THE CONSEQUENCES OF COVID-19 ON THE MENTAL HEALTH OF STUDENTS

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THE CONSEQUENCES OF COVID-19 ON THE MENTAL HEALTH OF STUDENTS

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Impact of the Perceived Mental Stress During the COVID-19 Pandemic on Medical Students' Loneliness Feelings and Future Career Choice: A Preliminary Survey Study

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The outbreak of the COVID-19 epidemic continues to unfold globally, and its negative impact on the public's mental health is starting to reveal. Serving as reserve talents for the healthcare system, medical students are not yet professionally matured enough to face one of the worst global public health crises. This may exert increased mental stress and loneliness feelings, which in turn negatively influence medical students' future career choice. To address the issue, we conducted three online survey studies investigating how the epidemic affects the mental health as well as career attitude of medical students in China during the COVID-19 pandemic outbreak. The results revealed preliminary evidence showing that the perceived stress induced by the COVID-19 epidemic might negatively affect medical students' future career choice, and the feeling of loneliness may play a mediating role. This study invites more attention to medical students' mental health during severe public health crisis such as the COVID-19 pandemic.

Keywords: COVID-19, loneliness, career attitude, medical students, mental stress

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INTRODUCTION

The outbreak of the COVID-19 epidemic has affected the lives of billions worldwide. In addition to causing economic upheaval and political unrest, the epidemic also poses a major challenge to public health—both physical and psychological (1, 2). Therefore, multidisciplinary researchers have been calling for attention to the mental health in various groups (3–5), among which understanding how the pandemic affects medical students is an important issue (6). The COVID-19 pandemic has brought a heavy burden on the global health system, and soon medical demand could outpace the medical capacity globally (7). This means we need all workforce available, and some countries have already moved their senior medical students to early graduation (8, 9). However, while being in training, medical students are missing the experience to deal with such severe situations, potentially leading to increased mental stress and in turn negatively influence their future career choice (10, 11).

In order to contain the coronavirus, governments across the world have enacted rigorous measures, such as the closure of borders, curfews, a general ban on assembly, and the closure of public places including parks, playgrounds, schools, universities, and shops.

These control measures placed millions of people in isolation (12, 13), and may further result in an increase of mental health concern in loneliness (14–19). Loneliness is a painful emotional experience of a discrepancy between actual and desired social contact (20–23). During the COVID-19 pandemic, medical professions are encountering more challenges than ever (24, 25), and are over-identified accompanied by sensitivity to criticism, which may lead to increased loneliness feelings (26). Ample studies have demonstrated that loneliness may negatively impact individuals' future career orientation [e.g., (27, 28)]. Therefore, this study aimed to examine the issue of how the COVID-19 pandemic influences medical students' future career choice as well as the mediating role of loneliness.

PERCEIVED MENTAL STRESS AND LONELINESS FEELINGS DURING THE COVID-19 PANDEMIC

The outbreak of the COVID-19 pandemic has exerted severe pressure on global healthcare systems and stressed the already busy labor capacities within the systems, highlighting an urgent need for more medical and healthcare professions (7–9). Accordingly, countries around the world have reinstated retired doctors as well as clinical academics to clinical practice, and have given permission to final-year medical students to start working prior to their graduation (29). It is well-acknowledged that the COVID-19 pandemic exerted severe security challenges to the medical and healthcare professions, which increased their mental stress (25). As for the senior medical students, although not directly being at the frontlines of the pandemic, the medical students are still facing the risk of becoming infected with COVID-19 due to their rotation in the hospital which is accompanied by close contact with various kinds of patients. Therefore, the medical students may suffer increased mental stress during the COVID-19 pandemic.

Previous studies have demonstrated that the perceived mental stress may intensify feelings of loneliness (30–32). For instance, Yarcheski et al. (33) reported a significant positive correlation between perceived mental stress and loneliness. Similarly, in a recent review, Brown et al. (34) have also demonstrated positive associations between perceived mental stress and loneliness feelings. During the COVID-19 pandemic, medical and healthcare professions may have a sense of over-identification with the pandemic accompanied by sensitivity to criticism, which may increase the perceived mental stress as well as loneliness feelings (26).

MEDICAL STUDENTS' CAREER ORIENTATION AND LONELINESS FEELINGS

Loneliness is a social construct, characterized by subjective feelings of social pain and/or isolation (32). The desire for social connections is a fundamental element in our survival gene (35, 36). Previous studies have examined the motivational aspects of individuals' interests in pursuing a career in medicine or healthcare to find new ways, not only to popularize these professions among adolescents and young adults but also to preemptively avoid future labor shortages in the healthcare sector during critical times such as the current COVID-19 pandemic. Literature has shown that intrinsic (i.e., personal interest, willingness to help), extrinsic (i.e., job security, financial remuneration), socio-demographic (i.e., gender, socio-economic status), as well as interpersonal factors (i.e., family, friends) could affect career preference of medical and healthcare students significantly (10, 11, 37, 38). The COVID-19 pandemic has exerted severe security challenges to the medical and healthcare professions, and may negatively influence their future career choice. For instance, the shortened internship experience may cause medical students to feel less prepared to enter the workforce. In addition, Isaac et al. (39) have revealed a negative relation between self-perception of social isolation, i.e., loneliness feelings, in medical students and their career intent.

THE PRESENT STUDY AND HYPOTHESIS

This study aimed to examine the negative impact of perceived mental stress during the COVID-19 pandemic on medical students' attitude toward their future career choice, and to further uncover the mediating role of loneliness. A cross-sectional survey was conducted in March 2020 (Study 1), when the confirmed cases of the COVID-19 reached peak level in China, and a new survey (Study 2) with different measurements of perceived influence on medical students' career choice was collected in June 2020 to confirm the findings of Study 1. Study 3 was finally conducted in June 2020 with non-medical students as a control. Based on previous findings, we hypothesized that, compared with the non-medical students, the perceived mental stress by medical students during the COVID-19 pandemic would negatively influence their career choice, which was mediated by their feelings of loneliness. The respondents in three studies all gave their consent before filling in the questionnaire, and all studies were approved by the Institutional Review Boards of Fujian Medical University and School of Management, Zhejiang University.

STUDY 1

Methods

Sample and Procedure

We conducted a cross-sectional survey to 12 medical colleges and universities in China in March 2020, the worst period of the COVID-19 pandemic in China. We finally recruited 906 medical students (312 males, 594 females; 21.75 ± 1.90 years old; 3.35 ± 1.51 year of college).

Abbreviations: COVID-19, The 2019 Novel coronavirus diseases.

Measures

Demographic

Respondents were asked to provide their demographic and academic information such as gender, age, origin, major and college year.

Perceived Influence on Career Choice

Respondents were asked to directly rate the influence of the COVID-19 pandemic on their attitude toward future career choice as medical professions in a 5-point Likert scale (1 = "very positive influence," 5 = "very negative influence").

Perceived Stress

Respondents then scored their mental stress status using a 14-item Chinese Perceived Stress Scale (CPSS) (40) modified from Cohen et al. (41) with a 5-point scale (0 = "never" to 4 = "very often"). Sample items include "In the last month, how often have you been upset because of something that happened unexpectedly?." In the present sample, the stress scale showed good internal consistency (Cronbach $\alpha = 0.87$).

Feelings of Loneliness

Respondents also rated their loneliness feelings using a 20-item UCLA Loneliness Scale (UCLA-LS), version 3 (42). Sample items include "I can find companionship when I want it," and "No one really knows me well." Each item was rated on a 4-point scale, ranging from 1 = "never" to 4 = "most of the time." The scale showed good internal consistency as well (Cronbach $\alpha = 0.92$).

Results

We firstly statistically assessed the common method bias using the Harman one-factor analysis. The first factor in our data explained only 26.27% of the variance, suggesting that common method bias was unlikely to confound the interpretations of our results.

The Pearson correlation analysis revealed significant positive relations between the scores on perceived mental stress ($M = 38.66$, $SD = 6.55$) and loneliness feelings ($M = 40.66$, $SD = 9.10$; $r = 0.62$, $p < 0.001$). In addition, the Pearson correlation analysis revealed significant positive correlations between the score of perceived influence on career choice ($M = 2.14$, $SD = 1.06$) and the respondents' age ($r = 0.09$, $p = 0.007$), college year ($r = 0.17$, $p < 0.001$), as well as their rating scores on perceived mental stress ($r = 0.11$, $p = 0.001$) and loneliness feelings ($r = 0.13$, $p < 0.001$). While controlling variables of age and college year, the partial correlation analysis still revealed significant positive correlations between the score of perceived influence on career choice and the mental stress score ($r = 0.11$, $p = 0.001$) as well as the loneliness score ($r = 0.14$, $p < 0.001$).

To further confirm the impact of perceived mental stress on respondents' career attitude and the mediating role of loneliness as well, we conducted a step-wise linear regression model taking age and college year as covariates. **Table 1** shows detailed results of the regression analysis. Consistent with the correlation findings, perceived mental stress showed a positive relation with respondents' career attitude (beta = 0.017, $p = 0.001$) as shown in Model 2, which was non-significant ($p = 0.426$) while taking loneliness feelings (beta = 0.013, $p = 0.005$) into consideration, suggesting a potential mediating role of loneliness.

The mediation test, using bootstrap (5000 times) by Model 4 in PROCESS for SPSS v3.5, confirmed that respondents' loneliness feelings fully mediated the relation between their perceived mental stress and career attitude (**Figure 1**). While taking loneliness feelings as the independent variable and perceived mental stress as the mediator, the same mediation test revealed significant direct effect [(LLCI, ULCI) = (0.002, 0.021)] but no significant indirect effect [(LLCI, ULCI) = (−0.003, 0.010)], confirming the unique mediating role of loneliness.

STUDY 2

Study 1 showed preliminary evidence that the perceived mental stress by medical students during the COVID-19 pandemic negatively influenced their future career choice, which was mediated by loneliness feelings (although the effect size is relatively small). Study 2 was then designed to confirm the main findings revealed in Study 1 three months later in June 2020 with different measurements of perceived influence on future career choice. In addition, Study 2 could also address the issue of whether the negative stress-career relation was a short-term phenomenon or not, since the COVID-19 pandemic had been well-controlled in China in June.

Method

We recruited 354 medical students from Fujian Medical University (196 males, 158 females; 21.09 ± 1.63 years; 2.86 ± 1.37 year of college). All respondents gave their consent and finished the same survey as used in Study 1, with different measurement of perceived influence of COVID-19 pandemic on their future career choice, and additional measurements of perceived risk during the COVID-19 pandemic.

In Study 1, we asked the respondents to directly rate the extent to which the COVID-19 pandemic influenced their future career attitude on a 5-point Likert scale, ranging from strong positive to strong negative influence. The results indicated that many of students rated positive influence, suggesting that the COVID-19 pandemic may exert impacts on medical students' future career attitude both negatively and positively. To focus on the negative influence, in Study 2 the respondents were asked to score two separate items that to what extent the COVID-19 pandemic negatively/positively influenced their future career attitude using a 3-point scale (1 = "no influence at all," 3 = very negative/positively influence).

In addition, to examine whether the COVID-19 pandemic increased medical students' mental stress or not, we also asked the respondents to score the possibility that they could get infected by COVID-19 using a 4-point scale (1 = "almost impossible," 4 = "highly possible").

Results

The Harman's single-factor analysis showed that the first factor in our data explained only 27.03% of the variance, suggesting that common method bias was unlikely to confound the interpretations of our results.

TABLE 1 | Results of step-wise linear regression models predicting respondents' career attitude in study 1.

Variables	Career preference					
	Model 1		Model 2		Model 3	
	Beta	*p*	Beta	*p*	Beta	*p*
Constant	1.650	0.000	2.209	0.000	2.145	0.000
Age	−0.064	0.029	−0.060	0.040	−0.063	0.031
College year	0.182	0.000	0.177	0.000	0.183	0.000
Stress			0.017	0.001	0.005	0.426
Loneliness					0.013	0.005
R^2	0.034	0.000	0.045	0.001	0.053	0.005
F	15.826	0.000	14.095	0.000	12.646	0.000
Loneliness	**Effect**		**SE**		**[LLCI, ULCI]**	
Total effect	0.017		0.005		[0.007, 0.027]	
Direct effect	0.005		0.007		[−0.007, 0.018]	
Indirect effect	0.012		0.004		[0.0034, 0.020]	

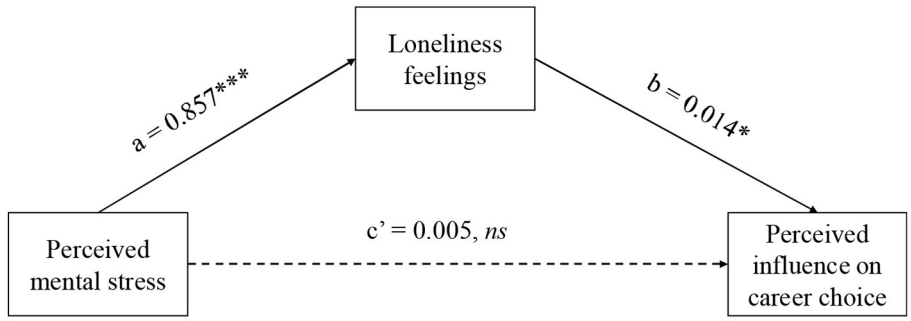

FIGURE 1 | Results of mediation test using bootstrap method in Study 1. ns, *, *** represents $p > 0.05$, $p < 0.05$, $p < 0.001$, respectively.

As expected, the self-reported possibility of infection ($M = 2.06$, $SD = 0.77$) positively correlated with respondents perceived mental stress (Cronbach $\alpha = 0.857$; $M = 38.18$, $SD = 7.21$; $r = 0.12$, $p = 0.023$), indicating that the COVID-19 pandemic indeed increased medical students' mental stress. Consistent with the findings revealed in Study 1, the Pearson correlation analysis also revealed a significantly positive correlation between the scores on perceived mental stress and loneliness feelings (Cronbach $\alpha = 0.818$; $M = 41.52$, $SD = 10.19$; $r = 0.633$, $p < 0.001$). Focusing on the perceived negative influenced of the COVID-19 pandemic on medical students' future career choice ($M = 1.48$, $SD = 0.53$), the Pearson correlation analysis revealed significant positive correlations between the negative career influence and their age ($r = 0.12$, $p = 0.021$) and college year ($r = 0.20$, $p < 0.001$). More importantly, the negative career influence also positively correlated with the perceived mental stress ($r = 0.12$, $p = 0.025$) as well as the loneliness feelings ($r = 0.20$, $p < 0.001$). The partial correlation analysis, taking age and college year as control variables, revealed similar results (stress-career: $r = 0.11$, $p = 0.043$; loneliness-career: $r = 0.18$, $p = 0.001$).

The step-wise linear regression models also revealed significant positive relation between the perceived mental stress and the negative career influence (beta = 0.008, p =.040), which was non-significant ($p = 0.879$) while taking loneliness feelings (beta = 0.010, p =.006) into consideration. Consistently, as **Table 2** shows, the mediation test using bootstrap method (5,000 times, in PROCESS for SPSS v3.5) further revealed that the respondents' loneliness feelings fully mediated the relation between perceived mental stress and negative career influence (**Figure 2**).

STUDY 3

Study 3 examined influence of the COVID-19 pandemic on non-medical students' future career choice as a control condition. We recruited 175 non-medical students (78 males, 97 females; 23.14 ± 2.44 years; 5.50 ± 2.36 year of college due to involvement of graduated students) during the same period as the Study 2 (in June 2020) in Zhejiang University. All respondents gave their consent and finished the same survey as used in Study 1.

The Harman's single-factor analysis showed that the first factor in our data explained only 32.27% of the variance, suggesting that common method bias was unlikely to confound interpretations of our results. Consistent with the findings of Study 1 and Study 2, a positive correlation was revealed between

TABLE 2 | Results of linear regression models predicting respondents' career attitude using perceived stress in study 2.

Variables	Career preference					
	Model 1		Model 2		Model 3	
	Beta	*p*	Beta	*p*	Beta	*p*
Constant	1.914	0.000	1.552	0.007	1.467	0.010
Age	−0.036	0.227	−0.032	0.282	−0.030	0.304
College year	0.109	0.002	0.103	0.003	0.095	0.006
Stress			0.008	0.043	−0.001	0.879
Loneliness					0.010	0.006
R^2	0.042	0.001	0.053	0.043	0.073	0.006
F	7.708	0.000	6.555	0.000	6.909	0.000
Loneliness	**Effect**		**SE**		**[LLCI, ULCI]**	
Total effect	0.008		0.004		[0.001,0.015]	
Direct effect	−0.001		0.005		[−0.010, 0.009]	
Indirect effect	0.009		0.003		[0.003, 0.015]	

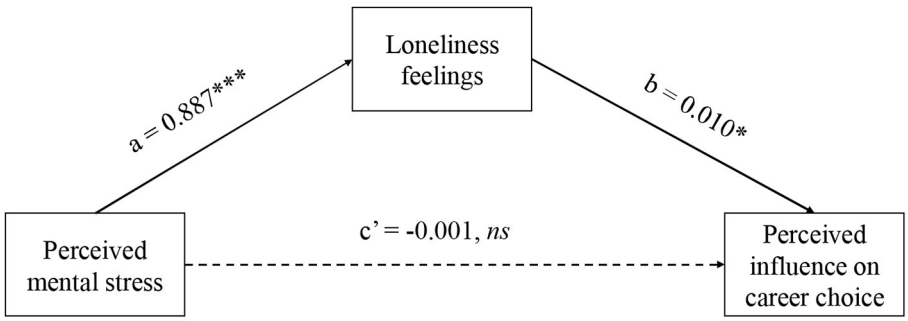

FIGURE 2 | Results of mediation test using bootstrap method in Study 2. ns, *, *** represents $p > 0.05$, $p < 0.05$, $p < 0.001$, respectively.

the scores of mental stress (Cronbach $\alpha = 0.627$; $M = 40.65$, $SD = 8.02$) and loneliness feelings (Cronbach $\alpha = 0.671$; $M = 52.95$, $SD = 5.80$; $r = 0.28$, $p < 0.001$). Even though, the perceived influence of the COVID-19 pandemic on non-medical students' future career choice ($M = 3.58$, $SD = 1.12$) showed no significant correlations with either mental stress ($r = -0.06$, $p = 0.466$) or loneliness feelings ($r = 0.034$, $p = 0.658$).

GENERAL DISCUSSION

Understanding the issue of how the COIVD-19 pandemic influences medical students' mental health and future career choice as medical and healthcare professions is an important topic in the current situation. Through 3 studies, we revealed that the perceived mental stress induced by the COVID-19 pandemic may negatively influence medical students' future career choice, which is mediated by their feelings of loneliness. Ample studies have examined the issues of how the COVID-19 pandemic affects individuals' mental health [e.g., (3–5)], however, very few studies focused on medical students' career attitude as well as the role of loneliness. Previous studies have identified that loneliness significantly impacts individuals' career orientation (27, 28, 39, 43). This research contributes to the literature understanding the impacts of the COVID-19 pandemic on medical students' mental health and career orientation, and calls for more attention to medical students' mental health and future career orientation during severe public health crisis such as the COVID-19 pandemic, emphasizing the importance of loneliness. Practically, both medical universities and governments should provide more psychological supports to medical students reducing their mental stress as well as the loneliness feelings in particular.

We mainly conducted two cross-sectional survey studies in March and June 2020 in China. March 2020 was the first month when the Chinese government activated level-1 public health emergency responses in 31 provincial-level regions in mainland China (44). June 2020 was the first month when people returned to the post-pandemic "normal" life in China after well-controlling the COVID-19. The two studies consistently revealed that the COVID-19 pandemic negatively impacts medical students' mental stress as well as feelings of loneliness. This prevalence psychological response in the time of COVID-19 pandemic is consistent with the general public (13). For instance, Romeo et al. (2) have identified several factors that could predispose University students to a high risk of developing

mental health symptoms as a consequence of the COVID-19 pandemic.

More importantly, we identify a critical role of loneliness suffered by medical students in their future career choice during the public health crisis, although the effect size is relatively small. One possible explanation is that the Chinese government adopted rigorous control measures timely and provided huge supports to medical and healthcare systems, reducing the negative influences of the COVID-19 pandemic. In the survey of Study 2, medical students reported great confidence in the Chinese government (3.81 ± 0.47), while rating the item of "how much confidence do you have in the government policy supporting medical and healthcare systems" on a 4-point scale (1, not at all; 4, very much). Even though, our studies with 1260 medical students consistently showed that the COVID-19 pandemic increased medical students' mental stress, which in turn aggravated their feelings of loneliness and may further negatively impact their future career choice. Future studies are needed to confirm the negative career influence from the severe public health crises.

Previous studies focusing on medical students' career choice have mainly emphasized intrinsic and extrinsic factors such as early specialty interest, self-competency, clinical exposure, and patient-doctor relationship (45), but neglected psychological factors such as loneliness. This research appeals to pay more attention to medical students' mental health during a serious public health crisis, emphasizing their loneliness feelings in particular, and its negative impact on their career choice as medical and healthcare professions.

It is noteworthy that Study 3 with non-medical students did not show the same stress-loneliness-career relation as revealed in medical students. Although the sample size of Study 3 was relatively small, even a clear tendency was not found. One possible explanation is that the COVID-19 pandemic not only poses a major challenge to public health, but also causes massive economic and political unrest, which further negatively impacted non-medical students' work situation. In order to contain the virus, governments across the world have enacted measures such as the closure of borders, curfews, a general ban on assembly, placing millions of people in isolation and subsequently damaging their own commercial system in the process. In this case, non-medical students may perceive feelings of uncertainty when it comes to job hunting. Thus, the perceived mental stress and feelings of loneliness may contribute little to their career choice. Future study is needed to address the issue of how the COVID-19 pandemic influences non-medical students' mental health and career situation.

The present research has several limitations as well. First, this research was a cross-sectional design, and hence cannot conclude a causal relationship between variables. Second, the samples were mainly recruited from the East coast of China. More studies should be done to examine the influence of the COVID-19 epidemic on medical students' mental health and career choice globally. More importantly, researchers should pay more attention to other critical factors such as poverty and lack of resources and examine how such factors influence the stress-loneliness-career relation in medical students. Third, the measurement of career influence had only one item, the robustness of the results should be confirmed in future studies. Even though, the respondents were asked to directly rate the scores of how the COVID-19 epidemic impacts their future career choice as medical and healthcare professions, providing preliminary evidence emphasizing the importance of the potential negative influence of the COVID-19 epidemic on medical students' mental health and career choice. Fourth, this research did not collect comparable samples from both medical and non-medical students in one study, limiting our conclusion on the uniqueness of the stress-loneliness-career relation induced by the COVID-19 epidemic in medical students, which should be confirmed in the future study.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The present studies were approved by the Ethical Review Boards of Fujian Medical University and School of Management, Zhejiang University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TL designed the theoretical framework and analyzed the data. QZ, XL, and LH collected the data. All authors wrote 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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ORIGINAL RESEARCH
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Prevalence and Risk Factors of Mental Health Symptoms and Suicidal Behavior Among University Students in Wuhan, China During the COVID-19 Pandemic

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Background: University students who are exposed to coronavirus disease 2019 (COVID-19) could be mentally distressed. We aimed to evaluate the pattern and risk factors of mental health and suicidal behavior among students who experienced long-term school closure due to the COVID-19 pandemic.

Methods: This large-sample, cross-sectional, online survey was conducted from June 29, 2020, to July 18, 2020. Eleven thousand two hundred fifty four participants were recruited from 30 universities located in Wuhan, Hubei Province, China. The prevalence of symptoms of depression, anxiety, insomnia, and posttraumatic stress disorder (PTSD) and suicidal behavior was evaluated using the Patient Health Questionnaire-9, Generalized Anxiety Disorder-7, Insomnia Severity Index, Posttraumatic Stress Disorder Checklist for DSM-5, and questions about suicidal ideation and attempts, respectively. Logistic regression was used to explore risk factors for mental health problems and suicidal behavior.

Results: The prevalence of mental health problems was 41.5% for depressive symptoms, 32.6% for anxiety symptoms, 35.0% for insomnia symptoms, 8.5% for PTSD symptoms, and 2.0% for suicidal behavior. Participants with high stress during the pandemic were at higher risk of symptoms of depression [adjusted odds ratio (OR) = 1.67, 95% confidence interval (CI) = 1.43–1.95, $p < 0.01$), anxiety (adjusted OR = 1.90, 95% CI = 1.63–2.23, $p < 0.01$), insomnia (adjusted OR = 1.64, 95%

CI = 1.44–1.87, $p < 0.01$), PTSD (adjusted OR = 1.71, 95% CI = 1.38–2.11, $p < 0.01$) and suicidal behavior (adjusted OR = 3.51, 95% CI = 2.28–5.40, $p < 0.01$). Distant relationship with parents, changes in lifestyle and alcohol use during the pandemic were associated with higher risk of mental health symptoms and suicidal behavior, whereas regular physical exercise reduced the risk of mental health problems.

Conclusions: The psychological symptoms and suicidal behavior were relatively high among students who attended university in Wuhan, China after 6 months of the COVID-19 outbreak in China. Comprehensive mental health services and suicide prevention strategies are essential for university students during the COVID-19 pandemic.

Keywords: university students, COVID-19, prevalence, mental health, suicidal behavior

INTRODUCTION

In December 2019, the coronavirus disease 2019 (COVID-19) outbreak began and was officially announced as a pandemic by the World Health Organization (1). People's lifestyles were profoundly changed by the serious health outcomes of COVID-19, and extremely strict containment measures were taken, including lockdown, quarantine, school closures, and social distancing (2, 3). The unpredictability and uncertainty of the COVID-19 pandemic that are associated with containment strategies and financial loss are among the major stressors that contribute to widespread emotional distress and a higher risk of psychiatric problems in vulnerable populations worldwide (4, 5), including COVID-19-infected cases (6), healthcare workers (7, 8), the elderly (9), and children and adolescents (10).

Mental health status and suicidal behavior among university students that are exacerbated due to long-term mandatory school closures during the pandemic require specific attention. University students might struggle with loneliness and isolation and experience severe psychological distress during the pandemic because of disconnections from friends and partners (11). Students who attended University in an epidemic area during the COVID-19 outbreak might suffer from stigma and discrimination, which were associated with a higher risk of mental health problems (2, 12). Additionally, mental health problem was strongly associated with suicidal ideation and attempts (13, 14). Individuals who had received counseling services on campus could no longer access counseling services, which may exacerbate their mental well-being and increase their risk of substance abuse or even suicidal behavior (11). Suicide is the second leading cause of death among individuals aged 15-29 years globally (15). A meta-analysis showed that the pooled prevalence of lifetime suicidal ideation and attempts among college students was 22.3 and 3.2%, respectively (16).

Several studies reported a potential rise of mental health problems and suicidal behavior among university students during the pandemic (2, 17–19). Major studies focused on a specific mental health problem and had a small sample size (20, 21), evaluated only specific groups (e.g., medical students) (19), or evaluated only one University (18). An exception was the online survey which assessed the prevalence of suicidal ideation, stress, and other mental symptoms among 69,054 university students in France (22). However, most of these investigations including this survey of France were conducted during early stages of the pandemic (18, 23). To date, many countries are facing substitantial threats from the ongoing pandemic and long-term quarantine. University students leaved school and have been changing their normal study habits and lifestyle for a prolonged period of time. Understanding their mental health status and related risk factors is vital for improving mental health, the development of public response strategies, and reopening schools in the future.

To better evaluate the impact of the long-term COVID-19 pandemic on psychological status and suicidal behavior among university students who experienced isolation due to returning home from Wuhan in early days of the pandemic, especially after long-term quarantine and school closure. We conducted a cross-sectional online survey to investigate the prevalence of mental health symptoms and suicidal behavior and potential risk factors among university students 6 months after the COVID-19 pandemic began in China.

METHODS

Study Design

The present study followed the American Association for Public Opinion Research reporting guidelines. Approval from the ethics committee of Peking University Sixth Hospital (Institute of Mental Health) was received before the study began. Informed consent was received online before the respondents began the questionnaire.

This cross-sectional online survey was conducted from June 29, 2020, to July 18, 2020. Based on convenience sampling method, in order to make our sample more representative, the survey involved universities including key universities, ordinary universities and vocational and technical colleges, and the types of subjects of universities were also taken into account. Finally, university students were recruited from 30 universities located in Wuhan, Hubei Province, China (24).

Self-administered questionnaires were sent to students through an online platform and all University classes level were invited to fill the questionaire. Before the survey began, the details of the survey were given by the class instructor to the class wechat group of students or psychological teacher,

the students take part in the survey voluntarily and all of the participants, who then provided informed consent electronically. The investigation was anonymous, and the confidentiality of all information was ensured.

Study Population

A total of 65,845 students clicked on the survey link, and 11,325 individuals provided the informed consent, for a participation rate of 17.20%. The respondents came from 31 province-level regions in China and attended 30 universities in Wuhan, Hubei Province, China. They returned home from Wuhan for winter vacation when the COVID-19 outbreak began and experienced quarantine in their own home during the pandemic. A total of 11,325 individuals provided informed consent and completed the questionnaires, among whom 71 individuals were excluded because of invalid questionnaire. Participants were excluded if their Body Mass Index (BMI) were out of the range of 13–50, younger than 15 years, or contradictory options about the same questions, for example, their marital status was married while they were younger than 20 years or the type of student they fill in wasn't consistent with that their school enrolled.

Measurements and Covariates

The primary outcome was the prevalence and associated factors of symptoms of depression, anxiety, insomnia and PTSD and suicidal behavior. The survey lasted approximately 10 min. The first part gathered demographic information, including gender, age, nationality, province, city/town, level of education, accommodation in the school, satisfaction with major, academic performance, graduates, peer and teacher relationships, relationship with immediate family, and so on. The second part included questions about the pandemic. The third part focused on the individuals' frequent behaviors before and during the pandemic. The three parts of the survey are included in the **Supplementary Table 1**.

The fourth part of the questionnaire focused on mental health, including a family history of mental illness, questions about suicidal behavior, and validated measurement tools (in Chinese). We used the 9-item Patient Health Questionnaire (PHQ-9) (25), Generalized Anxiety Disorder-7 (GAD-7) (26), Insomnia Severity Index (ISI) (27), and Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5) (28) to assess symptoms of depression, anxiety, insomnia, and PTSD, respectively. Total scores on these scales were interpreted as the following: PHQ-9 (normal, 0–4; mild depression, 5–9; moderate depression, 10–14; severe depression, 15–27), GAD-7 (normal, 0–4; mild anxiety, 5–9; moderate anxiety, 10–14; severe anxiety, 15–21), ISI (normal, 0–7; subthreshold insomnia, 8–14; moderate insomnia, 15–21; severe insomnia, 22–28), PCL-5 (normal, 0–32; positive for PTSD, 33–80). The cutoff scores for detecting risk factors of symptoms of depression, anxiety, insomnia, and PTSD were 5, 5, 8, and 33, respectively. Suicidal behavior during lifetime included active suicidal ideation and suicide attempts, which were initially screened using a modified inventory (29) in this study. Participants who answered in the affirmative were asked about the occurrence of suicidal ideation and suicide attempts specifically after the COVID-19 outbreak [e.g., "I thought about killing myself after the COVID-19 outbreak" [Yes/no]; "I deliberately tried to kill myself after the COVID-19 outbreak" (Yes/no)].

Statistical Analysis

Descriptive statistics were used to present demographic data. χ^2 tests were used to compare the prevalence of mild-to-severe mental health symptoms and suicidal ideation and attempts and multiple comparison corrections were conducted for χ^2 tests with more than 2 groups or 2 categories. To explore the factors that were potentially associated with depression, anxiety, insomnia, PTSD symptoms, and suicidal behavior, multiple logistic regression analyses were performed, and odds ratios (ORs) and 95% confidence intervals (CIs) are presented. All variables that were statistically significant in the unadjusted regression analysis were entered into the multivariable model, and then the backward method was applied to determine the variables that were statistically significant in the multivariable analysis. The variance inflation factor (VIF) of these variables >10 indicates high collinearity (30). All of the data analyses were performed using SPSS 22 software. The level of significance was set to $p < 0.05$, and all tests were two-tailed.

RESULTS

Demographic Characteristics

A total of 11,254 eligible participants from 31 province-level regions in China were included in the final analysis. Of the total sample, 4,054 individuals (36.02%) were male, 8,139 individuals (72.32%) were 15–20 years old, 408 individuals (3.63%) were graduates. More than half of the respondents [6,960 (61.84%)] lived in Hubei province during the pandemic, and 1,402 (12.46%) lived in Wuhan. Of the total number, 6,455 (57.36%) had a harmonious relationship with their classmates and teachers, and most of them had a close relationship with their parents [7,797 (69.28%)]. Furthermore, 76 individuals (0.68%) had confirmed or suspected COVID-19 or were in close contact with confirmed cases, 2,235 individuals (19.86%) were under high stress, and 8,279 individuals (73.56%) experienced changes in lifestyle during the pandemic. A total of 663 individuals (5.89%) reported alcohol use during the pandemic, and 424 individuals (3.77%) reported tobacco use during the pandemic. Additional demographic pandemic-related characteristics are presented in **Table 1**.

Prevalence of Symptoms of Depression, Anxiety, Insomnia, and PTSD and Suicidal Behavior

In this survey, among the 11,254 university students, 5,931 (52.70%) reported at least one symptom of depression, anxiety, insomnia, or PTSD or suicidal behavior. The prevalence of depressive symptoms among the total sample was 41.52% [4,673, including 2,970 (26.39%) with mild depression and 1,703 (15.13%) with moderate-to-severe depression]. The prevalence of anxiety was 32.58% [3,666, including 2,633 (23.40%) with mild anxiety and 1,033 (9.18%) with moderate-to-severe anxiety]. The prevalence of insomnia was 35.00% [3 939, including

TABLE 1 | Descriptive statistics of demographic characteristics and pandemic-related information for students.

Factor	Participants (no. [%])
Overall	11,254 (100.00)
Gender	
Female	7,200 (63.98)
Male	4,054 (36.02)
Age (years)	
15–20	8,139 (72.32)
>20	3,115 (27.68)
Nationality	
Han	10,421 (92.60)
National minority	833 (7.40)
Universities	
Key universities	2,964 (26.34)
Ordinary universities	6,090 (54.11)
Vocational and technical colleges	2,200 (19.55)
Level of education	
Less than college	3,209 (28.51)
College degree or higher	8,005 (71.13)
Postgraduate	40 (0.36)
Living area	
Wuhan	1,402 (12.46)
Hubei Province outside Wuhan	5,558 (49.39)
Other provinces	4,294 (38.16)
Are you graduates?	
Yes	408 (3.63)
No	10,846 (96.37)
Relationship with classmates and teachers	
Strained relationship	41 (0.36)
General relationship	4,758 (42.28)
Harmonious relationship	6,455 (57.36)
Intimacy with parents	
Distant	132 (1.17)
General	3,325 (29.55)
Close	7,797 (69.28)
Positive individual history of mental illness	
Yes	2,863 (25.44)
No	8,391 (74.56)
Positive family history of mental illness	
Yes	377 (3.35)
Unknown	1,608 (14.29)
No	9,269 (82.36)
Are you infected with COVID-19 (confirmed or suspected cases or close contacts)?	
Yes	76 (0.68)
No	11,178 (99.32)
Stress during COVID-19 pandemic	
High	2,235 (19.86)
Moderate	4,025 (35.77)
Low	4,994 (44.38)
Changes in lifestyle during COVID-19 pandemic	
Yes	8,279 (73.56)
No	2,975 (26.44)
Alcohol use during COVID-19 pandemic	
Yes	663 (5.89)
No	10,591 (94.11)
Tobacco use during COVID-19 pandemic	
Yes	424 (3.77)
No	10,830 (96.23)
Have you learned about some mental health knowledge during COVID-19 pandemic?	
Yes	6,746 (59.94)
No	4,508 (40.06)
Do you engage in regular physical exercise during COVID-19 pandemic?	
Yes	4,696 (41.73)
No	6,558 (58.27)

3,181 (28.27%) with subthreshold insomnia and 758 (6.74%) with moderate-to-severe insomnia]. The prevalence of PTSD symptoms was 8.46% (952). The prevalence of suicidal behavior was 2.03% [229, including 218 (1.94%) with suicidal ideation and 11 (0.10%) with suicide attempts].

Table 2 shows the severity of mental health symptoms and the presence of suicidal behavior, stratified by demographic characteristics and COVID-19-related factors. Female university students had a significantly lower prevalence of PTSD symptoms (7.50 vs. 10.16%, $p < 0.01$) but a higher prevalence of suicidal behavior compared with males (2.39 vs. 1.41%, $p < 0.01$). The prevalence of mental health symptoms and suicidal behavior was higher among graduates, and students with strained relationships with their classmates/teachers and parents. Individuals who had a prior history of mental illness and positive family history of psychosis had a higher prevalence of mental health symptoms and suicidal behavior. Participants with confirmed or suspected COVID-19 or were in close contact with confirmed cases had a higher prevalence of mental health symptoms and suicidal behavior. The prevalence of mental health problems and suicidal behavior were higher among university students with high stress (depression: 61.83 vs. 26.75%, $p < 0.01$; anxiety: 52.44 vs. 18.46%, $p < 0.01$; insomnia: 52.89 vs. 22.63%, $p < 0.01$; PTSD: 19.37 vs. 3.08%, $p < 0.01$; suicidal behavior: 5.46 vs. 0.58%, $p < 0.01$).

Participants who experienced changes in lifestyle, alcohol use, and tobacco use during the pandemic had a significantly higher prevalence of mental health symptoms and suicidal behavior. Participants who learned about mental health knowledge and exercised regularly during the pandemic had a significantly lower prevalence of mental health symptoms. The detailed information are presented in **Table 2**.

Factors Associated With Symptoms of Depression, Anxiety, Insomnia, and PTSD and Suicidal Behavior

The results of the univariate logistic regression analysis of demographic and COVID-19 pandemic-related variables are

TABLE 2 | Prevalence of symptoms of depression, anxiety, insomnia, and PTSD and suicidal behavior in the students.

