the direct or indirect effects between perceived stress and PTSD symptoms. Nurses ( $N = 723$ ) completed a questionnaire about perceived stress, PTSD symptoms, maladaptive cognitive emotion regulation strategies and psychological capital. After controlling for gender, age and work department, perceived stress was positively correlated with PTSD symptoms. Maladaptive cognitive emotion regulation strategies partially mediated this relationship. Psychological capital moderates the effects of perceived stress and maladaptive cognitive emotion regulation strategies on PTSD symptoms. Specifically, the positive correlation between perceived stress and PTSD symptoms was stronger among nurses with low levels of psychological capital than among nurses with high levels of psychological capital. At the same time, the positive correlation between maladaptive cognitive emotion regulation strategies and PTSD symptoms was stronger in nurses with a low level of psychological capital. Therefore, cognitive strategies and interventions oriented toward psychological capital may alleviate the PTSD symptoms of nurses in stressful situations.

## KEYWORDS

nurses, symptoms of post-traumatic stress disorder, perceived stress, cognitive emotional regulation, psychological capital

## Introduction

Post-traumatic stress disorder (PTSD) is a long-term psychosomatic disorder with delayed onset that develops in individuals following a threat or catastrophic traumatic event. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), clinical symptoms include repeated recurrence of traumatic experiences, continued avoidance of stimuli associated with traumatic events, negative changes in cognition and mood, and continued increased alertness (1). Worldwide, the prevalence of PTSD is reported to be 3.9% in the general population and 5.6% in those with traumatic exposure (2). However, nurses are at high risk for developing PTSD symptoms. The chronic job stressors and exposure to traumatic events are risk factors for PTSD symptoms in nurses (3). Nurses have both direct and indirect exposure to trauma, and their work may be a source of additional pressures such as workplace issues (violent behavior, high workload, patient suicide) and relationship problems (conflict with colleagues, workplace bullying, lack of support), etc. (4). In a recent integrative review, 6.7–95.7% of nurses showed at least **one** symptom of PTSD, and 8.5–20.8% met the criteria for PTSD (4). In addition, nurses have often been on the front lines during the COVID-19 pandemic, taking on more stress and work. According to one survey, 74.4% of nurses experienced moderate to severe perceived stress. 17.1% of nurses may have been diagnosed with PTSD (5). Life events are also important factors affecting the level of PTSD in nurses (6). A growing number of studies have shown that PTSD in nurses not only affects their physical and mental health, but also leads to adverse outcomes such as empathy fatigue, job burnout, low job satisfaction and poor quality of care (7, 8). Therefore, it is of great significance to pay attention to the factors influencing PTSD symptoms in nurses and to understand the relevant mechanisms underlying these symptoms in order to maintain and even improve nurses' physical and mental health.

It has been proved that the occurrence of disastrous and traumatic events will cause mental disorders (9), and the influence of objective events is determined to some extent by an individual's perception of the pressure resulting from the event (10). Compared with objective measurement of stressors, the perception of a stressful environment influences the individual's response more strongly (11). Lazarus and Folkman define perceived stress as an individual's response to an environment perceived as a threat to their ability and health (12). Surveys of perceived stress levels and PTSD symptoms in different populations have reportedly found a positive correlation between the severity of PTSD symptoms and perceived stress (13). A survey of medical workers in intensive care units found that respondents with moderate to high perceived stress scores were more likely to be diagnosed with PTSD than those with low perceived stress scores (5).

That is, perceived stress may increase the severity of PTSD symptoms (14). Although increasing numbers of studies have confirmed the effect of perceived stress on PTSD, little is known about the role of negative cognition and psychological capital in this relationship. In order to provide better prevention and intervention strategies and reduce the risk of PTSD in nurses, this study explored a moderated mediation model to reveal the possible mechanism behind this relationship.