	Depression[a]				Anxiety[b]				Insomnia[c]				PTSD[d]			Suicidal behavior	
	Participants (no. [%])				Participants (no. [%])				Participants (no. [%])				Participants (no. [%])			Participants (no. [%])	
Variable	**Normal**	**Mild**	**Moderate to severe**	***P*-value[e]**	**Normal**	**Mild**	**Moderate to severe**	***P*-value[e]**	**Normal**	**Subthreshold**	**Moderate to severe**	***P*-value[e]**	**Normal**	**Positive**	***p* value**		***p* value**
Overall	6,581 (58.48)	2,970 (26.39)	1,703 (15.13)		7,588 (67.42)	2,633 (23.40)	1,033 (9.18)		7,315 (65.00)	3,181 (28.27)	758 (6.74)		10,302 (91.54)	952 (8.46)		229 (2.03)	
Gender																	
Female	4,122 (57.25)	1,978 (27.47)	1,100 (15.28)	< 0.01	4,802 (66.69)	1,745 (24.24)	653 (9.07)	0.03	4,676 (64.94)	2,050 (28.47)	474 (6.58)	0.87	6,660 (92.50)	540 (7.50)	< 0.01	172 (2.39)	< 0.01
Male	2,459 (60.66)	992 (24.47)	603 (14.87)		2,786 (68.72)	888 (21.90)	380 (9.37)		2,639 (65.10)	1,131 (27.90)	284 (7.01)		3,642 (89.84)	412 (10.16)		57 (1.41)	
Living area[#]																	
Wuhan	839 (59.84)	340 (24.25)	223 (15.91)	0.28	956 (68.19)	303 (21.61)	143 (10.20)	0.23	911 (64.98)	385 (27.46)	106 (7.56)	0.42	1,258 (89.73)	144 (10.27)	0.04	41 (2.92)	0.02
Hubei Province outside Wuhan	3,243 (58.35)	1,520 (27.35)	795 (14.30)	0.88	3,779 (67.99)	1,305 (23.48)	474 (8.53)	0.10	3,665 (65.94)	1,552 (27.92)	341 (6.14)	0.03	5,113 (91.99)	445 (8.01)	0.42	106 (1.91)	0.99
Other provinces	2,499 (58.20)	1,110 (25.85)	685 (15.95)		2,853 (66.44)	1,025 (23.87)	416 (9.69)		2,739 (63.79)	1,244 (28.97)	311 (7.24)		3,931 (91.55)	363 (8.45)		82 (1.91)	
Are you graduates?																	
Yes	226 (55.39)	99 (24.26)	83 (20.34)	0.20	263 (64.46)	84 (20.59)	61 (14.95)	0.19	243 (59.56)	124 (30.39)	41 (10.05)	0.02	340 (83.33)	68 (16.67)	< 0.01	17 (4.17)	< 0.01
No	6,355 (58.59)	2,871 (26.47)	1,620 (14.94)		7,325 (67.54)	2,549 (23.50)	972 (8.96)		7,072 (65.20)	3,057 (28.19)	717 (6.61)		9,962 (91.85)	884 (8.15)		212 (1.95)	
Relationship with classmates and teachers[#]																	
Strained relationship	12 (29.27)	9 (21.95)	20 (48.78)	< 0.01	18 (43.90)	11 (26.83)	12 (29.27)	< 0.01	12 (29.27)	16 (39.02)	13 (31.71)	< 0.01	27 (65.85)	14 (34.15)	< 0.01	6 (14.63)	< 0.01
General relationship	2,304 (48.42)	1,482 (31.15)	972 (20.43)	< 0.01	2,804 (58.93)	1,383 (29.07)	571 (12.00)	< 0.01	2,733 (57.44)	1,613 (33.90)	412 (8.66)	< 0.01	4,230 (88.90)	528 (11.10)	< 0.01	126 (2.65)	< 0.01
Harmonious relationship	4,265 (66.07)	1,479 (22.91)	711 (11.01)		4,766 (73.83)	1,239 (19.19)	450 (6.97)		4,570 (70.80)	1,552 (24.04)	333 (5.16)		6,045 (93.65)	410 (6.35)		97 (1.50)	
Intimacy with parents[#]																	
Distant	37 (28.03)	36 (27.27)	59 (44.70)	< 0.01	48 (36.36)	41 (31.06)	43 (32.58)	< 0.01	46 (34.85)	52 (39.39)	34 (25.76)	< 0.01	91 (68.94)	41 (31.06)	< 0.01	17 (12.88)	< 0.01
General	1,461 (43.94)	1,041 (31.31)	823 (24.75)	< 0.01	1,813 (54.53)	1,025 (30.83)	487 (14.65)	< 0.01	1,780 (53.53)	1,208 (36.33)	337 (10.14)	< 0.01	2,857 (85.92)	468 (14.08)	< 0.01	128 (3.85)	< 0.01
Close	5,083 (65.19)	1,893 (24.28)	821 (10.53)		5,727 (73.45)	1,567 (20.10)	503 (6.45)		5,489 (70.40)	1,921 (24.64)	387 (4.96)		7,354 (94.32)	443 (5.68)		84 (1.08)	

(Continued)

TABLE 2 | Continued

Variable	Depression[a]				Anxiety[b]				Insomnia[c]				PTSD[d]			Suicidal behavior	
	Participants (no. [%])				Participants (no. [%])				Participants (no. [%])				Participants (no. [%])			Participants (no. [%])	
	Normal	Mild	Moderate to severe	*P*-value[e]	Normal	Mild	Moderate to severe	*P*-value[e]	Normal	Subthreshold	Moderate to severe	*P*-value[e]	Normal	Positive	*p* value		*p* value
Positive individual history of mental illness																	
Yes	915 (31.96)	1,033 (36.08)	915 (31.96)	< 0.01	1,229 (42.93)	1,017 (35.52)	617 (21.55)	< 0.01	1,130 (39.47)	1,248 (43.59)	485 (16.94)	< 0.01	2,316 (80.89)	547 (19.11)	< 0.01	143 (4.99)	< 0.01
No	5,666 (67.52)	1,937 (23.08)	788 (9.39)		6,359 (75.78)	1,616 (19.26)	416 (4.96)		6,185 (73.71)	1,933 (23.04)	273 (3.25)		7,986 (95.17)	405 (4.83)		86 (1.02)	
Positive family history of mental illness[#]																	
Yes	155 (41.11)	117 (31.03)	105 (27.85)	< 0.01	180 (47.75)	124 (32.89)	73 (19.36)	< 0.01	196 (51.99)	130 (34.48)	51 (13.53)	< 0.01	296 (78.51)	81 (21.49)	< 0.01	17 (4.51)	< 0.01
Unknown	663 (41.23)	541 (33.64)	404 (25.12)	< 0.01	848 (52.74)	491 (30.53)	269 (16.73)	< 0.01	866 (53.86)	565 (35.14)	177 (11.01)	< 0.01	1,367 (85.01)	241 (14.99)	< 0.01	57 (3.54)	< 0.01
No	5,763 (62.17)	2,312 (24.94)	1,194 (12.88)		6,560 (70.77)	2,018 (21.77)	691 (7.45)		6,253 (67.46)	2,486 (26.82)	530 (5.72)		8,639 (93.20)	630 (6.80)		155 (1.67)	
Are you infected with COVID-19 (confirmed or suspected cases or close contacts)?																	
Yes	21 (27.63)	18 (23.68)	37 (48.68)	< 0.01	25 (32.89)	24 (31.58)	27 (35.53)	< 0.01	26 (34.21)	27 (35.53)	23 (30.26)	< 0.01	48 (63.16)	28 (36.84)	< 0.01	5 (6.58)	0.02
No	6,560 (58.69)	2,952 (26.41)	1,666 (14.90)		7,563 (67.66)	2,609 (23.34)	1,006 (9.00)		7,289 (65.21)	3,154 (28.22)	735 (6.58)		10,254 (91.73)	924 (8.27)		224 (2.00)	
Stress during COVID-19 pandemic[#]																	
High	853 (38.17)	702 (31.41)	680 (30.43)	< 0.01	1,063 (47.56)	691 (30.92)	481 (21.52)	< 0.01	1,053 (47.11)	848 (37.94)	334 (14.94)	< 0.01	1,802 (80.63)	433 (19.37)	< 0.01	122 (5.46)	< 0.01
Moderate	2,070 (51.43)	1,311 (32.57)	644 (16.00)	< 0.01	2,453 (60.94)	1,224 (30.41)	348 (8.65)	< 0.01	2,398 (59.58)	1,384 (34.39)	243 (6.04)	< 0.01	3,696 (91.83)	329 (8.17)	< 0.01	78 (1.94)	< 0.01
Low	3,658 (73.25)	957 (19.16)	379 (7.59)		4,072 (81.54)	718 (14.38)	204 (4.08)		3,864 (77.37)	949 (19.00)	181 (3.62)		4,804 (96.20)	190 (3.80)		29 (0.58)	
Changes in lifestyle during COVID-19 pandemic?																	
Yes	4,409 (53.26)	2,433 (29.39)	1,437 (17.36)	< 0.01	5,224 (63.10)	2,185 (26.39)	870 (10.51)	< 0.01	4,988 (60.25)	2,631 (31.78)	660 (7.97)	< 0.01	7,477 (90.31)	802 (9.69)	< 0.01	200 (2.42)	< 0.01
No	2,172 (73.01)	537 (18.05)	266 (8.94)		2,364 (79.46)	448 (15.06)	163 (5.48)		2,327 (78.22)	550 (18.49)	98 (3.29)		2,825 (94.96)	150 (5.04)		29 (0.97)	
Alcohol use during COVID-19 pandemic																	
Yes	306 (46.15)	190 (28.66)	167 (25.19)	< 0.01	380 (57.32)	161 (24.28)	122 (18.40)	< 0.01	355 (53.54)	216 (32.58)	92 (13.88)	< 0.01	553 (83.41)	110 (16.59)	< 0.01	35 (5.28)	< 0.01
No	6,275 (59.25)	2,780 (26.25)	1,536 (14.50)		7,208 (68.06)	2,472 (23.34)	911 (8.60)		6,960 (65.72)	2,965 (28.00)	666 (6.29)		9,749 (92.05)	842 (7.95)		194 (1.83)	

(Continued)

TABLE 2 | Continued

Variable	Depression[a]				Anxiety[b]				Insomnia[c]				PTSD[d]			Suicidal behavior	
	Participants (no. [%])				Participants (no. [%])				Participants (no. [%])				Participants (no. [%])			Participants (no. [%])	
	Normal	Mild	Moderate to severe	*P*-value[e]	Normal	Mild	Moderate to severe	*P*-value[e]	Normal	Subthreshold	Moderate to severe	*P*-value[e]	Normal	Positive	*p* value		*p* value
Tobacco use during COVID-19 pandemic																	
Yes	206 (48.58)	111 (26.18)	107 (25.24)	< 0.01	244 (57.55)	99 (23.35)	81 (19.10)	< 0.01	241 (56.84)	124 (29.25)	59 (13.92)	< 0.01	349 (82.31)	75 (17.69)	< 0.01	16 (3.77)	0.01
No	6,375 (58.86)	2,859 (26.40)	1,596 (14.74)		7,344 (67.81)	2,534 (23.40)	952 (8.79)		7,074 (65.32)	3,057 (28.23)	699 (6.45)		9,953 (91.90)	877 (8.10)		213 (1.97)	
Have you learned about some mental health knowledge during COVID-19 pandemic?																	
Yes	4,006 (59.38)	1,802 (26.71)	938 (13.90)	0.02	4,598 (68.16)	1,602 (23.75)	546 (8.09)	0.04	4,439 (65.80)	1,883 (27.91)	424 (6.29)	0.03	6,229 (92.34)	517 (7.66)	< 0.01	99 (2.20)	0.32
No	2,575 (57.12)	1,168 (25.91)	765 (16.97)		2,990 (66.33)	1,031 (22.87)	487 (10.80)		2,876 (63.80)	1,298 (28.79)	334 (7.41)		4,073 (90.35)	435 (9.65)		130 (1.93)	
Do you engage in regular physical exercise during COVID-19 pandemic?																	
Yes	3,018 (64.27)	1,130 (24.06)	548 (11.67)	< 0.01	3,380 (71.98)	970 (20.66)	346 (7.37)	< 0.01	3,299 (70.25)	1,157 (24.64)	240 (5.11)	< 0.01	4,365 (92.95)	331 (7.05)	< 0.01	84 (1.79)	0.12
No	3,563 (54.33)	1,840 (28.06)	1,155 (17.61)		4,208 (64.17)	1,663 (25.36)	687 (10.48)		4,016 (61.24)	2,024 (30.86)	518 (7.90)		5,937 (90.53)	621 (9.47)		145 (2.21)	
Symptoms of depression																	
Normal	—	—	—		6,219 (94.50)	346 (5.26)	16 (0.24)	< 0.01	5,597 (85.05)	934 (14.19)	50 (0.76)	< 0.01	6,550 (99.53)	31 (0.47)	< 0.01	28 (0.43)	< 0.01
Positive	—	—	—		1,369 (29.30)	2,287 (48.94)	1,017 (21.76)		1,718 (36.76)	2,247 (48.08)	708 (15.15)		3,752 (80.29)	921 (19.71)		201 (4.30)	
Symptoms of anxiety																	
Normal	6,219 (81.96)	1,190 (15.68)	179 (2.36)	< 0.01	—	—	—		6,103 (80.43)	1,358 (17.90)	127 (1.67)	< 0.01	7,549 (99.49)	39 (0.51)	< 0.01	46 (0.61)	< 0.01
Positive	362 (9.87)	1,780 (48.55)	1,524 (41.57)		—	—	—		1,212 (33.06)	1,823 (49.73)	631 (17.21)		2,753 (75.10)	913 (24.90)		183 (4.99)	
Symptoms of insomnia																	
Normal	5,597 (76.51)	1,431 (19.56)	287 (3.92)	< 0.01	6,103 (83.43)	1,063 (14.53)	149 (2.04)	< 0.01	—	—	—		7,207 (98.52)	108 (1.48)	< 0.01	63 (0.86)	< 0.01
Positive	984 (24.98)	1,539 (39.07)	1,416 (35.95)		1,485 (37.70)	1,570 (39.86)	884 (22.44)		—	—	—		3,095 (78.57)	844 (21.43)		166 (4.21)	
Symptoms of PTSD																	
Normal	6,550 (63.58)	2,809 (27.27)	943 (9.15)	< 0.01	7,549 (73.28)	2,356 (22.87)	397 (3.85)	< 0.01	7,207 (69.96)	2,690 (26.11)	405 (3.93)	< 0.01	—	—		126 (1.22)	< 0.01
Positive	31 (3.26)	161 (16.91)	760 (79.83)		39 (4.10)	277 (29.10)	636 (66.81)		108 (11.34)	491 (51.58)	353 (37.08)		—	—		103 (10.82)	

(Continued)

TABLE 2 | Continued

Variable	Depression[a]				Anxiety[b]				Insomnia[c]				PTSD[d]				Suicidal behavior	
	Participants (no. [%])				Participants (no. [%])				Participants (no. [%])				Participants (no. [%])				Participants (no. [%])	
	Normal	Mild	Moderate to severe	*P*-value[e]	Normal	Mild	Moderate to severe	*P*-value[e]	Normal	Subthreshold	Moderate to severe	*P*-value[e]	Normal	Positive	*p* value		*p* value	
Suicidal behavior																		
Normal	6,553 (59.44)	2,899 (26.29)	1,573 (14.27)	< 0.01	7,542 (68.41)	2,532 (22.97)	951 (8.63)	< 0.01	7,252 (65.78)	3,085 (27.98)	688 (6.24)	< 0.01	10,176 (92.30)	849 (7.70)	< 0.01		—	
Positive	28 (12.23)	71 (31.00)	130 (56.77)		46 (20.09)	101 (44.10)	82 (35.81)		63 (27.51)	96 (41.92)	70 (30.57)		126 (55.02)	103 (44.98)			—	

[a]*Scores of 5 to 9 on the PHQ-9 were defined as mild depression, and scores of 10 or higher were defined as moderate-to-severe depression.*
[b]*Scores of 5 to 9 on the GAD-7 were defined as mild anxiety, and scores of 10 or higher were defined as moderate-to-severe anxiety.*
[c]*Scores of 8 to 14 on the ISI were defined as subthreshold insomnia, and scores of 15 or higher were defined as moderate-to-severe insomnia.*
[d]*Scores of 33 or higher on the PCL-5 were defined as PTSD symptoms.*
[e]*χ2 tests were used to compare the prevalence of mild-to-severe mental health symptoms in different populations.*
 # This means the first two groups are compared to the last group respectively.

presented in the **Supplementary Table 2**. In the multivariable analysis, females were associated with a lower risk of PTSD (adjusted OR = 0.61, 95% CI = 0.51–0.72, $p < 0.01$) but a higher risk of suicidal behavior (adjusted OR = 1.93, 95% CI = 1.39–2.68, $p < 0.01$) compared with males. Participants who were under high stress had a higher risk of mental health symptoms and suicidal behavior (depression: adjusted OR = 1.67, 95% CI = 1.43–1.95, $p < 0.01$; anxiety: adjusted OR = 1.90, 95% CI = 1.63–2.23, $p < 0.01$; insomnia: adjusted OR = 1.64, 95% CI = 1.44–1.87, $p < 0.01$; PTSD: adjusted OR = 1.71, 95% CI = 1.38-2.11, $p < 0.01$; suicidal behavior: adjusted OR = 3.51, 95% CI = 2.28–5.40, $p < 0.01$) during the pandemic than participants who were under low stress. Participants who had symptoms of depression were at higher risk of other mental problems (anxiety: adjusted OR = 19.98, 95% CI = 17.50–22.82, $p < 0.01$; insomnia: adjusted OR = 3.73, 95% CI = 3.31–4.19, $p < 0.01$; PTSD: adjusted OR = 3.91, 95% CI = 2.60–5.88, $p < 0.01$) and suicidal behavior (adjusted OR = 2.58, 95% CI = 1.54–4.33, $p < 0.01$). Students who had symptoms of anxiety were at higher risk of other mental problems (depression: adjusted OR = 19.89, 95% CI = 17.41–22.72, $p < 0.01$; insomnia: adjusted OR = 1.94, 95% CI = 1.72–2.19, $p < 0.01$; PTSD: adjusted OR = 13.26, 95% CI = 9.27–18.97, $p < 0.01$) and suicidal behavior (adjusted OR = 1.66, 95% CI = 1.07–2.59, $p = 0.02$). Students with symptoms of insomnia were at higher risk of other mental problems (depression: adjusted OR = 3.68, 95% CI = 3.26–4.14, $p < 0.01$; anxiety: adjusted OR = 1.98, 95% CI = 1.75–2.23, $p < 0.01$; PTSD: adjusted OR = 4.43, 95% CI = 3.54–5.54, $p < 0.01$). Participants who had symptoms of PTSD were at higher risk of other mental problems (depression: adjusted OR = 3.75, 95% CI = 2.47–5.69, $p < 0.01$; anxiety: adjusted OR = 13.45, 95% CI = 9.37–19.30, $p < 0.01$; insomnia: adjusted OR = 4.36, 95% CI = 3.50–5.45, $p < 0.01$) and suicidal behavior (adjusted OR = 2.71, 95% CI = 1.98–3.71, $p < 0.01$). Participants with suicidal behavior were at higher risk of mental problems (depression: adjusted OR = 2.00, 95% CI = 1.17–3.43, $p = 0.01$; anxiety: adjusted OR = 1.56, 95% CI = 1.01–2.41, $p = 0.04$; PTSD: adjusted OR = 2.84, 95% CI = 2.05–3.93, $p < 0.01$). Students with a prior history of mental illness had a higher risk than students without a prior history of mental illness (depression: adjusted OR = 1.81, 95% CI = 1.59–2.07, $p < 0.01$; anxiety: adjusted OR = 1.52, 95% CI = 1.33–1.73, $p < 0.01$; insomnia: adjusted OR = 2.20, 95% CI = 1.98–2.44, $p < 0.01$; PTSD: adjusted OR = 1.53, 95% CI = 1.30–1.81, $p < 0.01$; suicidal behavior: adjusted OR = 1.94, 95% CI = 1.45–2.61, $p < 0.01$). Participants with a positive family history of psychosis had a significantly higher risk of mental health problems than participants without a family history of psychosis (anxiety: adjusted OR = 1.42, 95% CI = 1.04–1.95, $p = 0.03$; PTSD: adjusted OR = 1.89, 95% CI = 1.36–2.64, $p < 0.01$). Participants who engaged in regular exercise during the pandemic reported a lower risk of symptoms of depression (adjusted OR = 0.86, 95% CI = 0.77–0.97, $p = 0.01$), and insomnia (adjusted OR = 0.82, 95% CI = 0.75–0.91, $p < 0.01$). Participants who experienced changes in lifestyle and alcohol use during the pandemic also had a significantly higher risk of mental health problems and suicidal behavior. Since symptoms of depression, anxiety, insomnia, PTSD and suicidal behavior are possibly

correlated, we examined the collinearity in five final models and the VIF indicated that no collinearity existed. The highest VIF was 1.51 (symptoms of anxiety) for depression symptoms, 1.52 (symptoms of depression) for anxiety symptoms, 2.07 (symptoms of anxiety) for insomnia symptoms, 2.10 (symptoms of depression) for PTSD symptoms, 2.07 (symptoms of anxiety) for suicidal behavior in each final model. The detailed results of the multivariable analysis are shown in **Table 3**.

DISCUSSION

The present study investigated the prevalence and factors associated with mental health symptoms and suicidal behavior among university students after long-term quarantine and school closures during the COVID-19 pandemic in China. All of the students in this study had a high risk of COVID-19 exposure because they went home for winter vacation from Wuhan, Hubei Province, where COVID-19 was first identified in China. Compared to other university students in China, they experienced quarantine after returning home and might suffer from stigma and discrimination. Overall, more than half of the participants (52.7%) reported at least one symptom of depression, anxiety, insomnia, or PTSD or suicidal behavior. We identified several vulnerable students and risk factors, including graduates, distant relationships with parents, a past history of mental illness, a positive family history of psychosis, moderate to high stress, changes in lifestyle, and alcohol use during the pandemic. We also found that regular exercise during the pandemic was protective against mental health problems. Altogether, our findings highlight concerns about mental well-being among university students and may contribute to the development of better health policies and population-based long-term mental health management and intervention strategies for future pandemics and other public health emergencies.

The prevalence of anxiety (32.6%) in the present study was higher than the results of a previous epidemiological study (19) among medical college students during the pandemic, showing that 24.9% of participants had symptoms of anxiety. This difference may be attributable to long-term quarantine experience in the present survey and the fact that medical students are a special group who may more easily acquire mental health knowledge. Additionally, with ongoing worries about current academic studies, future employment, personnel relationships, and life stress, university students may be vulnerable to the development of mental and sleep problems (2, 11). The prevalence of symptoms of depression among students in this study was higher than in another online study (31) that was performed 1 month after the COVID-19 outbreak began among undergraduate students, which may be attributable to the impact of long-term quarantine during the pandemic.

However, the prevalence of suicidal ideation (1.9%) in the present study was lower than in a study in which 18.0% of a sample of United States college students reported suicidal thoughts, measured by the PHQ-9 (18). Some previous studies showed that responses to items on the PHQ-9 that included self-harm or passive thoughts of death may not accurately reflect suicidal thoughts compared with questions that are designed specifically to assess suicidality, thus resulting in a higher rate of false positives (32–34). Moreover, the prevalence of suicidal ideation in the present study was lower than in a previous study that was conducted at the peak of the COVID-19 pandemic, which showed that 11.4% of university students reported suicidal thoughts (22). Our survey focused on the late sustained pandemic period, which is' another possible reason for the lower prevalence of suicidal ideation in the present study (35). A previous study showed that suicidality was associated with fear of the infection and the experience of social isolation, which were more serious at the peak of the pandemic than at the late pandemic period (2, 35). Further studies with a longer follow-up period after the COVID-19 pandemic and large geographic coverage are warranted.

The present study identified several risk groups who were more likely to develop mental health problems and suicidal behavior. Females had a significantly higher prevalence of suicidal behavior, which is consistent with the results of another study of senior high school students during the COVID-19 pandemic (36). The present results also showed that strained relationships with classmates/teachers and parents increased the risk of mental health problems. For most students, isolation from social networks was associated with more depressive symptoms (37). Conflicts and tension between family members, which may have increased because of staying at home during the pandemic (38), may descend into domestic violence and lead to a worsening of mental health problems and suicidal behavior (39–41). An interesting finding is that we did not find difference of psychological problems between students from Wuhan/Hubei and that from other provinces in final model. The reason may be that all students in our study attended universities in Wuhan and the finding may also indicated that the mental heath well-bing among university students are needed in whole country, not in special high risk area of COVID-19 pandemic.

Participants who had a prior history of mental health problems reported more severe mental health symptoms and suicidal behavior. A positive history of a psychiatric disorder is highly associated with new-onset mental disorders during a stressful period (42). Additionally, the present study also found that participants with a positive family history of psychosis were more likely to suffer from anxiety, and PTSD. Furthermore, this study showed the issue of coexistent mental health symptoms and suicidal behavior during the pandemic which is consistent with other epidemiologic studies (43–45). Another cross-sectional survey of college students found a strong positive interaction effect between anxiety disorder and depression (44). A large cohort study also showed that 40% individuals who had mental disorders were diagnosed with more than one disorder type (46). Our findings indicated the importance of early detection and intervention of mental health symptoms and suicidal behavior among high risk population. It is necessary to establish mental health promotion strategies, such as health education, early response to public tramatic events to further prevent mental

TABLE 3 | Multivariable regression analysis of risk factors associated with mental health symptoms and suicidal behavior.

	Depression[a]		Anxiety[b]		Insomnia[c]		PTSD[d]		Suicidal behavior	
Variable	**AOR (95% CI)**	***P*-value**	**AOR (95% CI)**	***P*-value**	**AOR (95% CI)**	***P*-value**	**AOR (95% CI)**	***P*-value**	**AOR (95% CI)**	***P*-value**
Gender (ref: male)										
Female	1.13 (1.00–1.27)	0.05	—		—		0.61 (0.51–0.72)	< 0.01	1.93 (1.39–2.68)	< 0.01
Are you graduates? (ref: no)										
Yes	—		—		—		2.04 (1.42–2.93)	< 0.01	1.67 (0.96–2.91)	0.07
Relationship with classmates and teachers (ref: harmonious)										
Strained	1.73 (0.64–4.66)	0.28	0.68 (0.26–1.80)	0.44	2.74 (1.16–6.47)	0.02	—		—	
General	1.38 (1.23–1.54)	< 0.01	1.20 (1.07–1.35)	< 0.01	1.17 (1.06–1.29)	< 0.01	—		—	
Intimacy with parents (ref: close)										
Distant	1.47 (0.82–2.63)	0.20	1.38 (0.81–2.36)	0.24	1.63 (1.04–2.57)	0.03	2.21 (1.36–3.58)	< 0.01	4.71 (2.57–8.64)	< 0.01
General	1.31 (1.15–1.48)	< 0.01	1.16 (1.03–1.32)	0.02	1.17 (1.06–1.30)	< 0.01	1.49 (1.26–1.75)	< 0.01	2.00 (1.49–2.68)	< 0.01
Positive individual history of mental illness (ref: no)										
Yes	1.81 (1.59–2.07)	< 0.01	1.52 (1.33–1.73)	< 0.01	2.20 (1.98–2.44)	< 0.01	1.53 (1.30–1.81)	< 0.01	1.94 (1.45–2.61)	< 0.01
Positive family history of mental illness (ref: no)										
Yes	1.02 (0.74–1.41)	0.88	1.42 (1.04–1.95)	0.03	—		1.89 (1.36–2.64)	< 0.01	—	
Unknown	1.61 (1.37–1.89)	< 0.01	1.20 (1.02–1.40)	0.02	—		1.38 (1.14–1.66)	< 0.01	—	
Stress during COVID-19 epidemic (ref: low)										
High	1.67 (1.43–1.95)	< 0.01	1.90 (1.63–2.23)	< 0.01	1.64 (1.44–1.87)	< 0.01	1.71 (1.38–2.11)	< 0.01	3.51 (2.28–5.40)	< 0.01
Moderate	1.42 (1.26–1.61)	< 0.01	1.75 (1.53–2.00)	< 0.01	1.44 (1.30–1.61)	< 0.01	0.98 (0.79–1.21)	0.84	1.99 (1.28–3.10)	< 0.01
Changes in lifestyle during COVID-19 pandemic (ref: no)										
Yes	1.40 (1.23–1.60)	<0.01	1.19 (1.03–1.38)	0.02	1.55 (1.37–1.74)	< 0.01	—		—	
Alcohol use during COVID-19 pandemic (ref: no)										
Yes	1.46 (1.15–1.87)	<0.01	—		1.26 (1.03–1.53)	0.02	—		2.31 (1.53–3.49)	< 0.01
Tobacco use during COVID-19 pandemic (ref: no)										
Yes	—		—		—		1.34 (0.95–1.88)	0.10	—	
Have you learned about some mental health knowledge during COVID-19 pandemic? (ref: no)										
Yes	—		—		—		0.86 (0.73–1.01)	0.06	—	
Do you engage in regular physical exercise during COVID-19 pandemic? (ref: no)										
Yes	0.86 (0.77–0.97)	0.01	—		0.82 (0.75–0.91)	< 0.01	—		—	
Symptoms of depression (ref: no)										
Yes	—		19.98 (17.50–22.82)[f]	< 0.01	3.73 (3.31–4.19)[g]	< 0.01	3.91 (2.60–5.88)[h]	< 0.01	2.58 (1.54–4.33)[i]	< 0.01
Symptoms of anxiety (ref: no)										
Yes	19.89 (17.41–22.72)[e]	<0.01	—		1.94 (1.72–2.19)[g]	< 0.01	13.26 (9.27–18.97)[h]	< 0.01	1.66 (1.07–2.59)[i]	0.02
Symptoms of insomnia (ref: no)										
Yes	3.68 (3.26–4.14)[e]	<0.01	1.98 (1.75–2.23)[f]	< 0.01	—		4.43 (3.54–5.54)[h]	< 0.01	—	
Symptoms of PTSD (ref: no)										
Yes	3.75 (2.47–5.69)[e]	<0.01	13.45 (9.37–19.30)[f]	< 0.01	4.36 (3.50–5.45)[g]	< 0.01	—		2.71 (1.98–3.71)[i]	< 0.01
Suicidal behavior (ref: no)										
Yes	2.00 (1.17–3.43)[e]	0.01	1.56 (1.01–2.41)[f]	0.04	—		2.84 (2.05–3.93)[h]	< 0.01	—	

[a]*Depression was defined as PHQ-9 score ≥ 5.*
[b]*Anxiety was defined as GAD-7 score ≥ 5.*
[c]*Insomnia was defined as ISI score ≥ 8.*
[d]*PTSD was defined as PCL-5 score ≥ 33.*
[e]*The highest VIF in the model of "depression" is 1.51 (symptoms of anxiety), 1.41 (symptoms of insomnia), 1.29 (symptoms of PTSD), and 1.06 (suicidal behavior).*
[f]*The highest VIF in the model of "anxiety" is 1.52 (symptoms of depression), 1.46 (symptoms of insomnia), 1.23 (symptoms of PTSD), and 1.06 (suicidal behavior).*
[g]*The highest VIF in the model of "insomnia" is 2.00 (symptoms of depression), 2.07 (symptoms of anxiety), and 1.24 (symptoms of PTSD).*
[h]*The highest VIF in the model of "PTSD" is 2.10 (symptoms of depression), 2.01 (symptoms of anxiety), 1.44 (symptoms of insomnia), and 1.04 (suicidal behavior).*
[i]*The highest VIF in the model of "suicidal behavior" is 1.98 (symptoms of depression) and 2.07 (symptoms of anxiety), and 1.25 (symptoms of PTSD).*

health problems and suicidal behavior during the COVID-19 pandemic (2, 47–49). Furthermore, this study showed that suicidal behavior tends to increase when mental health status is exacerbated during the pandemic, which indicate that the importance of establishing mental health promotion strategies to further prevent suicidal behavior (2, 47, 48). COVID-19

pandemic-related stress, and changes in health-related behaviors (e.g., exercise and alcohol consumption) were associated with a higher risk of mental health problems and suicidal behavior. Participants who were under moderate to high stress had a higher risk of mental health symptoms and suicidal behavior. This is consistent with findings that greater stress was significantly correlated with more negative psychological effects in both patients with severe acute respiratory syndrome and healthy control subjects (50). Previous studies also indicated that people under higher levels of stress, which might have come from work, family, or traumatic life events, were more vulnerable to suicidal behavior compared with control groups (51, 52). Moreover, a higher probability of mental health problems and suicidal behavior was also identified among individuals who experienced changes in lifestyle and who reported alcohol use during the pandemic. As a consequence of school closures, students' daily routines have changed dramatically, such as a reduction of social contacts and an increase of problem internet use, which can result in a higher incidence of mental health problems and suicidal behavior (53, 54). Furthermore, previous studies suggested that alcohol abuse was a major risk factor for mental health problems and suicidal behavior because of increases in impulsive and aggressive behaviors (51, 55–57). Conversely, limiting alcohol consumption might be associated with lower risk of mental illness and suicidal behavior (58). Thus, to avoid mental health problems during the COVID-19 pandemic, young people should maintain a healthy diet and adaptive lifestyle (59). We found that students who engaged in regular physical activities during the pandemic had a lower risk of depression, and insomnia. These findings are consistent with another study (60) of Chinese college students during the pandemic. Similarly, a previous study (22) of university students in France confirmed that more frequent physical activity was associated with less severe self-reported mental health symptoms. Thus, regular exercise is an effective strategy to promote mental well-being during the pandemic.

STRENGTHS AND LIMITATIONS

The strengths of this study included university students with high COVID-19 exposure experience in Wuhan, extensive geographic coverage in China, the large sample size, the evaluation of multiple risk factors, and the assessment of risk factors after long-term quarantine. The prevention and control of the pandemic in China is stabilizing, but sporadic cases are still being reported. Thus, issues that are related to prevention and control strategies still need to be addressed. We conducted this study with students who experienced long-term mandatory school closure (i.e., ∼one semester of the school year). Students who experience long-term school closure may be more vulnerable than students who experience shorter-term closure (18, 19, 31, 61). The COVID-19 pandemic has persisted for nearly 1 year at the time of this writing, which has negatively impacted the daily lives of people worldwide. Its impact on mental health problems and suicidal behavior need to be explored. Our findings provide useful information for health policies, the identification of at-risk students, and the development of population-specific psychological crisis management.

Our study also has several limitations. First, there were recall bias and information bias due to this survey included some questions about past situations, and selection bias since this was an voluntary online survey and the participation rate is low. Thus, the representativeness of the sample might be insufficient. Second, mental health symptoms and suicidal behavior were based on self-rating scales and items rather than clinical diagnoses. We were also unable to distinguish between preexisting mental health symptoms and new symptoms. Third, this was a cross-sectional study that reflected mental health status and suicidal behavior during the pandemic. Therefore, we were unable to identify associations between mental health problems and risk factors because of unclear chronology. More long-term longitudinal follow-up studies are warranted in the future.

CONCLUSIONS

The prevalence of symptoms of depression, anxiety, insomnia, and PTSD and suicidal behavior was high among university students who attended universities in Wuhan, China after long-term quarantine and school closures, especially among students with high stress, who experienced changes in lifestyle, and who reported alcohol use during the pandemic. Furthermore, graduation, distant relations with parents, and a personal or family history of mental illness were also associated with a higher risk of adverse mental health problems and suicidal behavior. These findings suggest that the COVID-19 pandemic may have severe and negative effects on mental health and suicidal behavior among vulnerable university students. Specific interventions that promote mental well-being among university students who are exposed to the long-term impact of the COVID-19 pandemic should be implemented.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The ethics committee of Peking University Sixth Hospital (Institute of Mental Health). Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

LLu, YB, and GH designed this survey, commented on and revised the manuscript, and wrote the final version. YX and SSu were responsible for data analysis and writing the initial draft. ZJ, QL, SG, YL, GH, and YB contributed to recruiting participants

and data collection. QL, LLi, YZ, LS, JQ, JD, SM, WY, YS, PW, KY, XL, SSun, and MR designed the questionnaire and commented on and revised the manuscript. AR, SC, YW, XT, and JS revised the manuscript. All of the authors contributed to the final draft of the manuscript.

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SUPPLEMENTARY MATERIAL

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Family Cohesion and Stress Consequences Among Chinese College Students During COVID-19 Pandemic: A Moderated Mediation Model

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Family plays a pivotal role in individuals' mental health. During the COVID-19 epidemic, people were being quarantined at home to prevent the further spread of the virus. Therefore, the influence of family on individuals is more significant than usual. It is reasonable to assume that family cohesion can effectively alleviate the stress consequences during the COVID-19 epidemic. In the present study, a moderated mediation model was constructed to examine the mechanisms underlying the association between family cohesion and stress consequences among Chinese college students. A large sample of Chinese college students ($N = 1{,}254$, $M_{age} = 19.85$, $SD_{age} = 1.29$) participated in the study. Results indicated that family cohesion was negatively related to stress consequences. Fear of COVID-19 partially mediated the link between family cohesion and stress consequences. Excessive affective empathy reported by participants served to aggravate the relation between fear of COVID-19 and stress consequences. The study helps us understand how internal and external factors affect individual mental health that provides meaningful implications for promoting mental health.

Keywords: family cohesion, fear of COVID-19, cognitive empathy, affective empathy, stress consequences, Chinese college students

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INTRODUCTION

Globally, as of June 9, 2021, COVID-19 has lasted over a year which has resulted in over 173 million confirmed cases of COVID-19, including over 3.7 million deaths (1). Undoubtedly, COVID-19 poses a threat to individuals' physical and mental health and seriously disrupts their normal life (2). During the COVID-19 epidemic, most people show different degrees of anxiety (66.9%), worry (71.7%), and fear (58.2%) (3) and 40% of people suffer from insomnia (4). In addition, college students have higher learning burnout during the COVID-19 epidemic (5). The stress-induced consequences stemming from the COVID-19 pandemic can be regarded as stress consequences, which refer to the individual's physical and psychological stress reaction caused by external pressure (6, 7).

Given the risks of the COVID-19 epidemic, it's highly imperative to design effective social interventions of stress consequences amongst college students who are at the developmental stage from adolescence to adulthood.

In order to avoid the further spread of COVID-19, citizens were advised to stay at home as much as possible to avoid non-essential contact with others. Because of home quarantine, we contact family members most frequently. Family cohesion is closely correlated with depression, insomnia, learning burnout, and anxiety (8–10), which are the manifestation of stress consequences. Thus, family cohesion may be also negatively correlated with stress consequences. There is no direct research to prove the relationship between family cohesion and stress consequences, nonetheless, we can conjecture that from previous studies. Thus, we explored and tested whether family cohesion was significantly related to stress consequences among Chinese college students during the COVID-19 pandemic and the underlying mechanisms in the relationship.

Family Cohesion and Stress Consequences

Family is an important environment for individual healthy development (11). Family cohesion comprises the emotional bonding between family members and the degree of autonomy experienced by individuals within the family system (12, 13). In the family, the primary goal is to fulfill various tasks including crisis tasks according to family process model theory (14). Some empirical studies have shown that family cohesion can alleviate the individual psychological problems contributing to mental health (15–17). According to the main-effect model (18), friendly relationships with the family can provide support for individuals under stress and promote healthy physical and mental development. The higher the family cohesion, the more support and help the individual can get from others, which can help the individual reduce the negative effects of stress. During the outbreak of COVID-19, individuals may suffer from psychological problems (e.g., depression), physical symptoms (e.g., insomnia), and behavior of weariness due to the pressure brought by the COVID-19 epidemic, which are the manifestation of the stress consequences (6). Accordingly, we assume that family cohesion may be negatively related to stress consequences.

Fear of COVID-19 as a Mediator

Likely, the relation between family cohesion and stress consequence is not just a simple and direct one. Studies have shown that there are mediating variables between family cohesion and stress consequences [e.g., insomnia; (19)]. Fear of COVID-19 which received widespread attention is noteworthy (20–22). Triggered by the novelty and uncertainty of COVID-19, fear of COVID-19 is a negative emotion, especially revealing in physical aspect (e.g., fear of infection), possibly leading to maladaptation [e.g., depression, anxiety; (23–25)]. Possibly, family cohesion can alleviate stress consequences by relieving the fear of COVID-19. Although not yet tested, it is reasonable to expect that fear of COVID-19 acts as a mediator between family cohesion and stress consequences.

Family cohesion is an important protective factor which is negatively related to negative emotion (26–29). As expected, the study during the COVID-19 epidemic period also has found a significant negative relationship between family cohesion and fear of COVID-19 (30). In families with a high level of cohesion, harmonious family communication can convey a sense of support and security, which can help individuals ease their fear of strange things (31). Fear of COVID-19 is a naturally occurring negative emotion due to the strangeness of the COVID-19. So, family cohesion may be negatively related to fear of COVID-19. According to the broaden-and-build theory, the sense of pleasure brought by family can alleviate the negative emotions of individuals (32). During the COVID-19 epidemic period, with higher family cohesion, the communication between individuals and their families is more pleasant and harmonious. The pleasure brought by the family helps to alleviate their fear. Besides, intimacy and love among family members can broaden the individual's thoughts (33) which can avoid paying too much attention to negative information of the COVID-19 epidemic increasing their negative emotion (e.g., fear). Also, the higher level of the family cohesion, the higher the frequency of communication between individuals and their families. It can be said that the current Chinese college students who suffer from the lack of psychological preparation and epidemic prevention experience have never experienced infectious disease with such a large scale and strong infectivity. Communicating with parents is also an effective way to gain experience for coping with the COVID-19 actively, thereby contributing to alleviating fear. Thus, family cohesion may be negatively related to fear of COVID-19.

Negative emotions may be closely related to stress consequences. Studies have shown that basic emotions (e.g., fear) are the basis for the development of complex emotions [e.g., depression; (34)]. An empirical study of adolescent survivors of the Wenchuan earthquake also has shown that fear is an important risk factor for depression (35). What's more, fear of COVID-19 is positively related to depression, anxiety (36–39), which are the manifestation of the stress consequences (6). Thus, as a basic emotion, fear of COVID-19 may be an important predictor of stress consequences which includes depression, anxiety. During the COVID-19 epidemic, it is quite normal for individuals to fear their families' safety as well as their own. If such feelings cannot be timely and effectively alleviated, the long-term fear is likely to lead to anxiety, depression, and physical disorders (stress consequences). Based on the above findings, we assume that fear of COVID-19 is positively associated with stress consequences. Thus, fear of COVID-19 may mediate the relation between family cohesion and stress consequences.

Empathy as a Moderator

Although family cohesion may decrease the impact of stress consequences through the mediating role of fear of COVID-19, not all individuals with higher fear of COVID-19 will equally perceive stress consequences. So, it is necessary to explore potential moderating variables that may influence the relation between fear of COVID-19 and stress consequences. Empathy refers to an affective state that is elicited by observing or

imagining the other's affective state, is similar to the other's emotional state and is caused by the other's emotional state (40). We often regarded empathy as a positive trait, promoting benign effect (41). However, from a more comprehensive perspective, the results of empathy include both positive and negative effects. In addition, some studies have shown that empathy is a multi-dimensional construct that includes both cognitive and affective empathy (42), which have different effects on stress consequences [e.g., depression, anxiety; (43)].

Affective empathy refers to our ability to experience an emotion similar to that of another person, even though the event that causes the emotion doesn't directly happen to us (44). The study showed that there was a positive association between affective empathy and anxiety (45) which was an obvious manifestation of stress consequences (6). Not surprisingly, affective empathy is also proved to be a risk factor for mental health in previous studies (46, 47). Wright et al. who explored the moderating effect of affective empathy found that affective empathy aggravated the adverse effect of other risk factors on depression (48). Thus, excessive affective empathy may be a moderator increasing the negative effects of fear of COVID-19 on stress consequences. Specifically, the impact of fear of COVID-19 on stress consequences may be stronger for college students with higher affective empathy.

Cognitive empathy refers to the recognition, understanding, and mentalizing of others' emotions (49). Evidence showed that cognitive empathy appeared positive for psychological health (16). Based on the risk buffering model (50), protective factors may reduce the negative impact of risk factors. Fear of COVID-19 as an emotional factor may hasten more serious stress consequences, which can be regarded as a risk factor promoting stress consequences. Cognitive empathy negatively correlated with depression and anxiety (51). Cognitive empathy can be considered as a protective factor to buffer the adverse effects of fear of COVID-19 on stress consequences. Specifically, the impact of fear of COVID-19 on stress consequences may be weaker for college students who report higher cognitive empathy.

The Present Study

Based on the literature review, we proposed the following hypotheses, as (**Figure 1**) shows:

Hypothesis 1. Family cohesion is negatively related to stress consequences.

Hypothesis 2. Fear of COVID-19 will mediate the relationship between family cohesion and stress consequences.

Hypothesis 3. (a) Excessive affective empathy will moderate the relationship between fear of COVID-19 and stress consequences. (b) Cognitive empathy will moderate the relationship between fear of COVID-19 and stress consequences (**Figure 1**).

METHOD

Participants

The study was approved by the Research Ethics Committee of the first author's institution and hosted on Survey Star (Changsha Ranxing Science and Technology, Shanghai, China) from March 16 to March 23, 2020. We obtained consent from all participating college students before the data collection. A total of 1,254 students (M_{age} = 19.85, SD_{age} = 1.29, $Range_{age}$ = 18–25, 66% female) anonymously completed the survey on measures including demographic variables, family cohesion, fear of COVID-19, empathy, and stress consequences. Among the total sample, 556(44.3%) were first years, 530 (42.3%) were second years, 116 (9.3%) were third years, and 52 (4.1%) were fourth years.

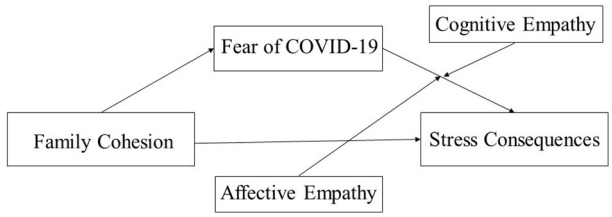

FIGURE 1 | The proposed moderated mediation model.

Measures

Family Cohesion

Family cohesion was measured by the cohesion dimension of the family adaptability and cohesion evaluation scale (13, 52). With higher total scores indicating higher levels of family cohesion, the scale consisted of 16 items (e.g., "The relationship between family members is very close") on a 5-point scale (1 = never, 5 = always), α = 0.820. Good reliability and validity of the family cohesion scale have been proved among Chinese participants (53–56). Confirmatory factor analysis (CFA) suggested that the model fit the data well: CFI = 0.998, TLI = 0.991, RMSEA = 0.053, 90%CI = [0.012, 0.106], SRMR = 0.008.

Fear of COVID-19

Fear of COVID-19 was measured by the fear of COVID-19 scale (30). Participants rated 9 items (e.g., "I worry about being infected by others") on a five-point scale (1 = never, 5 = always), α = 0.887. Higher scores indicate a higher level of fear of COVID-19. Good reliability and validity of the fear of the COVID-19 scale have been proved among Chinese participants (30). Confirmatory factor analysis (CFA) suggested that the model fit the data well: CFI = 0.994, TLI = 0.990, RMSEA = 0.038, 90%CI = [0.026, 0.049], SRMR = 0.019.

Empathy

Empathy was measured by the basic empathy scale (BES) (57, 58). Participants rated 20 items (e.g., "I am easily affected by others' emotions") on a five-point scale (1 = strongly disagree, 5 = strongly agree) assessing two dimensions of cognitive empathy (9 items) and affective empathy (11 items). Besides, the total score will be calculated after the items (8 items) are scored in reverse. Higher scores indicate a higher level of empathy. Good reliability and validity of the basic empathy scale have been proved among Chinese participants (59). In this study, Cronbach's α for cognitive empathy was 0.784, and Cronbach's

α for affective empathy was 0.737. Confirmatory factor analysis (CFA) suggested that the model fit the data well: CFI = 0.998, TLI = 0.991, RMSEA = 0.035, 90%CI = [0.000, 0.074], SRMR = 0.009.

Stress Consequences

Stress consequences were measured by the stress consequences scale (7), α = 0.885. Participants rated 17 items (e.g., "You may feel pain in some parts of your body, such as your head or chest") on a five-point scale (1 = strongly disagree, 5 = strongly agree), assessing three dimensions of behavioral symptoms (5 items), psychological symptoms (6 items), and physical symptoms (3 items). Besides, the total score will be calculated after the items (3 items) are scored in reverse. The higher the score, the stronger the stress consequences. Good reliability and validity of the stress consequences scale have been proved among Chinese participants (7). Confirmatory factor analysis (CFA) suggested that the model fit the data well: CFI = 0.968, TLI = 0.958, RMSEA = 0.054, 90%CI = [0.049, 0.059], SRMR = 0.029.