According to Garnefski et al., the general concept of emotion regulation can be regarded as a cognitive style of managing the intake of emotionally arousing information, which encompasses a broad range of cognitive, behavioral, emotional, and physiological responses (15). Garnefski et al. conceptualized cognitive emotional regulation as adaptive cognitive emotional regulation strategies (adaptive CERS) (e.g., positive reappraisal, positive focusing, putting into perspective, refocusing on planning and acceptance) and maladaptive cognitive emotional regulation strategies (maladaptive CERS) (e.g., self-blame, rumination, other-blame and catastrophizing) (15). The use of cognitive styles of maladaptive CERS has been reported to increase an individual's tendency to experience emotional problems, often associated with mental disorders (e.g., depression, anxiety, PTSD). Conversely, the use of adaptive CERS may prevent the onset and persistence of mental illness, often associated with better indicators of mental health (e.g., resilience) (16–19). The application of different strategies for cognitive emotion regulation when a person is faced with traumatic events or stress may lead to different mental health outcomes (20). Studies have confirmed that perceived stress is positively correlated with maladaptive CERS (21). Maladaptive CERS mediate the relationship between traumatic events or stress and mental health outcomes (16). According to theoretical studies and the existing literature, maladaptive CERS may mediate the relationship between perceived stress and PTSD symptoms. Therefore, in this study, we proposed the **first hypothesis**:

Hypothesis 1: Maladaptive cognitive emotion mediates the relationship between perceived stress and PTSD symptoms.

Although stress and Maladaptive cognitive emotion might influence PTSD symptoms, not all nurses with higher levels of stress and Maladaptive cognitive emotion experience more PTSD symptoms. Hence, it is vital to investigate the influential factor that might moderate the associations of stress and Maladaptive cognitive emotion with PTSD among nurses. Although stress has an adverse effect on PTSD symptoms (22), the diathesis–stress model suggests that people with vulnerable characteristics in stressful situations will have an increased likelihood of developing mental disorders (23). In other words, having good personality traits can modulate the psychological response to stress. Our research focuses on the characteristics of psychological capital, which Luthans et al. define as “the positive psychological state

of individuals in the process of growth and development,” including **four** core components: self-efficacy, hope, optimism and resiliency (24). A large number of studies have shown that psychological capital is an important protective factor for individual mental health and helps to resist the adverse effects of stress (such as psychological distress and job burnout) (25, 26). It also has a significant positive impact on satisfaction, organizational commitment and workplace wellbeing, and is a positive resource for combating employee stress symptoms and staff turnover (27). Psychological capital has been reported to be negatively correlated with negative coping, and can indirectly affect a person’s psychological distress level through their coping style (26). Psychological capital is negatively associated with maladaptive CERS, and this negative cognitive emotional coping may significantly impede the development of psychological capital (19). To our knowledge, although psychological capital acts as an important protective factor against the onset and persistence of psychological distress, the associations among psychological capital moderating perceived stress, maladaptive CERS, and PTSD symptoms have not been established. Therefore, in order to reduce the incidence of mental disorders among nurses, it is necessary to study the protective mechanism of psychological capital. Once it is understood how psychological capital moderates the association between perceived stress and maladaptive CERS/PTSD symptoms, nursing managers can design effective intervention plans to reduce the occurrence of PTSD symptoms in nurses. Therefore, we propose the following hypotheses:

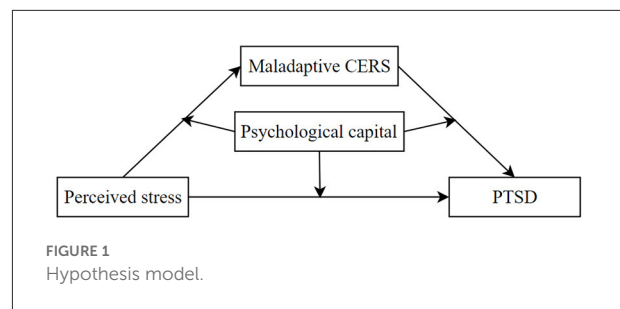
Hypothesis 2: Psychological capital moderates the relationship between perceived stress and PTSD symptoms.

Hypothesis 3: Psychological capital moderates the relationship between perceived stress and maladaptive CERS.

In addition, psychological capital can help individuals to alleviate the adverse effects of maladaptive CERS on mental health. Studies have shown that a high level of psychological capital has a protective effect on psychological vulnerability, and can buffer the adverse effects of maladaptive CERS on psychological vulnerability (28). However, whether psychological capital moderates the relationship between maladaptive CERS and PTSD symptoms needs further verification. Therefore, in this study, we propose the fourth hypothesis:

Hypothesis 4: Psychological capital moderates the relationship between maladaptive CERS and PTSD symptoms.