Procedure

The research was hosted on Survey Star (Changsha Ranxing Science and Technology, Shanghai, China) and participants were recruited electronically from March 16 to March 23, 2020, when the majority of the population was home isolated due to COVID-19. Participants anonymously completed the tests after informed consent was obtained from the schools, teachers, and participants. Also, participation in this study was entirely voluntary, and thus no compensation was given to participants.

Data Analysis

Firstly, descriptive statistics and Pearson correlations were calculated among the study variables. Secondly, the PROCESS macro for SPSS (Model 4) was applied to examine the mediating effect of fear of COVID-19 (60). Thirdly, the PROCESS macro (Model 16) was applied to examine the moderating effect of empathy on the indirect links between family cohesion and stress consequences. In the meanwhile, the demographic variables (gender, grade) were controlled when we examined the mediating effect and moderating effect. The bootstrap confidence intervals (CIs) determine whether the effects in Model 4 and Model 16 are significantly based on 5,000 random samples (60). An effect is regarded as significant if the CIs do not include zero. All study variables were standardized in Model 4 and Model 16 before data analyses.

RESULT

Preliminary Analyses

Table 1 showed means, *SD*s, and Pearson correlations for the study variables. As the results showed, family cohesion was negatively correlated with fear of COVID-19 and stress consequences and positively correlated with cognitive empathy. In addition, fear of COVID-19 was positively correlated with

TABLE 1 | Means, standard deviations, and correlations of the main study variables.

	M	*SD*	1	2	3	4	5
1. Family cohesion	4.192	0.622	–				
2. Fear of COVID-19	1.864	0.591	−0.364***	–			
3. Cognitive empathy	3.806	0.505	0.274***	−0.099***	–		
4. Affective empathy	3.497	0.510	−0.008	0.208***	0.374***	–	
5. Stress consequences	1.850	0.586	−0.499***	0.541***	−0.078**	0.211***	–

*N = 1,254; **p < 0.01 and ***p < 0.001.*

TABLE 2 | Testing the mediation effect and moderated mediation effect of family cohesion on stress consequences.

Predictors	Model 1 (FOC)		Model 2 (SC)		Model 3 (SC)	
	β (95%CI)	*t*	*β* (95%CI)	*t*	*β* (95%CI)	*t*
Gender	−0.178 (−0.284, −0.073)	−3.311**	−0.053 (−0.144, 0.037)	−1.154	0.010 (−0.083, 0.104)	0.219
Grade	0.280 (0.216, 0.343)	8.655***	0.124 (0.068, 0.180)	4.344***	0.103 (0.048, 0.158)	3.652***
FC	−0.341 (−0.392, −0.291)	−13.308***	−0.348 (−0.394, −0.302)	−14.849***	−0.357 (−0.404, −0.310)	−14.957***
FOC			0.387 (0.339, 0.434)	15.974***	0.361 (0.313, 0.409)	14.767***
CE					−0.002 (−0.051, 0.047)	−0.083
FOC×CE					−0.013 (−0.060, 0.034)	−0.557
AE					0.132 (0.083, 0.182)	5.296***
FOC × AE					0.098 (0.053, 0.144)	4.264***
R^2	0.190		0.408		0.430	
F	97.721***		215.043***		117.549***	

*N = 1,254; FC, family cohesion; FOC, fear of COVID-19; CE, cognitive empathy; AE, affective empathy; SC, stress consequences; Gender was dummy coded such that 0 = female and 1 = male; Grade was dummy coded such that 0 = first year, 1 = second year, 2 = third year, 3 = fourth year; **p < 0.01 and ***p < 0.001.*

affective empathy and stress consequences and negatively correlated with cognitive empathy. Stress consequences were negatively correlated with cognitive empathy and positively correlated with affective empathy.

Testing for Mediation Effect

The result showed that family cohesion was negatively correlated with stress consequences supporting Hypothesis 1 ($\beta = -0.480$, $t = -19.945$, $p < 0.001$, 95%CI = [−0.527, −0.433]). In Hypothesis 2, we assumed that fear of COVID-19 would mediate the relationship between family cohesion and stress consequences. This hypothesis was tested with Model 4 of the PROCESS macro (50). As **Table 2** showed, family cohesion was negatively associated with fear of COVID-19 ($\beta = -0.341$, $t = -13.308$, $p < 0.001$, 95%CI = [−0.392, −0.291]), which in turn was positively related to stress consequences ($\beta = 0.387$, $t = 15.974$, $p < 0.001$, 95%CI = [0.339, 0.434]). In the meantime, the negative direct association between family cohesion and stress consequences remained significant. The result supported Hypothesis 2. Fear of COVID-19 partially mediated the relationship between family cohesion and stress consequences (indirect effect = −0.132, $SE = 0.012$, 95%CI = [−0.156, −0.110]). The mediation effect accounted for 27.5% of the total effect of family cohesion and stress consequences.

Moderated Mediation Effect Analysis

To test the moderated mediation model, we used Model 16 of the SPSS macro-PROCESS compiled by Masten (50). The results of the empathy moderation test were shown in **Table 2**. The product (interaction term) of fear of COVID-19 and cognitive empathy didn't have a significant predictive effect on stress consequences ($\beta = -0.013$, $t = -0.557$, $p = 0.578$, 95%CI = [−0.060, 0.034]). The result did not support Hypothesis 3b. The product (interaction term) of fear of COVID-19 and affective empathy had a significant predictive effect on stress consequences ($\beta = 0.098$, $t = 4.264$, $p < 0.001$, 95%CI = [0.053, 0.144]). The result supported Hypothesis 3a. In order to further portray the interaction, we conducted simple slope plots and calculated beta coefficients at $-1SD$ and$+1SD$ from the mean of affective empathy (**Figure 2**). The result of simple slope tests showed that for college students with a higher level of affective empathy, the influence of fear of COVID-19 on stress consequences had a steeper slope, meaning it was statistically significant ($\beta_{simple} = 0.459$, $p < 0.001$, 95%CI = [0.395, 0.523]). For college students with a lower level of affective empathy, the influence of fear of COVID-19 on stress consequences was positively and statistically significant ($\beta_{simple} = 0.263$, $p < 0.001$, 95%CI = [0.194, 0.330]).

The bias-corrected percentile bootstrap analysis further indicated that the indirect effect of family cohesion on stress consequences through fear of COVID-19 was moderated by affective empathy. Particularly, for college students low in affective empathy, the indirect effect of family cohesion on stress consequences through fear of COVID-19 was significant, $b = -0.090$, $SE = 0.014$, 95% CI boot = [−0.117, −0.063]. The indirect effect was also significant for college students with high affective empathy, but stronger, $b = -0.157$, $SE = 0.016$, 95% CI boot = [−0.190, −0.125]. Results indicated that fear of COVID-19 mediated the effect of family cohesion on stress consequences, and affective empathy strengthened the mediating effect of fear of COVID-19 as well.

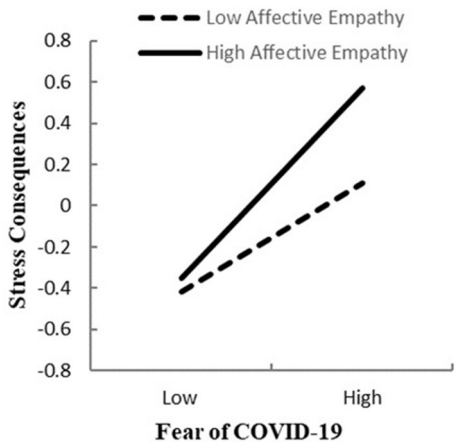

FIGURE 2 | Association between fear of COVID-19 and stress consequences at higher and lower levels of affective empathy.

DISCUSSION

A moderated mediation model was tested in our study to analyze the mechanisms underlying the association between family cohesion and stress consequences. The result showed that family cohesion was negatively related to stress consequences. Additionally, our findings contributed to the literature by testing a moderated mediation model, showing that fear of COVID-19 was a mediator between family cohesion and stress consequences, and the relation between fear of COVID-19 and stress consequences was moderated by affective empathy. The results help to understand the psychological processes of how family cohesion may lead to less serious stress consequences among Chinese college students.

The Relationship Between Family Cohesion and Stress Consequences

A significant negative association between family cohesion and stress consequences was found which supported the previous studies on family factors and mental health (61–63). As posited by the cognitive theory of stress and coping, an individual experiences stress when the environment's external demands exceed the individual's internal adaptive capacity (64). As an original environment and living environment of physical and mental growth, family plays an important role when individuals face stress especially for college students who suffer from the lack of necessary life experience and skills to cope with novel problems and negative emotions (65). On the one hand, family cohesion can promote internal resources (e.g., resilience) which is vital to coping with stress (66, 67). Previous studies have shown that individuals with high family cohesion have

stronger abilities to regulate negative emotion (68) which can decrease depression, anxiety, and learning burnout which are all manifestations of stress consequences (69–71). On the other hand, family cohesion is the emotional bond connecting family members that compels family members to engage with each other (72). Communicating amicably with family members can help individuals alleviate the stress consequences and promote mental health by releasing individual negative emotions and reaping more experience in coping with problems (73). During the COVID-19 epidemic, people with high family cohesion can deal with stress consequences via better ability for regulation by themselves and get more useful ways from the family to release stress to avoid stress consequences.

The Mediating Role of Fear of COVID-19

The mediating role of fear of COVID-19 between family cohesion and stress consequences was also tested in the present study. In our study, family cohesion buffered the fear of COVID-19, which in turn was positively related to stress consequences. The first path, wherein family cohesion was negatively related to fear of COVID-19 was consistent with a prior study on family and negative emotion (74). A comfortable and intimate family atmosphere encourages individuals to express their real emotions and feelings (75, 76). A good parent-child relationship has more emotional communication, which can help parents more easily identify children's emotional cues and respond supportively (77). Under the COVID-19 epidemic situation, individuals in families with a high level of cohesion are more likely to confide their fear about COVID-19 and terrible outcomes (e.g., infection and death) to their parents. As a useful way to release emotions (78), expressing emotion clearly to parents can help alleviate fear and avoid deterioration. At the same time, the cohesion among family members can also help parents to detect changes in children's moods. If children are so fearful of COVID-19, parents can provide support to them in time to help them cope with fear better.

The second path of the mediation model, wherein fear of COVID-19 was positively related to stress consequences was consistent with previous studies on stress consequences [e.g., depression; (79)]. As negative emotion, fear of COVID-19 may narrow the scope of attention and thinking action (26). The fear will cause attention bias that people pay more attention to the related negative information aggravating the feelings of helplessness and fear, which may promote the generation and aggravation of the complex emotion (e.g., depression, anxiety), which are all manifestations of stress consequences. Thus, fear of COVID-19 may intensify stress consequences. While fear of COVID-19 was a mechanism that mediated the relation between family cohesion and stress consequences, however, the remaining direct and negative effect suggests that family cohesion still independently affects stress consequences. According to the results, we should pay special attention to the important role of family cohesion which includes two non-ignorable aspects: dispositional and daily family cohesion, both of which are closely related to mental health (80). Therefore, the daily communication and emotional expression of family members play a positive role in helping individuals cope with stress, negative emotions, thereby improving mental health.

The Moderating Role of Empathy

The results further revealed that excessive affective empathy moderated the path between fear of COVID-19 and stress consequences. As expected, the association between fear of COVID-19 and stress consequences was stronger for college students who reported a higher level of affective empathy. For college students who reported low affective empathy, the relation between fear of COVID-19 and stress consequences was weaker. When others experience difficulties, feeling their experiences may lead to emotional infection and common pain (81), which could be a self-oriented response to others leading to pressure and even negative results (e.g., depression, anxiety) to the perceiver (82). With the help of social media (e.g., microblog), although we were quarantined at home during the COVID-19 epidemic, we could know that many people were suffering from illness. Due to the long incubation period and high infectivity of COVID-19, people would still be nervous and worried about their lives and the safety of their families even if they were quarantined at home. For individuals with high levels of affective empathy, it is easier for them to imagine themselves in the same situation (83) and even possibly regard the painful experiences of others and their family members as the possibility of their own future lives. The perception of other people's pain can aggravate the effect of fear of COVID-19 on stress consequences. The higher the level of affective empathy, the stronger the perception of other people's pain, which will aggravate the impact of fear of COVID-19 on stress consequences. Therefore, we need to pay attention to the individuals with a high level of affective empathy and try to help them decrease the level of affective empathy. For individuals with a lower level of affective empathy, they feel less pain than the people in the epidemic area, which induces a relatively less negative impact on their own emotions, alleviating the impact of fear of COVID-19 on the stress consequences. In addition, the relation between fear of COVID-19 and stress consequences was still significant at a low level of affective empathy. Thus, having a low level of affective empathy does not necessarily negate or reverse the effect entirely. Fear of COVID-19 remains a strong antecedent of stress consequences.

Besides, cognitive empathy didn't moderate the relation between fear of COVID-19 and stress consequences which overturned our hypothesis. Previous studies show that cognitive empathy is related to executive function (84, 85), especially inhibitory control, which may help us to inhibit emotional contagion to regulate our concern about others when we empathize with others (86). Studies have shown that the inhibitory control of individuals would be reduced under negative emotions (87–89). Under the common negative emotional atmosphere of COVID-19, inhibitory control may generally hinder the function of cognitive empathy. Thus, cognitive empathy can't moderate the relation between fear of COVID-19 and stress consequences.

Limitations and Future Directions

However, several limitations should be noted. First, the present study was cross-sectional, and causality cannot be inferred. Future studies may design longitudinal studies to confirm the causal hypotheses in this study. Second, all measures included in this study were self-report. Future studies may try to collect data from multiple informants (e.g., family members) to deepen the current findings. Third, the sample used in this study is entirely Chinese college students, limiting the extent to which the results of the current study can be generalized across cultures. Further investigation is still needed to test the current hypotheses across cultures.

Despite these limitations, the current study has several theoretical and practical contributions. In terms of theoretical significance, this study further extends previous research by proposing a mediating role of fear of COVID-19 and the moderating role of affective empathy. This will contribute to a better understanding of the importance of family cohesion for alleviating stress consequences and the different functions of cognitive empathy and affective empathy. From a practical perspective, our study may provide useful insights into how social and familial interventions may be designed to reduce college students' stress consequences during a pandemic. It has always been important for the government and schools to monitor and measure the emotional state and mental health of students. Without exception, even during the COVID-19 epidemic, family cohesion remains an important factor that is beneficial to their physical and mental health. College students are supposed to friendly interact with their families more, which can help individuals rationally view the epidemic, regulate their own negative emotions, and reduce fear and stress consequences. Society, school, and family should help students in coping strategies and guide them to adopt positive and effective ways to regulate negative emotions, such as cognitive reappraisal. Also, particularly during the COVID-19 epidemic, news implicates the spread of public empathy, which should be followed characteristics of the development stage of COVID-19, avoid causing extreme negative emotion and empathy (90). For example, reports should be rational and objective to stabilize the public emotion in the early stage of COVID-19. To avoid the harm of excessive affective empathy, authorities can guide individuals to take practical actions (such as donations) to help the critical epidemic area, so as not to overindulge in other people's suffering emotionally.

CONCLUSION

Results have shown that fear of COVID-19 serves as one potential mechanism between family cohesion and stress consequences. Moreover, the significant moderation effect of affective empathy warrants further examination of how excessive affective empathy can be detrimental to one's health. This study may give us some advice about how to alleviate stress consequences when we face difficulty (e.g., epidemic).

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.

AUTHOR CONTRIBUTIONS

YZe, BY, and YZh designed the study. YZe collected the data. BY and YZh analyzed the data and conceptualized the models. QY supervised the project. All authors have seen and approved the manuscript and wrote and revised the manuscript.

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

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Effects of COVID-19 on Mental Health and Anxiety of Adolescents Aged 13–16 Years: A Comparative Analysis of Longitudinal Data From China

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Background: Adolescence is an important stage of psychological development, and the psychological and mental problems of many adults are affected by the COVID-19 epidemic. The aim of this study was to understand the psychological status of this group during the epidemic, and to determine the risk factors leading to psychological stress, as well as protective factors.

Methods: An online survey was run on April 2, 2020. The participants were 254 adolescents aged 13–16 years from a junior high school in Jiangsu, China. The results were compared with the pre-epidemic data, which came from the psychological status survey routinely carried out by the school. Mental health variables were assessed via the Mental Health Test that included one validity subscale and eight content subscales.

Results: The number of adolescents with poor mental health increased significantly from 12.3 to 24.2%. There was significant increase in learning anxiety (33.7 vs. 56.4%), sensitivity tendency (19.8 vs. 46%), somatic anxiety (13.9 vs. 40.7%) and phobia tendency (4.4 vs. 10.1%). During the epidemic, there were significant differences between adolescents with normal and poor mental health in family structure, personality, relationship with siblings, daily exercise time, and risk of family members coming in contact with COVID-19. Living in stem family, no siblings, and risk of contracting COVID-19 from family members were significant risk factors for teenagers with poor mental health. Risk of contracting COVID-19 from family members was the most influential risk factor for learning anxiety, self-blaming tendency, sensitivity tendency, and somatic anxiety. Exercising for $\geq$1 h per day was a significant protective factor for poor mental health.

Conclusions: During the COVID-19 epidemic, adolescents aged 13–16 years have had psychosocial problems, especially learning anxiety, sensitivity tendency, somatic anxiety, and phobia tendency, as well as risk factors for developing them. Our study provides insights for potential interventions.

Keywords: COVID-19, adolescents, mental health, psychosocial problems, anxiety

INTRODUCTION

The epidemic of the coronavirus disease 2019 (COVID-19) constitutes a public health emergency of international concern, and poses a major threat to human life. As of April 30, 2020, >4.5 million people worldwide have fallen ill and >2,900,000 have died (1). The extent and impact of COVID-19 far exceed those of severe acute respiratory syndrome (SARS) (2). Frontline healthcare professionals and infected patients have always been the groups of most concern, but concern has been extended to the general population, including the psychological effects of coronavirus on anxiety, depression, helplessness and stigma (3–5). Fortunately, the morbidity of adolescents has been low during the epidemic; however, that does not mean that they have not been affected. Colizzi et al. reported a case of symptom exacerbation of a severe and persistent somatic, triggered by the fear of having COVID-19, and after treatment with the antipsychotic, dietary counseling, psychological support, the symptoms were significantly improved (6).

Adolescence is an important stage of psychological development, and the psychological and mental problems of many adults are affected by this period (7, 8). The core risks of this period are the development of symptoms and syndromes of anxiety that may range from transient mild symptoms to full-blown anxiety disorders. For adolescents between the ages of 13 and 16 years, the COVID-19 epidemic is a huge source of stress, similar to that of the SARS epidemic (9), which they have not previously encountered. Almost all of them have been isolated at home, with a small number of patients, and some are close contacts of patients, suspected patients or medical workers. Therefore, the direct and indirect psychological impact of the epidemic cannot be ignored. However, few studies have investigated the psychological impact of COVID-19 on adolescents aged 13–16 years in China.

In this study, we wanted to understand the psychological status of this group during the epidemic, and determine the risk factors leading to psychological stress, as well as protective factors, in order to provide insights for potential interventions.

MATERIALS AND METHODS

Participants and Procedure

We carried out this study in the junior middle school of a foreign language school in Jiangsu, China, which is a boarding school and the students' families were in good economic condition. The students live at school 5 days a week, with four people in a room and better living facilities. These teenagers have an hour a day to talk to their parents. The weekend is a rest day, and the children go back to their homes to get together with their families. The surveys were completed in an online classroom on April 2, 2020. Students aged 13–16 years participated in the surveys with the consent of their parents and themselves. None of them had major physical and psychiatric morbidities. The survey was completed in the form of an electronic questionnaire within 40 min under the video guidance of the school psychology teacher. Children who had difficulty on the Internet or asked for leave did not participate in the survey. The participants filled in some information about demographic data. A total of 254 questionnaires were distributed and collected, of which 248 were valid, and 6 questionnaires were excluded because of the high score of the validity scale. This project was approved by the Ethics Committee of Yancheng No. 1 People's Hospital (No. 2020K027). The participants were not paid and their parents were enthusiastic about the assessment of their children's psychological status.

The school pays great attention to the mental health of its students. In October every year, the psychology teacher conducts a questionnaire survey of the children. On October 12, 2019, the same group of adolescents as in the present study answered the same questionnaire in the psychology class. A total of 260 papers were distributed and collected, of which 8 were not reliable. These data provide us with the situation before the epidemic, but unfortunately, the questionnaire was anonymous and we did not have demographic information at that time.

Measurements

The following demographic data were collected: sex; age; living in urban or rural area; family structure (stem family—a family of three generations, nuclear family-parents and children only, extended family—parents and several pairs of married children, and single parent family); personality (introvert or extrovert); presence or absence of siblings; risk of family members coming in contact with COVID-19 (family members were medical workers, volunteers, community workers, or others with a high risk of contact with COVID-19); exercise time per day (<1 or ≥1 h); and number of times per week that participants left home during quarantine (never, 1 or 2 and ≥3 times).

We used the Mental Health Test (MHT), adapted by Professor Zhou Bucheng, East China Normal University, based on the General Anxiety Test, which is a popular adolescent anxiety scale in China (10, 11). These tests are variants of the Children's Manifest Anxiety Scale (CMAS). CMAS is widely used to measure children's anxiety in Europe and North America and is an internationally recognized standardized scale (12).

There were 100 items that needed to be answered in MHT, and respondents were asked to choose "yes" (score 1) or "no" (score 0). The scale contained 8 subscales and one validity scale. Eight subscales scales contained 90 items that measured eight specific subcategories of anxiety: learning anxiety, personal anxiety, loneliness anxiety, self-blaming tendency, sensitivity tendency, somatic anxiety, phobia anxiety, and impulsive tendency. Any subcategory score >8 meant clinical warning and indicated that the respondent was more likely to need further assessment, even psychological treatment. Ten items constitute the validity scale. The score of the validity scale represents the authenticity, and the questionnaire with more than 8 points indicates poor credibility and should be removed. The total score of the respondents was used to assess their mental health. The higher the score, the more serious the psychological anxiety, and a score ≥56 was considered to represent poor psychological status, including psychological

Abbreviations: COVID-19, coronavirus disease 2019; SARS, severe acute respiratory syndrome; MHT, Mental Health Test; CMAS, Children's Manifest Anxiety Scale; OR, odds ratios; CI, confidence interval.

problems. The test–retest reliability of MHT ranges from 0.67 to 0.86, and the correlation between each individual category and the total score measures 0.52–0.7 (13, 14).

Statistical Analysis

χ^2-tests were used to compare group differences of categorical data. Multivariate logistic regression was performed using stepwise variable selection, and all variables were entered into the model to explore independent influence for different risk dimensions, such as learning anxiety, personal anxiety, loneliness anxiety, self-blaming tendency, sensitivity tendency, somatic anxiety, phobia anxiety, and impulsive tendency. All hypotheses were tested at a significance level of 0.05. Data analyses were run on SPSS version 23.0.

RESULTS

Psychological Manifestations of Adolescents Before and During the COVID-19 Epidemic

Table 1 presents the psychological changes in this group of adolescents before and during the COVID-19 epidemic. Compared with before the epidemic, the proportion of adolescents with poor psychological status during the epidemic increased from 12.3 to 24.2% ($P = 0.001$). There were significant changes in learning anxiety (33.7 vs. 56.4%, $P < 0.01$), sensitivity tendency (19.8 vs. 46%, $P < 0.01$), somatic anxiety (13.9 vs. 40.7%, $P < 0.01$), and phobia tendency (4.4 vs. 10.1%, $P = 0.01$). Personal anxiety, loneliness anxiety, self-blaming tendency, and impulsive tendency were no different from those before the epidemic.

TABLE 1 | Psychological manifestations of adolescents before and during the COVID-19 epidemic.

Characteristics	Before the epidemic ($n = 252$)	During the epidemic ($n = 248$)	P
General MHT, % (*n*)			0.001
≤55 points	87.7 (221)	75.8 (188)	
>55 points	12.3 (31)	24.2 (60)	
Learning anxiety, % (*n*)			<0.01
≤8 points	66.3 (167)	43.5 (108)	
>8 points	33.7 (85)	56.4 (140)	
Personal anxiety, % (*n*)			0.21
≤8 points	91.7 (231)	86.9 (219)	
>8 points	8.3 (21)	11.5 (29)	
Loneliness anxiety, % (*n*)			0.83
≤8 points	90.5 (228)	89.9 (223)	
>8 points	9.5 (24)	10.1 (25)	
Self-blaming tendency, % (*n*)			0.93
≤8 points	80.2 (202)	79.8 (198)	
>8 points	19.8 (50)	20.6 (50)	
Sensitivity tendency, % (*n*)			<0.01
≤8 points	80.2 (202)	54.0 (134)	
>8 points	19.8 (50)	46.0 (114)	
Somatic anxiety, % (*n*)			<0.01
≤8 points	86.1 (217)	59.3 (147)	
>8 points	13.9 (35)	40.7 (101)	
Phobia anxiety, % (*n*)			0.01
≤8 points	95.6 (241)	89.9 (223)	
>8 points	4.4 (110)	10.1 (25)	
Impulsive tendency, % (*n*)			0.16
≤8 points	94.0 (237)	90.7 (225)	
>8 points	61.0 (5)	9.3 (230)	

Comparison of Sociodemographic Features Between Normal and Poor Mental Health Groups During the COVID-19 Epidemic

Table 2 presents sociodemographic features of the adolescents during the COVID-19 epidemic and compared the normal mental health group ($n = 188$) with the poor mental health group ($n = 60$). There were significant differences in family structure, personality, siblings, exercise time per day, and family members at risk of coming in contact with COVID-19 between adolescents with normal and poor mental health. The adolescents with normal mental health were more likely to come from nuclear families (81.9 vs. 51.7%, $P < 0.01$), have extrovert personality (67 vs. 45%, $P < 0.01$), have siblings (55.3 vs. 40%, $P = 0.04$), exercise ≥1 h/day (33 vs. 10%, $P < 0.01$), and have no risk of family members coming in contact with COVID-19 (90 vs. 56.7%, $P < 0.01$). There was no significant difference in sex, living area and number of times the respondents left their home per week during the epidemic.

Outcomes of Psychological Manifestations

Multivariate logistic regression analyses showed that living in stem family [odds ratio (OR), 3.74; 95% confidence interval (CI), 1.83–7.63; $P < 0.01$], no siblings (OR, 2.21; 95%CI, 1.09–4.49; $P = 0.03$), risk of family members coming in contact with COVID-19 (OR, 6.38; 95% CI, 2.85–14.26; $P < 0.01$) were risk factors for poor mental health, and exercising for ≥1 h per day (OR, 0.23; 95% CI, 0.09–0.62; $P < 0.01$) was a protective factor (**Table 3**).

The risk factors for each subscale were different. Risk of family members coming in contact with COVID-19 (OR, 2.28; 95% CI, 1.07–4.85; $P = 0.03$) was independently associated with risk of learning anxiety among adolescents, while exercising for ≥1 h per day was a protective factor (OR, 0.52; 95% CI, 0.29–0.93; $P = 0.03$). For personal anxiety models, extrovert personality (OR, 0.27; 95% CI, 0.11–0.66; $P < 0.01$) was a protective factor. For loneliness anxiety, living in a stem family was an independent risk factor (OR, 3.14; 95% CI, 1.28–7.70; $P = 0.01$). Three variables were independently associated with risk of self-blaming tendency: living in a stem family (OR, 2.13; 95% CI, 1.04–4.37; $P = 0.04$); no siblings (OR, 2.62; 95% CI, 1.28–5.38; $P = 0.01$); and risk of family members coming in contact with COVID-19 (OR, 4.97; 95% CI, 2.26–10.81; $P < 0.01$). There were also three risk factors for sensitivity tendency: female sex (OR, 2.18; 95% CI,

TABLE 2 | Comparison of sociodemographic features between adolescents with normal and poor mental health during the COVID-19 epidemic.

Characteristics	Normal mental health ($n = 188$)	Poor mental health ($n = 60$)	P
Sex, % (n)			0.17
Male	48.4 (91)	38.3 (23)	
Female	51.6 (97)	61.7 (37)	
Age (years), % (n)			0.67
13	20.7 (39)	20 (12)	
14	30.3 (57)	31.7 (19)	
15	36.2 (68)	30.0 (18)	
16	12.8 (24)	18.3 (11)	
Living areas, % (n)			0.64
Rural	34.6 (65)	38.3 (23)	
Urban	65.4 (123)	61.7 (37)	
Family structure, % (n)			
Nuclear family	81.9 (154)	51.7 (31)	<0.01
Stem family	18.1 (34)	48.3 (29)	
Extended family	0	0	
Others	0	0	
Personality, % (n)			<0.01
Introverted	33.0 (62)	55.0 (33)	
Extroverted	67.0 (126)	45.0 (27)	
Siblings, % (n)			0.04
No	55.3 (104)	40.0 (24)	
Yes	44.7 (84)	60.0 (36)	
Exercise time per day, % (n)			0.001
<1 h	67.0 (126)	90.0 (54)	
≥1 h	33.0 (62)	10.0 (6)	
No. of times leaving home, % (n)			0.74
0	75.0 (141)	76.7 (46)	
1 or 2	18.6 (35)	15.0 (9)	
≥3	6.4 (12)	8.3 (5)	
Risk of family members coming in contact with COVID-19, % (n)			<0.01
No	90.0 (169)	56.7 (34)	
Yes	10.0 (19)	43.3 (26)	

TABLE 3 | Outcomes of psychological manifestations.

Variables	OR (95%CI)	P
Models for general MHT		
Family structure (stem vs. nuclear)	3.74 (1.83–7.63)	<0.01
Siblings (yes vs. no)	2.21 (1.09–4.49)	0.03
Exercise time per day (≥1 vs. <1 h)	0.23 (0.09–0.62)	<0.01
Risk of family members coming in contact with COVID-19 (yes vs. no)	6.38 (2.85–14.26)	<0.01
Models for learning anxiety		
Exercise time per day (≥1 vs. <1 h)	0.52 (0.29–0.93)	0.03
Risk of family members coming in contact with COVID-19 (yes vs. no)	2.28 (1.07–4.85)	0.03
Models for personal anxiety		
Personality (extrovert vs. introvert)	0.27 (0.11–0.66)	<0.01
Models for loneliness anxiety		
Family structure (stem vs. nuclear)	3.14 (1.28–7.70)	0.01
Models for self-blaming tendency		
Family structure (stem vs. nuclear)	2.13 (1.04–4.37)	0.04
Daily exercise (yes vs. no)	2.62 (1.28–5.38)	0.01
Risk of family members coming in contact with COVID-19 (yes vs. no)	4.97 (2.26–10.81)	<0.01
Models for sensitivity tendency		
Sex (female vs. male)	2.18 (1.25–3.80)	0.01
Daily exercise (yes vs. no)	2.27 (1.30–3.96)	<0.01
Risk of family members coming in contact with COVID-19 (yes vs. no)	4.36 (1.99–9.55)	<0.01
Models for somatic anxiety		
Risk of family members coming in contact with COVID-19 (yes vs. no)	9.07 (3.95–20.82)	<0.01
Models for phobia anxiety		
Sex (female vs. male)	2.75 (1.02–7.41)	<0.05
Family structure (stem vs. nuclear)	4.08 (1.63–10.20)	<0.01
Exercise time per day (≥1 vs. <1 h)	0.10 (0.01–0.77)	0.03
Models for impulsive tendency		
No variables were entered		

OR, Odds ratio; CI, confidence interval.

1.25–3.80; $P = 0.01$); no siblings (OR, 2.27; 95% CI, 1.30–3.96; $P < 0.01$); and risk of family members coming in contact with COVID-19 (OR, 6.38; 95% CI, 1.99–9.55; $P < 0.01$). Regarding somatic anxiety, the risk factor was risk of family members coming in contact with COVID-19 (OR, 9.07; 95% CI, 3.95–20.82; $P < 0.01$). For phobia anxiety, risk factors were female sex (OR, 2.75; 95% CI, 1.02–7.41; $P < 0.05$); and living in a stem family (OR, 4.08; 95% CI, 1.63–10.20; $P < 0.05$). Exercising for ≥1 h per day was a protective factor (OR, 0.10; 95% CI, 0.01–0.77; $P < 0.05$). For impulsive tendency, no variable was entered.

DISCUSSION

The mental health of adolescents aged 13–16 years has been greatly affected during the COVID-19 epidemic, and the number of people who need consultation has increased. In particular, the numbers of adolescents with early signs of learning anxiety, sensitivity tendency, somatic anxiety, and phobia anxiety have increased significantly. In the public health crisis, the risk perception of disease has a negative impact on people's mental health (15). Although adolescents aged 13–16 years are not the main group with COVID-19 virus infection, they must cope with psychological distress and are at risk of allostatic overload (16). Indeed, according to clinimetric criteria, allostatic overload can be diagnosed in the presence of a current identifiable source of distress in the form of recent life events and/or chronic stress; the stressor is judged to tax or exceed the individual coping skills when its full nature and full circumstances are evaluated. The reasons for the psychological distress to which adolescents aged 13–16 years were exposed might be related to many factors, such as being quarantined at home for a long time, facing waves of negative news, fearing that they or their loved ones could be infected by the virus, lack of awareness of the disease, bemoaning

the fragility of life, becoming sensitive to their own physical discomfort, and even fear of death. Such distress was seen with the SARS and Ebola virus outbreaks (17, 18).

In this study, the changes in sensitivity tendency, physical anxiety, and phobia anxiety may have been closely related to intolerance of uncertainty. Wright *et al.* explained the relationship between intolerance of uncertainty and adolescent health anxiety (19). Learning anxiety has always been one of the major problems in adolescent mental health that becomes more serious during epidemics (11, 20). This change may be related to the maladjustment caused by the change in learning method from classroom to online teaching.

Generally, the stressors faced by adolescents are their studies, interpersonal relationships, and parents' expectations. However, the COVID-19 epidemic, as an acute infectious disease, has acute, large-scale, and uncontrollable stressors, which is in sharp contrast to the stressors of ordinary life. The relationship between sex, age, place of residence, and mental health has been weakened.

In this study, we found several potential risk factors for adolescents to develop poor mental health, such as family structure, personality, number of siblings, and sex. Undoubtedly, these risk factors might endure allostatic overload and favor the development of psychopathology, including anxiety (20–23). The risk of family members coming in contact with COVID-19 has become the most widespread factor, and has come from awareness of the virus, through the Internet, media, and parents. Intensive media broadcasts, false reports and disinformation about the virus, as well as some extreme case reports, have brought unfounded fears to adolescents. Fear of getting COVID-19, were associated with more negative feelings (24). In addition, negative emotions such as anxiety, fear, tension, and worry spread via social networks (25). As Commodari *et al.* believes, in the face of this unknown virus, appropriate psychological education intervention is very necessary (26). For adolescents, teachers, and parents should pay attention to these and help them to adjust these excessive negative emotions (24, 26, 27). Fortunately, exercising time ≥1 h/day was a protective factor for poor mental health. Other studies have shown that exercise, especially aerobic exercise, can relieve anxiety (28, 29), while sedentary behavior has the opposite effect (30). Hence, physical exercise should be promoted during the epidemic.

The present study had some limitations. First, we adopted a longitudinal design but we did not analyze the psychological changes among different subgroups and the causes for these changes, and the difference between the two questionnaires on social demography limited our conclusion. Second, psychological assessment was based on an online survey and on self-report tools. The use of clinical interviews is encouraged in future studies to allow a more comprehensive assessment of the problem. Third, young people from poor families were not included in our study, and we need to cover a larger sample size and a wider range of socioeconomic groups to make the conclusions more representative.

CONCLUSIONS

During the COVID-19 epidemic, adolescents aged 13–16 years have had psychosocial problems, especially learning anxiety, sensitivity tendency, somatic anxiety, and phobia tendency, as well as risk factors for developing them. They are in need of mental health care and recovery programs. At the same time, our study provides insights for potential interventions. Strengthening physical exercise can alleviate psychological anxiety. Teachers and educators should encourage young people to develop appropriate physical exercises and guide young people's psychology to maintain a healthy and positive mental state. Furthermore, how to guide them is the focus of the next step.

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 this project was approved by the Ethics Committee of Yancheng No. 1 People's Hospital (No. 2020K027), and we obtained informed consent from all students and one of their parents or legal guardians. 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) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

JQ and YD conceived and designed the study. HL and YW collected data. JW performed the statistical analysis. HL and JQ drafted the manuscript. JW and HL reviewed and revised manuscript. All authors read and approved the final manuscript and content of the final 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/fpsyt.2021.695556/full#supplementary-material

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

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Family Care, Economic Stress, and Depressive Symptoms Among Chinese Adults During the COVID-19 Outbreak: Difference by Urban and Rural Areas

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Background: Although several studies have shown an association of family care with a high level of depressive symptoms, the relationship between them remains indistinguishable.

Objective: This study aims to examine the associations between family care, economic stress, and depressive symptoms among Chinese adults in urban and rural areas during the COVID-19 outbreak.

Methods: Based on cross-sectional data collected through online surveys from February 1st to 10th 2020 in China the present study recruited 2,858 adults. It used multiple linear regression to examine the association between family care and depressive symptoms, while economic stress was examined as moderators on the above relationship.

Results: The results showed that caring for both the elderly and children was significantly associated with higher depressive symptoms compared with non-caregivers (B = 2.584, 95%CI: 1.254, 3.915), and a similar result was also found in urban areas. Also, caring for the elderly only was also had a higher level of depressive symptoms than non-caregivers in rural areas (B = 3.135, 95%CI: 0.745, 5.525). Meeting the care needs was significantly associated with lower depressive symptoms compared with unmet care needs, while for rural caregivers, the results were not significant. Besides, economic stress strengthened the effect of family care needs on depressive symptoms for sandwich-generation caregivers who provide care to both the elderly and children (B = 0.605, 95%CI: 0.077, 1.134). While in rural areas, the moderation effects of economic stress were only found for elderly caregivers (B = 1.106, 95%CI: 0.178, 2.035).

Conclusion: These findings suggest that we should pay more attention to the family caregiver's mental health during the COVID-19 outbreak. In addition, more effective policies should be developed to provide financial support for family caregivers, especially for sandwich-generation caregivers and rural elderly caregivers.

Keywords: family care, depressive symptoms, COVID-19, economic stress, urban-rural difference

INTRODUCTION

Mental health problems, such as depressive symptoms might have been triggered by public health crises and growing financial loss amid and after the COVID-19 outbreak (1, 2). The family care environment has also been affected during the COVID-19 outbreak. On the one hand, the outbreak of COVID-19 posed a challenge to the health care system, informal family caregivers had to provide complex care to family members with illness (3). On the other hand, most of the operations in educational institutions and welfare facilities were shut down under lockdown policy (4, 5), and more tasks regarding care were reassigned to the family, which increased the extra burden of family caregivers. As a consequence, the social disruption caused by the COVID-19 pandemic augmented psychological distress among family caregivers (6). Furthermore, owing to several factors, such as the traditional culture of filial piety, lack of social care resources, etc., the family still bore the primary responsibility for care in China (7, 8). For example, one study showed that 92.71% of family members provided elderly care (9). At the same time, because of the lack of formal care, child care was mainly undertaken by family members such as parents and grandparents (10). In conclusion, unlike developed countries, in China, due to the lack of a developed social care system, family care was almost entirely dependent on the family members (8). As a result, the limited access to healthcare resources and the closure of public services put more care pressure on family caregivers who already had a heavy care task. Therefore, there is a need to focus on the mental health of family caregivers during the epidemic, especially in China.

Family Care and Mental Health Symptoms

Family care generally refers to family caregivers assisting family members who need care, usually unpaid (11), which involves care needs and satisfaction in our study. Previous studies have analyzed the relationship between family care and depressive symptoms, but with inconsistent results. Some researchers found that family care needs were related to a high level of depressive symptoms (12–14), while recent research started to focus on the positive outcomes of family caregiving (e.g., satisfaction, self-esteem) (15, 16). Moreover, according to the stress model, meeting the care demands was a stressor for caregivers, which was associated with caregivers' depressive symptoms (17, 18). On the contrary, another study found that caregivers whose care needs were satisfied would be less likely to suffer depressive symptoms, even if they were facing the high stress of caregiving (19). Although studies have emphasized the importance of family care needs and care needs satisfaction during the pandemic context (6, 20, 21), the specific relationship between these factors and depressive symptoms has not been established. Furthermore, none of these studies have examined the relationship between care needs, care needs satisfaction and depressive symptoms simultaneously. Thus, to clarify the relationship between these factors, it is necessary to examine the implicit connection of family care needs, care needs satisfaction, and depressive symptoms during the pandemic among adults in China.

Comparison of Different Types of Caregivers

In China, childcare played an important role in family care (10). Nonetheless, a large number of studies focused on eldercare instead of childcare and found that family care was associated with depressive symptoms (22, 23). Unlike childcare, the deterioration of physical health among the aged was observed owing to the reason that they need more care (24, 25). Moreover, with the life cycle theory, eldercare elicited more negative emotions, whereas childcare generated more positive emotions (26). These differences often put sandwich-generation caregivers (i.e., caring for both the elderly and the children) in a difficult situation, as they had to meet the care needs of two conflicting roles (27). Additionally, the risk from COVID-19 may vary by the type of caregivers, for example, COVID-19 represented a greater threat to older adults than children (28), and sandwich-generation caregivers were at high risk of infection owing to the multigenerational characteristics of care (29). Surprisingly, most studies compared caregivers as a whole with non-caregivers (12, 30). Thus, there are no studies to examine the relationship between different types of family care and depressive symptoms during the COVID-19 outbreak. Therefore, research is needed on the association of depressive symptoms among sandwich-generation caregivers, caregivers of children only, and caregivers of the elderly only compared with non-caregivers.

Economic Stress as a Moderating Variable

During the COVID-19 outbreak, economic stress could affect the impact of family care on caregiver depressive symptoms. According to the stress process theory, life events such as the lockdown policy may bring adverse changes to people's family roles, and these stresses would increase their mental health risk (6, 31), and even under normal circumstances, financial problems were associated with a high level of depressive symptoms among family caregivers (32). In the context of COVID-19, acute economic stress such as immediate unemployment and financial insecurity increased the risk of caregivers' mental health symptoms (6). Thus, there is a need to take economic stress into

account as an interactive factor that exacerbates family caregivers' depressive symptoms.

Urban vs. Rural Differences

Considering urban-rural dual structure and epidemic background in China, associations between family care, economic stress, and depressive symptoms during the pandemic may differ between the urban and rural areas. On the one hand, substantial urban-rural disparities emerged in income sources, social welfare, care resources, and the satisfaction of care needs in China (33, 34). As the contradiction between supply and demand intensifies, rural caregivers tended to bear a heavier care burden than urban caregivers (35). Consequently, significant differences were found in depressive symptoms (36). However, all of the above studies were conducted before the COVID-19 outbreak. In addition, although the COVID-19 outbreak had affected both urban and rural areas, the impact of the epidemic was more profound in urban areas because they were closer to the epicenter of the pandemic and had more intensive population movements (37, 38). As a result, the closure of public services and the overburdened medical system in this public health emergency also increased the burden on urban family caregivers (39). Unfortunately, the difference in the relationship between family care and depressive symptoms between urban and rural areas in this challenging period is still unknown. On the other hand, under the dual economic structure, urban-biased social welfare expenditure increased the income inequality between urban and rural areas, making rural and urban caregivers face different economic care pressures (34). During the period of COVID-19, the lockdown policy has increased the financial burden of rural families in particular (40). However, the moderating effects of economic stress on the relationship between family care and depressive symptoms between rural and urban areas have not been examined. Thus, urban-rural differences should be considered when analyzing the relationship between family care, economic stress, and depressive symptoms.

Objectives and Hypothesis

The objectives of the study include (1) examine the relationship between different types of family care(measured in terms of family care needs and care needs satisfaction) and depressive symptoms, (2) test the moderating role of economic stress on the above relationship, (3) examine the difference of the relationship between family care and depressive symptoms between urban and rural areas, and further investigate rural-urban differences in the moderating effects of economic stress on the relationship between family care and depressive symptoms. Correspondingly, our first hypothesis involves care needs and care needs satisfaction. We hypothesized that the different types of including care needs and care needs satisfaction would be associated with depressive symptoms. In addition, we assume that adult caregivers report higher levels of depressive symptoms compared to adult non-caregivers. Meanwhile, we expect that care needs satisfaction was associated with lower levels of depressive symptoms compared to unmet care needs. Our second hypothesis relates to the moderation effect of economic stress and family care on depressive symptoms. We assume that economic stress may strengthen the relationship between family care and depressive symptoms. Lastly, our hypothesis shows concerns about the difference between rural and urban areas. For family care, we expect that the relationship between family care and depressive symptoms will vary between rural and urban areas. Meanwhile, we assume that the moderating effects of economic stress on the relationship between family care and depressive symptoms differ between rural and urban areas.

METHODS

Study Design and Participants

Participants were recruited through an online survey called the psychological status of Chinese adults during the COVID-19.This survey was distributed through a web-based platform (https://www.wjx.cn/app/survey.aspx) from February 1st to 10th 2020. Convenience sampling and snowball sampling were used to recruit participants. Initially, several key contact participants in specific groups were selected, for example, a chief nurse, class tutor, or company manager, etc. Next, critical contact participants were requested to distribute the questionnaires to the subjects through their WeChat group (a widely-used communication tool for people in China). Then, the subjects in each WeChat group were asked to send the questionnaire web link to their WeChat friends. The online survey required respondents to answer every question, so there was no missing data in our study. In total, 2,858 valid samples aged over 18 were obtained. It should be noted that non-caregivers were not included in the sample that meets care needs. Thus, only 1,056 samples were included in the model when considered the relationship between care needs satisfaction and depressive symptoms.

Eligibility Criteria

The inclusion criteria were Chinese citizens who obtained written informed consent and were over 18 years old.

The exclusion criteria were any conditions that affected the quality of the questionnaire, including <10 min of response time, confusion of logic, etc.

Sample Size

The sample size was calculated using the following formula: $N = Z^2\ pq/d^2$ (41). In this sample size calculation, Z = the standard normal deviation [1.96 at 5% of type 1 errors ($P < 0.05$)], p = prevalence of depression in China. A systematic review found that the prevalence of depressive symptoms in China ranged from 14.6 to 48.3% during the pandemic (42). Based on the estimated maximum incidence, we set $p = 0.483$. $q = 1–p$, d = absolute error or precision (when $10\% < p < 90\%$, it is suggested to set d as 0.05) (43, 44). According to the above value setting, the sample size calculated by the formula is 384 in our study. Considering that there will be invalid questionnaires in sample collection, we finally collected more than 384 samples. In total, 2,858 valid samples aged over 18 were obtained.

Procedures

Participants were recruited through an online survey, and once participants accessed the site, they would visit the informed

consent page. People agreed to participate by clicking the label of the informed consent page. The questionnaire usually took 10–20 min to complete, and participants were asked to answer each question during the process. After excluding 134 low-quality questionnaires (Exclusion criteria were any conditions that affected the quality of the questionnaire, including <10 min of response time, confusion of logic, etc.) total of 2,858 subjects was included in the final analysis. The flowchart of the study is shown in **Figure 1**.

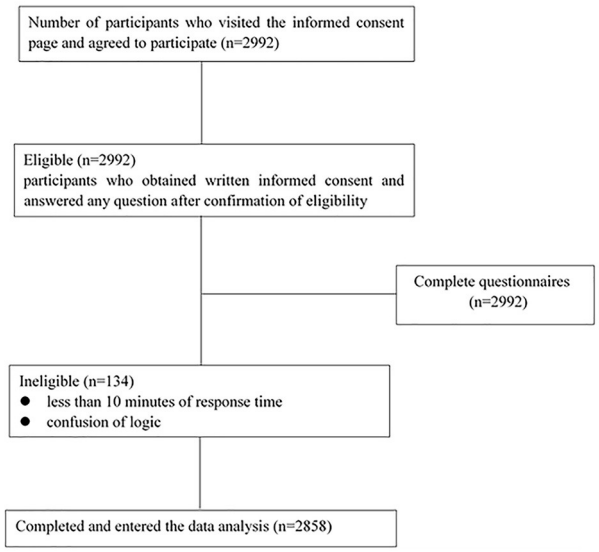

FIGURE 1 | Flowchart of participant inclusion, exclusion, and completeness of surveys.

Measures

Dependent Variables

Depressive symptoms were assessed by the Center for Epidemiologic Studies Depression Scale (CEDS mainly used to evaluate the depressive symptoms of the general population in the previous week) (45). This scale has 20 items using 4 response options from 0 to 3, which has been found to have good reliability and validity in China (46, 47). The overall score ranged from 0 to 60. The higher scores indicate a high level of depressive symptoms. Based on the present data, the Cronbach's alpha of this scale was 0.93 in this study.

Independent Variables

In this study, care recipients mainly included the elderly and children. We assessed family care needs by asking the following question: "In the past 2 months, did they need to take care of elders." The same questions were asked about childcare as well. The answer option was "Yes" or "No." On this basis, we classified them into four types: care for the elderly only, care for the children only, care for both the elderly and the children, no need for care.

We measured family care needs satisfaction through the question: "In the past 2 months, whether the eldercare was satisfied." The same questions were asked about childcare as well. The answer option was "Yes" or "No." On this basis, we also classified them into four types: satisfy the elderly, satisfy the children, satisfy both the elderly and the children, and unsatisfied.

Moderator Variable

Economic stress was defined as economic hardships perceived by Chinese adults in the COVID-19 outbreak period. Based on related literature during the epidemic (6, 48), three items were developed to measure economic stress. It was assessed by the following items: economic loss, livelihood destruction, and lack of basic necessities. For each item, the options range from 1 (not at all) to 4 (very much). The overall score was summed by three items from 3 to 12. The higher scores refer to the heavier economic stress. Based on the present data, the Cronbach's alpha of this scale was 0.78.

Demographic and Socioeconomic Variables

Demographic and socioeconomic variables were as follows: gender (male/female), age (18–25, 26–30, 31–40, 41–50, 51, and over), ethnicity [Han (1)/else(0)], religion (believe/not believe), marriage (married/unmarried), party (yes/no), education (junior high school and below, high school/technical school, junior college, undergraduate, postgraduate, and above), occupations (medical workers, service staffs, social service workers, teachers and operators, students, workers and farmers, unemployed, and others), income (low/middle and high), living arrangement (live alone /live with spouses and children /live with parents and grandparents/else), Wuhan exposure (yes/no), media exposure [frequently (1)/sometimes (2)/less (3)/very less (4)] pre-psychological problems (yes/no), post-psychological problems (yes/no), 2-week illness (yes/no).

First, previous studies have found that females, younger people, unmarried persons, and non-Communist party members were prone to report higher depressive symptoms (49, 50). In addition, lower education levels and income were associated with high levels of depressive symptoms (49). At the same time, compared with other occupations, medical staff had higher depressive symptoms during the epidemic (51). Furthermore, another study found that pre-psychological problems, post-psychological problems, 2-week illness were significantly associated with higher depressive symptoms (52). Finally, Wuhan exposure, media exposure, ethnicity, religion, and living arrangement were also considered in the previous studies (52, 53). Therefore, these variables were included in this study because they had been examined in previous related studies (49–53).

Party was measured through the question: "Are you a member of the Communist Party of China?" with two response alternatives: "Yes" or "No." Pre-psychological problems were based on this question "Did you have any psychological or emotional problems before the epidemic outbreak?" The answer option was "Yes" or "No." Post-psychological problems were measured through the question: "Did you have any psychological or emotional problems after the epidemic outbreak" with two response alternatives: "Yes" or "No." The 2-week illness was established through the question: "Have you had any headaches,

TABLE 1 | Descriptive statistics of sample characteristics.

	Total		Urban		Rural		*P*
	N	%	*N*	%	*N*	%	
Gender							
Female	1,532	53.6	1,033	55.3	499	50.4	0.013
Male	1,326	46.4	835	44.7	491	49.6	
Age							
18–25	691	24.2	360	19.3	331	33.4	<0.001
26–30	645	22.6	394	21.1	251	25.4	
31–40	891	31.2	653	35.0	238	24.0	
41–50	400	14.0	324	17.3	76	7.7	
>51	231	8.1	137	7.3	94	9.5	
Ethnicity							
Else	120	4.2	81	4.3	39	3.9	0.615
Han	2,738	95.8	1,787	95.7	951	96.1	
Religion							
No	2,586	90.5	1,704	91.2	882	89.1	0.065
Yes	272	9.5	164	8.8	108	10.9	
Party							
No	2,132	74.6	1,278	68.4	854	86.3	<0.001
Yes	726	25.4	590	31.6	136	13.7	
Marriage							
Unmarried	1,137	39.8	638	34.2	499	50.4	<0.001
Married	1,721	60.2	1,230	65.8	491	49.6	
Education							
Junior high school and below	268	9.4	74	4.0	194	19.6	<0.001
High school/Technical school	387	13.5	196	10.5	191	19.3	
Junior College	488	17.1	289	15.5	199	20.1	
Undergraduate	1,257	44.0	954	51.1	303	30.6	
Postgraduate and above	458	16.0	355	19.0	103	10.4	
Job							
Medical workers	421	14.7	332	17.8	89	9.0	<0.001
Service staffs	259	9.1	173	9.3	86	8.7	
Social service workers	230	8.0	189	10.1	41	4.1	
Teachers and operators	648	22.7	461	24.7	187	18.9	
Students	424	14.8	221	11.8	203	20.5	
Workers and farmers	388	13.6	171	9.2	217	21.9	
Unemployed and others	488	17.1	321	17.2	167	16.9	
Income							
middle and high	2,531	88.6	1,734	92.8	797	80.5	<0.001
low	327	11.4	134	7.2	193	19.5	
Living arrangement							
Live alone	265	9.3	174	9.3	91	9.2	<0.001
Live with spouses and children	1,519	53.1	1,102	59.0	417	42.1	
Live with parents and grandparents	949	33.2	513	27.5	436	44.0	
Else	125	4.4	79	4.2	46	4.6	
Wuhan exposure							
No	2,445	85.5	1,608	86.1	837	84.5	<0.001
Yes	413	14.5	260	13.9	153	15.5	
Media exposure							
frequently	1,608	56.3	1,108	59.3	500	50.5	<0.001
sometimes	762	26.7	490	26.2	272	27.5	
less	259	9.1	153	8.2	106	10.7	

(Continued)

TABLE 1 | Continued

	Total		Urban		Rural		*P*
	N	%	*N*	%	*N*	%	
very less	229	8.0	117	6.3	112	11.3	
Pre-psychological problems							
No	2,440	85.4	1,589	85.1	851	86.0	0.519
Yes	418	14.6	279	14.9	139	14.0	
Post-psychological problems							
No	2,030	71.0	1,321	70.7	709	71.6	0.614
Yes	828	29.0	547	29.3	281	28.4	
Two-week illness							
No	2,657	93.0	1,734	92.8	923	93.2	0.686
Yes	201	7.0	134	7.2	67	6.8	
Family care needs							
Care for the elderly only	286	10.0	192	10.3	94	9.5	<0.001
Care for the children only	435	15.2	321	17.2	114	11.5	
Care for both the elderly and the children	335	11.7	251	13.4	84	8.5	
No need for care	1,802	63.1	1,104	59.1	698	70.5	
Care needs satisfaction							
Satisfy the elderly	241	22.8	162	21.2	79	27.1	0.237
Satisfy the children	397	37.6	294	38.5	103	35.3	
Satisfy both the elderly and children	196	18.6	146	19.1	50	17.1	
Unsatisfy	222	21.0	162	21.2	60	20.5	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Depressive symptoms	14.51	11.68	14.18	11.57	15.12	11.88	0.043
Economic stress	7.78	2.54	7.67	2.55	8.0	2.49	0.001

Chi-square tests and t-tests were used to report the significance of differences between urban sample and rural sample.

fever, etc., in the last 2 weeks?" The answer option was "Yes" or "No."

Statistical Analysis

Descriptive statistics were conducted to analyze sample distributions. Means and standard deviations (SD) were used to describe continuous variables (depressive symptoms, economic stress), and frequency (*n*) and percentages (%) were used for categorical variables. Chi-square tests and *t*-test were used to test rural-urban differences between variables. Since dependent variables were continuous variables, several multiple linear regression (MLR) models were employed to examine the relationship between family care and depressive symptoms after adjusting for confounding variables. The interaction variables were created by economic stress and family care. Finally, several linear regression models were used to examine the interaction effects of economic stress on the relationship between family care and depressive symptoms. All analyses were conducted using Stata 15.0.

RESULTS

Table 1 shows the descriptive statistics of sample characteristics. Among 2,858 adult respondents, female (53.6%) and married (60.2%) accounted for over half, and the age distribution was mainly concentrated in the 31–40 years old range (31.2%). The level of education was mainly undergraduate (44.0%). The Han ethnicity (95.8%) and irreligious (90.5%) were more than 90%, and over 70% of respondents were not party members. 11.4% of respondents considered they were a low-income group. Most of the respondents were teachers and operators (22.7%), while social service workers and service staff each accounted for less than a tenth (8.0, 9.1%).

In terms of care needs, the proportions of only caring for the elderly, caring for children, taking care of both the elderly and the children, and not needing caring were 10.0, 15.2, 11.7, and 63.1%, respectively. In terms of meeting care needs, the proportions of satisfying the elderly, satisfying the children, satisfying both the elderly and the children, and unsatisfied were 22.8, 37.6, 18.6, and 21.0%, respectively. The overall mean score was 14.51 (SD = 11.68; range 0–60) for the depressive symptoms and 7.78 (SD = 2.54; range 3–12) for the economic stress. There were significant differences in variables between urban and rural areas. For example, rural residents reported higher levels of depressive symptoms and economic stress than urban residents.

Table 2 presented the multiple linear regression analysis results for the relationship between family care needs and depressive symptoms. After controlling the relevant variables,

TABLE 2 | Multiple liner regression analysis of the relationship between family care needs, economic stress and depressive symptoms.

	Model 1-Overall	Model 2-Urban	Model 3-Rural
	***B* (95% CI)**	***B* (95% CI)**	***B* (95% CI)**
Family care needs (Ref: No need for care)			
Care for the elderly only	1.296 (−0.051, 2.643)	0.446 (−1.196, 2.087)	3.135* (0.745, 5.525)
Care for the children only	1.134 (−0.094, 2.362)	0.949 (−0.510, 2.407)	1.508 (−0.823, 3.839)
Care for both the elderly and the children	2.584*** (1.254, 3.915)	2.193** (0.638,3.748)	3.297* (0.688, 5.905)
Economic stress	0.641*** (0.481, 0.801)	0.637*** (0.443,0.831)	0.626*** (0.340, 0.913)
Adjusted *R*-squared	0.168	0.171	0.164
N	2,858	1,868	990

p < 0.05,p < 0.01, and ***p < 0.001. B, the unstandardized coefficients. 95% confidence intervals in brackets. All confounding variables (gender, age, ethnicity, religion, party, marriage, education, job, income, living arrangement, Wuhan exposure, media exposure, pre-psychological problems, post-psychological problems, and 2-week illness) were controlled in the above models.*

TABLE 3 | Multiple liner regression analysis of the relationship between family care needs satisfaction, economic stress and depressive symptoms.

	Model 1-Overall	Model 2-Urban	Model 3-Rural
	***B* (95% CI)**	***B* (95% CI)**	***B* (95% CI)**
Care needs satisfaction (Ref: Unsatisfy)			
Satisfy the elderly	−3.915*** (−6.069, −1.762)	−5.133*** (−7.622, −2.644)	−1.203 (−5.693, 3.286)
Satisfy the children	−3.353*** (−5.258, −1.447)	−3.905*** (−6.068, −1.741)	−1.495 (−5.507, 2.517)
Satisfy both the elderly and children	−3.209** (−5.381, −1.037)	−3.744** (−6.219, −1.268)	−2.415 (−6.973, 2.143)
Economic stress	0.834*** (0.546, 1.122)	0.740*** (0.413, 1.068)	1.142*** (0.530, 1.754)
Adjusted R-squared	0.185	0.195	0.201
N	1,056	764	292

***p < 0.01, ***p < 0.001. B, the unstandardized coefficients. 95% confidence intervals in brackets. All confounding variables (gender, age, ethnicity, religion, party, marriage, education, job, income, living arrangement, Wuhan exposure, media exposure, pre-psychological problems, post-psychological problems, and 2-week illness) were controlled in the above models. Note that, non-caregivers were not included in the family care satisfaction sample. Thus, only 1,056 samples were included in the model when considered the relationship between care needs satisfaction and depressive symptoms.*

sandwich-generation caregivers had a higher level of depressive symptoms than non-caregivers ($B = 2.584$, 95%CI: 1.254, 3.915). However, caring for the elderly or caring for the children was not significantly associated with depressive symptoms compared with non-caregivers. Economic stress was significantly associated with a higher level of depressive symptoms ($B = 0.641$, 95%CI: 0.481, 0.801). Besides, in urban areas, only sandwich-generation caregivers had a significant association with a higher level of depressive symptoms compared with non-caregivers ($B = 2.193$, 95%CI: 0.638, 3.748). While in rural areas, in addition to sandwich-generation caregivers, elderly caregivers also had a higher level of depressive symptoms than non-caregivers ($B = 3.297$, 95%CI: 0.688, 5.905; $B = 3.135$, 95%CI: 0.745, 5.525).

Table 3 showed the multiple linear regression analysis results for the relationship between family care needs satisfaction and depressive symptoms. After controlling the relevant variables, the satisfactions of different types of family care needs were all significantly associated with lower levels of depressive symptoms compared with unmet care needs. These results also applied to the urban sample. While for rural areas, the results were not significant.

Table 4 and **Figures 2–4** showed the interaction effect of family care needs and economic stress on depressive symptoms. The interaction effect of caring for both the elderly and the children and economic stress on depressive symptoms was significant ($B = 0.605$, 95%CI: 0.077, 1.134; **Figure 2**), and a similar result was also found in urban areas ($B = 0.605$, 95%CI: 0.004, 1.207; **Figure 3**). While in rural areas, economic stress only played a moderator role in the relationship between caring for the elderly and depressive symptoms ($B = 1.106$, 95%CI: 0.178, 2.035; **Figure 4**).

Table 5 presented the interaction effect of care needs satisfaction and economic stress on depressive symptoms. The interaction effect of care needs satisfaction and economic stress on depressive symptoms was not observed significantly.

DISCUSSION

In this study, family care was partially associated with depressive symptoms. Besides, economic stress strengthened the association between family care needs and depressive symptoms. However, the moderating effects of economic stress were only found in sandwich-generation caregivers and rural elderly caregivers. Furthermore, this study also found that the correlation between family care and depressive symptoms was different between urban and rural areas. Some hypotheses in this study have

TABLE 4 | Multiple liner regression analysis of the interaction effect of family care needs and economic stress on depressive symptoms.

	Model 1-Overall	Mode2-Urban	Mode3-Rural
	***B* (95% CI)**	***B* (95% CI)**	***B* (95% CI)**
Family care needs (Ref: No need for care)			
Care for the elderly only	1.268 (−0.079, 2.615)	0.468 (−1.174, 2.110)	2.965* (0.574, 5.355)
Care for the children only	1.122 (−0.105, 2.350)	0.948 (−0.510, 2.406)	1.485 (−0.845, 3.816)
Care for both the elderly and the children	2.404*** (1.064, 3.743)	2.128** (0.572, 3.684)	2.724 (−0.098, 5.547)
Economic stress	0.551*** (0.356, 0.745)	0.571*** (0.328, 0.814)	0.490** (0.160, 0.819)
Family care needs × Economic stress (Ref: No need for care)			
Care for the elderly only × Economic stress	0.407 (−0.139, 0.953)	−0.009 (−0.687, 0.670)	1.106* (0.178, 2.035)
Care for the children only × Economic stress	−0.031 (−0.473, 0.411)	−0.026 (−0.540, 0.488)	−0.092 (−0.987, 0.804)
Care for both the elderly and the children × Economic stress	0.605* (0.077, 1.134)	0.605* (0.004, 1.207)	0.708 (−0.489, 1.905)
Adjusted R-squared	0.170	0.172	0.167
N	2,858	1,868	990

**p < 0.05, **p < 0.01, ***p < 0.001. B, the unstandardized coefficients. 95% confidence intervals in brackets. All confounding variables (gender, age, ethnicity, religion, party, marriage,education, job, income, living arrangement, Wuhan exposure, media exposure, pre-psychological problems, post-psychological problems, and 2-week illness) were controlled in the above models.*

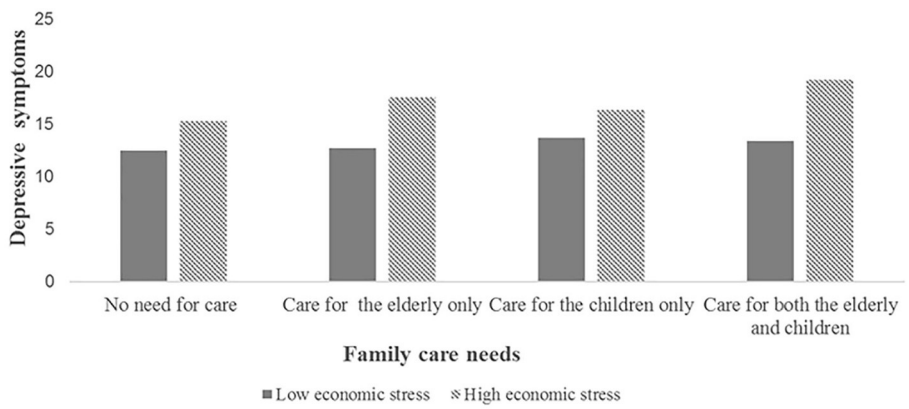

FIGURE 2 | The interaction effect of family care needs and economic stress on depressive symptoms in the overall sample.

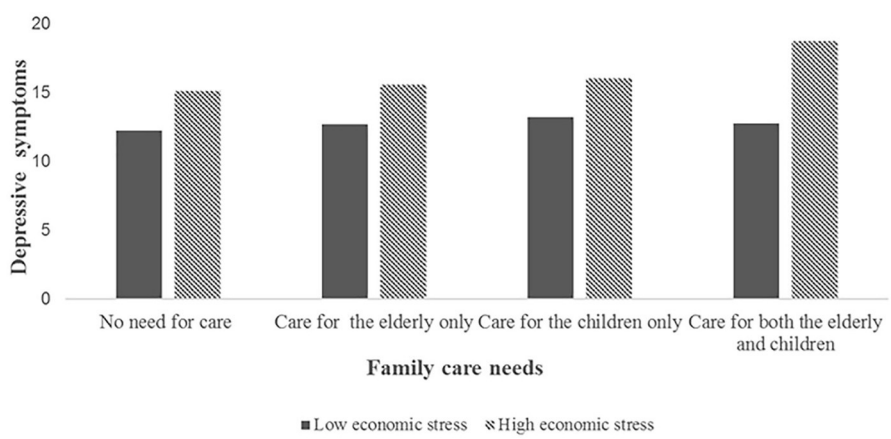

FIGURE 3 | The interaction effect of family care needs and economic stress on depressive symptoms in the urban sample.

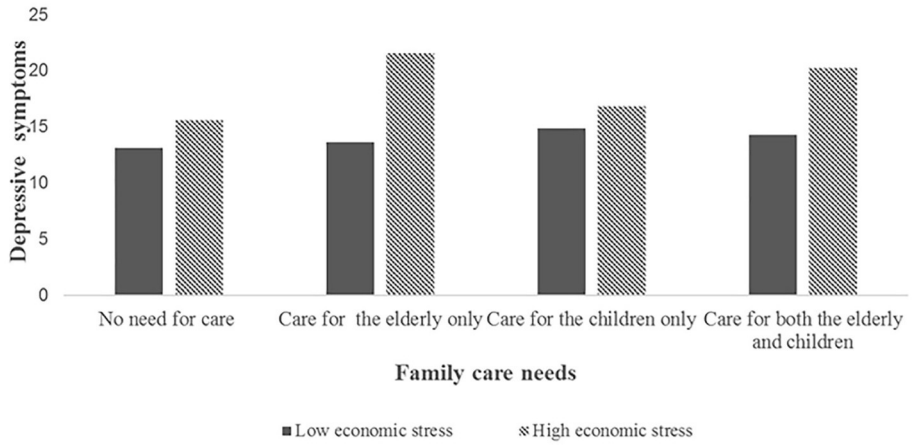

FIGURE 4 | The interaction effect of family care needs and economic stress on depressive symptoms in the rural sample.

been confirmed, which may provide a theoretical basis for the formulation of mental health intervention strategies for family caregivers.

This study revealed that in comparison with the non-caregivers, the level of depressive symptoms among sandwich-generation caregivers was higher. Similar results were found in previous findings (54). According to the family-role overload theory, family caregivers played multiple roles and did not have enough time and energy to cope with the difficult situations, making them vulnerable to stress (55, 56). Sandwich-generation caregivers have to continue to provide not only complex care to the old and the children but also need to cope with increasingly difficult work and care problems at home during crisis (3), which put them at a higher risk for depressive symptoms. Furthermore, the multi-generational family structure may become an essential source of transmission. For example, older people and children may be at high risk of infection because of sandwich-generation caregivers who work outside the home (29). Consequently, to protect the care recipients, sandwiched caregivers will worry more about being infected. In addition, the social disruption caused by COVID-19 affected the quality of family relationships (6). Not surprisingly, the family relationship of the sandwiched caregivers will be further strained. Therefore, the mental health of the sandwich-generation caregivers should be concerned during the epidemic.

However, the relationship between family care needs and depressive symptoms showed urban-rural differences. We found that caring for the elderly only was related to the high levels of depressive symptoms in rural areas, besides caring for both the elderly and children. The results can be explained as follows: First, from age structure, the aging degree of the rural population has exceeded that of the urban population, presenting the phenomenon of urban-rural aging population reversed (57). Second, due to rural labor out-migration, elderly care problems were more severe in rural area (58). Finally, the COVID-19 has posed greater challenges for finite healthcare resources in rural regions (e.g., shortages of resources and staff), especially for the elderly with severe illness and chronic diseases (59). Given these differences, rural caregivers face considerable barriers to caring for the elderly in this harsh period. As a result, it is unsurprising to see the relatively high levels of depressive symptoms among rural elderly caregivers. The findings of this study remind us to pay attention to the mental health problems of sandwich-generation caregivers and rural elderly caregivers during the epidemic. On the one hand, in the intervention policies formulation process, we should be aware that sandwich-generation caregivers face a two-fold vulnerability: high risk of infection and psychological crisis. On the other hand, more policies are needed to address the care dilemmas faced by rural elderly caregivers during the crisis.

Furthermore, our results showed that care needs satisfaction was correlated with less depressive symptoms compared with unmet care needs. This was contrary to the results of a previous study which found that meeting the continuous care needs of family members was a stress burden that increased the risk of depressive symptoms among caregivers (60). According to Maslow's hierarchy of needs theory, there was a strong link between the satisfaction of psychological needs and mental health. Although family care was an unpaid activity, caregivers also experienced satisfaction in the process of meeting care recipients' needs (61). However, this relationship was not pronounced in rural areas. The reason for this might be that as a result of the rural labor out-migration rural care recipients were inherently difficult to obtain family care (33). Even worse, COVID-19 posed new risks to the satisfaction of basic living needs, in rural neighborhoods. For example, getting health care and seeking family assistance were all accompanied by challenges (59). Thus, some rural family care needs may not be adequately satisfied in this particular period. Based on this finding, effective measures are needed to meet the family care needs of COVID-19. In particular, we should provide timely psychological counseling to the caregivers who do not satisfy the family care needs and affirm their efforts in this challenging period (3).

TABLE 5 | Multiple liner regression analysis of the interaction effect of family care needs satisfaction and economic stress on depressive symptoms.

	Model 1-Overall	Model 2-Urban	Model 3-Rural
	B **(95% CI)**	***B*** **(95% CI)**	***B*** **(95% CI)**
Care needs satisfaction (Ref: Unsatisfy)			
Satisfy the elderly	−3.784*** (−5.949, −1.619)	−4.893*** (−7.400, −2.386)	−1.589 (−6.113, 2.935)
Satisfy the children	−3.208** (−5.126, −1.289)	−3.677*** (−5.854, −1.500)	−1.610 (−5.659, 2.439)
Satisfy both the elderly and children	−3.176** (−5.365, −0.987)	−3.486** (−5.975, −0.996)	−3.037 (−7.908, 1.834)
Economic stress	1.169*** (0.515, 1.822)	1.250** (0.495, 2.005)	0.743 (−0.636, 2.121)
Care needs satisfaction × Economic stress (Ref: Unsatisfy)			
Satisfy the elderly × Economic stress	−0.196 (−1.058, 0.665)	−0.705 (−1.724, 0.315)	0.921 (−0.778, 2.619)
Satisfy the children × Economic stress	−0.747 (−1.528, 0.034)	−0.879 (−1.767, 0.009)	−0.048 (−1.700, 1.603)
Satisfy both the elderly and children × Economic stress	0.105 (−0.819, 1.029)	0.042 (−1.008, 1.092)	0.875 (−1.307, 3.058)
Adjusted R-squared	0.187	0.198	0.200
N	1,056	764	292

$^{**}p < 0.01$, $^{***}p < 0.001$. B, the unstandardized coefficients. 95% confidence intervals in brackets. All confounding variables (gender, age, ethnicity, religion, party, marriage, education, job, income, living arrangement, Wuhan exposure, media exposure, pre-psychological problems, post-psychological problems, and 2-week illness) were controlled in the above models.

Moreover, economic stress played a moderator role in the relationship between caring for both the elderly and children and depressive symptoms. Sandwich-generation caregivers with higher economic stress were at increased risk of depressive symptoms. This is consonant with previous research that shows that compared with other types of care, sandwich-generation caregivers tended to consume more resources, including economic resources, which posed an increased risk of depression (54). This interaction may be explained in line with COR theory (conservation of resources) that stated that individuals tended to preserve, protect, and build resources. Therefore, the potential or actual loss of resources would make them tense and stressed (62). Sandwich-generation caregivers needed to pay not only for the medical resources and services of the elderly but had to bear the education expenses of the children also (63). Consequently, they might experience a greater loss of resources than other types of caregivers. Especially, sandwich-generation caregivers who had greater economic stress would have fewer resources to cope with caregiving stressors during the COVID-19 epidemic, which may be detrimental to their mental health.

It is interesting to note that the moderating role of economic stress on the association between family care needs and depressive symptoms was established only for elderly caregivers in rural areas. Two channels may explain this result. On the one hand, compared with the urban elderly, most rural elderly did not have a pension and mainly relied on their family members (64), so they had fewer economic resources to cushion financial losses caused by COVID-19 (59). On the other hand, rural elderly caregivers had less income to help them cope with the financial risks of COVID-19 compared with their counterparts in urban regions. Restrictive policies related to the epidemic caused many rural laborers to fail to obtain jobs, resulting in a decline in income levels (40). Meanwhile, because of the urban-biased social security policy, many migrant workers could not get financial support from unemployment insurance in this pandemic (65). Thus, focusing on urban-rural differences, it is imperative to establish effective policies to provide financial support for rural elderly caregivers.

LIMITATION AND IMPLICATIONS

This study has the following limitations. First, the cross-sectional data cannot be causally inferred. More longitudinal studies are needed to establish causal associations between family care and depressive symptoms. Secondly, some potential confounders were not controlled in the analysis, such as COVID-19 quarantine, and change in lifestyle due to quarantine. Therefore, these need to be considered in future studies. Thirdly, the data was collected online and based on non-random sampling, possibly leading to the risk of selection bias. In addition, we only measured whether the elderly and children needed care, without specifying how many hours of care. Furthermore, we did not test the degree of care needs satisfaction. Therefore, further research is required to examine them. Next, because our data were collected at the early stage of the COVID-19 outbreak, it was not clear whether the relationship between family care and depressive symptoms would sustain in the long run. Thus, long-term and larger-scale region studies are needed to further test our conclusions. Finally, the scales used in our study are self-reporting and screening tools, not clinical diagnostic instruments. To improve the accuracy of the research, more studies with diagnostic criteria are needed in the future.

Despite these limitations, this study provided some implications. Firstly, this study found that family care needs were associated with a high level of depressive symptoms among Chinese adults, especially sandwich-generation caregivers. Thus, psycho-educational intervention should be delivered for family caregivers. Secondly, it is essential to meet the care needs of family care. Therefore, timely information should be collected from families with care needs,

including care burden and specific care needs. Furthermore, given the economic stress exacerbating sandwich-generation caregivers' depressive symptoms, a comprehensive policy should be established to provide economic support (livelihood support, basic material support, and economic subsidy) for the sandwich-generation caregivers. Finally, considering the differences in family care between urban and rural areas, we should give more psychological intervention and financial support to urban sandwich-generation caregivers and rural elderly caregivers.

CONCLUSION

The study suggests family care is partially associated with depressive symptoms among Chinese adults during the COVID-19 outbreak. Moreover, the moderating effects of economic stress are only found in sandwich-generation caregivers and rural elderly caregivers. Therefore, we advocate psychological intervention for the family caregivers' mental health. In addition, more effective policies should be developed to provide financial support for family caregivers, especially for sandwich-generation caregivers and rural elderly caregivers.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Peking University. 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

LZ, JG, and CL drafted the manuscript. FA, MS, XW, YW, and JW were involved in revising the manuscript. All authors were involved in writing the manuscript and approve of its final 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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Stress and Anxiety to Viral Epidemics-6 for Medical Students: Psychometric Properties of the Anxiety Measure for the COVID-19 Pandemic

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The aim of this study was to explore the psychometric properties and validity of Stress and Anxiety to Viral Epidemics-6 items (SAVE-6) among medical students who are at high risk of coronavirus disease 2019 (COVID-19) infection. A total of 212 medical students participated in the online anonymous survey that used SAVE-6, Coronavirus Anxiety Scale (CAS), Generalized Anxiety Disorder-7 items (GAD-7), and Work and Social Adjustment Scale (WSAS). We observed that the single-factor structure model of the SAVE-6 scale showed good internal consistency (Cronbach's alpha = 0.756) and a good convergent validity with GAD-7 (rho = 0.320, $p < 0.001$), CAS (rho = 0.229, $p < 0.001$), and WSAS (rho = 0.278, $p < 0.001$). The appropriate cut-off score of the SAVE-6 scale was determined as 15 points in accordance with at least a mild degree of generalized anxiety (GAD-7 score of 5) among medical students. In conclusion, the SAVE-6 scale can be applied to medical students as a reliable and valid rating scale to assess anxiety response to the present viral pandemic.

Keywords: stress, anxiety, psychological, health personnel, medical student, COVID-19

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INTRODUCTION

The ongoing global coronavirus disease 2019 (COVID-19) pandemic, which began in January 2020, has seized the entire world. In Korea, since the first confirmed case on January 20, 2020, 149,191 confirmed cases and 1,993 deaths have occurred as of June 2021[1]. Many patients have died in a psychiatric hospital in the neighboring area of Daegu city, which recorded a major breakout. Thereupon, patients as well as doctors, nurses, guardians, and other healthcare workers in the hospital were often infected by the virus. Since then, several hospitals conducted cohort quarantine or closed the emergency room that was occupied by the infected people for a certain period (1). Currently, a system of examination for classification and confirmation of patients has been moderately established; however, in the earlier days of the pandemic, healthcare workers experienced unprecedented quarantining (2). Despite the ongoing vaccination drives for healthcare workers as per the government's vaccination policy, they are still unable to be completely liberated from the anxiety of accidental exposure to the infection.

[1] Available online at: http://ncov.mohw.go.kr/en/ (accessed June 17, 2021).

Like medical personnel, medical school students are also prone to anxiety regarding COVID-19 in hospitals since the onset of the COVID-19 pandemic (3). Although virtual classes were introduced as a part of social distancing, due to the nature of medical education, medical students were scheduled to meet for on-site education in venues like laboratory classes in basic medicine, clinical clerkship in training hospitals, and medical licensing examinations (4). Medical students are on the cusp of becoming medical experts as they are not yet certified medical professionals but are still trainees in the field (5). They may feel the responsibility of being medical experts, in spite of inadequate medical practice. Simultaneously, they constantly worry about spreading infection to their families or partners, similar to the general public. As can be seen in the medical students' syndrome, those who lack practical experience in the field are more vulnerable to worrying about diseases due to their inadequate knowledge of diseases or symptoms (6). As COVID-19 continues to progress, medical students are forced to overcome the fear of an uncertain disease and simultaneously face the difficulties of working in hospitals just like other medical personnel.

We developed the Stress and Anxiety to Viral Epidemics-9 items (SAVE-9) scale for measuring work-related stress and anxiety of healthcare workers in response to the ongoing viral pandemic (7). Since medical students are not healthcare workers, it is not appropriate to apply the SAVE-9 scale to them. We observed that the SAVE-9 scale was clustered into two factors: factor I—"anxiety about the viral epidemic" and factor II—"work-related stress associated with the viral epidemic." We previously explored the validity of factor I (namely, SAVE-6) for measuring anxiety of the general population in Korea (8) and Lebanon (9). Several rating scales such as Coronavirus Anxiety Scale (CAS) (10), COVID-19-Anxiety Questionnaire (11), Fear of COVID-19 Scale (12), Obsession with COVID-19 Scale (13), Coronavirus Pandemic Anxiety Scale (14), COVID-19 Anxiety Syndrome Scale (15), and COVID-19 Anxiety Scale (16) were also developed and applied to assess the anxiety response of the general population to the viral epidemic. SAVE-6 included items inquiring about the apprehension of an individual during the current pandemic situation, worry about avoidance behavior of others, and concern about their own health and that of their family members (8, 9). In this study, we hypothesized that the SAVE-6 scale can be applied usefully to measure the anxiety response of medical students to the viral epidemic. Thus, we aimed to explore the psychometric properties and applicability of SAVE-6 among medical students who are at high risk of contracting COVID-19.

Abbreviations: CAS, Coronavirus Anxiety Scale; CFA, confirmatory factor analysis; CFI, comparative fit index; CID, Cronbach's alpha if item is deleted; GAD-7, Generalized Anxiety Disorder-7 items; KMO, Kaiser–Meyer–Olkin; RMSEA, root-mean-square-error of approximation; ROC, receiver operating characteristic; SAVE-6, Stress and Anxiety to Viral Epidemics-6 items; SRMR, standardized root-mean-square residual; TLI, Tucker Lewis index; UUCM, University of Ulsan College of Medicine; WSAS, Work and Social Adjustment Scale.

MATERIALS AND METHODS

Participants and Procedure

This study was conducted through an online anonymous survey using Google Forms among medical students at the University of Ulsan College of Medicine (UUCM) between July 13 and August 1, 2020. The study protocol was approved and written informed consent for participation was waived by the Institutional Review Board (2020-1067) of the Asan Medical Center.

Symptom Assessment

Stress and Anxiety to Viral Epidemics-6 Items

The Stress and Anxiety to Viral Epidemics-6 items (SAVE-6) scale is a version extracted from the original SAVE-9 scale (7) which was developed to assess work-related stress and anxiety of healthcare workers in response to the viral epidemic. The utility of SAVE-6 among the general population has been studied in Korea (8) and Lebanon (9). The items are rated on a 5-point Likert scale: 0 (never), 1 (rarely), 2 (sometimes), 3 (often), and 4 (always)[2]. A higher total score indicates a higher level of anxiety in response to the viral epidemic.

Generalized Anxiety Disorder 7 Items

The Generalized Anxiety Disorder-7 items (GAD-7) scale, a self-rating questionnaire, assesses general anxiety of people. It comprises seven items and is rated using a scale ranging from 0–3 (where, 0 = not at all, 3 = nearly every day), and the total score ranges from 0 to 21. A higher score reflects a more severe degree of anxiety symptoms (17). We used the Korean version of the GAD-7 scale[3]. In this sample, Cronbach's alpha = 0.894, and McDonald's omega = 0.903.

Coronavirus Anxiety Scale

The CAS scale screens anxiety and fear associated with COVID-19 in people (10). It consists of five items including dizziness, sleep disturbance, tonic immobility, appetite loss, and abdominal distress and is rated on a scale of 0–4 (0 = not at all, 4 = nearly every day). The Korean version of CAS was validated and used in this study (18). In this sample, Cronbach's alpha = 0.854, and McDonald's omega = 0.870.

Work and Social Adjustment Scale

The Work and Social Adjustment Scale (WSAS) examines functional impairment due to an identified psychiatric problem. It consists of five domains: (1) the ability to work or study, (2) home management, (3) social leisure activities, (4) private leisure activities, and (5) the ability to maintain close relationships. The WSAS is rated on a scale of 0–8 (0 = not at all, 8 = severely impaired) (19). In this study, we applied the Korean version of the WSAS that was created and translated with the author's permission in previous studies (18). In this sample, Cronbach's alpha = 0.717, and McDonald's omega = 0.776.

[2] Available online at: https://www.save-viralepidemic.net (accessed June 17, 2021).
[3] Available online at: https://www.phqscreeners.com/ (accessed June 17, 2021).

Statistical Analysis

The SAVE-6 total score differences in gender (men vs. women), generalized anxiety (GAD-7 $\geq$ 5 vs. GAD-7 $<$ 5), and functional impairment of mental health (WSAS $\geq$ 11 vs. WSAS $<$ 11) were examined using independent *t*-tests. Correlations of the SAVE-6 total score with GAD-7, CAS, and WSAS were examined using Spearman's correlations, since the distributions of those scales scores were not within the normal limit. Before performing confirmatory factor analysis (CFA), the normality assumption of each of the six items was checked based on skewness and kurtosis for an acceptable limit of range $\pm$ 2 (20). The sampling adequacy and data suitability were examined using the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. A bootstrap (2,000 samples) maximum likelihood CFA was conducted for the six items of SAVE-6 to explore the factorial validity for a unidimensional structure. Multi-group CFAs were run to examine whether SAVE-6 measures anxiety response the same way across gender (men vs. women), generalized anxiety (GAD-7 $\geq$ 5 vs. GAD-7 $<$ 5), and functional impairment of mental health (WSAS $\geq$ 11 vs. WSAS $<$ 11). Satisfactory model fit was defined by a standardized root-mean-square residual (SRMR) value $\leq$ 0.05, root-mean-square-error of approximation (RMSEA) value $\leq$ 0.10, comparative fit index (CFI) and Tucker Lewis index (TLI) values $\geq$ 0.90 (21, 22). The reliability and internal consistency of the factor was examined using Cronbach's alpha and McDonald's omega coefficients. Receiver operating characteristic (ROC) analysis was performed to explore the appropriate cut-off score of the SAVE-6 scale in accordance with generalized anxiety symptoms. Furthermore, we conducted an independent *t*-test and a chi-square test to examine the differences in clinical variables or rating scale scores using the IBM SPSS Statistics for Windows, Version 21.0 and AMOS version 27.

RESULTS

A total of 212 medical students in the UUCM participated in this survey (**Table 1**). Among them, 150 (70.8%) were men, and the proportions of students in each grade were similar. No students were infected, two of them had quarantine experience, and 15 (7.1%) of them reported having a past history of psychiatric symptoms.