To date, no study has investigated the regulatory and mediating mechanisms among perceived stress, maladaptive CERS, PTSD symptoms, and psychological capital. Therefore, based on theories and the existing literature, we constructed a moderated mediation model (Figure 1) to investigate the mediating and regulating mechanisms of perceived stress in predicting PTSD symptoms, so as



to provide empirical support and theoretical guidance for the occurrence and persistence of PTSD symptoms among nurses.

## Materials and methods

### Participants and procedure

Convenience sampling was used in this cross-sectional study, which was conducted in eight hospitals in Jiangsu Province from September 12 to September 22, 2021. Data were collected through an online survey platform (<https://www.wjx.cn/>), and all information was obtained in the form of an anonymous self-report. Candidates eligible to participate in this study were actively working registered nurses, without a history of psychiatric disorders, aged 18 years or older, and with at least 1 year of experience, who also volunteered to participate in this study. Intern nurses, refresher nurses, retired nurses, nurses working in non-clinical posts, and nurses who experienced life events were not allowed to participate in this study. The sample size was calculated using the formula  $N = Z_{\alpha/2}^2 \pi(1 - \pi)(DEFF) / d^2$  ( $\pi$  = Estimate of the expected proportion,  $d$  = Desired level of absolute precision,  $DEFF$  = Estimated design effect) (29). In this study,  $\alpha = 0.05$ ,  $Z_{\alpha/2} = 1.96$ ,  $\pi = 17.1\%$ ,  $DEFF = 1$ , When the value of  $\pi$  is outside 20~80%,  $d = 3\%$ , Considering 10% dropout rates, we calculated that the total sample size was 667 in this study (5). A total of 1,424 people participated in the survey, 83 questionnaires that did not fit the nursing profession were excluded, as were 187 questionnaires that took <500 s to fill. Four hundred thirty-one registered nurses were excluded because they had experienced at least one life event in the list of life events such as divorce, death of a spouse, heavy debt, robbery, moving, serious illness or serious injury to a family member, and death of a family member. A total of 723 data pieces were available for analysis. Data collection for this study was approved by the Ethics Committee of the School of Nursing, Yangzhou University (No: YZUHL2021028). During the study investigation, participants were told they could withdraw from the study at any time.



## Measures

### The PTSD checklist for DSM-5 (PCL-5)

The Post-traumatic Stress Disorder Screening form is based on the Diagnostic and Statistical Manual of Mental Disorders, Edition 5 (DSM-5) criteria (30). The questionnaire consists of 20 items, including intrusive symptoms (criterion B: questions 1–5), avoidance symptoms (criterion C: questions 6–7), negative alteration in cognition and mood symptoms (criterion D: questions 8–14), and hyperarousal (criterion E: questions 15–20). The questionnaire was rated on a five-point Likert scale of 0 (not at all) to 4 (extremely). The total score is 0–80. A higher score indicates a higher level of PTSD symptoms. The scale has been widely used to measure PTSD symptoms among health care workers (31), with a positive screening cutoff of 33 points. In this study, the Cronbach's alpha was 0.972 for the PCL-5 scale.

### The Chinese version of the perceived stress scale

The perceived stress scale developed by Cohen et al. was used to measure the self-perceived stress level (32). The scale includes two dimensions, tension and control, with 14 items, each on a five-point Likert scale ranging from 0 (never) to 4 (very common). Scores range from 0 to 56, and the total score is positively correlated with perceived stress. The Chinese version of the scale has been proven to have good reliability and validity (33, 34). In this study, the Cronbach's alpha was 0.691 for the CPSS scale.

### Maladaptive cognitive emotion regulation strategies (maladaptive CERS)

The Cognitive Emotion Regulation Questionnaire (CERQ) was developed by Garnefski et al., and is used to evaluate strategies for cognitive emotion regulation in the face of negative events (15). The Chinese version of the Cognitive Emotion Regulation Questionnaire (CERQ-C) used in this study has good reliability and validity (35). There were 36 items in the questionnaire, including nine dimensions, five kinds of adaptive CERQ-C (positive reappraisal, positive focusing, putting into perspective, refocusing on planning, and acceptance) and four kinds of maladaptive cognitive emotion regulation strategies (self-blame, rumination, other-blame, and catastrophizing) respectively, and five-point Likert scales from 1 (never) to 5 (always) were used to assign scores. In this study, the CERQ-C maladaptive strategy questionnaire was used and Cronbach's alpha was 0.960.