TABLE 1 | Demographic characteristics of participants (*N* = 212).

Variables	Mean ± SD, *N* (%)
Gender (male)	150 (70.8%)
Grade	
Pre-medicine 1st (UUCM, total *N* = 39)	36 (17.0%)
Pre-medicine 2nd (UUCM, total *N* = 46)	38 (17.9%)
Medicine 1st (UUCM, total *N* = 39)	30 (14.2%)
Medicine 2nd (UUCM, total *N* = 40)	32 (15.1%)
Medicine 3rd (UUCM, total *N* = 43)	44 (20.8%)
Medicine 4th (UUCM, total *N* = 40)	32 (15.1%)
COVID-19 questions	143 (15.3%)
Did you experience being quarantined due to infection with COVID-19? (Yes)	2 (0.9%)
Did you experience being infected with COVID-19? (Yes)	0 (0.0%)
Psychiatric history	
Have you experienced or been treated for depression, anxiety, or insomnia? (Yes)	15 (7.1%)
Rating scales scores	
Stress and anxiety to viral epidemics-6 items (SAVE-6)	11.0 ± 4.5 (0–23)
Generalized anxiety disorder-7 items (GAD-7)	1.9 ± 3.0 (0–17)
Coronavirus anxiety scale (CAS)	0.3 ± 1.2 (0–10)
Work and social adjustment scale (WSAS)	8.5 ± 6.2 (0–28)

SD, standard deviation; UUCM, University of Ulsan College of Medicine.

Factor Structure of the Stress and Anxiety to Viral Epidemics-6 Items Among Medical Students

The normality assumption for the six items of SAVE-6 were checked using the skewness and kurtosis values, and we accepted values ranged within $\pm$ 2 (**Table 2**). Before the factor analysis, we checked sampling adequacy and data suitability, and observed that the KMO measure was 0.79 and Bartlett's test of sphericity was $p < 0.001$. CFA showed a single-factor model with good fit for all indices (CFI = 0.96; TLI = 0.94; SRMR = 0.04; RMSEA = 0.07), and these results supported the factorial validity of the SAVE-6 scale. Multi-group CFAs were conducted to test whether SAVE-6 measured the same way across gender (men vs. women), anxiety (GAD-7 $\geq$ 5 vs. GAD-7 $<$ 5), and functional impairment of mental health (WSAS $\geq$ 11 vs. WSAS $<$ 11). The results showed no differences in gender (CFI = 0.96; TLI = 0.94; SRMR = 0.04; RMSEA = 0.07), anxiety (CFI = 0.96; TLI = 0.93; SRMR = 0.04; RMSEA = 0.07), and mental health (CFI = 0.94; TLI = 0.91; SRMR = 0.06; RMSEA = 0.09), which demonstrated that measurement invariance was not observed when we measured anxiety response across gender, anxiety, or mental health using the SAVE-6 scale.

Reliability and Evidence-Based Relationship With Other Variables

The SAVE-6 scale showed good internal consistency among medical students (Cronbach's alpha = 0.756, and McDonald's omega = 0.773), and it was similar to the Cronbach's alphas if each item was deleted (0.677–0.759, **Table 2**). SAVE-6 had a good convergent validity based on Spearman correlation coefficient with GAD-7 (rho = 0.320, $p < 0.001$), CAS (rho = 0.229, $p < 0.001$), and WSAS (rho = 0.278, $p < 0.001$). The SAVE-6 scale score was significantly higher among female students [$t_{(210)} = 3.573$, $p < 0.001$], with generalized anxiety {GAD-7 $\geq$ 5, [$t_{(210)} = 3.396$, $p < 0.001$]} and functional impairment of mental health {WSAS $\geq$ 11, [$t_{(210)} = 3.387$, $p < 0.001$]}.

TABLE 2 | Factor structure of the stress and anxiety to viral epidemics-6 items applied to medical students.

Items	Responses					Mean ± SD	Skewness	Kurtosis	CID	Factor loading
	0	1	2	3	4					
1. Are you afraid the virus outbreak will continue indefinitely?	2.4%	9.0%	17.9%	53.8%	17.0%	2.74 ± 0.93	−0.871	0.645	0.759	0.446
2. Are you afraid your health will worsen because of the virus?	21.7%	34.4%	26.9%	13.7%	3.3%	1.42 ± 1.08	0.405	−0.546	0.756	0.610
3. Are you worried that you might get infected?	19.8%	35.4%	19.3%	20.8%	4.7%	1.55 ± 1.16	0.349	−0.881	0.694	0.736
4. Are you more sensitive toward minor physical symptoms than usual?	17.5%	19.8%	17.5%	35.4%	9.9%	2.00 ± 1.29	−0.224	−1.169	0.677	0.804
5. Are you worried that others might avoid you even after the infection risk has been minimized?	45.8%	36.8%	5.2%	9.9%	2.4%	0.86 ± 1.05	1.288	0.899	0.744	0.569
6. Do you worry your family or friends may become infected because of you?	11.3%	9.9%	19.3%	44.8%	14.6%	2.42 ± 1.19	−0.729	−0.367	0.707	0.697

Cronbach's alpha = 0.756.
SD, standard deviation; SAVE-6, Stress and Anxiety to Viral Epidemics-6 items; CID, Cronbach's alpha if item is deleted.
0 = never; 1 = rarely; 2 = sometimes; 3 = often; 4 = always.

Cut-Off Score for Stress and Anxiety to Viral Epidemics-6 Items Among Medical Students

ROC analysis was conducted to explore the appropriate cut-off score of the SAVE-6 scale among medical students in accordance with at least a mild degree of generalized anxiety (GAD-7 score of 5). We observed that a score of 15 points was appropriate (area under the curve = 0.657, sensitivity = 0.51, specificity = 0.77).

DISCUSSION

In this study, we explored the psychometric properties and convergent validity of SAVE-6 among medical students and observed that the single-factor structure of SAVE-6 showed good internal consistency and convergent validity with other anxiety scales like GAD-7 and CAS. Furthermore, the appropriate cut-off score of the SAVE-6 scale was determined as 15 with at least a mild degree of generalized anxiety (GAD-7 score of 5) among medical students.

The SAVE-9 scale was originally developed to assess healthcare workers' stress and anxiety to the viral epidemic. Before commencing the study, we considered applying the SAVE-9 scale to medical students, since they stayed at the hospital and occasionally performed patient care roles. However, we decided to use SAVE-6, which was originally meant to be applied to the general population, since SAVE-9 had a few items that were not applicable to medical students. First, item 9 of SAVE-9, "Do you think that your colleagues would have more work to do due to your absence from a possible quarantine and might blame you?" was not appropriate for medical students, since they do not work professionally and thus are not replaced by other medical students. Additionally, item 6, "Do you feel skeptical about your job after going through this experience?" is also not applicable to medical students. Clinical clerkship is not a "job" for medical students, as they will begin working professionally as doctors in the future. Furthermore, item 7, "After this experience, do you think you will avoid treating patients with viral illnesses?" can be a question about "selecting their majors after getting a medical license."

In this study, a single-structure model of SAVE-6 was confirmed to be valid and in line with previous studies (8, 9). However, we observed a relatively low factor loading value of 0.446 for item 1, "Are you afraid that the virus outbreak will continue indefinitely?" The survey was conducted during the summer of 2020, when people were worried that the COVID-19 pandemic would be difficult to control, which may have contributed to the high proportion of answers of "often" (53.8%) and "always" (17.0%) among medical students. In this model, values >0.6 for factor loading are acceptable. However, a value of <0.5 is also acceptable when the composite reliability is higher than 0.6 (23). In this study, we observed good reliability (Cronbach's alpha = 0.756, and McDonald's omega = 0.773), thus this model was accepted. Furthermore, the reliability was not significantly more even if the item 1 was deleted (**Table 2**). The factor loading value was <0.6 for item 5, "Are you worried that others might avoid you even after the infection risk has been minimized?", due to the high proportion of the responses of "never" (45.8%) and "rarely" (36.8%). This result was similar to that of our previous study of SAVE-6 applied to the general Korean population (8).

The appropriate cut-off score for the SAVE-6 scale in accordance with at least a mild degree of GAD-7 was determined to be 15 among the participants of this study. In our previous studies, we observed the same results among the general population (8) and healthcare workers (factor I of the SAVE-9 scale) (7). Although it can vary depending on groups, races, or regions, SAVE-6 can be a useful tool for measuring the anxiety response of medical students to a viral epidemic like the current COVID-19 pandemic.

The anonymous online survey method is a limitation of this study. Amid the ongoing pandemic, we conducted an online

survey to prevent the spread of the viral infection. Among the participants, no one was infected, and only two experienced quarantine. This low proportion of actual infection experience or quarantine may have influenced the results. Insufficient sample size is also one of the limitations of this study. Another limitation is that rating scales in this study were not formally validated for medical students. Additionally, the participation of UUHM students and the uneven gender ratio of the sample can be regarded as limitations. Furthermore, information about the participants' ages was not recorded since all participants were in their 20s, and we grouped them based on their grades and not age. In conclusion, the SAVE-6 scale can be applied to medical students as a reliable and valid rating scale to assess anxiety response to the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board (2020-1067) of the Asan Medical Center. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JA drafted or provided critical revision of the article. JA and JL performed experiments and analysis. JL provided final approval of the version to publish. YH agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. SC and JP contributed substantially to the conception and design of the study, the acquisition of data, and or the analysis and interpretation. All authors contributed to the article and approved the submitted version.

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Suicidality and Its Associated Factors Among Students in Rural China During COVID-19 Pandemic: A Comparative Study of Left-Behind and Non-Left-Behind Children

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Introduction: The coronavirus disease 2019 (COVID-19) has rapidly spread worldwide. The harmful impact of COVID-19 is beyond just physical health concern. The unprecedented public health crisis has also taken its toll on the mental health of adolescents. The present study aims to estimate the prevalence of suicidal ideation and attempts and investigate the similarities and differences in the influential factors for suicidal ideation and attempts among left-behind children (LBC) and non-left-behind children (NLBC) in rural China during the COVID-19 pandemic.

Method: A total of 761 rural Chinese students, of whom 468 were left behind, completed the cross-sectional questionnaires including demographic data, Cognitive Emotion Regulation Questionnaire, nine-item Patient Health Questionnaire, seven-item Generalized Anxiety Disorder Scale, suicidal ideation, and suicidal attempts. Chi-square test, independent-sample *t*-test, and logistic regression were performed in the statistical analysis.

Results: Overall, 36.4 and 10.4% of rural Chinese students reported suicidal ideation (37.8% for LBC vs. 34.1% for NLBC) and attempts (11.3% for LBC vs. 8.9% for NLBC) during the COVID-19 pandemic. Among LBC, parental educational level (adjusted odds ratio, Adj. OR = 1.60), maladaptive strategies (Adj. OR = 1.04), anxious symptoms (Adj. OR = 2.61), and depressive symptoms (Adj. OR = 3.85) were significantly associated with suicidal ideation, while age (Adj. OR = 0.56), maladaptive strategies (Adj. OR = 1.08), symptoms of anxiety (Adj. OR = 3.85), and symptoms of depression (Adj. OR = 2.68) were significantly related to suicidal attempts during the COVID-19 outbreak. Among NLBC, gender (Adj. OR = 2.20), parental educational level (Adj. OR = 1.77), perceived family economic status (Adj. OR = 0.39), anxious symptoms (Adj. OR = 2.38), and depressive symptoms (Adj. OR = 2.77) were significantly associated with suicidal ideation, whereas only anxious symptom (Adj. OR = 5.85) was significantly related to suicidal attempts.

Conclusion: Suicidal ideation and attempts are prevalent among students in rural China during the COVID-19 outbreak. Our findings also revealed the shared and unique factors

for suicidal ideation and attempts among LBC and NLBC during the COVID-19 epidemic. With regard to the differences between LBC and NLBC, the use of maladaptive strategies and age might be vital factors for suicide prevention measures directed specifically toward LBC, whereas interventions sensitive to gender and perceived social economic status should be specifically designed for NLBC amid the COVID-19 pandemic.

Keywords: suicidal ideation, suicidal attempts, left-behind children, maladaptive strategies, depressive symptoms, anxious symptoms

INTRODUCTION

Since December 2019, the coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2), has rapidly spread worldwide and affected every continent (1). The harmful impact of COVID-19 is beyond just physical health concern (2). The unprecedented public health crisis has also taken its toll on the mental health of the public. Adolescence is a vulnerable stage, and adolescents experience a time of difficult transition, which makes them particularly susceptible to the detrimental effect of COVID-19 (3).

Suicide, as a major public health concern, is the second most leading cause of death among individuals aged 10–24 years (4, 5). Suicidal ideation and attempts are the most prominent precursors of complete suicide which is a preventable public health problem (6, 7). Suicidal ideation refers to the thoughts or impulses of committing suicide, while suicidal attempts refer to self-destructive behaviors with the intention to die (8). It has been reported that ∼4 per 100,000 adolescents aged 10–19 die by suicide annually (9). Recent literature suggested that COVID-19 contributed to the higher risk of suicidality among adolescents (10). A priority agendum for the prevention of suicide in adolescents during COVID-19 is to identify the potential influential factors of suicidal ideation and attempts.

The influential factors for suicidal behaviors were multiple in origin, including psychological, biological, cognitive, social, and family factors (11, 12). A study examining the prevalence and factors of suicide among rural adolescents of China found that poor academic performance, life stress, external locus of control, symptoms of depression, and aggression were associated with the enhanced risk of suicide (11). Previous literature provided evidence for the association between negative emotional regulation strategies and suicidal behaviors. Difficulties with using cognitive reappraisal were found to be related to enhanced suicidal risk (13, 14). Additionally, anxious and depressive symptoms have been proven to be two independent risk factors for suicide (15, 16). Recent evidence suggested that quarantine experiences, enhanced psychological distress, unemployment, poor health-related information, and pre-existing sleep and mental problems were risk factors for suicidal ideation among the general population during the COVID-19 outbreak (17). Although many studies have presented the relationship between numerous psychosocial factors and suicidal behaviors as described above, the updated prevalence and influential factors for suicidal ideation and attempts among rural adolescents during the COVID-19 pandemic remain elusive.

A rural area refers to a geographic region that is located outside towns or cities with a low population density and small settlements (18). In a rural area, agriculture is the main source of livelihood, along with other primary industries. In recent years, China has experienced a rapid urbanization process, which contributes to a large-scale rural-to-urban migration. Rural residents migrate to cities to get employed on account of economic incentives (19). Over the recent decades, the number of rural-to-urban migrant workers has increased dramatically in China (20). The majority of rural migrant workers have to leave their children living in their hometown due to the high cost of living in urban cities and huge barriers to education and healthcare, resulting in the "left-behind children" phenomenon. Based on the available literature, left-behind children (LBC) are those aged 18 or below who continue to live in their hometown when one or both parents migrate to cities for work for at least 6 months (21, 22). According to a national survey conducted by the China Women's Federation in 2013, more than 60 million children in rural China are left behind, accounting for more than one-third of rural Chinese children and more than one-fifth of the entire population of children in China. The national survey also revealed an uneven distribution of the left-behind group in China, with LBC mainly gathering in mid-west China such as Sichuan Province and Anhui Province (14, 23). The findings regarding whether the rate of mental health problems is higher in LBC than in non-left-behind children (NLBC) are not homogenous in the previous literature. Some previous literature has suggested that, compared with NLBC, LBC presented a higher prevalence of psychological problems due to impaired parent–child bonding, reduced parental support, and weakened parental guidance (6, 24). However, some recent research also presented no significant difference in psychological status between LBC and NLBC (25–27).

In recent decades, there is growing empirical literature that investigated the mental health status and its associated factors among LBC; however, less is known regarding the difference in the updated prevalence of suicidal ideation and attempts and the influential factors for suicidal ideation and attempts among LBC and NLBC during the COVID-19 outbreak. The study aims to assess the prevalence of suicidal ideation and attempts among LBC and NLBC amid the COVID-19 pandemic and investigate the shared and unique factors influencing the suicidal ideation and attempts among LBC and NLBC.

METHOD

Participants

The cross-sectional study was conducted from August 1 to 5, 2020 in the rural areas of Anhui Province, which is a relatively under-developed and labor-exporting region (28). We randomly selected 15 classes from five senior high schools using two-stage random cluster sampling. In the first stage of sampling, five schools were randomly selected using a random number table. At the second stage of sampling, five classes were randomly selected from each school using a random number table. The inclusion criteria for the participants were as follows: (1) aged below 18 years old and (2) being born and raised in the countryside.

The participants were recruited through in-class invitation. Five well-trained investigators explained the purpose and procedure of the survey before starting it. The paper-based questionnaires were administrated in schools during classroom time. There is no incentive for completing the survey. A total of 780 students were invited to participate, with nine students refusing to answer the survey and 10 students returning incomplete survey. Finally, 761 participants were included in the analysis, including 468 LBC (61.5%) and 293 NLBC (38.5%).

The research processes were approved by the Research Ethics Commission of the Second Military Medical University and the permission to investigate was obtained from the local Education Bureau and school administrators. All the participants and their caregivers signed the informed consent form.

Measurements

Socio-Demographic Variables

The sociodemographic characteristics obtained from the participants included age, gender, parental educational level, perceived family economic status, and left-behind or non-left-behind. With regard to parental educational level, we ranked it as low and high corresponding to elementary or below, high school or above, respectively. The LBC were considered to be participants with one or both parents having migrated to work for at least 6 months.

Maladaptive Emotion Regulation Strategies

Cognitive Emotion Regulation Questionnaire (CERQ) was used to measure emotion regulation strategies used to regulate emotion in response to stressful life events (29). The 36-item questionnaire consists of nine four-item subscales assessing different emotion regulation strategies, including four maladaptive strategies (self-blame, other-blame, rumination, and catastrophizing) and five adaptive strategies (positive focusing, planning, positive reappraisal, putting into perspective, and acceptance) (30). The participants were asked to rate how often they engage in each strategy on a five-point Likert scale, ranging from 1 "almost never" to 5 "almost always." The scores of maladaptive (CERQ_M) strategies were calculated by summing the relevant subscales. The scale has been widely used in research with adolescents and showed good reliability and validity (31). In the present study, the Cronbach's alpha of CREQ_M was 0.852.

Anxious Symptoms

The Chinese version of the seven-item Generalized Anxiety Disorder Scale (GAD-7) was employed to measure symptoms of anxiety (32). The individuals were required to rate the frequency of each symptom during the past 2 weeks on a four-point scale ranging from 0 (not at all) to 3 (nearly every day). The sum scores of GAD-7 range from 0 to 21, with higher scores denoting more severe symptoms of anxiety. A cutoff of GAD-7 $\geq$10 was used to screen symptoms of anxiety (33). The scale has demonstrated good psychometric properties in adolescent samples (34, 35). In the present study, the Cronbach's alpha of GAD-7 was 0.913.

Depressive Symptoms

The Chinese version of the Patient Health Questionnaire-9 (PHQ-9) was utilized to measure depressive symptoms during the past 2 weeks. Each item was scored from 0 (not at all) to 3 (nearly every day), yielding a total score ranging from 0 to 27. A higher total score represented more severe symptoms of depression. The optimal dichotomization cutoff point on PHQ-9 was 10 (36). The scale has been widely used in measuring symptoms of depression in adolescents and presented adequate psychometric properties (35, 37). The Cronbach's alpha of PHQ-9 in the current study was 0.882.

Suicidal Ideation and Suicidal Attempts

Suicidal ideation and suicidal attempts were assessed with two items: "I thought about killing myself" and "I deliberately tried to kill myself," which were derived from the Youth Self-Report questionnaire (38). The response options were "never," "sometimes," and "often" during the past month. The participants who chose "sometimes" or "often" on the first item were characterized as having suicidal ideation, and those who answered "sometimes" or "often" on the second item were considered to have suicidal attempts. This measure of suicidal ideation and suicidal attempts has been broadly used in prior research on adolescent suicidality (39, 40).

Statistical Analysis

Firstly, descriptive analyses were performed to describe the demographic characteristics of the respondents. The differences in the variables including demographic variables among LBC and NLBC were assessed by chi-square test and independent-sample *t*-test. Secondly, univariate logistic regression was employed to evaluate the univariate associations of demographic variables, maladaptive strategies, anxious symptoms, and depressive symptoms with suicidal ideation and attempts among LBC and NLBC, respectively. Finally, multivariate logistic regression models were conducted to investigate the potential influential factors for suicidal ideation and suicidal attempts among LBC and NLBC, respectively. Adjusted odds ratios (OR) and 95% confidence interval (95% CI) were reported. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS), version 25.0. All variables were binary, and statistical significance was defined as $P < 0.05$ (two-sided tests).

TABLE 1 | The demographic characteristics of the left-behind children (LBC) and non-left-behind children (NLBC) groups; mean ± SD or no. (%).

Variables	Total (n = 761)	LBC (n = 468)	NLBC (n = 293)	X^2/t
Total	761 (100)	468 (61.5)	293 (38.5)	
Age (years)	16.09 (0.61)	16.10 (0.60)	16.07 (0.64)	0.799
Gender				0.50
Male	451 (59.3)	282 (60.3)	169 (57.7)	
Female	310 (40.7)	186 (39.7)	124 (42.3)	
Parental educational level				0.28
Low	378 (49.7)	236 (50.4)	142 (48.5)	
High	383 (50.3)	232 (49.6)	151 (51.5)	
Perceived family economic status				0.37
Below average	112 (14.7)	66 (14.1)	46 (15.7)	
Average/above average	649 (85.3)	402 (85.9)	247 (84.3)	
Scores of maladaptive strategies	41.37 (10.29)	41.64 (10.22)	40.94 (10.42)	0.91
Anxiety				1.27
No	578 (76.0)	349 (74.6)	229 (78.2)	
Yes	183 (24.0)	119 (25.4)	64 (21.8)	
Depression				0.76
No	550 (72.3)	333 (71.2)	217 (74.1)	
Yes	211 (27.7)	135 (28.8)	76 (25.9)	
Suicidal ideation				1.06
No	484 (63.6)	291 (62.2)	193 (65.9)	
Yes	277 (36.4)	177 (37.8)	100 (34.1)	
Suicidal attempts				1.16
No	682 (89.6)	415 (88.7)	267 (91.1)	
Yes	79 (10.4)	53 (11.3)	26 (8.9)	

TABLE 2 | Univariate logistic regression results of the association between suicidal ideation and predictors.

	Total	Non-left-behind children	Non-left-behind children
Age (years)	0.97 (0.76, 1.23)	0.99 (0.72, 1.35)	0.94 (0.64, 1.38)
Gender			
Male	1.00	1.00	1.00
Female	1.72 (1.27, 2.32)	1.55 (1.06, 2.27)	2.06 (1.26, 3.37)
Parental educational level			
Low	1.00	1.00	1.00
High	1.43 (1.06, 1.92)	1.40 (0.96, 2.04)	1.49 (0.91, 2.42)
Perceived family economic status			
Below average	1.00	1.00	1.00
Average/above average	0.59 (0.39, 0.88)	0.69 (0.41, 1.17)	0.45 (0.24, 0.86)
Scores of maladaptive strategies	1.06 (1.04, 1.08)	1.07 (1.05, 1.09)	1.05 (1.02, 1.07)
Anxiety			
No	1.00	1.00	1.00
Yes	5.84 (4.07, 8.38)	6.61 (4.17, 10.47)	4.69 (2.61, 8.43)
Depression			
No	1.00	1.00	1.00
Yes	6.33 (4.47, 8.95)	8.07 (5.14, 12.68)	4.28 (2.47, 7.41)

RESULTS

Demographic Characteristics

The sample characteristics are shown in **Table 1**. The age of the participants ranged from 14 to 18 years old, with a mean age of 16.09 ± 0.61 years old. Approximately 15% of the sample perceived the financial status of their family to be below average. A considerable proportion of the sample had symptoms of anxiety (24.0%) and depression (27.7%) during the COVID-19 outbreak. The self-reported 6-month prevalence of suicidal ideation and attempts among adolescents in rural China was 36.4 and 10.4% during the COVID-19 pandemic. No significant differences in age, gender, parental educational level, scores of maladaptive strategies, anxious symptoms, depressive symptoms, suicidal ideation, and suicidal attempts between LBC and NLBC were found.

Factors Influencing the Suicidality of Rural Adolescents During the COVID-19 Pandemic

Univariate Analysis

The univariate associations of predictors with suicidal ideation and attempts are presented in **Tables 2**, **3**. Females were more likely to report suicidal ideation than males in both LBC and NLBC groups (OR = 1.55, 95% CI: 1.06–2.27 and OR = 2.06, 95% CI: 1.26–3.37). Across the overall sample, participants with a high parental educational level had a significantly higher likelihood of suicidal ideation (OR = 1.43, 95% CI: 1.06–1.92). Nevertheless, this difference was not significant in the LBC and NLBC groups. In the overall sample, adolescents who rated their financial status as average or above average were at a lower risk of having suicidal ideation than those who rated their financial status as below average (OR = 0.59, 95% CI: 0.39–0.88). However, this discrepancy disappeared in the LBC group. For both LBC and NLBC groups, high levels of maladaptive strategies were associated with a higher likelihood of suicidal ideation (OR = 1.07, 95% CI: 1.05–1.09 and OR = 1.05, 95% CI: 1.02–1.07). Anxious and depressive symptoms were positively associated with suicidal ideation not only in the LBC group (OR = 6.61, 95% CI: 4.17–10.47 and OR = 8.07, 95% CI: 5.14–12.68) but also in the NLBC group (OR = 4.69, 95% CI: 2.61–8.43 and OR = 4.28, 95% CI: 2.47–7.41).

Across the total sample, females were more likely to attempt suicide (OR = 1.75, 95% CI: 1.10–2.80). However, these differences were not significant in the NLBC group. For both LBC and NLBC groups, students with high scores of maladaptive strategies presented higher rates of suicidal attempts (OR = 1.11, 95% CI: 1.08–1.15 and OR = 1.07, 95% CI: 1.03–1.11). In the overall sample, symptoms of anxiety and depression were positively related to suicidal attempts (OR = 9.92, 95% CI: 5.92–16.63 and OR = 7.73, 95% CI: 4.63–12.89).

TABLE 3 | Univariate logistic regression results of the association between suicidal attempts and predictors.

	Total	Left-behind children	Non-left-behind children
Age (years)	0.80 (0.54, 1.16)	0.76 (0.47, 1.23)	0.83 (0.43, 1.48)
Gender			
Male	1.00	1.00	1.00
Female	1.75 (1.10, 2.80)	1.82 (1.03, 3.24)	1.67 (0.74, 3.74)
Parental educational level			
Low	1.00	1.00	1.00
High	1.60 (1.00, 2.58)	1.38 (0.77, 2.45)	2.27 (0.95, 5.39)
Perceived family economic status			
Below average	1.00	1.00	1.00
Average/above average	0.59 (0.33, 1.05)	0.67 (0.32, 1.41)	0.46 (0.18, 1.18)
Scores of maladaptive strategies	1.10 (1.07, 1.12)	1.11 (1.08, 1.15)	1.07 (1.03, 1.11)
Anxiety			
No	1.00	1.00	1.00
Yes	9.92 (5.92, 16.63)	9.39 (4.98, 17.71)	10.81 (4.43, 26.36)
Depression			
No	1.00	1.00	1.00
Yes	7.73 (4.63, 12.89)	9.26 (4.82, 17.77)	5.52 (2.38, 12.80)

TABLE 4 | Results of the multivariate logistic regression analyses predicting suicidal ideation among the total sample, left-behind children (LBC), and non-left-behind children (NLBC).

	Model 1–Total	Model 2–LBC	Model 3–NLBC
Age (years)	0.91 (0.69, 1.20)	0.83 (0.57, 1.21)	0.97 (0.64, 1.48)
Gender			
Male	1.00	1.00	1.00
Female	1.72 (1.23, 2.41)	1.44 (0.92, 2.23)	2.20 (1.27, 3.79)
Parental educational level			
Low	1.00	1.00	1.00
High	1.61 (1.14, 2.26)	1.60 (1.02, 2.49)	1.77 (1.01, 3.12)
Perceived family economic status			
Below average	1.00	1.00	1.00
Average/above average	0.62 (0.39, 0.99)	0.91 (0.48, 1.73)	0.39 (0.19, 0.82)
Scores of maladaptive strategies	1.03 (1.01, 1.05)	1.04 (1.02, 1.07)	1.01 (0.99, 1.04)
Anxiety			
No	1.00	1.00	1.00
Yes	2.42 (1.55, 3.79)	2.61 (1.47, 4.62)	2.38 (1.12, 5.06)
Depression			
No	1.00	1.00	1.00
Yes	3.39 (2.22, 5.16)	3.85 (2.23, 6.67)	2.77 (1.40, 5.48)

Multivariate Analysis

The results of multivariate logistic regression analyses are presented in **Tables 4**, **5**. Three models were conducted to explore the influential factors influencing suicidal ideation and attempts among the total sample, LBC, and NLBC, respectively. After adjusting for demographic characteristics, symptoms of anxiety and depression were associated with a higher risk of suicidal ideation in both LBC (OR = 2.61, 95% CI: 1.474.62 and OR = 3.85, 95% CI: 2.236.67) and NLBC groups (OR = 2.38, 95% CI: 1.12–5.06 and OR = 2.77, 95% CI: 1.40–5.48). For both LBC and NLBC groups, students with a high parental educational level were more likely to report suicidal ideation (OR = 1.60, 95% CI: 1.02–2.49 and OR = 1.77, 95% CI: 1.01–3.12). A high score of maladaptive strategies remained negatively related to suicidal ideation in multivariate analysis among LBC only (OR = 1.04, 95% CI: 1.02–1.07). For NLBC only, the odds ratios of reporting suicidal ideation likewise remained higher among females than males (OR = 2.20, 95% CI: 1.27–3.79) and lower among adolescents with a perception of average/above average financial status than those with a perception of below average financial status (OR = 0.39, 95% CI: 0.19–0.82).

After controlling for confounders, symptoms of anxiety were strongly associated with the risk of suicidal attempts in both LBC and NLBC groups (OR = 3.85, 95% CI: 1.73–8.59 and OR = 5.85, 95% CI: 1.86–18.33). Age was a significant predictor of suicidal attempts in the LBC group only (OR = 0.56, 95% CI: 0.32–0.97). Overall, females were nearly twice as likely to report suicidal attempts as males (OR = 1.82, 95% CI: 1.07–3.11). Nonetheless, this was not found in either group. Higher scores of maladaptive strategies and symptoms of depression were positively associated with a greater risk of suicidal attempts within the overall sample (OR = 1.05, 95% CI: 1.03–1.08 and OR = 2.44, 95% CI: 1.26–4.71). However, the discrepancy was not significant in the NLBC groups.

DISCUSSION

This cross-sectional study revealed that the rates of suicidal ideation and attempts were 36.4 and 10.4% in a sample of rural Chinese students during the COVID-19 outbreak. In a recent study conducted 3 months earlier than our study, the rates of suicidal ideation and attempts among senior high school students in rural China were 31.3 and 7.5% (41), which is lower than our findings. A more recent meta-analysis presented the prevalence of suicidal ideation and attempts as 14.5 and 12.7% in individuals aged 12–15 years across 46 low- and middle-income countries (42), which is far less than the estimates reported in the present study. This indicates that the rates of suicidal ideation and attempts among rural Chinese children were extremely alarming during the COVID-19 pandemic and should be taken very seriously as a public health priority. The rates of anxious symptoms, depressive symptoms, and suicidal ideation and attempts were similar in both LBC and NLBC groups during the outbreak of COVID-19. Although this is consistent with recent findings that suggested that the damaging impact of left-behind was limited to the physical aspect of health and no significant difference in suicidality between LBC and NLBC was observed (26, 27), our results deserve further discussion. Our findings indicate that not only

TABLE 5 | Results of the multivariate logistic regression analyses predicting suicidal attempts among the total sample, left-behind children (LBC), and non-left-behind children (NLBC).

	Total	LBC	NLBC
Age (years)	0.69 (0.45, 1.05)	0.56 (0.32, 0.97)	0.87 (0.43, 1.75)
Gender			
Male	1.00	1.00	1.00
Female	1.82 (1.07, 3.11)	1.79 (0.91, 3.54)	1.74 (0.71, 4.29)
Parental educational level			
Low	1.00	1.00	1.00
High	1.65 (0.98, 2.87)	1.50 (0.76, 2.95)	2.33 (0.87, 6.28)
Perceived family economic status			
Below average	1.00	1.00	1.00
Average/above average	0.78 (0.39, 1.55)	1.17 (0.46, 2.95)	0.42 (0.14, 1.28)
Scores of maladaptive strategies	1.05 (1.03, 1.08)	1.08 (1.04, 1.21)	1.02 (0.97, 1.06)
Anxiety			
No	1.00	1.00	1.00
Yes	4.15 (2.17, 7.95)	3.85 (1.73, 8.59)	5.85 (1.86, 18.33)
Depression			
No	1.00	1.00	1.00
Yes	2.44 (1.26, 4.71)	2.68 (1.16, 6.19)	1.99 (0.66,6.00)

LBC but also NLBC are vulnerable to suicidality during the COVID-19 epidemic. The majority of the existing literature have focused on the mental health problems of LBC, while the mental health of NLBC has been relatively neglected in the rural mental health literature. Thus, our findings indicate that attention should not only be paid to the mental health problems of LBC but also be paid to the psychological status of NLBC. The present study also provided robust evidence suggesting that there was no significant difference in the characteristics between LBC and NLBC. Notably, our results presented that, in both LBC and NLBC groups, the majority perceived their family's financial status to be average or above average. Parents of NLBC are usually content with the income they earned and choose to stay in rural areas. Migrant workers get better employment opportunities with higher income, and LBC could receive relatively more remittances from their migrant parents (26, 43). Thus, both LBC and NLBC would perceive better financial status.

More than describing the current situation of suicidal ideation and attempts in rural Chinese children, our findings also revealed the potential risk and protective factors of suicidality in LBC and NLBC during the COVID-19 pandemic, respectively. For both LBC and NLBC, anxious symptoms were positively associated with suicidal ideation and attempts, which is consistent with the previous literature (15, 44). In our study, symptoms of depression predicted suicidal ideation in both LBC and NLBC groups, while depressive symptoms were only associated with suicidal attempts in LBC. This result is intriguing and warrants further investigation and replication. Both LBC and NLBC with a better educated parent were more likely to report suicidal ideation. This echoes the existing evidence during COVID-19 (45). Better educated parents remained busy with their jobs even during the pandemic and had less time to communicate with their children, which might increase the risk of experiencing mental health problems. Additionally, among LBC only, maladaptive strategy was a risk factor for suicidal ideation, and age and maladaptive strategies were influential factors for suicidal attempts, indicating the unique stress faced by LBC. Older LBC predicted a lower likelihood of suicidal attempts in our study, which contradicts the previous findings (42). The disparity might be attributed to the different age range of the participants. For example, a recent study reported that older age was associated with higher odds of suicidal behaviors. However, the age span of the participants was only from 12 to 15, and the study lacked the data on rural children aged 16–18 (42). The use of maladaptive strategies was only associated with suicidality among LBC. Compared with LBC, NLBC might have experienced more parental supervision (6), which could reduce the negative effect of maladaptive emotional regulation strategies on suicidality. Furthermore, gender and perceived family economic status were related to suicidal ideation only in the NLBC group. Consistent with the previous literature (6, 46), female NLBC were more likely to report suicidal ideation than their male counterparts. Previous evidence suggested that girls tended to be more sensitive to interpersonal relationships, and distinct hormone changes in girls vs. boys during pubertal maturation might also account for the disparity (6, 47). A perceived higher family economic status was associated with decreased odds of suicidal ideation, which is in line with previous literature suggesting the protective role of socioeconomic status in mental health (48).

Several limitations should be mentioned. Firstly, the present study employed a cross-sectional design, which cannot be used to make causal inferences. Future researchers might conduct a longitudinal research to explore the mechanisms of how influential factors result in suicidality among rural children in China. Secondly, the research involved self-reported questionnaires, and response bias might undermine the accuracy of the findings. Future study might collect information from diverse informants (e.g., teachers or parents). Thirdly, in the present study, we did not distinguish between rural children with one parent migrating and rural children with two parents migrating, and this therefore needs to be considered in further studies. Fourthly, all the subjects were recruited from schools, which might result in selection bias since LBC might have dropped out of school before completing compulsory education. Finally, the participants in our study were only from a rural area of Anhui province, which might restrict the generalization of the results to children in other rural areas of China.

To the best of our knowledge, our study is the first to provide an updated insight into the prevalence and the influential factors of suicidal ideation and attempts in LBC and NLBC during the COVID-19 pandemic. The rates of suicidal ideation and attempts were extremely high in both LBC and NLBC groups amid the pandemic. The study also highlighted the differences in risk factors for suicidal ideation and attempts between LBC and NLBC, which could help design targeted interventions to prevent suicidality among rural Chinese 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 Second Military Medical University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

TH contributed to the writing of this article and the statistical analysis and is the first author. WC and WD led the whole study, including carrying out this study, and putting forward the study. XM, XS, and FL contributed to the data collection and statistical analysis. All authors contribute to the editing of the manuscript and have approved the final manuscript.

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BRIEF RESEARCH REPORT
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Positive Information of COVID-19 and Anxiety: A Moderated Mediation Model of Risk Perception and Intolerance of Uncertainty

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Although COVID-19 information has been shown to play an important role in anxiety, little is known about the mediating and moderating mechanisms underlying this relationship. In the present study, we examined whether risk perception mediated the relationship between positive information of COVID-19 and anxiety and whether this mediating process was moderated by intolerance of uncertainty. A sample of 3,341 college students participated in this study and completed questionnaires regarding positive information of COVID-19, risk perception, intolerance of uncertainty, and anxiety. The results indicated that positive information of COVID-19 was significantly and negatively associated with anxiety and that risk perception partially mediated this relationship. Intolerance of uncertainty further moderated the relationship between positive information of COVID-19 and risk perception. Specifically, the relationship between positive information of COVID-19 and risk perception was significant for college students with low intolerance of uncertainty, while it became weaker for those with high intolerance of uncertainty.

Keywords: COVID-19, risk perception, intolerance of uncertainty, anxiety, moderated mediation model

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HIGHLIGHTS

- Positive information of COVID-19 was associated with anxiety.
- Risk perception mediated between positive information of COVID-19 and anxiety.
- Intolerance of uncertainty moderated the relationship between positive information of COVID-19 and risk perception.

INTRODUCTION

Since 2020, the ongoing outbreak of coronavirus disease 2019 (COVID-2019) has swept the world. COVID-19 is an infectious disease caused by severe acute respiratory syndrome corona virus 2 (SARS-COV-2) with droplets and contact as the main modes of transmission (1). As a global case spike, the WHO has declared that COVID-19 is currently a global public health emergency (2). COVID-19 is characterized by high infectivity and high mortality. As of midnight on May 28, 2021, 169,172,262 cases had been confirmed, and 3,420,774 deaths resulted from COVID-19 globally. The widespread and rapid spread of COVID-19 has raised intense public attention and mental health stress, such as anxiety (3). Serious anxiety not only damages individuals' psychological function but also reduces individuals' immunity (4, 5). Immunity plays an important role in the prevention and

treatment of COVID-19. Therefore, how to reduce the level of public anxiety during COVID-19 has become a question worthy of attention.

Positive Information of COVID-19 and Anxiety

With the advent of the Internet 2.0 era, social media systems, dominated by Facebook, Twitter, and MicroBlog, have expanded rapidly, which makes it more convenient for people to access information. Since the COVID-19 outbreak, social media has become an important channel for people to know about COVID-19, and information about COVID-19 has been widely spread on social media. COVID-19, as a sudden risk event, will lead to the synchronous transmission of emotions with information as the carrier (6). The outbreak of Covid-19 has seriously threatened individuals' lives and life, so they need to obtain effective information. Wang (7) shows that the improvement of information effectiveness can relieve information anxiety. Shi et al. (8) found that positive SARS information, including recovery information with SARS and measures government took to prevent the spread of SARS, can improve individuals' mental health. Individuals will feel relieved after collecting and selecting valuable information from the massive epidemic information, which buffers the discomfort caused by traumatic events. Individuals having higher confidence in authority are associated with lower anxiety and individual having sufficient information about control measures beliefs in the ability to protect oneself and others are strongly associated with lower anxiety during COVID-19 epidemic (9). Trust in governmental actions to face COVID-19 and the subjective level of information regarding COVID- 19 are negatively associated with anxiety (10). The more positive information about the epidemic situation (such as the number of people cured, measures that are taken by the government) is obtained, the more certain they are about the safety of their environment, and they have more clear plans for their own lives, which may alleviate their anxiety. No study, to the best of our knowledge, has examined the relation between positive information of COVID-19 (such as the number of people cured, measures taken by the government) and anxiety among Chinese college students. Thus, the aim of the present study is to investigate whether positive information of COVID-19 (such as the number of people cured, measures taken by the government) is significantly associated with anxiety and examine the potential mediating and moderating mechanisms in this association.

Risk Perception as a Mediator

Risk perception, defined as the subjective feeling and understanding of risk events, reflects the values and ideology of the individual (11, 12). When risk events (such as COVID-19) occur, the individual is affected by the information on risk events, and the individual will have subjective feelings and judgments on risk events and then produce a corresponding emotional experience and preparation behavior (13). Drawing from the Risk Information Seeking and Processing model (RISP) (14), we propose risk perception as a mediator between positive information of COVID-19 and anxiety. According to the RISP, after individuals acquire information on risk events, they will use the information to assess the severity of risk events and then generate corresponding emotional experiences. The model predicts that greater risk perception leads to increased negative emotion and decreased positive emotion (14). Anxiety is one of the most important emotional responses to risk perception (15). Although not yet tested, it is reasonable to expect that risk perception acts as a mediator between positive information of COVID-19 and anxiety. In the following section, previous research findings are reviewed to support this argument.

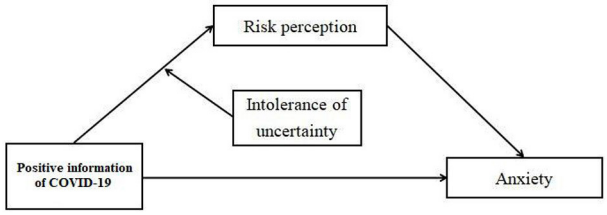

FIGURE 1 | The proposed theoreticalmodel.

First, according to the cognitive model, information on risk events (such as COVID-19) will be associated with individuals' risk perception (16). A previous study showed that the more positive information an individual obtains about epidemic, the lower the risk perception (8). Second, high risk perception is more likely to develop high level of anxiety. The cognitive expectation theory of anxiety holds that anxiety is largely induced by the uncertainty of events and the severity of consequences (17). Individuals with a high level of risk perception generally believe that risk events are highly uncertain and uncontrollable and will bring serious consequences, which leads to anxiety (18).

Intolerance of Uncertainly as a Moderator

Although positive information of COVID-19 may be significantly associated with anxiety through the mediating role of risk perception, not all individuals who are exposed to COVID-19 homogeneously experience a higher level of risk perception and show anxiety. Therefore, it is important to explore potential moderating variables that may influence the relationship between positive information of COVID-19 and anxiety.

The COVID-19 pandemic has created a high degree of uncertainty worldwide, and uncertainty distress is an understandable reaction. If uncertainty persist, it could become mental problem (19). Intolerance of uncertainty affects how individuals perceive, interpret, and respond to future uncertain situations (20) which is related to a variety of mental health problems (such as anxiety) (21) and plays a central role in the formation of generalized anxiety disorder (22, 23). Intolerance of uncertainty is a good indicator for clinical intervention (24) and is positively correlated with risk perception (25). The ecological theory proposes that individual development is the interaction between individuals and the environment, and individuals in the same environment will develop differently due to different individual characteristics (26). According to ecological theory, not all individuals who

receive the same information about COVID-19 have the same level of risk perception, and the relationship between environmental factors (such as positive information of COVID-19) and development outcomes (such as risk perception) may be moderated by individual characteristics (such as intolerance of uncertainty). Tolerance of uncertainty refers to the set of negative and positive psychological response-cognitive, emotional, and behavioral-provoked by the conscious awareness of ignorance about particular aspects of the world, which is associate with health behavior and health outcomes (27). Intolerance of uncertainty (IU) refers to a dispositional negative orientation toward uncertainty and its consequences and is correlated with a tendency to react negatively on emotional, cognitive, and behavioral levels to uncertain and unpredictable situations (28). Intolerance of uncertainty is correlated with a failure to employ effective emotion regulation strategies, negative thoughts, and emotions about problems, and a perceived inability to cope effectively with aversive responses to uncertainty (29, 30).

Positive information of COVID-19 can help individuals more clearly understand COVID-19, which helps to reduce the uncertainty about COVID-19 and reduce risk perception. Positive information of COVID-19 is a protective factor for risk perception. The protective-limiting hypothesis (杯水薪) proposes that the environmental protective factor may lose its ability to counteract risk once the individual risk factor reaches a certain level (the protective effects of environmental factors are dampened in the face of high individual risk factors) (31). In this case, the beneficial effects of environmental factors will be stronger for individuals who have lower levels of risk factors. Hence, compared to college students with high intolerance of uncertainty, for college students with low intolerance of uncertainty, the relationship between positive information of COVID-19 and risk perception is stronger. Intolerance of uncertainty moderate the relationship between positive information of COVID-19 and risk perception such that high intolerance of uncertainty may weaken the association between positive information of COVID-19 and risk perception. To our knowledge, however, no previous studies have examined whether intolerance of uncertainty is a risk factor that moderates the relationship between positive information of COVID-19 and risk perception. Then, we examined whether the relationship between positive information of COVID-19 and risk perception would be moderated by intolerance of uncertainty.

The Present Study

Taken together, the aims of the current study were 2-fold. First, the current study tested whether risk perception would mediate the relationship between positive information of COVID-19 and anxiety. Second, we tested whether intolerance of uncertainty would moderate the association between positive information of COVID-19 and risk perception (**Figure 1**). Based on the literature review, we proposed the following hypotheses:

Hypothesis 1. Positive information of COVID-19 would be positively correlated with anxiety.

Hypotheses 2. Risk perception would mediate the relationship between positive information of COVID-19 and anxiety.

Hypotheses 3. Intolerance of uncertainty would moderate the association between positive information of COVID-19 and risk perception.

METHODS AND MATERIALS

Participants

After obtaining colleges and participants' consent, the research team distributed anonymous questionnaires to 3,341 college students (1,128 males and 2,213 females) in China: 1,765 (52.83%) freshmen, 1,138 (34.07%) sophomores, 306 (9.15%) juniors, and 132 (3.95%) seniors. The mean age of the participants was 19.57 years ($SD = 1.38$).

Instruments

Positive Information of COVID-19 Questionnaire

Positive information of COVID-19 was assessed using positive information of COVID-19 questionnaire. This questionnaire was developed for individuals in the Chinese population. Based on the previous research (8), the questionnaire included two dimensions: (1) positive information of COVID-19 and (2) information on preventive measures of COVID-19. We compiled the COVID-19 questionnaire comprising 14 items (e.g., "I will get COVID-19 information through official channels"). Participants rated the items on a five-point scale (1 = strongly disagree to 5 = strongly agree), with higher scores representing that individual get more positive information about COVID-19. Confirmatory factor analysis (CFA) of this questionnaire suggested that the two-factors model fit the data well: CFI = 0.91, TLI = 0.90, RMSEA = 0.04, 90% CI = [0.03, 0.06], SRMR = 0.03. In the present study, Cronbach's alpha for this questionnaire was 0.96.

Risk Perception Scale

Risk perception was assessed using the Risk Perception Scale. This scale was developed for individuals in the Chinese population. We compiled the Risk Perception Scale, comprised of 10 items. The scale included two dimensions: (1) familiarity (6 items; e.g., "I understand the cause of COVID-19") and (2) controllability (4 items; e.g., "The government has taken appropriate measures to deal with COVID-19"). The response scale ranges from 1 (strongly disagree) to 5 (strongly agree). Responses to all items were averaged, with higher scores indicating that the individual believes that COVID-19 is more uncontrollable. Confirmatory factor analysis (CFA) of risk perception scale suggested that the two-factors model fit the data well: CFI = 0.90, TLI = 0.90, RMSEA = 0.07, 90% CI = [0.06, 0.09], SRMR = 0.06. In the present study, Cronbach's alpha for this scale was 0.72.

Intolerance of Uncertainty Scale (IUS-12)

The Intolerance of Uncertainty Scale is a 12-item scale that was developed by Carleton et al. (32). We used Chinese translation of the scale (33). Individuals rated each item (e.g., "Unforeseen events upset me greatly") on a five-point scale ranging from 1 (not at all characteristic of me) to 5 (entirely characteristic of me). Higher total scores indicated higher levels of intolerance of uncertainty. The Chinese version of the Intolerance of Uncertainty Scale has been demonstrated to be reliable and valid

(34, 35). In the present study, Cronbach's alpha for this scale was 0.92.

Self-Rating Anxiety Scale

Anxiety was measured using Chinese version of the Self-rating Anxiety Scale (36). The scale contains 20 self-reported items (e.g., "I feel more nervous and anxious than usual"). It is a 4-point scale ranging from 1 (none or a little of the time) to 4 (most or all of the time). Higher scores indicated higher levels of anxiety. The Chinese version of the Self-rating Anxiety Scale has been demonstrated to be reliable and valid (37). In the present study, Cronbach's alpha for this scale was 0.75.

Procedure

This investigation was approved by the first author's University Ethics Committee. We obtained consent from all participants. Students were invited to participate in the survey anonymously and free to withdraw from the study at any time. Since this study was conducted during the COVID-19 pandemic, data collection was conducted *via* the Internet from February 9 to March 1, 2020. As an incentive for the participants, they received a small gift after the surveys were completed.

Statistical Analysis

First, data screening revealed that there were no outliers in our data, and responses with missing data were excluded from data processing. Second, the study presented descriptive statistics and Pearson correlations for variables of interest. Mplus 7.4 was applied to examine the hypothesized moderated mediation model, and we evaluated the following goodness of fit indices to assess the adequacy of the model: the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the standardized root mean square residual (SRMR). Values >0.95 for the CFI and TLI, values <0.08 for the RMSEA, and SRMR are all considered an acceptable fit of the model to the data (38, 39). All study variables were standardized before structural equation modeling (SEM).

RESULTS

Preliminary Analyses

Table 1 shows the means, standard deviations, and correlations of the variables. Positive information of COVID-19 was found to be negatively correlated with anxiety ($r = -0.14$, $p < 0.001$), which supported our first research hypothesis (Hypothesis 1). Risk perception was positively correlated with positive information of COVID-19 ($r = -0.50$, $p < 0.001$), intolerance of uncertainly ($r = 0.16$, $p < 0.001$), and anxiety ($r = 0.28$, $p < 0.001$). Intolerance of uncertainty was positively correlated with anxiety ($r = 0.20$, $p < 0.01$). Gender was correlated with anxiety. Age was correlated with positive information of COVID-19, risk perception, intolerance of uncertainty and anxiety. This result suggested that gender and age should be regarded as covariates in the next stage of analyses.

TABLE 1 | Means, standard deviations, and correlations of the main study variables.

	M	SD	1	2	3	4	5	6
1. Age	19.57	1.38	1					
2. Gender	1.66	0.47	−0.08**	1				
3. Information	3.87	0.74	0.06**	−0.01	1			
4.Risk perception	2.23	0.45	−0.04*	−0.01	−0.50***	1		
5. Intolerance of uncertainty	2.75	0.70	0.09***	−0.02	−0.01	0.16***	1	
6. Anxiety	1.58	0.30	0.04*	−0.09***	−0.14***	0.28***	0.20***	1

*N = 3,341. *P < 0.05, **P< 0.01, ***P< 0.001.*

Testing for Mediation Effect and Moderated Mediation Effect

The random algorithm was used to parcel the items in each scale as indicators for each latent variable and each scale was packaged into 3 indicators in the present study. In the present study, age and gender were used as covariates in the structural equation model analysis. We used maximum likelihood to test the mediation model and moderated mediation model. The theoretical mediation model and moderated mediation model were examined with Mplus 7.4 (40). The results of the structural equation model analyzing the model showed that the mediation model (CFI = 0.95, TLI = 0.94, RMSEA = 0.06, 90% CI = [0.04, 0.07], SRMR = 0.05) and moderated mediation model (CFI = 0.95, TLI = 0.93, RMSEA = 0.07, 90% CI = [0.05, 0.08], SRMR = 0.06) fit the data well. The results showed that the values for the fit indices were excellent (38, 39).

According to this mediation model, positive information of COVID-19 was negatively related to college students' risk perception ($\gamma = -0.69$, $t = -33.12$, $p < 0.001$). Moreover, risk perception was positively related to college students' anxiety ($\gamma = 0.12$, $t = 5.10$, $p < 0.001$). This result indicated that risk perception mediated the relationship between positive information of COVID-19 and college students' anxiety. This model indicated that positive information of COVID-19 was directly related to college students' anxiety ($\gamma = -0.07$, $t = -2.70$, $p < 0.01$); therefore, risk perception partially mediated the relationship between positive information of COVID-19 and anxiety, which supported our second research hypothesis (Hypothesis 2). The effect size of the mediation effect was 0.53.

According to this moderated mediation model presented in **Figure 2**, positive information of COVID-19 was negatively related to college students' risk perception ($\gamma = -0.59$, $t = -34.11$, $p < 0.001$). Moreover, risk perception was positively related to college students' anxiety ($\gamma = 0.16$, $t = 5.40$, $p < 0.001$). This result indicated that risk perception mediated the relationship between positive information of COVID-19 and college students' anxiety. Moreover, this model indicated that positive information of COVID-19 was directly related to college students' anxiety ($\gamma = -0.06$, $t = -2.14$, $p < 0.05$); therefore, risk perception partially mediated the relationship between positive information of COVID-19 and anxiety. Moreover, the interaction of positive information of COVID-19 and intolerance

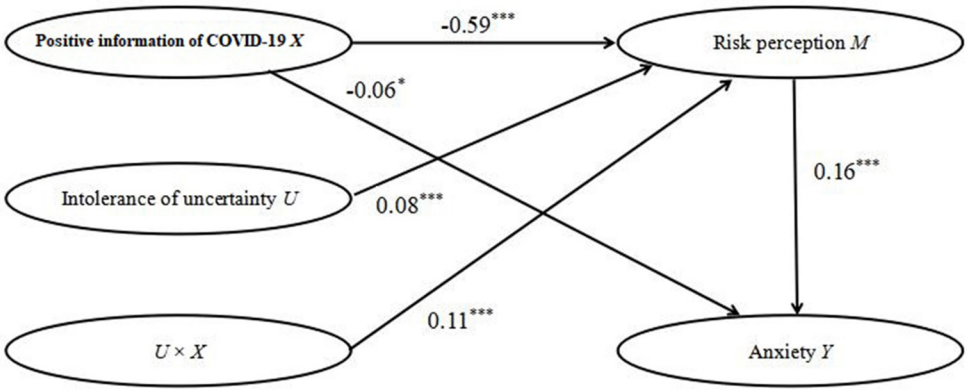

FIGURE 2 | Moderated mediation result. *$P < 0.05$, ***$P < 0.001$.

of uncertainty was significantly related to risk perception ($\gamma = 0.11$, $t = 5.55$, $p < 0.001$). Consistent with our third hypothesis (Hypothesis 3), intolerance of uncertainty moderated the relationship between positive information of COVID-19 and risk perception.

To further portray the interaction, we conducted simple slope plots and calculated beta coefficients at -1 *SD* and $+1$ *SD* from the mean of risk perception. As depicted in **Figure 3**, for college students with a higher level of intolerance of uncertainty, the influence of positive information on risk perception was negative and statistically significant ($\beta = -0.48$, $t = -22.14$, $p < 0.001$). For college students with a lower level of intolerance of uncertainty, the influence of positive information on risk perception had a steeper slope, meaning it was more statistically significant ($\beta = -0.70$, $t = -42.82$, $p < 0.001$). This finding indicated that the negative relationship between positive information of COVID-19 and risk perception was greater for college students who had lower levels of intolerance of uncertainty compared to those with higher levels of intolerance of uncertainty, but these relationships remained negative overall.

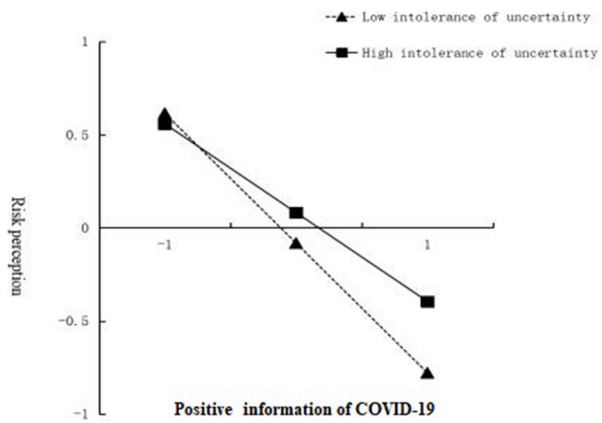

FIGURE 3 | Association between positive information of COVID-19 and risk perception at higher and lower levels of intolerance of uncertainty.

DISCUSSION

The current study investigated the relationship between positive information of COVID-19 and individuals' anxiety. Our findings showed that positive information of COVID-19 was negatively related to anxiety. The access to more positive information of COVID-19 can increase individuals' confidence in overcoming the virus and can more positively look at the difficulties they are facing, and even make it possible for them to make a clear life and study plan (41, 42). One study suggests that more exposure to information was positively associated with anxiety throughout the EU during H5N1 (43). The reason may be as follows. First, the measurements of the epidemic information and anxiety were different. Van den Bulck and Custers (43) used TV viewing to measure exposure risk information. In their study, they used data from the European Audiovisual Observatory Yearbook 15 to obtain national estimates of average TV viewing per person per day, but anxiety was measured using self-report. Second, they assumed that those who watched a lot of TV also watch a lot of news, and the longer individuals watched TV, the more information they got about epidemic. As they said, TV viewing behavior showed that heavy TV viewers watched a lot of everything. As we all know, not all TV shows are about the epidemic such as TV play. In our study, we used positive information of COVID-19 questionnaire to measure positive information of COVID-19. The more information about the epidemic situation during the COVID-19 pandemic (such as the number of people cured, measures that are taken by the government, etc.) is obtained, the more certain individuals are about the safety of their environment, which can help people recognize the crisis and reduce their panic and anxiety.

Although the relationship between positive information of COVID-19 and anxiety is well-understood, the underlying

mediation and moderation mechanisms are less clear. Our findings indicated that the beneficial effect of positive information of COVID-19 on anxiety was partially explained by risk perception. Furthermore, the relationship between positive information of COVID-19 and risk perception was moderated by the intolerance of uncertainty. The following sections discuss each of the research hypotheses in light of this mediation and moderation model of positive information of COVID-19 and anxiety.

The Mediating Role of Risk Perception

The present study is the first to demonstrate the mediating role of risk perception in the association between positive information of COVID-19 and anxiety. That is, positive information of COVID-19 weakens risk perception about COVID-19, which in turn reduces anxiety among college students. Therefore, risk perception is not only an outcome of COVID-19 but also a protective factor against individuals' anxiety. Furthermore, it is worth noting that risk perception only partially mediated the relationship between positive information of COVID-19 and anxiety. The remaining direct and negative relationship between positive information of COVID-19 and anxiety may suggest that positive information of COVID-19 may function as a direct factor that can significantly reduce college students' anxiety.

In addition to the overall mediation result, each of the separate links in our mediation model is noteworthy. For the first stage of the mediation process (i.e., positive information of COVID-19→ risk perception), the present study found that positive information of COVID-19 was related to lower risk perception. This finding is consistent with the social amplification of the risk framework (44). That is, both the information source and nature of the information have an impact on risk perception. First, the more reliable the source of information, the more positive the individual perception of risk (45, 46). Second, positive information about an outbreak has a positive association with an individual's risk perception (8). The greater the impact of healing information and government preventive measures of COVID-19, the lower the level of individuals' risk perception. Throughout COVID-19, experts and government organizations have released authoritative and accurate information about COVID-19, which enables individuals to rationally assess risk events and generate positive risk perceptions.

For the second stage of the mediation model (i.e., risk perception→ anxiety), the present study found that risk perception was associated with less anxiety. The reason may be as follows. First, individuals with low risk perception tend to believe that COVID-19 is controllable, which reduces the uncertainty of risk events and thus reduces individuals' anxiety (47). Second, the death reminder hypothesis holds that anxiety arises from the fear of death (48). During COVID-19, individuals' anxiety has primarily come from the risk of infection. When individuals have a positive risk perception of the epidemic, they tend to believe that the epidemic is controllable and preventive measures are effective, which reduces individuals' fear of infection with COVID-19 and thus reduces individuals' anxiety.

The Moderating Role of Intolerance of Uncertainty

Our results also showed that intolerance of uncertainty moderated the relationship between positive information of COVID-19 and risk perception. This pattern is consistent with the protective-limiting model (31) and suggests that the effect of positive information of COVID-19 on risk perception is weaker for college students with a high rather than low intolerance of uncertainty. This result indicates that the protective effect of positive information of COVID-19 on individual development/risk perception is relatively sensitive, and the risk/negative effect of intolerance of uncertainty is relatively strong, which not only lead to an increase in risk perception but also to a weakening of the protective effect of epidemic information. There is a possible explanation for this finding. As individuals acquire more positive information about COVID-19, they perceive less uncertainty about COVID-19. However, not all individuals who receive the same positive information about COVID-19 have the same level of risk perception. For college students with a low intolerance of uncertainty, their tolerance of uncertainty for risk events is high. When they receive positive information of COVID-19, they tend to view the epidemic in a positive cognitive way and believe that COVID-19 is controllable, which leads to a stronger protective effect of epidemic information on risk perception. The reduction of uncertainty caused by epidemic information is more likely to reduce their risk perception. In contrast, college students with a high intolerance of uncertainty are more sensitive and negative to the uncertainty of COVID-19. When they receive positive information of COVID-19, they tend to view epidemic information in a negative cognitive way, which leads to the weakening of the protective effect of epidemic information. In other words, college students with a high intolerance of uncertainty benefit less from positive information of COVID-19 compared to those who have a low intolerance of uncertainty. To our knowledge, the present study is the first to confirm that intolerance of uncertainty as a moderator moderated the relationship between positive information of COVID-19 and risk perception. Therefore, our results filled this gap in understanding the relationship between epidemic information and risk perception.

Limitations

There are also some limitations in the present investigation that need to be noted. First, the present study employed a cross-sectional design that does not allow for causal inferences. Future research should employ experimental and longitudinal designs to better explain the causal direction. Second, like any study based solely on self-report for data collection, there may have been response biases and social desirability effects. The results should be replicated with other, more comprehensive or even representative samples to achieve even more generalizable conclusions. Third, the present study was conducted in a sample of Chinese college students, which potentially limits the generalizability and indicates that similar research should be conducted in other types of samples.

Despite these limitations, the current study has several theoretical and practical contributions. From a theoretical perspective, this study further extended the previous research by confirming the mediating role of risk perception and the moderating role of intolerance of uncertainty. This would contribute to a better understanding of the relationship between positive information of COVID-19 and anxiety. From a practical perspective, with increasing positive information, college students maybe reasonably assess risk, and their anxiety maybe decrease. Government departments can conduct effective risk communication by releasing timely information about COVID-19, such as vaccine research progress and the infection rate, to help individuals establish risk perception rationally and reduce their anxiety. Moreover, college students with low level of intolerance of uncertainty may reduce their risk perception by disseminating more effective information. Compared to college students with low level of intolerance of uncertainty, for college students with high level of intolerance of uncertainty, they not only should get more positive information about the COVID-19 pandemic, but also reduce the level of intolerance of uncertainty in order to reduce risk perception.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

JZ and TM wrote the manuscript. All authors contributed to the article, approved the submitted version, carried out the concepts, design, data acquisition, analysis, and manuscript editing.

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Association Between Future Orientation and Anxiety in University Students During COVID-19 Outbreak: The Chain Mediating Role of Optimization in Primary-Secondary Control and Resilience

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The unfamiliar and menacing epidemic has undoubtedly increased the anxiety of students. Therefore, the strategies to reduce anxiety are urgently required. The present study principally investigated a protective mechanism of future orientation in anxiety during the low-risk period of COVID-19 outbreak. The study was conducted in 528 non-infected students (range = 16–24 years) recruited from five universities in China. The participants completed questionnaires between January 22, 2021, and January 24, 2021. Chain intermediary analyses were performed after controlling for gender and age. Results indicated that future orientation lowers anxiety through (a) optimization in primary and secondary control, (b) resilience, and (c) chain mediating path of optimization in primary and secondary control coupled with resilience. We investigated how individuals deal with risk factors after encountering adversity and how their psychological flexibility stimulates and promotes them to achieve a well-adapted developmental state. This study provided reference suggestions on reducing anxiety levels during an emergency.

Keywords: COVID-19, optimization in primary and secondary control, anxiety, future orientation, resilience

INTRODUCTION

According to the expectancy model of fear (1), the events that shatter people's expectations trigger fear and anxiety, which has also been proven by studies on COVID-19 outbreak (2, 3). The self-efficacy theory (4) suggests that the people who are confident can cope with future events and are rarely anxious, which has been proven by a study on positive future orientations (5). However, in-depth studies are required to understand why future-oriented people exhibit lesser anxiety than other people and the underlying mechanism. Therefore, the aim of the present study was to investigate the relationship between future orientation and anxiety in non-infected students during COVID-19 outbreak. Future orientation for teenagers concretely includes planning

(exploration and investment in future) and evaluation (emotional experience related to future education, career, and marriage goals). Considering that students' future orientation goals and concerns are most often associated with development tasks (6), educational and professional fields were targeted in this study.

People who aim for future and possess strong motivation to execute their plans are less anxious about existing emergencies (7). However, the motivation to realize future is weakened under challenging situations. Compared with the motivation, which is a temporary and highly fluctuating cognitive phenomenon, optimization in primary and secondary control scale (OPS) is a stable behavioral tendency derived from intrinsic motivation (8). The lifelong development view (9) suggests that the OPS, as a model of adjusting oneself with the external environment, optimizes, and maintains motivation by increasing either resource inputs or reliance on compensation strategies (10, 11), thereby reducing future anxiety (12–14). Therefore, we assumed that future orientation reduces anxiety by the mediation of OPS.

Although the effects of severe challenges that lead to stressful situations and setbacks of individual emotions have been proven, individuals do not experience negative emotions in a stressful situation alone. Positive emotions can be developed by constructing personal resources such as resilience (15–19). Resilience is not only a dynamic process between dangerous and protective characteristics (20) but also an individual's superior adaptability (21, 22). Moreover, it a result of the change process (23, 24). Organisms possess the essential response-ability of dynamic regulation and instant adaptation for self-protection and survival when the environment changes, which is a "self-regulation mechanism" determined by biological genetics (25). Resilience seems to be a self-protection instinct in humans (26) that help people in dealing with negative emotions (27, 28). Therefore, we assumed that future orientation could reduce anxiety by increasing resilience.

Notably, OPS and psychological resilience are not separate intermediaries. The process model of mental resilience (26) suggests that in response to life stimuli, protective factors either mobilize, reintegrate, and ultimately restore to maintain a balance or lose balance (15–19). Among these factors, OPS's support is a protective factor (29, 30). In the present study, we hypothesized that the future orientation could reduce anxiety through the chain mediation path of OPS and resilience.

Consequently, the study investigated the relationship between future orientation and anxiety in non-infected students during the low-risk period of COVID-19 outbreak. We propose three hypotheses in this study (**Figure 1**):

Future orientation could reduce anxiety through

H1: the mediating effect of OPS;
H2: the mediating effect of resilience;
H3: the chain mediating path between OPS and resilience.

MATERIALS AND METHODS

Participants

Based on previous studies, over 500 participants were enrolled in this study (31–33). In this study, we have contacted each college secretary, obtained the oral consent of the secretary and class counselor, and informed all participants of the purpose of the study. We obtained the paper version of all the participants' informed consent, who were studying in five universities located in different cities of China. Study questionnaires were filled in by the recruited students between January 22, 2021, and January 24, 2021. During the mental health education course (∼45 min), the research assistant told all students to fill out the paper questionnaire voluntarily with payment. After completion of the survey, the participants received 0.77 US dollars−2.3 US dollars as a bonus according to the consistency and completeness of their answers. The assistants also imported data entries to ensure that the data remains anonymous to the researchers.

Participants were required to fill in their sex (1 = male, 2 = female), their family's living status (1 = urban, 2 = rural), and their age and family structure. The age of all participants ranged from 16 to 24 years old (M = 19.16 years, SD = 0.94). The majority of all participants were from cities (about 77.98%, n = 412), with the remainder (about 22.02%, n = 116) were from towns. Among them, 93.75% of the subjects were from two-parent families (n = 495), included 266 males and 262 females. The author's research ethics committee approved the study.

Connor–Davidson Resilience Scale

The Connor–Davidson Resilience Scale (CD-RISC), initially developed by Connor and Davidson, is a 25-item scale used to evaluate resilience (34), and it was modified into a Chinese version by Yu and Zhang (35). CD-RISC contains three subscales, namely strength (for example, can you cope with increasing pressure?), tenacity (for example, even if there is no hope, can you not give up easily?), and optimism (for example, can you see the other side of the coin?). CD-RISC is a 5-point Likert scale ranging from 0 (not correct at all) to 4 (almost always correct) that assesses resilience of participants. The final score is obtained by adding all items, and it ranges from 0 to 100; the higher the final score, the higher is the resilience. The Chinese version of CD-RISC exhibits superior reliability and validity (36), and was widely used in participants aged 13–30 (35, 37–41). It exhibited a stable internal consistency in the present study (Cronbach's alpha coefficient = 0.939).

Future Orientation Questionnaire

Future orientation questionnaire (FQD) is mainly used to examine the development of future orientation of youths, and it was initially developed by Nurmi et al. (42). FQD with a 44-item scale mainly investigates the extent of future exploration (for example, have you often searched for information related to future education?) and investment (for example, did you prepare for your future objective?) in terms of aspects such as family, occupation, and education. This study investigated both the future educational (for example, do you often think about or plan your education you will receive in the future?) and occupational areas (for example, how determined are you to execute your future career plan after graduation?) of the participants. FQD uses a 5-point Likert scale ranging from 1 (never) to 5 (always) to assess the resilience of participants. The total score is the sum of the average scores of all items, with high total scores

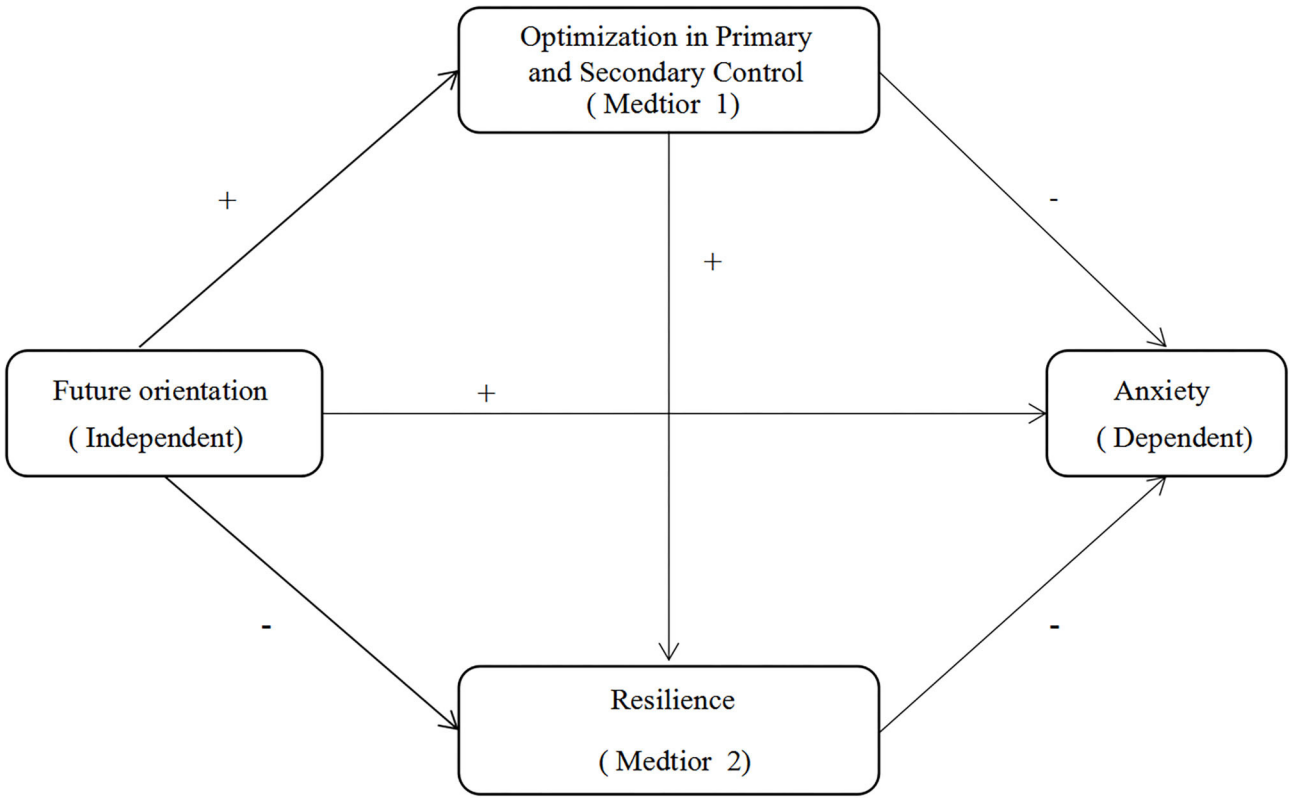

FIGURE 1 | The proposed chain mediation model. Indirect effect 1, Future orientation → Optimization in primary and secondary control → Anxiety; Indirect effect 2, Future orientation → Resilience → Anxiety; Indirect effect 3, Future orientation → Optimization in primary and secondary control → Resilience → Anxiety.

denoting a high future orientation level. The Chinese version of FQD shows good reliability and validity (6), and was widely used in participants aged 13–30 (6, 43). It demonstrated a stable internal consistency (Cronbach's alpha coefficient = 0.868) in the present investigation.

Self-Rating Anxiety Scale

Self-rating anxiety scale (SAS), first developed by (44), is used to examine participants' anxiety symptoms over the preceding 7 days. It comprises 20 items and is scored by a 4-point Likert scale, ranging from 1 (no time or very little time) to 4 (absolutely most or all-time). A total SAS score of >50 indicates that the participant is more likely to develop anxiety symptoms. The Chinese version shows satisfactory reliability and validity (45). The self-rating anxiety scale is widely used in participants aged 15–24 (46, 47). In this study, the internal consistency of this questionnaire was stable (Cronbach's alpha coefficient = 0.881).

OPS Scale

The OPS scale includes five subscales: selective primary control (for example, after setting a goal, I am willing to work hard to develop the skills required to achieve the goal), selective secondary control (for example, I can avoid any interference when I decide to do something), compensatory primary control (for example, when I cannot directly achieve a goal, I occasionally use a roundabout way to achieve it), compensatory secondary control (for example, when I am in difficult situations, I often comfort myself by telling that in many ways I am in a better position than others), and optimization (for example, if something takes a lot of time, I will consider whether I should invest). The 44-item OPS scale was designed by Heckhausen et al. (49) and further revised by Wang et al. (48). The first four subscales consist of eight items, and the optimization subscale comprises 12 questions. The total score is the sum of the average scores of all the items and is scored on the basis of a five-point scale (1–5). The higher the total score, the higher is the degree of optimization in primary and secondary controls (48, 49). The OPS scale is widely used in university students (50, 51). The Chinese version of OPS exhibits superior reliability and validity (48), and it demonstrated a strong internal consistency in the present study (Cronbach's alpha coefficient = 0.956).

Statistical Analyses

SPSS 25.0 software was used for statistical analysis. First, perform descriptive statistics and Pearson correlation analysis on the research variables. Previous studies have found that some demographic factors, such as gender and age, are related to

anxiety (52–54). Based on the above findings, we selected these variables as possible covariates in the subsequent analysis. Sex is a dichotomy variable (0 = male; 1 = female). Age is measured by the age of the respondent (in years).Statistical analyses were conducted using Model 6 of the PROCESS macro provided by (55), with future orientation as the independent variable, anxiety as the dependent variable, OPS and resilience as the intermediate chain variables, and controlling gender and age as covariance for examining the chain mediating effect of future orientation and anxiety. Moreover, 5,000 bootstrap samples with 95% confidence intervals were conducted to calculate the significance of indirect effects.

RESULTS

Correlations Among All Variables

Table 1 presents the outcomes of the Pearson correlation test. A negative correlation was observed between anxiety and future orientation ($r = -0.17$, $p < 0.01$). OPS and future orientation were found to have a positive correlation ($r = 0.34$, $p < 0.01$); however, OPS was found to be negatively correlated with anxiety ($r = -0.29$, $p < 0.01$). Resilience was found to be positively correlated with future orientation ($r = 0.46$, $p < 0.01$) and negatively correlated with anxiety ($r = -0.38$, $p < 0.01$). Moreover, OPS displayed a positive correlation with resilience ($r = 0.49$, $p < 0.01$).

TABLE 1 | Correlations among different variables ($N = 528$).

	Mean	SD	FOQ	OPS	CD-RISC	SAS
FOQ	15.561	2.232	1.000			
OPS	3.331	0.542	0.339**	1.000		
CD-RISC	63.182	14.921	0.458**	0.493**	1.000	
SAS	48.970	11.033	−0.170**	−0.284**	−0.383**	1.000

FOQ, Future Orientation Scale; OPS, Optimization in Primary and Secondary Control Scale; CD-RISC, the Connor–Davidson Resilience Scale; SAS, Zung's Self-Rating Anxiety Scale.
****p < 0.001, **p < 0.01, *p < 0.05.*

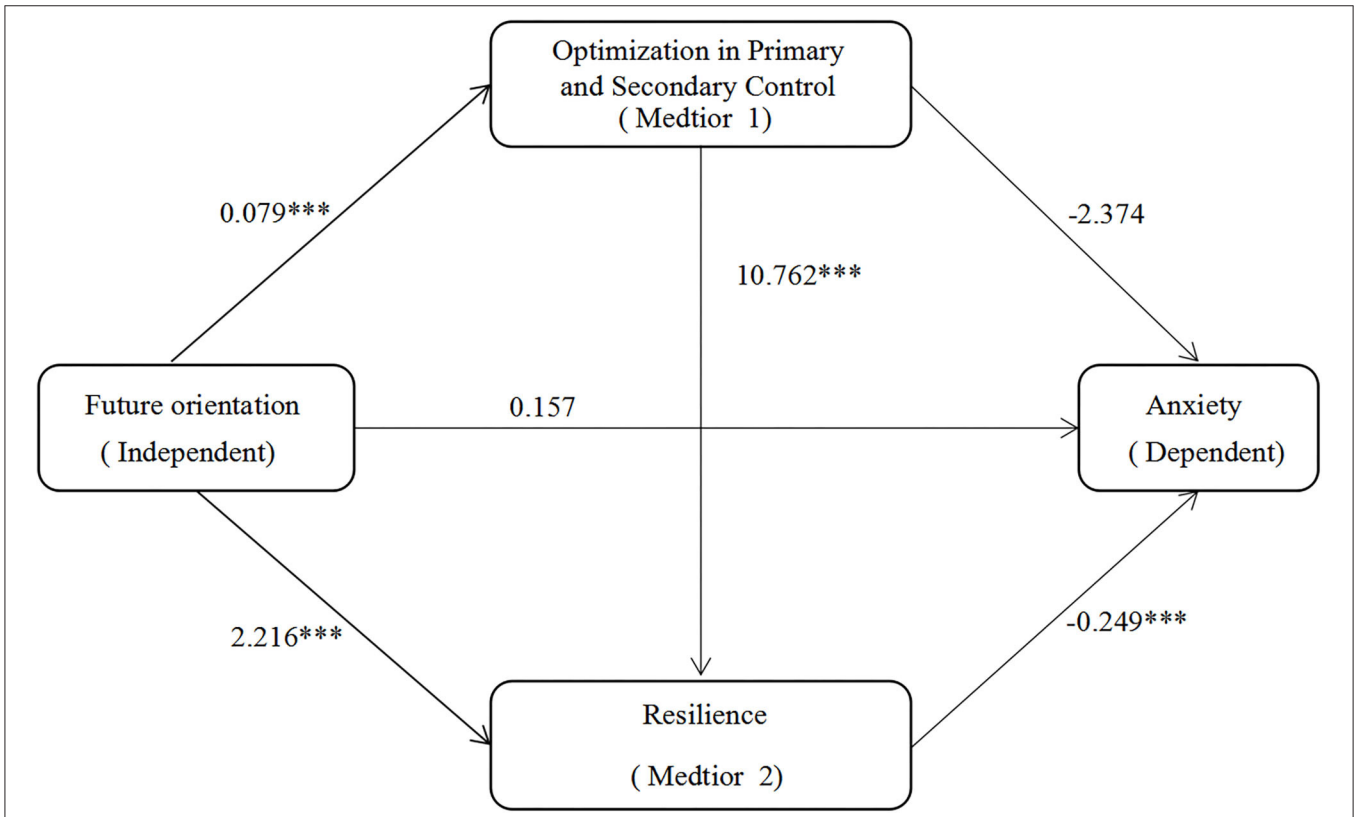

FIGURE 2 | Results of the chain mediation model. Indirect effect 1, Future orientation → Optimization in primary and secondary control → Anxiety; Indirect effect 2, Future orientation → Resilience → Anxiety; Indirect effect 3, Future orientation → Optimization in primary and secondary control → Resilience → Anxiety. ****p* < 0.001.

The Chain Mediating Analysis

Chain intermediary analyses were performed after controlling for gender and age (**Figure 2** and **Table 2**). Results revealed that the higher future development direction predicts significantly better OPS (B = 0.079, $t = 5.220$, $p < 0.001$). Future orientation (B = 2.216, $t = 5.609$, $p < 0.001$) and OPS (B = 10.762, $t = 5.976$, $p < 0.001$) predicted resilience. Resilience negatively predicted anxiety (B = −0.249, $t = -5.652$, $p < 0.001$). Furthermore, the bootstrap method indicated the significant mediation effects of OPS (**Table 3**; Effect = −0.188, Boot SE = 0.107, Boot 95% CI = [−0.435, −0.026]), resilience (Effect = −0.552, Boot SE = 0.144, Boot 95% CI = [−0.892, −0.315]), and their chain mediation (Effect = −0.212, Boot SE = 0.067, Boot 95% CI = (−0.373, −0.105]), accounting for 16.934, 49.766, and 19.125% of the total effect, respectively.

DISCUSSION

This study principally investigated the chain mediating path of future orientation and anxiety in the non-infected students during COVID-19 outbreak. The results showed that future orientation lowers anxiety through the indirect paths of OPS, resilience, and the chain mediating path of OPS and resilience.

Previous studies have found that some demographic variables are related to anxiety. For example, female are more anxious than male (53, 54). This can also be because male are more susceptible to stress and therefore are at risk of anxiety and depression, and Young people are more anxious than the old one (56). The deleterious effect of anxiety and depressive symptomatology is tempered by age (52). The children from two-parent families are less anxious than those from single-parent families (57). It may be because two-parent families have better financial security and quality company time. Furthermore, urban residents are more anxious than rural residents (58). This may be due to fiercer competition in the urban economy, which is more likely to cause anxiety.

This result was found to be consistent with the hypothesis that future orientation reduces anxiety through OPS (H1). From the functional perspective of the evolutionary theory, the pursuit of control is an individual's innate biological instinct (8, 59). When the individual's sense of control is threatened and reduced, the uncertainty and disorder make individuals feel anxious. Yet, the OPS is a control strategy for allocating resources to regulate oneself and the environment. The compensatory control theory research suggests that when an individual encounters irreversible factors, the psychological significance of using OPS lies in reducing the psychological discomfort caused by uncertain factors and meeting the needs for structure and order (60). In addition, compared with the individuals with fatalistic and hedonistic time orientation, individuals with future time views produce more positive motives to respond to life changes (61),

TABLE 2 | Chain mediation models between future orientation and anxiety ($N = 528$).

Predictors	Model 1 (OPS)		Model 2 (CD-RISC)		Model 3 (SAS)	
	B	*t*	B	*t*	B	*t*
Sex	0.105	2.265	−1.363	−1.269	−1.359	−1.469
Age	−0.043	−1.579	0.565	1.015	0.449	1.035
FOQ	0.079	5.220***	2.216	5.609***	0.157	0.602
OPS			10.762	5.976***	−2.374	−1.989
CD-RISC					−0.249	−5.652***
R^2		0.132		0.343		0.165
F		18.414***		53.281***		15.051***

*FOQ, Future Orientation Scale; OPS, Optimization in Primary and Secondary Control Scale; CD-RISC, the Connor–Davidson Resilience Scale; SAS, Zung's Self-Rating Anxiety Scale. The dependent variable in Models 1–3 was separately optimized in primary and secondary control, resilience, and anxiety. ***p < 0.001; **p < 0.01; *p < 0.05.*

TABLE 3 | Chain mediating paths between future orientation and anxiety.

	Effect	BootSE	BootLLCI	BootULCI	Relative effect (%)
Direct effect	0.157	0.26	−0.354	0.667	
Indirect effect 1	−0.188	0.107	−0.435	−0.026	16.93
Indirect effect 2	−0.552	0.144	−0.892	−0.315	49.77
Indirect effect 3	−0.212	0.067	−0.373	−0.105	19.13
Total indirect effect	−0.952	0.168	−1.315	−0.664	85.83

Indirect effect 1, Future Orientation Scale → Optimization in Primary and Secondary Control Scale → Zung's Self-Rating Anxiety Scale; Indirect effect 2, Future Orientation Scale → the Connor–Davidson Resilience scale → Zung's Self-Rating Anxiety Scale; Indirect effect 3, Future Orientation Scale → Optimization in Primary and Secondary Control Scale → the Connor–Davidson Resilience Scale.

which reduces future anxiety. Moreover, research from Future Time Perspective (FTP) shows that students with positive future time insight also have a more positive attitude toward their academic tasks (10). The achievement goal theory also believes that in the process of completing academic tasks, students' goals or intentions have a guiding effect on the emotions in the learning situation (62).

Furthermore, this study revealed that future orientation could reduce anxiety by increasing resilience (H2). Block and Kremen (63) reported that positive emotionality is an essential characteristic of resilience, which helps an individual in developing an optimistic attitude toward life and effectively cope with anxiety and adversity (64–66). Moreover, theoretical and empirical studies have indicated that anxiety is related to negative thinking about future (67). Negative cognition affects psychological changes, such as self-regulation (68) and adaptation to life events (67); these psychological changes further exacerbate the anxiety level of students.