### The nurse psychological capital questionnaire (PCQ-R)

This instrument was developed by Luthans et al. to evaluate the psychological capital of employees (36). Luo Hong et al.

translated and revised the scale based on the characteristics of nursing work (37), with a total of 20 items, including self-efficacy, hope, resilience and optimism. The questionnaire used a six-point Likert scale, rated from 1 (strongly disagree) to 6 (strongly agree), and the total score was 20–120. The higher the score, the higher the level of psychological capital. This scale has been proved to have good reliability and validity (25, 37). In this study, the Cronbach's alpha was 0.991 for the PCQ-R scale.

### The patient health questionnaire-9

The Generalized Anxiety Disorder Scale-7 was used to assess the severity of seven depression symptoms in the last 2 weeks (38). The scale uses a 4-point Likert scale from 0 (not at all) to 3 (nearly every day), with an overall score range of 0 to 27. The scores of 5, 10 and 20 were the threshold of mild, moderate and severe depression, respectively (38). In this study, the Cronbach's alpha of GAD-7 was 0.954.

## Statistical analyses

The data were analyzed using IBM SPSS Version 26, and the SPSS macro PROCESS was used to test the moderated mediation model (39). The analysis was carried out in four steps. First, the basic characteristics of nurses were analyzed by descriptive statistics. The Mann-Whitney U nonparametric test and Kruskal-Wallis nonparametric test were used to compare the PTSD scores of nurses with different demographic characteristics. Second, the Harman single-factor test was used for a common method deviation test (40). Spearman correlation was used for analysis of correlation and the basic situation of measured variables was described. Third, Model 4 (a simple mediation model) in the SPSS macro PROCESS was used to analyze the mediating effect of maladaptive cognitive emotion regulation strategies on the relationship between perceived stress and PTSD symptoms. Fourth, the SPSS macro PROCESS model 59 was used to analyze the moderating effect of psychological capital on the direct or indirect relationship between perceived stress and PTSD symptoms. All study variables except covariables were standardized before PROCESS analysis. The bootstrapping method (5,000 bootstrapping samples) with 95% confidence intervals (CIs) was conducted to detect the significance of the effects (39).

## Results

### Characteristics of the research participants

The 723 nurses were aged from 22 to 59 years, with an average of 32.91 ( $\pm 6.73$ ) years, and their working years ranged from 1 to 40, with an average of 11.34 ( $\pm 7.55$ ). The demographic

characteristics of the study participants and univariate analysis for the factors related to the level of PTSD symptoms is shown in Table 1. The results showed that gender ( $p = 0.018$ ), age ( $p = 0.016$ ), work department ( $p = 0.036$ ), and depression ( $p < 0.001$ ) were associated with PTSD symptoms.

## Common method deviation test

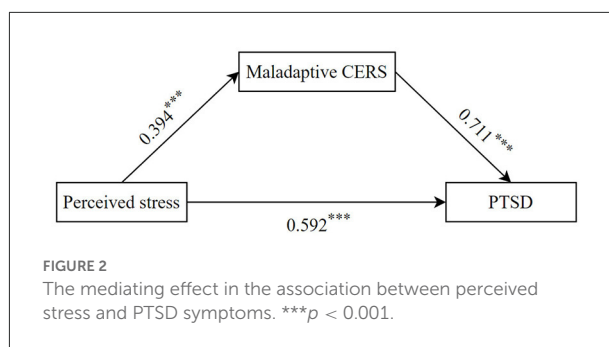
The Harman single factor test was used to test common method deviation. The results showed that there were seven factors whose initial eigenvalue was  $>1$ . The first factor explained 37.46% of the total variation, which was less than the critical value of 40%, indicating that there was no serious common method bias.