This study also revealed that future orientation reduces anxiety of students through the chain mediation of OPS and resilience (H3). Individuals with high future orientation ordinarily have high motivation for achievement (69, 70); people choose adaptive strategies to maintain and continuously stimulate their level of motivation to achieve future goals (67). Additionally, because the choice of strategy makes people more adaptive to life (71), this strategy further leads to less anxiety (72). On the other hand, during the formation and development of resilience, OPS plays a critical intermediary role as a protective factor in reducing the negative impact of unfavorable situations in an individual (29, 30), thereby reducing anxiety.

There are some limitations, for example, we failed to conduct in-depth research and failed to understand other sociological information. Considering that students come from families with guaranteed income may be less anxious, but students come from families with less financial security may be the opposite. In our future research, we aim to use a longitudinal design or experimental paradigm to further support this research hypothesis. Finally, the questions that we aim to explore in our future studies are: how do the protective factors of resilience and anxiety constitute an utterly dynamic system; how does it interact with various risk factors; and how do OPS and resilience stimulate and promote each other, which help students maintain a good state of emotions, abilities, and social interactions in the process of growth?

CONCLUSIONS

Collectively, we explored the protective factors for anxiety. We investigated how students deal with the risk factors after encountering adversity and how their psychological flexibility stimulates and promotes them to achieve a well-adapted developmental state. The findings showed that future orientation reduces anxiety through the indirect paths of OPS and resilience and the chain mediating pathway of OPS and resilience, which provide students the reference suggestions and intervention guidance on reducing anxiety in case of emergencies.

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 First Affiliated Hospital of Xi'an Jiaotong University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YC: conceptualization, methodology, formal analysis, writing—original draft, and visualization. CL: conceptualization and writing—review and editing. JZ, HX, and CG: conceptualization, project administration, writing—review and editing, and supervision. All authors contributed to the article and approved the submitted version.

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Psychological Outcomes and Associated Factors Among the International Students Living in China During the COVID-19 Pandemic

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Background: The emergence of coronavirus disease 2019 (COVID-19) has created a severe mental health problem for international students living in China. Despite the little information on the psychological impact on international students, we aimed to assess the psychological outcomes and associated factors among international students currently living in China during the COVID-19 pandemic.

Methods: An online cross-sectional survey was conducted from May 28, 2020 to June 12, 2020 on 402 full-time international students across 26 provinces in China. The frequency of symptoms of depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear was assessed with the English versions of the Depression Anxiety Stress Scale (DASS-21), Insomnia Severity Index (ISI), Kessler Psychological Distress Scale (K6), University of California, Los Angeles, Loneliness Scale (UCLA-LS), and Fear of COVID-19 scale (FCV-19S) scales, respectively.

Results: The prevalence of symptoms of depression (73.4%), anxiety (76.6%), stress (58.5%), insomnia (77.6%), psychological distress (71.4%), loneliness (62.4%), and fear (73.1%) among international students during the COVID-19 pandemic was shown. The prevalence of moderate to extremely severe symptoms of all psychological outcomes was significantly associated with 26–30-year-old students, students who lived with roommates, and students who stayed in China shorter than 2 years. Participants in the central region reported significantly moderate to extremely severe symptom levels of all the psychological outcomes except fear symptoms. Univariate analysis indicated that a significant association of all psychological outcomes was found among 26–30-year-old students and students who stayed in China shorter than 2 years. Multivariate analysis showed that Engineering, Business, Social Sciences and Law, and Language students were significantly associated with the symptoms of depression, anxiety, insomnia, and fear. Participants staying in China for shorter than 2 years were associated with a higher risk of all psychological outcomes except psychological distress and loneliness symptoms.

Conclusions: We found a higher prevalence of psychological outcomes and risk factors among international students during the COVID-19 pandemic. We immediately appealed to university authorities, mental health professionals, and government officials to provide mental health interventions and strategies for their international students, particularly young, central region students, living with roommates, different study backgrounds, and short time staying during the pandemic.

Keywords: China, COVID-19, international students, mental health, psychological outcomes

INTRODUCTION

A large number of studies have established that any stressful event such as natural disasters and manufactured traumas has a significant mental health impact among affected individuals (1, 2). Recently, such diseases, namely, the novel coronavirus, have come out in China. The first four cases were reported on December 29, 2019, and all were linked to the Huanan (Southern China) Seafood Wholesale Market. All four patients were identified by local hospitals using a surveillance mechanism for "Pneumonia of unknown etiology" in Wuhan, the capital city of Hubei province, central region, China (3). The local hospital identified the coronavirus on January 7, 2020, and named it severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (3). On January 30 of the same year, the World Health Organization declared the outbreak of a Public Health Emergency of International Concern (PHEIC) (4), the official name of the new disease was named coronavirus disease 2019 (COVID-19) on February 11, 2020 (5). It was officially declared as a global pandemic on March 11, 2020 (6).

As of June 13, 2020, the official website of the National Health Commission of China confirmed that 83,075 cases of COVID-19 had been identified, while 4,634 people have died of COVID-19 across China (7). The COVID-19 pandemic has impacted 216 countries, areas, or territories globally and infected 7,553,182 people, including 423,349 deaths documented globally by the last count of June 13, 2020 (8). To point out this serious issue, the World Health Organization proclaimed that there would be high possibilities of an increase in stress, anxiety, fear, behavioral changes, loneliness, depression, and suicidal activities due to the COVID-19 pandemic (9). A recent review showed that high rates of indications of anxiety (6.33–50.9%), depression (14.6–48.3%), post-traumatic stress disorder (7–53.8%), psychological distress (34.43–38%), and stress (8.1–81.9%) were reported among general population during the COVID-19 outbreak in China, Spain, Italy, Iran, the USA, Turkey, Nepal, and Denmark (10).

It was an assumption that by 2020, the volume of international students would soar up to 8 million globally (11). On April 15, 2019, the Ministry of Education of the People's Republic of China announced that nearly 500,000 international students are currently studying in China (12). During the winter vacation and spring festival holiday, few international students went back to their own countries. However, there was a considerable number of international students who did not go back and decided to keep staying in China. The university authorities advised the students to stay and not leave the campus to ensure the health and safety of all international students. This situation hampered their studies, interrupted their daily routines and habits, and severely impacted their physical and mental health. Already many countries focused on the psychological impact of the COVID-19 epidemic on the universities' local students (13–16). However, compared to local students under regular circumstances, international students are more prone to mental health problems (17).

At present, to the best of our knowledge, this is the first study to investigate the magnitude of psychological outcomes and associated factors by using standardized rating scales among the international students living in China during the COVID-19 outbreak. Not only during the COVID-19 outbreak but also during previous bio-disasters that there had been less information about the mental health status among international students around the world (18–20). Hence, this study aimed to evaluate the psychological outcomes among international students who remained in China during the COVID-19 epidemic period by quantifying the magnitude of depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear by analyzing potential risk factors associated with these symptoms.

MATERIALS AND METHODS

Study Design

This online cross-sectional survey study was conducted through a snowball sampling process *via* WeChat from May 28, 2020, to June 12, 2020. We developed an online questionnaire using Questionnaire Network (https://www.wenjuan.com/), the link to which could be shared *via* WeChat (a popular Chinese social media platform). Clicking the survey link in WeChat took international students directly to the online questionnaire. We urged these international students to share the survey link to their WeChat contact list friends and friends they considered suitable for this survey. The snowball sampling process continued until a sufficient number of sample sizes were obtained. Participants anonymously completed the self-administered electronic questionnaire for ∼20 min with no financial incentive. The participants were fully informed that they were free to discontinue participation at any time, and the researcher guarantees the confidentiality of participants' information. Overall, data were collected from 84 universities and 26 provinces across seven geographical regions of China (Eastern region, Northern region, Southwest region, Northeast region, Central region, Southern region, and Northwest region). Out of these seven geographical regions of China, international students from 45 countries filled out the online questionnaire. These 45

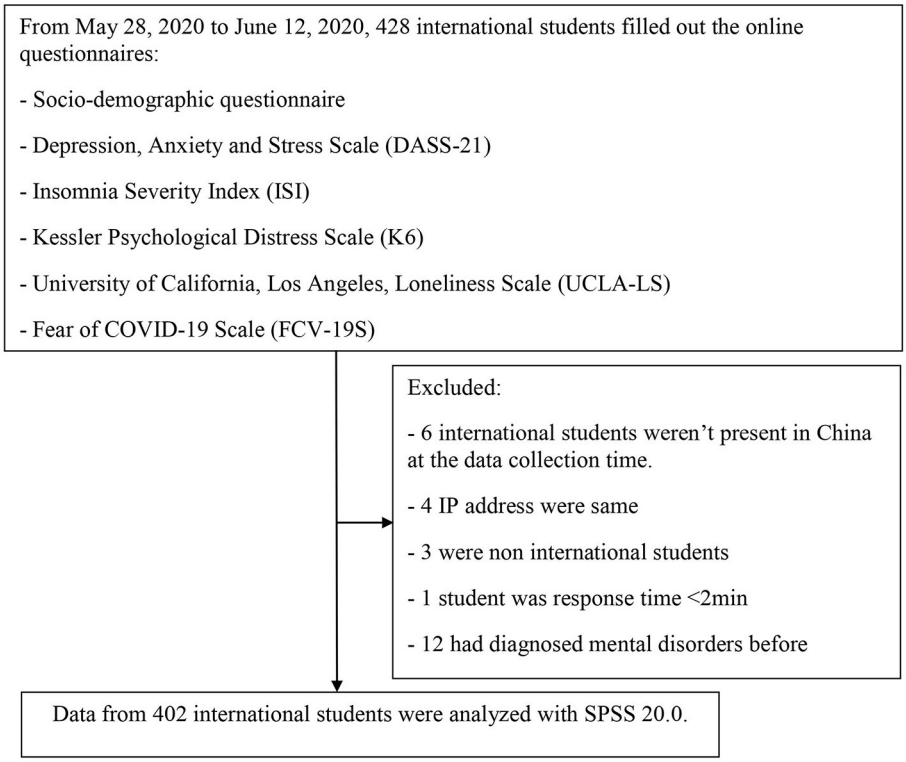

FIGURE 1 | Flowchart of the study.

countries are divided into four geographical areas (Asia, Africa, Europe, and America). Additionally, the Ethics Committee of the First Affiliated Hospital, Zhejiang University School of Medicine, approved this study. Respondents received an online written informed consent form before answering the questionnaire.

Participants

The target sample size of the participants was determined using the formula:

$$n = [z2 \times p \times (1 - p)/e2]/[1 + (z2 \times p \times (1 - p)/(e2 \times N))]$$

where $z = 1.96$ for a confidence level (α) of 95%,
$p = 0.5$ for proportion (expressed as a decimal),
$e = 5\%$ for margin of error, and
$N = 500{,}000$ for population size.

By substituting the values into the formula, the given value is $n = 383.86$. Therefore, a minimum sample size of 384 international students needs to be included in the sample. A total of 428 international students filled out the online questionnaires for this study. The inclusion criteria were as follows: (1) 18 years or older and (2) international students staying in the epidemic areas of mainland China during the outbreak of COVID-19. Exclusion criteria were (1) <18 years old, (2) international students who were not living in mainland China throughout the pandemic period, and (3) diagnosed and treated for mental illness before the outbreak. Out of 428 questionnaires filled up by the international students, 402 (93.9%) valid data were obtained. The detailed flow chart of this study is given in **Figure 1**.

Measurements

Demographic Information

Demographic data were self-reported by the participants, including gender and age. The world's geographical regions are divided into four regions (Asia, Africa, Europe, or America). The geographical regions of China have been divided into seven regions (eastern, northern, southwest, northeast, central, southern, or northwest region). Information was collected on students' religion, marital status, living conditions, living place, education level, and areas of study, namely, Arts and Humanities, Medicine, Engineer, Agricultural, Business Studies, Social Sciences and Law, and Language. In the last question, participants were asked about the stay period in China. They were given four options: <1, <2, 2–3, and >3 years.

Depression, Anxiety, and Stress Scales

The Depression Anxiety Stress Scale (DASS-21) (21) was measured using the depression, anxiety, and stress during the past week through 21 items. Each of the three DASS-21 scales consists of seven items, and each item uses a 4-point Likert scale ranging from 0 (Did not apply to me at all) to 3 (Applied to me very much or most of the time). The total score of full scale ranges from 0 to 63, while the scale score of each dimension ranges from

0 to 21. The cumulative score for each subscale is computed by summing the scores for the items and multiplying by 2. Example items include "I couldn't seem to experience any positive feeling at all" for depression, "I was aware of dryness of my mouth" for anxiety, and "I found it hard to wind down" for stress. The cutoff points for a case finding are 10 for depression, 8 for anxiety, and 15 for stress. The depression subscale consists of items 3, 5, 10, 13, 16, 17, and 21 with scores ranging from normal (0–9), mild (10–13), moderate (14–20), severe (21–27), to extremely severe (28+). The anxiety subscale consists of items 2, 4, 7, 9, 15, 19, and 20, with scores ranging from normal (0–7), mild (8–9), moderate (10–14), severe (15–19), to extremely severe (20+). Finally, the stress subscale consists of items 1, 6, 8, 11, 12, 14, and 18, with scores ranging from normal (0–14), mild (15–18), moderate (19–25), severe (26–33), to extremely severe (34+). The DASS-21 is a reliable, easy-to-use screening instrument and has been well-received globally. We used the English version of the DASS-21 scales validated by past research (21). The internal consistency (Cronbach's alpha) in this study for depression, anxiety, and stress was found to be 0.81, 0.84, and 0.80, respectively, indicating good reliability.

Insomnia Severity Index

The Insomnia Severity Index (ISI) is a seven-item self-report questionnaire widely used to evaluate the nature, severity, and impact of insomnia (22). The ISI investigates participants' difficulty in falling asleep, remaining asleep, early waking, the satisfaction derived from the sleep pattern, impairments emerging in day-to-day functioning, awareness of sleep-related impairments, and stress levels caused by sleep problems in the last 2 weeks. Items are rated on a 5-point Likert scale, ranging from 0 (no problem) to 4 (very severe problem). The total score of the seven-item ISI ranges from 0 to 28. The total score was categorized into four different groups: no clinically significant insomnia (0–7), subthreshold insomnia (8–14), moderate insomnia (15–21), and severe insomnia (22–28) (23). In this study, the English version of the ISI scale score of 8 or higher indicates probable insomnia symptoms (22, 24). The English version of the ISI has good reliability and validity in general and clinical populations (24). The internal consistency (Cronbach's alpha) in this study was found to be 0.92, which indicates excellent reliability.

Kessler Psychological Distress Scale

The Kessler Psychological Distress Scale (K6) is a shortened, six-item version of the K10. In this study, the Kessler psychological distress scale assessed the participants' psychological distress (25). It contains six questions that ask participants to rate how often they have felt nervous, hopeless, restless, or fidgety, so depressed that nothing could cheer them up, that everything was an effort and worthless during the last 30 days. Answers were scored on a 5-point scale ranging from 1 (None of the time) to 5 (All of the time) and summed to create a continuous total score ranging from 6 to 30. We used the English version of the K6 scale validated by past research (26). A value of 13 or higher on the K6 indicates high or severe psychological distress. Values between 8 and 12 indicate moderate psychological distress, and a value between 0 and 7 denotes no psychological distress (27). The internal consistency (Cronbach's alpha) was found as 0.90, indicating excellent reliability in this study.

University of California, Los Angeles, Loneliness Scale

Loneliness was measured using the three-item short form of the revised University of California, Los Angeles, Loneliness Scale (UCLA-LS) (28). Three items assessed the frequency that an individual had felt a lack of companionship, left out, or isolated from others over the last week. Answers were scored on a 3-point scale ranging from 1 (Hardly ever) to 3 (Often) and summed to create a continuous total score ranging from 3 to 9. We used the English version of the UCLA-LS scale validated by past research (28). Participants with a score of 6 or higher were categorized as experiencing a high level of loneliness (29). The score then collapsed into one of two categories: a score of 3–5 reflects a negative screening for loneliness, and a score of 6–9 reflects a positive screening for loneliness. The internal consistency (Cronbach's alpha) in this study was found as 0.72, which indicates acceptable reliability.

Fear of COVID-19 Scale

The Fear of COVID-19 Scale (FCV-19S) is a self-report questionnaire to assess the level of fear associated with COVID-19. It was reliable and valid in determining COVID-19 fear among the general population (30). It consists of seven items (e.g., I am most afraid of coronavirus-19, my hands become clammy when I think about coronavirus-19) with a 5-point Likert scale response from 1 (strongly disagree) to 5 (strongly agree), and its total score range is 7–35. The higher the score indicates, the greater the fear of coronavirus-19 (30). Because no official severity for fear of COVID-19 scale was available, we used a severity scale using percentiles of FCV-19S score as follows: mild ($\leq$17), moderate (18–23), and severe ($\geq$24) (31). The internal consistency of the FCV-19S in the present study was excellent (Cronbach's $\alpha = 0.92$).

Statistical Analysis

Data analysis was performed using SPSS statistical software version 20.0 (IBM Corporation, Armonk, NY, USA). The Kolmogorov–Smirnov-test and Shapiro–Wilk-test were used to assess the normal distribution of variables. The original scores of the five measuring instruments were non-normally distributed. For this reason, we expressed median values with interquartile ranges (IQRs). The ranked data derived from each level's counts for symptoms of depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear were presented as numbers and percentages. The non-parametric Mann–Whitney *U*-test and Kruskal–Wallis-test were applied to compare the severity of each symptom between two or more groups. Spearman correlations were performed to determine the relationships between levels of depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear symptoms. In this study, binary logistic regression analysis was used to identify potential risk factors for psychological outcomes symptoms. Relationships between risk factors and

TABLE 1 | Sample characteristics ($N = 402$).

Factors	Participants, No. (%)
Overall	402 (100.0)
Gender	
Male	340 (84.6)
Female	62 (15.4)
Age (years)	
18–25	129 (32.1)
26–30	162 (40.3)
31–35	85 (21.1)
36–40	26 (6.5)
Geographical regions, World	
Asia	361 (89.8)
Africa	28 (7.0)
Europe	8 (2.0)
America	5 (1.2)
Geographical regions, China	
Eastern	223 (55.5)
Northern	28 (7.0)
Northwest	21 (5.2)
Northeast	19 (4.7)
Central	52 (12.9)
Southern	14 (3.5)
Southwest	45 (11.2)
Religion	
Islam	314 (78.1)
Hinduism	20 (5.0)
Buddhist	33 (8.2)
Christian	30 (7.5)
Others	1 (0.2)
No religion	4 (1.0)
Marital status	
Unmarried	293 (72.9)
Married	108 (26.9)
Divorced/separated/widowed	1 (0.2)
Living conditions	
Alone	106 (26.4)
Roommate	210 (52.2)
Family	85 (21.1)
Other	1 (0.2)
Living place	
Dormitory	320 (79.6)
Hotel	11 (2.7)
Outside of the campus	71 (17.7)
Education level	
Bachelor	160 (39.8)
Master	112 (27.9)
Doctor/Ph.D.	123 (30.6)
Other	7 (1.7)
Area of study	
Arts and Humanities	14 (3.5)
Medicine	41 (10.2)
Engineer	142 (35.3)
Agricultural	56 (13.9)
Business studies	38 (9.5)
Social Sciences and Law	35 (8.7)
Language	57 (14.2)
Other	19 (4.7)
Stay period in China (years)	
<1	35 (8.7)
<2	132 (32.8)
2–3	93 (23.1)
>3	142 (35.3)
Total score, median (IQR)	
Depression symptoms	18.0 (8.0–26.0)
Anxiety symptoms	18.0 (8.0–26.0)
Stress symptoms	16.0 (10.0–26.0)
Insomnia symptoms	13.0 (8.0–21.0)
Psychological distress symptoms	10.0 (12.0–22.0)
Loneliness symptoms	2.0 (5.0–7.0)
Fear symptoms	12.0 (17–29.0)

IQR, interquartile range.

psychological outcomes were expressed as crude odds ratio (COR) for univariate analyses and adjusted odds ratio (AOR) for multivariate analyses. Both were 95% confidence intervals (CIs), and $p < 0.05$ were regarded as statistically significant.

RESULTS

Demographic Characteristics

A total of 402 international students aged between 18 and 40 years old from seven regions of China completed the questionnaire, of whom 340 (84.6%) were male, and 62 (15.4%) were female. One hundred sixty-two participants aged between 26 and 30 years old (40.3%). The majority of participants was from Asian countries (89.8%). More than half of the participants were from eastern regions (55.5%). Most of the participants belonged to Islam (78.1%) and were unmarried (72.9%). More than half of the participants lived with a roommate (52.2%), and their living place was a dormitory (79.6%). Lower than half of the participants had a bachelor's educational level (39.8%) and Engineering students (35.3%). One-third of the participants stayed in China for more than 3 years (35.3%). The median (IQR) scores on the depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear symptoms for all participants were sufficient respectively in 18.0 (8.0–26.0), 18.0 (8.0–26.0), 16.0 (10.0–26.0), 13.0 (8.0–21.0), 10.0 (12.0–22.0), 2.0 (5.0–7.0), and 12.0 (17.0–29.0) (**Table 1**).

The Severity of Psychological Outcomes and Associated Factors

A considerable proportion of participants had symptoms of depression (73.4%), anxiety (76.6%), stress (58.5%), insomnia

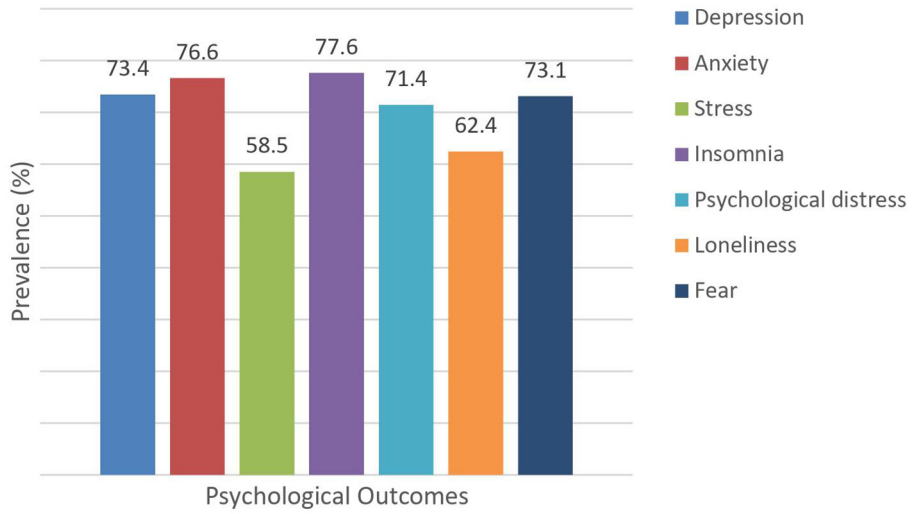

FIGURE 2 | Prevalence of psychological outcomes during the COVID-19 pandemic.

(77.6%), psychological distress (71.4%), loneliness (62.4%), and fear (73.1%) (**Figure 2**). Male participants reported experiencing moderate to extremely severe symptoms of depression, anxiety, insomnia, and fear than the female participants. The prevalence of moderate to extremely severe symptoms of all the psychological outcomes was significantly higher in the age groups of 26–30 years old than in other age groups. Significantly moderate to extremely severe symptom levels of all the psychological outcomes were higher in central region students, except fear symptoms, than in other regions. Compared with those living alone and other, participants living with a roommate were associated with moderate to extremely severe symptoms of all the psychological outcomes. Participants who lived in the dormitory were significantly associated with moderate to extremely severe symptoms of depression, anxiety, stress, and insomnia. Bachelor students reported experiencing more severe symptoms of all the psychological outcomes except insomnia and fear. On the other hand, master students were significantly associated with more severe symptoms of insomnia and fear. Participants who were Arts and Humanities students were significantly associated with moderate to extremely severe symptoms of depression and anxiety, while Social Sciences and Law students were higher in insomnia and fear symptoms. On the other hand, Language students were significantly associated with more severe symptoms of psychological distress and loneliness. The prevalence of moderate to extremely severe symptoms of all the psychological outcomes was significantly higher in participants staying in China for <2 years compared with staying in China <1, 2–3, and >3 years (**Table 2**).

Correlations of Psychological Outcomes

Table 3 presents Spearman's correlation of all study variables. The results indicated that depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear symptoms significantly and positively correlated with one another ($p <$ 0.01). It was rare that five scales were significantly and positively correlated with one another compared with other research.

Risk Factors of Psychological Outcomes

We performed binary logistic regression analyses to identify demographic and relevant contextual factors associated with psychological outcomes. The univariate logistic regression analyses (**Supplementary Table 1**) showed that male participants presented higher depression, anxiety, insomnia, and fear symptoms than female students. A significance of all the psychological outcomes was found among 26–30-year-old students rather than in other age groups. Depression, anxiety, stress, insomnia, and fear symptoms were more common among eastern region students compared to other regions. Compared with those living in a hotel and outside, participants who lived in the dormitory were more likely to report all the psychological outcomes except psychological distress and fear symptoms. Depression, insomnia, and psychological distress were more common among bachelor students than in other education levels. Compared with other areas of study, Arts and Humanities, Engineering, Social Sciences and Law, and Language students were significantly associated with the symptoms of depression, anxiety, stress, insomnia, loneliness, and fear. Students whose staying period in China was <2 years were significantly associated with all the psychological outcomes than other students.

The multivariate logistic regression analysis showed that 31–35-year-old students were more likely to have depression, anxiety, stress, insomnia, and psychological distress symptoms than other age groups. Compared with other areas of study, participants of Engineering, Business, Social Sciences and Law, and Language students were significantly associated with the symptoms of depression, anxiety, insomnia, and fear. Compared to those whose stayed period in China 3 years or more, students whose staying period in China <1 year were associated with

TABLE 2 | Severity categories of depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear measurements in total cohort and subgroups.

		Gender			Age (years)					Geographical regions, World					Geographical regions, China								Religion						
		No. (%)			No. (%)					No. (%)					No. (%)								No. (%)						
Severity category	**Total, No. (%)**	**Male**	**Female**	***P*-value**	**18–25**	**26–30**	**31–35**	**36–40**	***P* value**	**Asia**	**Africa**	**Europe**	**America**	***P*-value**	**Eastern**	**Northern**	**Northwest**	**Northeast**	**Central**	**Southern**	**Southwest**	***P*-value**	**Islam**	**Hinduism**	**Buddhist**	**Christian**	**Others**	**No religion**	***P*-value**
Depression symptoms																													
Normal to mild	153 (38.1)	122 (35.9)	31 (50.0)	0.03	49 (38.0)	47 (29.0)	37 (43.5)	20 (76.9)	0.00	133 (36.8)	18 (64.3)	1 (12.5)	1 (20.0)	0.01	113 (50.7)	9 (32.1)	3 (14.3)	6 (31.6)	7 (13.5)	6 (42.9)	9 (20.0)	0.00	121 (38.5)	12 (60.0)	8 (24.2)	8 (26.7)	1 (100.0)	3 (75.0)	0.03
Moderate to extremely severe	249 (61.9)	218 (64.1)	31 (50.0)		80 (62.0)	115 (71.0)	48 (56.5)	6 (23.1)		228 (63.2)	10 (35.7)	7 (87.5)	4 (80.0)		110 (49.3)	19 (67.9)	18 (85.7)	13 (68.4)	45 (86.5)	8 (57.1)	36 (80.0)		193 (61.5)	8 (40.0)	25 (75.8)	22 (73.3)	-	1 (25.0)	
Anxiety symptoms																													
Normal to mild	127 (31.6)	100 (29.4)	27 (43.5)	0.02	45 (34.9)	36 (22.2)	29 (34.1)	17 (65.4)	0.00	115 (31.9)	11 (39.3)	1 (12.5)	-	0.21	97 (43.5)	7 (25.0)	3 (14.3)	3 (15.8)	4 (7.7)	5 (35.7)	8 (17.8)	0.00	101 (32.2)	6 (30.0)	8 (24.2)	7 (23.3)	1 (100.0)	1 (100.0)	0.02
Moderate to extremely severe	275 (68.4)	240 (70.6)	35 (56.5)		84 (65.1)	126 (77.8)	56 (65.9)	9 (34.6)		246 (68.1)	17 (60.7)	7 (87.5)	5 (100.0)		126 (56.5)	21 (75.0)	18 (85.7)	16 (84.2)	48 (92.3)	9 (64.3)	37 (82.2)		213 (67.8)	14 (70.0)	25 (75.8)	23 (76.7)	-	-	
Stress symptoms																													
Normal to mild	210 (52.2)	171 (50.3)	39 (62.9)	0.06	68 (52.7)	75 (46.3)	45 (52.9)	22 (84.6)	0.00	186 (51.5)	17 (60.7)	5 (62.5)	2 (40.0)	0.67	145 (65.0)	15 (53.6)	7 (33.3)	8 (42.1)	10 (19.2)	6 (42.9)	19 (42.2)	0.00	165 (52.5)	11 (55.0)	15 (45.5)	14 (46.7)	1 (100.0)	4 (100.0)	0.34
Moderate to extremely severe	192 (47.8)	169 (49.7)	23 (37.1)		61 (47.3)	87 (53.7)	40 (47.1)	4 (15.4)		175 (48.5)	11 (39.3)	3 (37.5)	3 (60.0)		78 (35.0)	13 (46.4)	14 (66.7)	11 (57.9)	42 (80.8)	8 (57.1)	26 (57.8)		149 (47.5)	9 (45.0)	18 (54.5)	16 (53.3)	-	-	
Insomnia symptoms																													
No clinically significant to subthreshold	159 (39.6)	126 (37.1)	33 (53.2)	0.01	51 (39.5)	48 (29.6)	38 (44.7)	22 (84.6)	0.00	134 (37.1)	20 (71.4)	3 (37.5)	2 (40.0)	0.00	118 (52.9)	12 (42.9)	3 (14.3)	5 (26.3)	8 (15.4)	5 (35.7)	8 (17.8)	0.00	125 (39.8)	11 (55.0)	9 (27.3)	11 (36.7)	-	3 (75.0)	0.22
Moderate to severe	243 (60.4)	214 (62.9)	29 (46.8)		78 (60.5)	114 (70.4)	47 (55.3)	4 (15.4)		227 (62.9)	8 (28.6)	5 (62.5)	3 (60.0)		105 (47.1)	16 (57.1)	18 (85.7)	14 (73.7)	44 (84.6)	9 (64.3)	37 (82.2)		189 (60.2)	9 (45.0)	24 (72.7)	19 (63.3)	1 (100.0)	1 (25.0)	
Psychological distress symptoms																													
None	40 (10.0)	34 (10.0)	6 (9.7)	0.93	11 (8.5)	11 (6.8)	8 (9.4)	10 (38.5)	0.00	32 (8.9)	6 (21.4)	1 (12.5)	1 (20.0)	0.15	33 (14.8)	2 (7.1)	1 (4.8)	2 (10.5)	-	2 (14.3)	-	0.00	34 (10.8)	2 (10.0)	1 (3.0)	3 (10.0)	-	-	0.76
Moderate to severe	362 (90.0)	306 (90.0)	56 (90.3)		118 (91.5)	151 (93.2)	77 (90.6)	16 (61.5)		329 (91.1)	22 (78.6)	7 (87.5)	4 (80.0)		190 (85.2)	26 (92.9)	20 (95.2)	17 (89.5)	52 (100.0)	12 (85.7)	45 (100.0)		280 (89.2)	18 (90.0)	32 (97.0)	27 (90.0)	1 (100.0)	4 (100.0)	
Loneliness symptoms																													
Low	151 (37.6)	123 (36.2)	28 (45.2)	0.18	46 (35.7)	52 (32.1)	36 (42.4)	17 (65.4)	0.00	129 (35.7)	15 (53.6)	3 (37.5)	4 (80.0)	0.06	102 (45.7)	10 (35.7)	10 (47.6)	5 (26.3)	6 (11.5)	3 (21.4)	15 (33.3)	0.00	126 (40.1)	3 (15.0)	8 (24.2)	11 (36.7)	-	3 (75.0)	0.05
High	251 (62.4)	217 (63.8)	34 (54.8)		83 (64.3)	110 (67.9)	49 (57.6)	9 (34.6)		232 (64.3)	13 (46.4)	5 (62.5)	1 (20.0)		121 (54.3)	18 (64.3)	11 (52.4)	14 (73.7)	46 (88.5)	11 (78.6)	30 (66.7)		188 (59.9)	17 (85.0)	25 (75.8)	19 (63.3)	1 (100.0)	1 (25.0)	
Fear symptoms																													
Mild	108 (26.9)	83 (24.4)	25 (40.3)	0.00	41 (31.8)	32 (19.8)	24 (28.2)	11 (42.3)	0.03	91 (25.2)	12 (42.9)	3 (37.5)	2 (40.0)	0.16	86 (38.6)	4 (14.3)	3 (14.3)	3 (15.8)	7 (13.5)	1 (7.1)	4 (8.9)	0.00	82 (26.1)	7 (35.0)	8 (24.2)	7 (23.3)	1 (100.0)	3 (75.0)	0.13
Moderate to severe	294 (73.1)	257 (75.6)	37 (59.7)		88 (68.2)	130 (80.2)	61 (71.8)	15 (57.7)		270 (74.8)	16 (57.1)	5 (62.5)	3 (60.0)		137 (61.4)	24 (85.7)	18 (85.7)	16 (84.2)	45 (86.5)	13 (92.9)	41 (91.1)		232 (73.9)	13 (65.0)	25 (75.8)	23 (76.7)	-	1 (25.0)	

(Continued)

TABLE 2 | Continued

Severity category	Total, No. (%)	Marital status				Living conditions					Living place				Education level					Area of study									Stay period in China (years)				
		No. (%)				No. (%)					No. (%)				No. (%)					No. (%)									No. (%)				
		Unmarried	Married	Div/Sep/Wid	*P*-value	Alone	Roommate	Family	Other	*P*-value	Dormitory	Hotel	Outside of the campus	*P*-value	Bachelor	Master	Doctor/Ph.D.	Other	*P*-value	Arts and Humanities	Medicine	Engineer	Agricultural	Business studies	Social Sciences and Law	Language	Other	*P* value	<1	<2	2–3	>3	*P*-value
Depression symptoms																																	
Normal to mild	153 (38.1)	120 (41.0)	33 (30.6)	-	0.12	76 (71.7)	37 (17.6)	39 (45.9)	1 (100.0)	0.00	105 (32.8)	9 (81.8)	39 (54.9)	0.00	46 (28.8)	35 (31.3)	66 (53.7)	6 (85.7)	0.00	3 (21.4)	21 (51.2)	40 (28.2)	27 (48.2)	13 (34.2)	9 (25.7)	24 (42.1)	16 (84.2)	0.00	23 (65.7)	21 (15.9)	30 (32.3)	79 (55.6)	0.00
Moderate to extremely severe	249 (61.9)	173 (59.0)	75 (69.4)	1 (100.0)		30 (28.3)	173 (82.4)	46 (54.1)	-		215 (67.2)	2 (18.2)	32 (45.1)		114 (71.3)	77 (68.8)	57 (46.3)	1 (14.3)		11 (78.6)	20 (48.8)	102 (71.8)	29 (51.8)	25 (65.8)	26 (74.3)	33 (57.9)	3 (15.8)		12 (34.3)	111 (84.1)	63 (67.7)	63 (44.4)	
Anxiety symptoms																																	
Normal to mild	127 (31.6)	95 (32.4)	32 (29.6)	-	0.68	62 (58.5)	31 (14.8)	33 (38.8)	1 (100.0)	0.00	90 (28.1)	6 (54.5)	31 (43.7)	0.01	39 (24.4)	32 (28.6)	53 (43.1)	3 (42.9)	0.00	3 (21.4)	17 (41.5)	37 (26.1)	21 (37.5)	9 (23.7)	8 (22.9)	16 (28.1)	16 (84.2)	0.00	21 (60.0)	17 (12.9)	21 (22.6)	68 (47.9)	0.00
Moderate to extremely severe	275 (68.4)	198 (67.6)	76 (70.4)	1 (100.0)		44 (41.5)	179 (85.2)	52 (61.2)	-		230 (71.9)	5 (45.5)	40 (56.3)		121 (75.6)	80 (71.4)	70 (56.9)	4 (57.1)		11 (78.6)	24 (58.5)	105 (73.9)	35 (62.5)	29 (76.3)	27 (77.1)	41 (71.9)	3 (15.8)		14 (40.0)	115 (87.1)	72 (77.4)	74 (52.1)	
Stress symptoms																																	
Normal to mild	210 (52.2)	165 (56.3)	45 (41.7)	-	0.02	93 (87.7)	70 (33.3)	46 (54.1)	1 (100.0)	0.00	155 (48.4)	9 (81.8)	46 (64.8)	0.00	70 (43.8)	56 (50.0)	78 (63.4)	6 (85.7)	0.00	7 (50.0)	28 (68.3)	57 (40.1)	30 (53.6)	20 (52.6)	15 (42.9)	36 (63.2)	17 (89.5)	0.00	29 (82.9)	44 (33.3)	38 (40.9)	99 (69.7)	0.00
Moderate to extremely severe	192 (47.8)	128 (43.7)	63 (58.3)	1 (100.0)		13 (12.3)	140 (66.7)	39 (45.9)	-		165 (51.6)	2 (18.2)	25 (35.2)		90 (56.3)	56 (50.0)	45 (36.6)	1 (14.3)		7 (50.0)	13 (31.7)	85 (59.9)	26 (46.4)	18 (47.4)	20 (57.1)	21 (36.8)	2 (10.5)		6 (17.1)	88 (66.7)	55 (59.1)	43 (30.3)	
Insomnia symptoms																																	
No clinically significant to subthreshold	159 (39.6)	122 (41.6)	37 (34.3)	-	0.29	80 (75.5)	36 (17.1)	42 (49.4)	1 (100.0)	0.00	113 (35.3)	8 (72.7)	38 (53.5)	<0.001	51 (31.9)	33 (29.5)	69 (56.1)	6 (85.7)	0.00	4 (28.6)	21 (51.2)	38 (26.8)	30 (53.6)	15 (39.5)	9 (25.7)	26 (45.6)	16 (84.2)	0.00	21 (60.0)	23 (17.4)	28 (30.1)	87 (61.3)	0.00
Moderate to severe	243 (60.4)	171 (58.4)	71 (65.7)	1 (100.0)		26 (24.5)	174 (82.9)	43 (50.6)	-		207 (64.7)	3 (27.3)	33 (46.5)		109 (68.1)	79 (70.5)	54 (43.9)	1 (14.3)		10 (71.4)	20 (48.8)	104 (73.2)	26 (46.4)	23 (60.5)	26 (74.3)	31 (54.4)	3 (15.8)		14 (40.0)	109 (82.6)	65 (69.9)	55 (38.7)	
Psychological distress symptoms																																	
None	40 (10.0)	30 (10.2)	10 (9.3)	-	0.90	17 (16.0)	8 (3.8)	15 (17.6)	-	0.00	29 (9.1)	-	11 (15.5)	0.14	7 (4.4)	6 (5.4)	23 (18.7)	4 (57.1)	0.00	2 (14.3)	6 (14.6)	10 (7.0)	14 (25.0)	3 (7.9)	2 (5.7)	2 (3.5)	1 (5.3)	0.00	6 (17.1)	7 (5.3)	6 (6.5)	21 (14.8)	0.01
Moderate to severe	362 (90.0)	263 (89.8)	98 (90.7)	1 (100.0)		89 (84.0)	202 (96.2)	70 (82.4)	1 (100.0)		291 (90.9)	11 (100.0)	60 (84.5)		153 (95.6)	106 (94.6)	100 (81.3)	3 (42.9)		12 (85.7)	35 (85.4)	132 (93.0)	42 (75.0)	35 (92.1)	33 (94.3)	55 (96.5)	18 (94.7)		29 (82.9)	125 (94.7)	87 (93.5)	121 (85.2)	
Loneliness symptoms																																	
Low	151 (37.6)	95 (32.4)	56 (51.9)	-	0.31	51 (48.1)	55 (26.2)	44 (51.8)	1 (100.0)	0.00	113 (35.3)	2 (18.2)	36 (50.7)	0.02	54 (33.7)	36 (32.1)	58 (47.2)	3 (42.9)	0.06	4 (28.6)	23 (56.1)	40 (28.2)	31 (55.4)	16 (42.1)	11 (31.4)	14 (24.6)	12 (63.2)	0.00	21 (60.0)	30 (22.7)	36 (38.7)	64 (45.1)	0.00
High	251 (62.4)	198 (67.6)	52 (48.1)	1 (100.0)		55 (51.9)	155 (73.8)	41 (48.2)	-		207 (64.7)	9 (81.8)	35 (49.3)		106 (66.3)	76 (67.9)	65 (52.8)	4 (57.1)		10 (71.4)	18 (43.9)	102 (71.8)	25 (44.6)	22 (57.9)	24 (68.6)	43 (75.4)	7 (36.8)		14 (40.0)	102 (77.3)	57 (61.3)	78 (54.9)	
Fear symptoms																																	
Mild	108 (26.9)	81 (27.6)	27 (25.0)	-	0.72	58 (54.7)	28 (13.3)	21 (24.7)	1 (100.0)	0.00	81 (25.3)	5 (45.5)	22 (31.0)	0.23	38 (23.8)	23 (20.5)	45 (36.6)	2 (28.6)	0.03	3 (21.4)	22 (53.7)	26 (18.3)	16 (28.6)	10 (26.3)	4 (11.4)	15 (26.3)	12 (63.2)	0.00	14 (40.0)	15 (11.4)	18 (19.4)	61 (43.0)	0.00
Moderate to severe	294 (73.1)	212 (72.4)	81 (75.0)	1 (100.0)		48 (45.3)	182 (86.7)	64 (75.3)	-		239 (74.7)	6 (54.5)	49 (69.0)		122 (76.3)	89 (79.5)	78 (63.4)	5 (71.4)		11 (78.6)	19 (46.3)	116 (81.7)	40 (71.4)	28 (73.7)	31 (88.6)	42 (73.7)	7 (36.8)		21 (60.0)	117 (88.6)	75 (80.6)	81 (57.0)	

TABLE 3 | Spearman's correlations of psychological outcomes.

Scales	1	2	3	4	5	6	7
1	1						
2	0.794**	1					
3	0.796**	0.790**	1				
4	0.699**	0.704**	0.704**	1			
5	0.767**	0.738**	0.769**	0.795**	1		
6	0.522**	0.527**	0.538**	0.591**	0.593**	1	
7	0.691**	0.704**	0.641**	0.674**	0.688**	0.535**	1

$^{**}p < 0.01$.
1, Depression; 2, anxiety; 3, stress; 4, insomnia; 5, psychological distress; 6, loneliness; 7, fear.

depression and loneliness symptoms. On the other hand, those who were in China for <2 years had all kinds of psychological outcomes except psychological distress and loneliness symptoms. The detailed results of multivariate logistic regression analysis are shown in **Supplementary Table 2**.

DISCUSSION

The first broad range study investigates the magnitude of psychological outcomes and associated factors among international students currently living in China during the COVID-19 pandemic. This cross-sectional survey enrolled 402 respondents and revealed a high prevalence of psychological effects among international students during the COVID-19 epidemic residing in China. Overall, more than half of all participants reported depression, anxiety, stress, insomnia, psychological distress, loneliness, and fear symptoms. This high prevalence of mental health symptoms is supported and consistent with previous studies in various age groups, gender, marital status, education, place of living, fields, and different countries.