## Correlation analysis of measurement variables

For preliminary analysis of the relationships between variables, descriptive statistics and correlation analysis were conducted, as shown in Table 2. The results showed that maladaptive CERS ( $r = 0.182, p < 0.001$ ) and PTSD symptoms ( $r = 0.365, p < 0.001$ ) were positively correlated with perceived stress. In addition, perceived stress ( $r = -0.389, p < 0.001$ ), maladaptive CERS ( $r = -0.326, p < 0.001$ ) and PTSD symptoms ( $r = -0.429, p < 0.001$ ) were negatively correlated with psychological capital. Finally, maladaptive CERS was positively correlated with PTSD symptoms ( $r = 0.674, p < 0.001$ ).

## Testing for mediation effect

According to hypothesis 1, we evaluated whether maladaptive CERS plays a mediating role between perceived stress and PTSD symptoms, as shown in Figure 2. Model 4 (a simple mediation model) in the SPSS macro PROCESS was used to test the mediation effect. After controlling for age, gender and work department, perceived stress had a significant predictive effect on PTSD symptoms ( $\beta = 0.592, p < 0.001$ ). Perceived stress significantly predicted maladaptive CERS ( $\beta = 0.394, p < 0.001$ ), and maladaptive CERS significantly predicted PTSD symptoms ( $\beta = 0.711, p < 0.001$ ). Bootstrapping analysis further showed that the indirect effect of maladaptive CERS was significant (indirect effect = 0.280, SE (Standard Error) = 0.044, 95%CI = [0.198, 0.368]), and the direct effect of perceived stress and PTSD symptoms was significant ( $\beta = 0.592, p < 0.001$ ). Maladaptive CERS partially mediated the relationship between perceived stress and PTSD symptoms, accounting for 32.11% of the total effect. Therefore, hypothesis 1 is supported.



## Testing for moderated mediation

According to hypothesis 2, we tested whether psychological capital played a moderating role between perceived stress and PTSD symptoms, as shown in Figure 3. After controlling for age, gender, and work department, perceived stress was positively associated with PTSD symptoms ( $\beta = 0.293, p < 0.001$ ), whereas psychological capital was negatively associated with PTSD symptoms ( $\beta = -0.091, p < 0.01$ ). Furthermore, psychological capital significantly moderated the direct association between perceived stress and PTSD symptoms ( $\beta = -0.118, p < 0.001$ ). To further examine the effect of different levels of psychological capital on PTSD symptoms, we divided psychological capital into a low level psychological capital group (1 standard deviation below the mean) and a high level psychological capital group (1 standard deviation above the mean) for simple slope analysis. As shown in Figure 4, the effect of perceived stress on PTSD symptoms has a steeper slope for people with low levels of psychological capital than for people with high levels of psychological capital. For those with low levels of psychological capital, higher perceived stress was associated with higher PTSD symptoms ( $\beta = 0.411, p < 0.001$ ), whereas for those with high levels of psychological capital, this association was weakened ( $\beta = 0.175, p < 0.001$ ). This implies that psychological capital inhibits the positive relationship between perceived stress and PTSD symptoms. Therefore, hypothesis 2 is supported.

We examined the potential moderating role of psychological capital in the indirect associations between perceived stress and PTSD symptoms *via* maladaptive CERS, as shown in Figure 3. The results showed that the interaction between maladaptive CERS and psychological capital was significant in predicting PTSD symptoms ( $\beta = -0.067, p < 0.01$ ); however, the interaction between perceived stress and psychological capital was not significant in predicting maladaptive CERS ( $\beta = -0.003, p > 0.05$ ). Thus, hypothesis 3 is not supported. A simple slope analysis is shown in Figure 5, which describes the relationship between maladaptive CERS and PTSD symptoms on two levels of psychological capital (i.e., 1 standard deviation below the mean and 1 standard

TABLE 1 Demographic characteristics of the study participants and univariate analysis for the factors related to the level of PTSD symptoms.

Variable	<i>n</i> (%)	PTSD Median (interquartile range)	Z/H	<i>p</i>
Age			−2.415 <sup>a</sup>	0.016
<30	229 (31.7)	8.00 (1.00, 20.00)		
≥30	494 (68.3)	12.00 (3.00, 20.00)		
Sex			−2.369 <sup>a</sup>	0.018
Male	12 (1.7)	1.50 (0.00, 14.75)		
Female	711 (98.3)	12.00 (2.00, 20.00)		
Marital status			−1.529 <sup>a</sup>	0.126
Single	150 (20.7)	8.00 (1.00, 20.00)		
Married	573 (79.3)	12.00 (2.00, 20.00)		
Working years			3.931 <sup>b</sup>	0.140
≤5	145 (20.1)	8.00 (0.00, 20.50)		
6–10	261 (36.1)	13.00 (2.00, 20.00)		
≥11	317 (43.8)	12.00 (2.50, 20.00)		
Education degree			3.211 <sup>b</sup>	0.201
Below bachelor's degree	54 (7.5)	8.50 (1.00, 20.00)		
Bachelor's degree	664 (91.8)	12.00 (2.00, 20.00)		
Above bachelor's degree	5 (0.7)	3.00 (0.00, 14.00)		
Work department			10.302 <sup>b</sup>	0.036
Internal medicine	294 (40.7)	9.00 (1.00, 20.00)		
Surgical	225 (31.1)	12.00 (1.00, 20.00)		
ICU	82 (11.3)	14.50 (1.00, 26.00)		
Emergency department	57 (7.9)	15.00 (4.00, 24.00)		
Other departments	65 (9.0)	15.00 (3.00, 23.50)		
Depression			248.593 <sup>b</sup>	<0.001
None	313 (43.3)	3.00 (0.00, 10.00)		
Mild	298 (41.2)	17.00 (8.00, 21.00)		
Moderate	98 (13.6)	32.50 (20.00, 40.25)		
Severe	14 (1.9)	41.50 (12.25, 64.75)		

<sup>a</sup>Mann-Whitney U nonparametric test.<sup>b</sup>Kruskal-Wallis nonparametric test.

deviation above the mean). It can be seen that the effects of maladaptive CERS on PTSD symptoms have a steeper slope when compared with individuals with high levels of psychological capital. Higher maladaptive CERS were associated with higher PTSD symptoms in those with low levels of psychological capital ( $\beta = 0.654$ ,  $p < 0.001$ ); however, the association was weakened in those with high levels of psychological capital ( $\beta = 0.520$ ,  $p < 0.001$ ). This suggests that psychological capital inhibits the positive association between maladaptive CERS and PTSD symptoms, and hypothesis 4 is thereby supported.

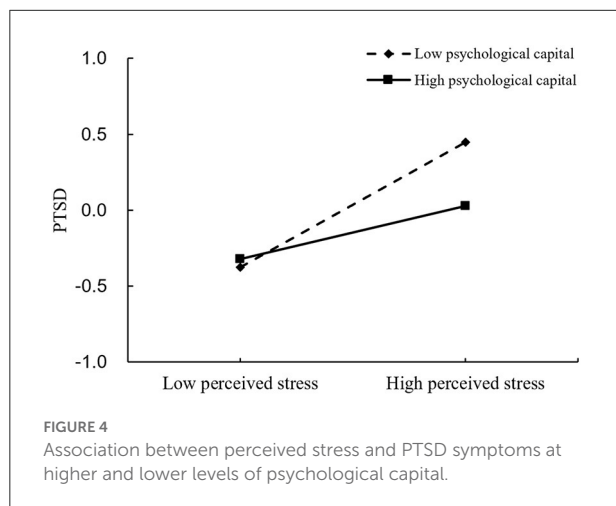
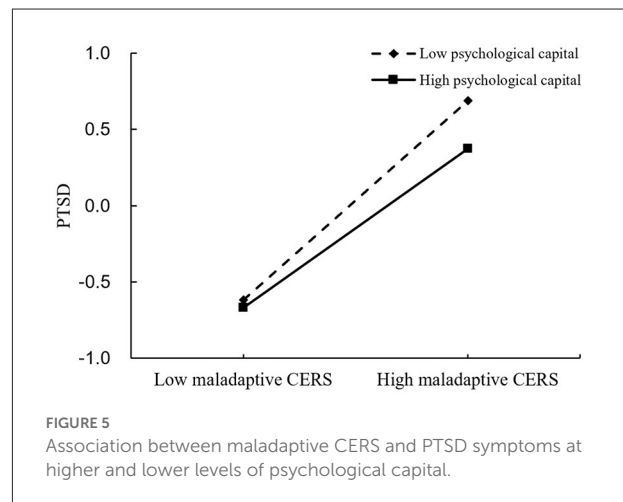
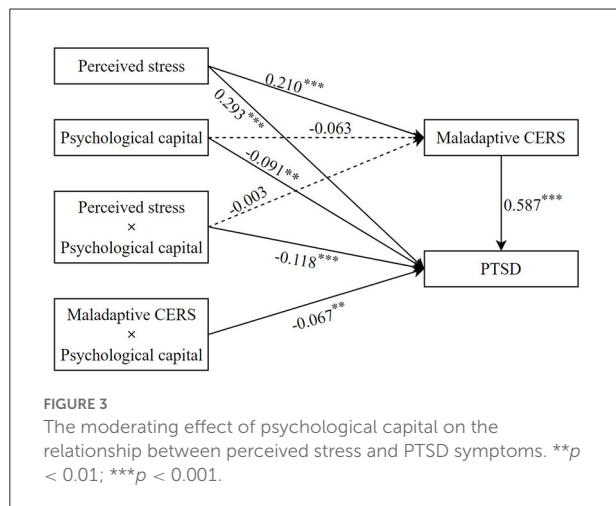
## Discussion

Although there is growing evidence that stress has a significant effect on PTSD symptoms, few studies have explored the role of maladaptive CERS and psychological capital in this relationship using a process-oriented approach. Based on previous studies and theoretical frameworks, we constructed a moderated mediation model. In this study, we found that the relationship between perceived stress and PTSD symptoms is partly mediated by maladaptive CERS and moderated by psychological capital. These findings may help in the

TABLE 2 Descriptive statistics and correlations for all variables.

Variable	M	SD	1	2	3	4
Perceived stress	23.93	6.92	1.00			
Maladaptive CERS	36.39	11.68	0.182***	1.00		
PTSD	14.19	13.95	0.365***	0.674***	1.00	
Psychological capital	88.47	21.03	-0.389***	-0.326***	-0.429***	1.00

*N* = 723; \*\*\**p* < 0.001.



development of targeted interventions aimed at reducing nurses' risk of developing PTSD symptoms in stressful situations.

Our results suggest that maladaptive CERS mediate the association between perceived stress and PTSD symptoms, and that higher levels of perceived stress are associated with higher levels of maladaptive CERS, which in turn are associated with higher levels of PTSD symptoms. In addition, our findings showed that maladaptive CERS, perceived

stress and PTSD symptoms were positively correlated, which confirms the findings of previous studies (18, 21, 22). Our results are consistent with previous findings that the use of maladaptive CERS is an important mechanism underlying the negative effects of stress on psychological dysfunction (41). When nurses use maladaptive CERS more frequently, PTSD symptoms increase, with the increase of perceived stress. This suggests that maladaptive CERS are important risk factors for PTSD symptoms in nurses. Nurses should avoid maladaptive cognitive emotional regulation strategies in order to prevent the adverse effects of perceived stress on PTSD symptoms. In future research, further investigation is needed to determine which specific cognitive emotion regulation strategies are more protective or confer more risk for PTSD symptoms. In conclusion, maladaptive CERS induced by perceived stress may be an important risk factor for the development of PTSD symptoms.

In addition, psychological capital was negatively correlated with perceived stress and PTSD symptoms in our study, which is consistent with previous findings (42, 43). Wang et al. showed that perceived stress was more likely to lead to negative emotions among medical students with lower levels of psychological capital (42). Our results support our hypothesis that psychological capital is a mediator of the direct relationship between perceived stress and PTSD symptoms and,

more specifically, perceived stress is an important risk factor for developing PTSD symptoms in nurses with low levels of psychological capital. Hobfoll proposed the conservation of resources theory, which argues that valuable resources play a positive role in the individual stress response. These resources include material resources, power, interpersonal relationships and positive psychological factors (44, 45). This means that psychological capital, as a positive psychological quality, is regarded as a protective factor for mental health, so that individuals can still have good adaptability in the face of environmental pressure. When facing the pressures of life and work, individuals with a higher level of psychological capital can mobilize positive psychological resources and alleviate the negative impact of pressure with an optimistic attitude, strong self-efficacy and resilience.

The moderating effect model of psychological capital holds that psychological capital influences individual, group and organizational outcome variables through its moderating effect, which is supported by empirical research (46). As hypothesized, psychological capital moderated the association between maladaptive CERS and PTSD symptoms and, in particular, the adverse effects of maladaptive CERS on PTSD symptoms were greater for nurses with lower levels of psychological capital than for nurses with higher levels. Adaptive cognitive emotion regulation and psychological capital have been reported to have a role in regulating and maintaining mental health (28). Good psychological capital, with positive psychological qualities of self-efficacy, hope, resilience and optimism, helps an individual to deal with negative events with a positive attitude, promotes the stimulation of individual positive emotions, and alleviates the negative effects of maladjustment on PTSD symptoms.

In conclusion, high psychological capital moderated the effects of perceived stress on PTSD symptoms, allowing individuals to cope effectively with stress and alleviating the effects of maladaptive CERS on PTSD symptoms. This means that improving nurses' level of mental capital is an important measure to prevent mental health problems. However, contrary to our hypothesis, psychological capital does not play a moderating role in perceived stress and maladaptive CERS; that is, psychological capital does not protect against the negative effects of perceived stress on maladaptive CERS. A possible explanation is that maladaptive CERS are often associated with mental health problems, such as depression and PTSD symptoms (16, 18). However, adaptive CERS are usually associated with positive psychological factors, such as resilience and psychological capital (17, 19). Given the lack of research, larger studies are needed to confirm these findings.

Our study provides new evidence of an association between the mediating role of maladaptive CERS and the moderating role of psychological capital in the relationship between perceived stress and PTSD symptoms. However, our study has some limitations. First, the cross-sectional design of the study makes

it difficult to infer a causal relationship among these variables, and large-scale, multi-center prospective studies are needed to verify the findings. Second, the study excluded registered nurses with traumatic life events, but did not investigate the nurses' traumatic work experience and work stressors, and these traumatic experiences have an important impact on the occurrence and development of PTSD. Third, we observed a very skewed gender distribution in our sample, with 98.3% of the participants being females. The gender-related findings might be totally biased. Further study should be conducted to replicate our findings in a gender-balanced sample. Finally, the data used in this study were all obtained from the supervisor reports of the participants, so the results may be biased, and the interpretation and application of the results should be cautious. Future studies should consider collecting data from multiple sources to improve the objectivity of measurement.

Despite these limitations, there are important practical implications. On the one hand, in our study, maladaptive CERS were a major factor linking perceived stress and PTSD symptoms. It is important to note that cognitive strategy is a modifiable factor, and previous empirical studies have shown that cognitive training can increase the use of adaptive CERS and decrease the use of maladaptive CERS (47, 48). On the other hand, our results suggest that psychological capital plays a moderating role in perceived stress/maladaptive CERS and PTSD symptoms. Studies by Dello et al. show that training courses on psychological capital can significantly improve the level of individual psychological capital, and the effect of the intervention is lasting (49). This means that interventions targeting individual psychological capital may be effective in preventing or alleviating mental health problems. We suggest that health professionals should develop and provide prevention and intervention programs oriented toward cognitive emotion and psychological capital to promote the maintenance of mental health among health workers.

In conclusion, our study constructed a moderated mediation model to examine the relationship between perceived stress and PTSD symptoms. Maladaptive CERS are a partial mediator between perceived stress and PTSD symptoms. In addition, psychological capital moderates the effects of perceived stress and maladaptive CERS on PTSD symptoms. Our findings highlight the importance of evaluating and improving interventions for maladaptive CERS and psychological capital, which may be effective strategies to prevent or reduce PTSD symptoms in nurses.

## Data availability statement

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



## Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the School of Nursing, Yangzhou University (No: YZUHL2021028). 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

MX: conception and design of the study, writing the original draft, analysis of data, and data curation. YY, HC, and MD: resources and acquisition of data. YL: conception and design of the study, writing the review, and supervision. HS and JiQ: analysis of data. TZ and JZ: conceptualization. JuQ, YB, SJ, YH, ZY, YF, and XG: data curation. 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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