The present study found that 73.4, 76.6, and 58.5% of the participants had depression, anxiety, and stress symptoms. This study's rates were lower than the previous studies. For example, a web-based cross-sectional survey of 476 university students living in Bangladesh utilizing the Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder (GAD-7) found that 82.4% of students have mild to severe depressive symptoms, and 87.7% of students have mild to severe anxiety symptoms (32). In Jordan, an online survey conducted in April 2020 involved 456 undergraduate students utilizing the DASS-21 who reported that the majority of students had symptoms of depression (74.1%), anxiety (59.6%), and stress (61.2%) (33). Another study that involved 2,086 college students regarding the impact of COVID-19 on their mental health in April 2020 found that 91% of the participants had anxiety or stress symptoms (34).

Our results showed that the prevalence of insomnia symptoms was 77.6%, which was greater than that in previous studies. A recent systematic scoping review of 78 articles related to various professions like university students found that the prevalence of sleeping disorders ranged from 2.3 to 76.6% (35). Our study found that 71.4% of the participants reported psychological distress symptoms. These rates were higher than in the previous studies. For example, a longitudinal study of 622 nursing students in Italy, utilizing the GHQ-12, found that >70% had significant levels of psychological distress (36). A previous study investigating predictive factors for impaired mental health to the COVID-19 pandemic in 2020 among 549 medical students using PHQ-9, GAD-7, ISI, and K6 scales in Morocco indicated that 62.3, 74.6, 62.6, and 69% reported anxiety, depression, insomnia, and distress symptoms, respectively (37). However, Zhang et al. (38) revealed that the detection rate of anxiety symptoms was about 15% in medical students from Mongolia medical colleges in mainland China, and 77% of the students had shown distress symptoms in the past 7 days.

Our findings showed that the prevalence of loneliness symptoms was 62.4%, lower than the other studies (39, 40). In a prospective cohort study of 213 Art students in the Netherlands, utilizing the loneliness scale, researchers found that at least 75% of the participants dealt with moderate to very severe loneliness in all 3 months during the COVID-19 lockdown (40). Furthermore, the results indicated that the prevalence of fear symptoms was 73.1%, higher than in the earlier studies (41). A survey conducted in 912 nursing students and graduates during the last 18 months from public and private universities of Mexico used the fear of COVID-19 scale to find fear regarding COVID-19 in 50.3% (41).

In this study, the findings revealed that males were more likely to have depressive, anxiety, insomnia, and fear symptoms than female students. A recent online cross-sectional survey performed in Delhi NCR, Maharashtra, and Tamil Nadu during May 2020 investigated 335 dental students and practitioners who used PHQ-9 scores found that those who were depressed were likely to be male than female (42). However, the result of this study was consistent with the other research conducted in China that male students were significantly more anxious than female students (43). Furthermore, another study found that male students had a higher rate of insomnia than female students (27.7 vs. 20.0%) (44). However, in our research, we found that male sex was associated with fear symptoms during the COVID-19 outbreak, which differed from the previous studies, indicating that female students showed higher levels of fear of COVID-19 than male students (45). It could be the reason that a male

student was more likely to engage in risk-taking behaviors (46). In addition, the majority of the students in this study were male (84.6%).

Our study demonstrated that participants aged 26–30 years reported statistically significantly associated psychological outcomes. The participants of this group were highly pressurized in multifetch levels that impacted heavily on their mental health. This finding might cause more anxiousness about the study, career, family, and sometimes financial management of young participants. Many studies found that young students were at higher risks of general psychiatric disorders, stress, anxiety, depression, loneliness, psychological distress, suicidal ideation, insomnia, and post-traumatic stress symptoms (46–49). A recent cross-sectional survey performed in India during May 2020 investigated 335 dental students and practitioners who used PHQ-9 scores and found that those who were depressed were likely to be younger than 30 years old (42).

The present study also demonstrated that central region students reported significant association with all the psychological outcomes except fear symptoms. There are eight provinces in central regions, and Hubei is one of them. Wuhan is the capital of Hubei Province in the People's Republic of China. In December 2019, the outbreak of COVID-19 began in Wuhan. This city first implemented a Level 1 response to the public health emergency and a lockdown on January 23, 2020, due to the high fatality rate (50). During the lockdown period, students did not get permission to go outside the campus. Most of the people, except for those involved in epidemic prevention and control, the police, and few workers of necessary industries, were required to stay at home (51, 52). Under the government policies on COVID-19, universities of China, especially in the Wuhan region, issued strict rules for local and international students to prevent the transmission of the virus in the university community. This situation has created a panic situation among the students, especially those living in the earthquake's epicenter.

After Wuhan city, the government of all provinces in China implemented a Level 1 response to the public health emergency on January 29, 2020 (53). Earlier studies have shown that public health emergencies have a significant impact on the mental health of college students (54). Hence, all universities in China were mandated to be closed in the spring of 2020. A previous study investigating the psychological impact of the COVID-19 outbreak in 2020 developed by using a questionnaire among 504 valid responses from international students in Hubei province, China, found that it was 2.12 times greater in students from Wuhan than in those from other areas (55). It may be because the respondents in affected areas paid more attention to the safety of their families (56). However, another study of 2,485 students from six universities investigated using online survey versions of the PCL-C and PHQ-9 found that those living in the worst-hit areas were at the highest risk of developing post-traumatic stress disorder (PTSD) and depression (13).

Our study revealed that participants who lived with a roommate were more likely to report moderate to extremely severe symptoms of all the psychological outcomes. In a recent study from the USA, students living with roommates showed secondary associations between physiologically and environmentally related sleep hygiene practices and depressive symptoms (57). A cross-sectional survey among final-year dental undergraduate students in a dental teaching institution in Bangalore, India, found that students who had been staying with roommates were least commonly reported to have mental health problems (58). Since bachelor and master's students living with a roommate in a dormitory, so they had more talk to each other about COVID-19 rather than other topics during the pandemic. Sometimes, they got insufficient information or got misinformation ("fake news"). A recent study found that inadequate details (59) or misinformation on COVID-19 (60) was associated with poorer mental health (61).

Our findings indicated that participants whose living places were dormitories were significantly associated with psychological outcomes except for psychological distress and fear symptoms. A recent study conducted in the United Arab Emirates on 433 students has found that students staying in a shared house or dorm (hostel) are more anxious about COVID-19 than those staying in a villa or apartment (62). They were cut off from meeting others except for virtual meetings. It posed heavy tension and other mental disorders among them due to a lack of communication. It might be that the concerned authorities strictly monitored students who lived in dormitories during the pandemic. However, they were allowed to go outside for a limited time purchasing daily commodities. It created an adverse effect on their minds, followed by mental health problems. For students living with dorms or shared houses, other factors such as online classes and exams, financial crisis, and null social gatherings adversely affected their minds. It is probably the first time that international students took part in online courses and exams. Since it was a new teaching and learning idea, many did not get used to it, consequently creating anxiousness.

The current study found that bachelor students reported significant association with depression, anxiety, stress, and psychological distress symptoms, consistent with previous studies (63, 64). International students who are staying far from their parents/loved ones are at a higher risk of developing mental problems such as anxiety and depression (65). They are worried about their health and education and have a massive concern for the well-being of their families (65, 66). A previous study investigating the psychological impact of the COVID-19 outbreak in 2020 developed by using a questionnaire among 504 valid responses from international students in Hubei province, China, found that the bachelor and Ph.D. students were more likely to be affected than the master students (55). Long-term living students had better knowledge about the illness, more adaptability, adjustment power, and prevention measures than the freshers, which could further shelter them from mental health symptoms. Due to long periods of staying, they are mostly well-acquainted with the local people, culture, customs, food habits, and environment, which created a plus point for them to tackle the worst situation in the pandemic. Newcomers, on the contrary, were devoid of assimilation process of the local culture and customs that led them to pose stress and anxiety during the pandemic.

This present study revealed that Arts and Humanities, Engineering, Social Sciences and Law, and Language students

reported significant association with all the psychological outcomes except psychological distress symptoms, consistent with the previous studies (43, 46, 47, 67, 68). Odriozola-González et al. conducted a study of 2,530 participants at the University of Valladolid in Spain at the beginning of the COVID-19 outbreak. Their study found that participants who studied arts and humanities, social sciences, and law had higher scores of anxiety, depression, stress, and impact of the event than those who studied other subjects. A recent study of the psychological impact of the COVID-19 outbreak on 3,936 students in France found that those who studied in a language program had significantly more anxiety symptoms than those in other programs (69). However, results from another study in the 362 different medical and engineering colleges of Karachi from 2018, evaluated using the HAM-D, showed that the rate of depression was higher in engineering students than in medical students (48). Moreover, several studies evidence that the health sciences or engineering area students were found to present higher symptomatology scores than those in others (70, 71).

Our study showed that participants staying in China for <2 years were significantly associated with all the psychological outcomes. Our findings were different from previous findings of a survey conducted during the pandemic in China. It noted that international students who had been in China for <3 years suffered 2.19 times more than the students who had been here for 1 or 2 years (55). It may be because the students with a more extended stay in China reported more concerns and consequences than the students who stayed for a short period. It may be associated with the respondent's age and marital status. However, another study found that international students staying in another country for more than 1 year were more depressed than local-born students (72). Future epidemiological studies should emphasize psychopathological variations and temporality of mental health problems in different populations. The mental health of international students is also essential. Nonetheless, multipronged interventions should be developed and adopted to address the existing psychosocial challenges and promote mental health amid the COVID-19 pandemic.

STRENGTHS AND LIMITATIONS

The strength of this study includes its extensive geographic coverage from 7 regions of inter-26 provincial level of China, 84 different types of universities, 45 country's international students, and the critical study period. Besides, to the best of our knowledge, this is the first nationwide study that systematically investigated the mental health outcomes and associated factors by standardized rating scales among international students living in China during the COVID-19 pandemic. This study finding may provide helpful information for government leaders and higher education institutions to recognize high-risk international students and design a framework for acute and long-term psychological services for them. This finding may also help the government to focus more on international students' mental health while combating the COVID-19 pandemic. Our investigation output will significantly impact psychiatry and public mental health and is conducive to psychiatrists, clinicians, and investigators in their research and deliver valuable information for universities authorities, policymakers, healthcare providers, and government officials. Additionally, this study could help them develop better prevention and treatment plans for their patients, general people, and local and international students, and mental health promotion globally.

Like all other studies, this study also has several limitations. First, the study was relatively small. Second, most of the participants in the current survey were from male students and Asian countries, which might have skewed the results. Third, the self-administered instruments can predict with some level of assurance that a person will meet the full criteria for a psychological disorder. However, the instruments themselves do not serve to diagnose these disorders. They should not take the place of complete diagnostic evaluation by experts. Fourth, the study's cross-sectional design did not permit the elucidation of causal relationships. Finally, the results may only reflect the current mental health status during the epidemic. Longitudinal follow-up studies are needed to determine the possible long-term mental health consequences among international students during the COVID-19 pandemic.

CONCLUSION

The present study is the first broad range study investigating the magnitude of psychological outcomes and associated factors by standardized rating scales among international students living in China during the COVID-19 pandemic. A higher prevalence of psychological symptoms was found among the international students living in China during COVID-19 and risk factors. This study implies that universities need to take measures to prevent, identify, and deal with the mental health problems of international students during the COVID-19 pandemic. The findings of this study provide a scientific foundation in mental health interventions or support and practical strategies aimed at reminding researchers, university authorities, healthcare providers, and government officials to take precautions.

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 First Affiliated Hospital, Zhejiang University School of Medicine. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AM and JL: conceptualization and methodology. AM: formal analysis and writing—original draft. AM and LN: data curation.

AM, JL, LN, SH, and YX: writing—review and editing. 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/fpsyt.2021.707342/full#supplementary-material

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Social Capital Changes After COVID-19 Lockdown Among Youths in China: COVID-19 Impact on Lifestyle Change Survey (COINLICS)

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Introduction: Social capital, the effective functioning of social groups through networks of relationships, can affect mental health and may be affected by COVID-19. We aimed to examine the changes in social capital before and after the COVID-19 lockdown among the Chinese youth.

Methods: A national convenience sample of 10,540 high school, undergraduate, and graduate students, from the COVID-19 Impact on Lifestyle Change Survey (COINLICS), reported their demographic and social capital information before and after the COVID-19 lockdown. Social capital was retrospectively measured at four levels: individual (ISC), family (FSC), community (CSC), and society (SSC). The changes of social capital were also compared across three educational levels.

Results: Overall, ISC and CSC scores generally decreased after lockdown (15.1 to 14.8 and 13.4 to 13.1, respectively), while FSC and SSC scores increased significantly (12.7 to 13.0 and 7.1 to 7.2, respectively). At the individual level, most participants showed a constant perceived social capital; more of the remaining participants showed decreased than increased ISC (30.5% vs. 17.0%) and CSC scores (28.4% vs. 19.1%), while more participants showed increased than decreased FSC (21.7% vs. 9.2%) and SSC scores (10.3% vs. 3.9%). Heterogeneities in social capital changes existed across educational levels.

Conclusions: Our findings would provide health professionals and policy-makers solid evidence on the changes in social capital of youths after lockdowns, and therefore help the design of future interventions to rebuild or improve their social capital after epidemics/disasters.

Keywords: COVID-19, social capital, mental health, youths, lockdown

INTRODUCTION

Social capital is broadly defined as the sum of trustworthy, reciprocal and resource-rich network connections (1). As a sophisticated formulation of the broader concepts of "social cohesion," "social support," "social integration," or "civil society," social capital is of great significance to both individuals and society (1, 2). From an individual perspective, social capital has been revealed as a crucial determinant of multiple health outcomes (e.g., adolescent well-being, mental health), with plausible pathways from social capital to health (1). From a society perspective, social capital is also proved as an asset to empower and mobilize a society and its members (3, 4). Especially highlighted is the crucial role of social capital when a nation's people face disasters or catastrophes (5). For instance, a survey in Japan showed that social capital buffered the effects of natural disasters and helped to resume groups' health during the 2011 Great East Japan Earthquake and Tsunami (5, 6). Given its crucial roles, preventing the possibility of dramatic post-disaster decline in social capital deserves attention, especially for youths who are fairly dependent on society and family (7). The youth might be more likely to show a significant change in social capital when facing disasters, which may directly or indirectly affect their mental health and also vary by age and level of maturity (i.e., youths of different levels of maturity may perceive social capital differently) (8, 9).

The coronavirus disease 2019 (COVID-19) that broke out nearly all over the world is undoubtedly disastrous (10). In China, to curb the spread of the epidemic, the government adopted strict policies including conducting a lockdown (11, 12). Thus, many factors closely related to social capital of the youth, such as social participation and interpersonal communication, may have undergone significant changes. For instance, even when social media platforms were available, face-to-face communication could not be achieved with the long period of social distancing and stay-at-home recommendations during the lockdown. Currently, despite the lockdown has been lifted, the abovementioned adverse situations have aroused the concern that social capital of youths might have been affected and changed. These changes might be negative because some factors, such as excessive reaction to the lockdown policy and poor psychological status (for stressful life events, extended home confinement, brutal grief information pollution on social media), might affect interpersonal or social cohesion (13–15). On the other hand, with effective emergency management, the whole society may have greater solidarity when facing disasters, leading to a positive change in social capital. However, the impacts of COVID-19 on social capital of the youth remain unknown in China. Furthermore, considering the heterogeneity in maturity and lifestyles (e.g., living at school or home) among youths, the level of social capital at baseline (i.e., at normal times before COVID-19 lockdown) and the degree of change in social capital after COVID-19 lockdown that may vary across educational levels, the social capital changes across educational levels are also examined.

This study aimed to examine differences in social capital in the months before COVID-19 lockdown was implemented (January 2020, also referred to as before lockdown) and after COVID-19 lockdown was lifted (May 2020, also referred to as after lockdown), as well as the variation in social capital changes across the educational levels, on the basis of a national convenience sample of 10,540 Chinese youths. Our findings would provide empirical evidence and references for targeted interventions of social capital reconstruction among youths in China, and may also benefit other countries which have encountered lockdown measures to different extents.

METHODS

Data

The data used in this study were from the COVID-19 Impact on Lifestyle Change Survey (COINLICS), a national retrospective online survey designed by an expert panel consisting of epidemiologists, statisticians, health psychologists, and sociologists. A snowball sampling strategy was adopted to distribute the online questionnaire via social media platforms in May 2020 among youths at three educational stages (i.e., high school, college, and graduate students) in China (16). A total of 10,540 individuals completed the questionnaire anonymously. All subjects voluntarily participated in our study with informed consent, and the study was carried out in accordance with the Helsinki Declaration of 1964.

Measurement of Social Capital

The individual social capital (ISC), family social capital (FSC), and community social capital (CSC) comprehensively reflect one's perception of social capital from peers/friends, family members, and neighbors, which have been proved to be associated with youths' health promotion or risk behaviors (17, 18). Also, measures taken by the government and relevant sectors to contain the COVID-19 pandemic have unprecedentedly attracted substantial social attention and possibly raised public trust, which could be reflected by the society social capital (SSC) (19).

The measurements of the four dimensions of social capital above (ISC, FSC, CSC, and SSC) were adapted from the scales of a validated Chinese version of Health-related Social Capital Measurement (20). According to characteristics of the living and studying environments of the youth, we tailored the 15 items in four dimensions (**Table 1**). The answer to each item ranges from 1 (strongly disagree) to 5 (strongly agree), with a higher total score indicating stronger social capital.

Statistical Analysis

Descriptive statistics were used for the participants' demographic characteristics and social capital, with mean and standard deviation (SD) for continuous variables, and percentages for categorical variables. Differences in demographic characteristics, the changes of social capital before and after the lockdown, and the frequency differences at the individual level among youths of different educational levels were compared based on *t*-tests/ANOVA for continuous variables, or χ^2 tests for categorical variables. R 3.6.2 was used to perform all statistical analyses. Statistical significance was declared if a two-sided $p < 0.05$.

TABLE 1 | The percentages of the participating Chinese youths who (strongly) agreed each survey question of social capital before and after the COVID-19 lockdown in the COVID-19 Impact on Lifestyle Change Survey (COINLICS).

	Variables	All (n = 10,540)	High school (n = 2,855)	Undergraduate (n = 7,419)	Graduate (n = 266)
Individual social capital					
Q1	You have many close contacts.				
	Before lockdown	7.3	4.3	8.2	11.7
	After lockdown	4.0	2.8	4.5	4.5
Q2	You have many social interactions with people other than your family members.				
	Before lockdown	8.6	5.5	9.4	16.9
	After lockdown	5.9	4.1	6.6	6.8
Q3	You always trust people who have social interaction with you.				
	Before lockdown	60.4	49.9	64.1	70.3
	After lockdown	58.5	47.4	62.5	67.3
Q4	You always receive emotional/financial/instrumental support from friends/classmates.				
	Before lockdown	54.2	43.5	57.8	66.5
	After lockdown	54.2	43.0	58.0	65.8
Q5	You have a good relationship with your classmates.				
	Before lockdown	71.8	61.4	75.5	80.5
	After lockdown	70.4	59.7	74.2	79.7
Family social capital					
Q6	You live with family members.				
	Before lockdown	74.1	87.6	70.1	38.7
	After lockdown	90.2	93.1	89.5	80.1
Q7	You have a good relationship with your family (mainly including parents, brothers and sisters).				
	Before lockdown	81.6	75.9	83.5	87.6
	After lockdown	79.2	74.5	80.8	85.0
Q8	You always receive emotional/financial/instrumental support from family members.				
	Before lockdown	73.5	64.2	76.9	79.0
	After lockdown	73.7	64.3	77.1	80.5
Community social capital					
Q9	You frequently participate in activities organized by community organizations.				
	Before lockdown	13.8	4.7	17.5	9.0
	After lockdown	10.9	3.5	13.9	7.9
Q10	You always receive support from community organizations.				
	Before lockdown	8.4	4.7	9.9	6.4
	After lockdown	7.9	4.4	9.2	7.1
Q11	You always receive emotional/financial/instrumental support from your teachers or instructors.				
	Before lockdown	26.0	20.9	27.8	30.8
	After lockdown	29.3	22.2	31.8	35.7
Q12	You are very concerned about what happens in the same community/dormitory building.				
	Before lockdown	36.5	33.7	37.3	45.1
	After lockdown	41.4	35.8	43.0	54.9
Q13	You agree that people who live in the same community/dormitory can be trusted.				
	Before lockdown	24.2	25.7	31.6	25.4
	After lockdown	24.6	26.4	33.1	26.1

(Continued)

TABLE 1 | Continued

Variables		All (n = 10,540)	High school (n = 2,855)	Undergraduate (n = 7,419)	Graduate (n = 266)
Society social capital					
Q14	You trust other health organizations/governmental organizations very much.				
	Before lockdown	57.7	64.7	55.1	56.8
	After lockdown	60.6	66.6	58.3	59.4
Q15	You agree with the statement that talented people will be recognized by the society.				
	Before lockdown	46.9	46.4	46.8	54.5
	After lockdown	48.0	47.4	48.1	51.9

RESULTS

Of 10,540 participants in the study, 2,855 participants were high school students, 7,419 participants were undergraduate students, and 266 participants were graduate school students (**Table 2**). The participants aged from 15 to 33 years, with a mean age of 19.9±2.3. Most of them were female (71.3%), of Han ethnicity (94.9%), non-urban residents (61.8%), and from the west region (87.1%). Around half of the participants had a household income of 12,000–60,000 *yuan* per year. Significant differences were observed for all demographic characteristics among the three educational levels. More specifically, the percentages of urban residents were higher in undergraduate students (42.6%) and graduate students (62.8%) than in high school students (24.3%), and no high school students from the central region were enrolled.

The score of all dimensions of social capital showed significant differences (all $p < 0.001$) among three educational levels both before and after the lockdown (**Table 3**). Overall, the ISC score decreased from 15.1 to 14.8 and CSC score decreased from 13.4 to 13.1, while the FSC score increased from 12.7 to 13.0 and SSC score increased from 7.1 to 7.2 (all $p < 0.001$). In different educational groups, the ISC score and CSC decreased in all subgroups (all $p < 0.01$); the FSC score of undergraduate students increased ($p < 0.001$); and the SSC score increased in all subgroups (all $p < 0.05$).

At the individual level, most of the youths participating in the study showed constant social capital scores between the two time points, with the percentage ranging from 52.5 to 85.8% across four scales (**Table 3**). In addition, overall, more participants had decreased than increased ISC scores (30.5% vs. 17.0%) and CSC scores (28.4% vs. 19.1%), and more participants had increased rather than decreased FSC scores (21.7% vs. 9.2%) and SSC scores (10.3% vs. 3.9%). Participants at different educational levels also showed the same trend as the whole group. Among graduate students, 45.9% of participants had decreased ISC score and 47.0% of them had increased FSC score, which were higher than the other groups; among undergraduate students, the percentages of the participants with decreased CSC (30.3%) and increased SSC (10.6%) scores were higher than the other groups. Differences in the composition ratio of individual-level changes among educational levels were found (all $p < 0.05$) in all dimensions of social capital.

DISCUSSION

This is a retrospective study based on a national sample, which provided a picture of changed social capital among youths before and after the lockdown. We found significant changes in social capital of all dimensions across educational levels, except for the FSC in high school and graduate students. At the individual level, most youths' social capital after lockdown was constant compared to before lockdown. However, more youths showed a decline in their ISC and CSC than those showed an ascent; more youths showed an ascent in their FSC and SSC than those with decreased scores. Heterogeneities in social capital changes existed across educational levels.

Several explanations may account for the changes in social capital among youths, especially regarding the significant decline of ISC and CSC. Previous research has suggested that social contact and community participation among population might be disrupted in the face of a disaster or catastrophe (e.g., earthquake or tsunami) (7). During the COVID-19 outbreak, although the lockdown in China was lifted in April, social distancing was still recommended, and parents may adopt the advice to prevent youths away from networking activities (e.g., wedding, club parties, classmate gathering). These measures may affect their social contact especially with their friends and community, as online communication platforms cannot compensate for the emotional demands of face-to-face communication and community participation (21). In addition, the decline might also attribute to the adverse mental health status affected by COVID-19, which was inconducive to interpersonal communication.

Different from previous studies on post-disaster social capital concerns (7), the improvements in FSC and SSC found in this study suggested that the impact of COVID-19 on social capital is not entirely negative. COVID-19 and the accompanying lockdown, in some sense, granted opportunities for family members to communicate internally, which might account for the improvement in FSC. In terms of SSC,

TABLE 2 | Baseline characteristics of the participating youths in the COVID-19 Impact on Lifestyle Change Survey (COINLICS).

Variable	Mean (SD) or percentage (%)				
	All (n = 10,540)	High school (n = 2,855)	Undergraduate (n = 7,419)	Graduate (n = 266)	*P*-value
Age (year)	19.9 (2.3)	17.5 (1.2)	20.6 (1.8)	24.7 (3.4)	**<0.001**
Sex					**<0.001**
Male	28.7	24.2	30.4	27.8	
Female	71.3	75.8	69.6	72.2	
Ethnicity					**<0.001**
Han	94.9	96.7	94.4	91.0	
Minority	5.1	3.3	5.6	9.0	
Urbanicity					**<0.001**
Urban	38.2	24.3	42.6	62.8	
Non-urban	61.8	75.7	57.4	37.2	
Region[a]					**<0.001**
Northeast	0.3	0.1	0.3	3.4	
East	9.2	0.7	11.9	25.2	
West	87.1	99.2	83.5	56.8	
Central	3.4	0.0	4.3	14.6	
Household income (*yuan*/year)					**<0.001**
<12,000	20.0	24.5	18.7	6.8	
≥12,000–20,000	28.0	35.6	25.8	8.3	
>20,000–60,000	26.7	25.8	27.3	21.8	
>60,000–10,0000	13.1	9.5	14.1	23.3	
>100,000–200,000	8.6	3.3	10.0	25.9	
>200,000	3.6	1.3	4.1	13.9	
Major					**<0.001**
Medical Science	37.0	88.7	16.5	52.3	
Science/Engineering	25.8	10.5	31.7	26.3	
Social Science	37.2	0.8	51.8	21.4	

[a]*Northeast (Liaoning, Jilin, Heilongjiang province), East (Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan province), Central (Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan province), and West of China (Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang). All significant p-values (p < 0.05) were bolded.*

the possible mechanism accounted for the increase might be the government's effective disaster management and social governance. Specifically, the Chinese public has a high level of trust in the government. In face of the disaster, the Chinese government and health agencies has actively and rationally taken countermeasures during the epidemic to curb the spread of COVID-19, which strengthened the social cohesion. All industries (especially the health industry) were united against COVID-19, and positive news reports promoted solidarity. Furthermore, the lockdown lifted *per se* demonstrated the effectiveness of national unity in the fight against the pandemic, which may have profoundly strengthened the social capital among youths. These factors might grant youths the spirit of solidarity and sense of security in facing the disaster, thus increasing the SSC to some extent (22).

There are some suggestions to policy-makers and health professionals on the basis of our findings. For example, to prevent further decreases in or even increase ISC and CSC among youths, health professionals could collaborate with schools to develop online peer communication activities and thus provide emotional support (14); policy-makers should take measures to improve community services, and develop guidelines and instructions to anticipate the needs of vulnerable youths, especially those who used to take less advantage of social capital (23). To maintain or further increase SSC, relevant authorities may strengthen the monitoring of social media to curb the spread of false information. In addition, what aroused our concern is that the decline in ISC and CSC may persist even after lockdown. Since a previous study suggested that the coronavirus may have a long-term transmission trend (24), social distancing is still inevitable. New strategies are needed to reshape social capital especially the ISC and CSC. For example, opening some public places under strict monitoring in low-risk areas (such as cinemas and bookstores) may promote the participation of community activities. Since many countries are still under lockdown, we hope our study could provide some references for other countries or regions. Our study also found the heterogeneities in social capital changes existed across educational levels before and after the lockdown, which implies that policy-makers should take

TABLE 3 | Changes in social capital before and after the COVID-19 lockdown among the participating youths in the COVID-19 Impact on Lifestyle Change Survey (COINLICS).

Variable	Median [p25, p75] or percentage (%)				*P*-value†
	All (*n* = 10,540)	High school (*n* = 2,855)	Undergraduate (*n* = 7,419)	Graduate (*n* = 266)	
Population-level					
Individual social capital					
Before lockdown	15 (13, 17)	14 (12, 16)	16 (13, 17)	14 (12, 16)	**<0.001**
After lockdown	15 (13, 17)***	14 (12, 16)***	15 (13, 17)***	14 (12, 16)***	**<0.001**
Family social capital					
Before lockdown	13 (11, 15)	13 (11, 15)	13 (11, 15)	13 (11, 15)	**<0.001**
After lockdown	13 (12, 15)***	13 (11, 15)	14 (12, 15)***	13 (11, 15)	**<0.001**
Community social capital					
Before lockdown	13 (11, 15)	12 (10, 14)	14 (11, 16)	12 (10, 14)	**<0.001**
After lockdown	13 (11, 15)***	12 (10, 14)**	13 (11, 15)***	12 (10, 14)**	**<0.001**
Society social capital					
Before lockdown	7 (6, 8)	7 (6, 8)	7 (6, 8)	7 (6, 8)	**<0.001**
After lockdown	7 (6, 8)***	7 (6, 8)*	7 (6, 8)***	7 (6, 8)*	**<0.001**
Individual-level					
Individual social capital					**<0.001**
Increased	17.0	17.3	16.9	17.3	
Constant	52.5	54.9	52.1	36.8	
Decreased	30.5	27.7	31.0	45.9	
Family social capital					**<0.001**
Increased	21.7	11.7	24.7	47.0	
Constant	69.1	80.0	65.8	43.2	
Decreased	9.2	8.3	9.5	9.8	
Community social capital					**<0.001**
Increased	19.1	13.6	21.1	22.9	
Constant	52.6	63.1	48.7	47.4	
Decreased	28.4	23.3	30.3	29.7	
Society social capital					**0.025**
Increased	10.3	9.7	10.6	7.5	
Constant	85.8	86.8	85.4	85.7	
Decreased	3.9	3.5	4.0	6.8	

*Values under a given variable were marked by asterisks, if the difference before and after COVID-19 lockdown within a given educational level was significant (*p < 0.05, **p < 0.01, ***p < 0.001). †P-values tested the significance of the differences in each variable across educational levels. All P-values were based on t-tests/ANOVA for continuous variables or χ^2 tests for categorical variables. All significant p-values (p < 0.05) were bolded.*

into consideration the educational level and types of social capital while developing tailored interventions for recovery of social capital.

Our study has some limitations. First, since our study measures a before and after scenario by asking about the "before" retrospectively and the social capital data are self-reported, there may be recall and reporting bias; particularly, this recall was made during a traumatic ongoing event, which may further skew the perception of all levels of social capital (e.g., being under-perceived) due to negative or depressive emotion during the long-lasting pandemic. However, the self-assessment of social capital at two time points might reflect their perceived changes which are usually closely correlated with their actual changes (16, 25, 26). Second, we only measured two time points in this study, thus were not able to track the dynamic trends of social capital during the whole period (27). Third, this study was conducted based on a national convenience sample that may not be fully representative of the Chinese youth. Using a snowball sampling technique may lead to some notable skewness in the collected data (28, 29), such as a considerably large proportion of females and youths from western regions of China in our study. Besides, all participating youths were students, so the results may not be extrapolated to other youth groups (e.g., out-of-school youth). However, this large convenience sample, promptly recruited online, presents unique strengths by drawing important conclusions from the targeted population during the epidemic without risk of infection. Note that this approach and the resultant findings may differ in the context of many natural disasters (e.g., earthquake, tsunami) which can cause the loss of ability to stay in touch or trade information via electronic means, and thus affect the ability to build or use social capital.

Our large-scale nationwide study suggested the changes of social capital among the Chinese youths before and after the COVID-19 lockdown. Specifically, the social capital at individual and community level generally declined, while the family-level social capital and society-level social capital generally ascended. Our findings would inform policy-makers and health professionals of the changed social capital among youths during COVID-19 lockdown, for better policy making and clinical practice to improve youths' mental health in the post-COVID era. School administrators should also be informed of these changes, so in-class and extracurricular programs could be designed to counteract them. Although our findings also serve as important references for other countries or regions in which lockdown measures are in effect or to be (re)considered, perceptions on and changes in social capital, especially SSC, under similar situations in those countries and regions with more individualistic subcultures and/or less trust in governments may be significantly different or even reversed. Therefore, more efforts in the countries of different cultures are warranted to increase all dimensions of social capital in adaptive approaches.

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 Sichuan University Medical Ethical Review Board (KS2020414). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

BY, MLu, SY, and PJ took a principal role in designing the study, writing the protocol, developing methodologies, analyzing the data, and drafting the manuscript. PJ contributed to the proposal writing and made a critical revision to the manuscript. JZ contributed to the write up of the study protocol and made a revision to the manuscript. MLi and BY performed the statistical analysis. SY and PJ supervised the study and edited the manuscript. All authors read and approved the final manuscript.

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Anxiety and Depression in Chinese Students During the COVID-19 Pandemic: A Meta-Analysis

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Background: The novel 2019 coronavirus disease (COVID-19) pandemic has spread rapidly worldwide and poses a global health threat.

Aims: This study assessed the prevalence of anxiety and depression symptoms in Chinese students during the COVID-19 pandemic and explored potential moderating factors.

Methods: We searched English and Chinese databases using pertinent keywords for articles published and unpublished, up until November 2020. The estimate of the overall prevalence of anxiety and depression was conducted through a random-effects model.

Results: A total of 31 cross-sectional studies were included. The overall prevalence of anxiety and depression symptoms in Chinese students during the COVID-19 pandemic was 24.0% (95% CI [20.0–29.0%]) and 22.0% (95% CI [18.0–27.0%]) respectively. Subgroup analyses revealed that Chinese middle school students were at heightened risk of anxiety, while university students were at heightened risk of depression. Students who lived in higher-risk areas presented severe anxiety and depression, especially during the late period of the COVID-19 epidemic.

Conclusions: Overall, during the COVID-19 pandemic, there was a high prevalence of anxiety in Chinese students and a high prevalence of depression among Chinese students in high-risk areas. Therefore, comprehensive and targeted psychological interventions should be developed to address the mental health of students in different grades, especially in high-risk areas and during the late period of the COVID-19 pandemic.

Keywords: COVID-19, anxiety, depression, China, meta-analysis

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INTRODUCTION

The novel 2019 coronavirus disease (COVID-19)—caused by SARS-CoV-2—is an emerging, rapidly evolving pandemic (1). The first case of acute infectious pneumonia caused by COVID-19 emerged from Wuhan, China (2, 3). Due to the high infectiousness of COVID-19 and its consequent wide and rapid spread, Chinese schools and factories closed, and the government implemented home isolation (4). Furthermore, the impact of the COVID-19 outbreak on mental health remains poorly understood, although many Chinese people have exhibited a tendency toward increased mental health issues and sensitivity to social risks within China (5, 6).

Anxiety and depressive symptoms have been common mental health problems for populations during the COVID-19 pandemic (2, 7). Students, as a vulnerable population, are relatively prone to anxiety and depression symptoms (8), and the COVID-19 pandemic has led to short- and long-term anxiety and depression among students (9, 10). Prolonged anxiety and depression are associated with increased levels of negative mental health of students, resulting in symptoms such as fear, stress, insomnia (10, 11), and behaviors such as aggression, smartphone addiction, and suicide (12). However, the proportion of students who experienced anxiety and depression during the COVID-19 is unclear. China has experienced a relatively complete outbreak process because it took a series of measures to control the outbreak as early as possible. Therefore, it is necessary to explore the incidence of anxiety and depression symptoms of students in China during the COVID-19 to provide data that may help in controlling the global COVID-19 pandemic.

Existing systematic analyses and meta-analyses have assessed the prevalence of anxiety and depression among children and adolescents during the COVID-19 pandemic. The systematic analysis of Nearchou et al. (13), which included adolescents $\leq$ 18 years old, found that COVID-19 increased adolescent depression and anxiety. The meta-analysis of Panda et al. (14) revealed that the overall prevalence of anxiety and depression among children worldwide was 34.5 and 41.7%, respectively. Luo et al. (15) indicated that the pooled prevalence of depressive symptoms in Chinese university students was 26.0% during the COVID-19 pandemic. However, to the best of our knowledge, no meta-analysis has evaluated the prevalence of anxiety and depression among Chinese students overall. The results of extant studies of the level of anxiety and depression in Chinese students during the COVID-19 pandemic are inconsistent. Some studies reported prevalence of anxiety of 24.9% (16) and depression of 16.5% (17), whereas other studies reported a 37.4% prevalence of anxiety and 43.7% prevalence of depression in students (18). In addition, little is known about the effect of potential factors that may influence the overall prevalence of anxiety and depression of students during the COVID-19 pandemic.

Based on risk theory and the spatial relationship of population outflow, two factors—pandemic risk areas and pandemic development progression—may be related to the prevalence of anxiety and depression (19, 20). Furthermore, the substantial levels of anxiety and depression caused by COVID-19 and their severity may also be associated with increased age (21, 22). These three potential factors (pandemic risk areas, pandemic period, and study grade) may have moderating effects on the prevalence of anxiety and depression of students (23).

This meta-analysis provides a timely assessment of the prevalence of anxiety and depression among students in China during the early period of the COVID-19 crisis. We further explored how different pandemic risk areas, pandemic development processes, and study grades affected students' anxiety and depression symptoms to inform recommendations for the prevention of, and interventions against, anxiety and depression during the COVID-19 pandemic.

METHODS

Search Strategy

This study was performed according to PRISMA. Two authors (the first and second author) independently searched the English databases Web of Science, PubMed, Medline, Embase, PsycInfo, and Google Scholar; and the Chinese databases Wanfang, China National Knowledge Infrastructure, and China Science and Technology Journal. Subsequently, we manually searched the references of selected studies, up to November 2020. A third person participated in the discussion if there were discrepancies. Appropriate keywords were used to search, including (*2019-ncov* OR *coronavirus* OR *corona virus* OR *novel coronavirus pneumonia* OR *COVID-19*), (*depression* OR *depressive* OR *Depression*), (*anxiety* OR *mental health problem*), (*children* OR *adolescents* OR *student* OR *youth*), (*China* OR *Chinese*).

Inclusion and Exclusion Criteria

Studies that met the following criteria were included: (a) Participants were Chinese primary, secondary, or undergraduate students; however, we excluded students with severe psychological distress or posttraumatic stress disorder. (b) The outcome was the prevalence of anxiety and depression among Chinese students during the COVID-19 pandemic. However, studies that referred to other mental health problems (e.g., stress, dementia) or behavioral problems (e.g., suicide, insomnia) were excluded. Although stress and anxiety are often used interchangeably (24), most researchers agree that the definitions of stress and anxiety are different (25, 26). Stress is an emotional and physical tension in response to threat, while anxiety is the body's natural response to stress (27, 28). Based on the different definitions of stress and anxiety, stress was excluded from this study. (c) Study design included cross-sectional studies (field or online surveys). We excluded review research or research plans with incomplete or unidentified data (29), conference abstracts or case reports, studies with incomplete data, and research in duplicate publications.

Quality Evaluation

The Agency for Healthcare Research and Quality (AHRQ) was specifically designed to evaluate the quality of cross-sectional studies in systematic reviews (30). The AHRQ includes 11 items that are answered as "yes," "no," or "unclear." When the quality assessments of the two authors differed, the original articles were re-examined by a third person until a quality rating was agreed upon.

Data Extraction and Code

We developed a data extraction table. The extracted contents included the author(s), year, time point of the pandemic, pandemic area, measurement scale, the method of completing the scale, age of the participants, total sample size, number of persons with anxiety or depression, and the prevalence of anxiety and depression. In addition, two researchers independently extracted and coded the data. When there was a discrepancy, discussions were conducted with a third person to reach a final conclusion.

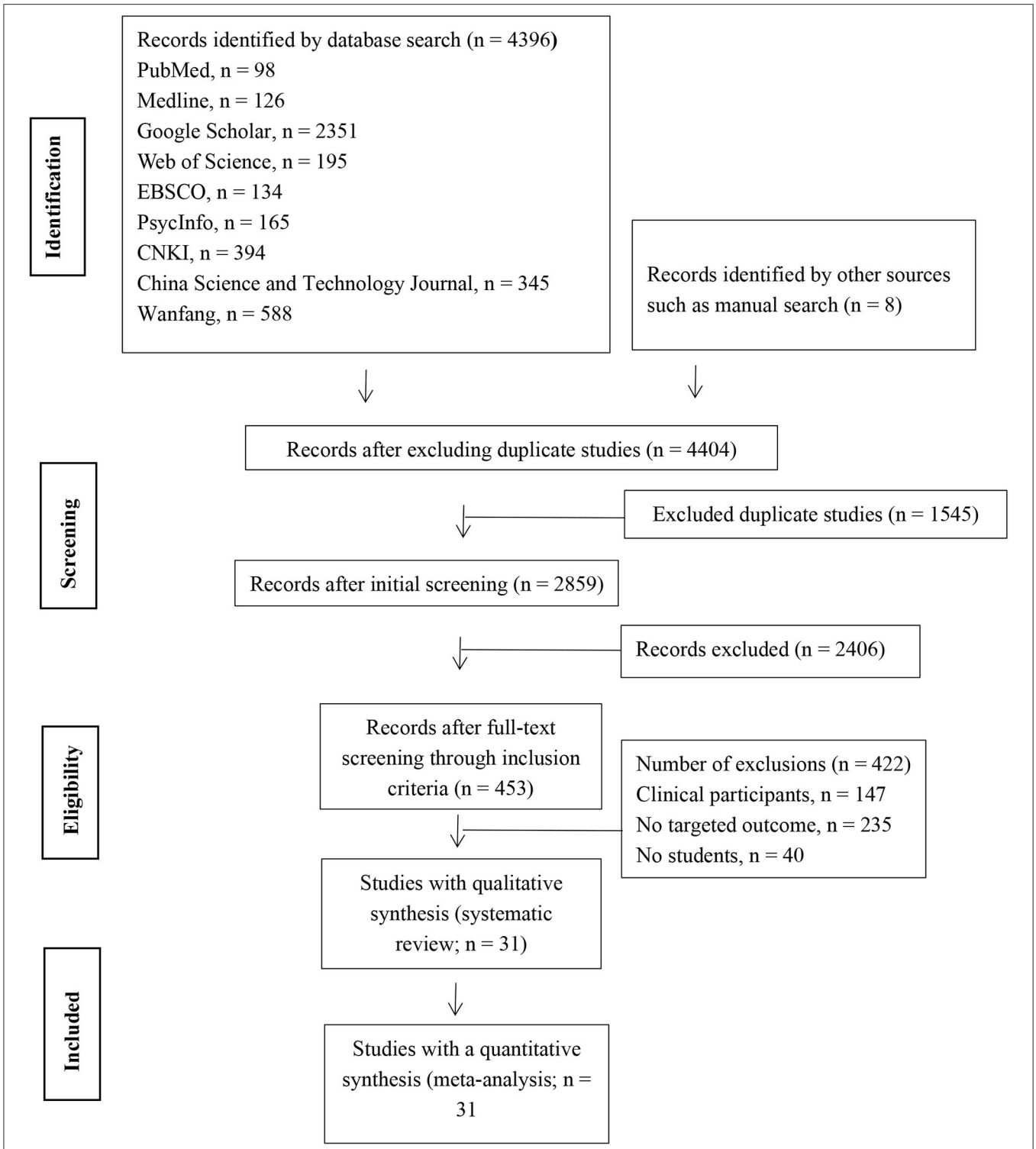

FIGURE 1 | PRISMA literature screening process.

The pandemic area was divided into three levels of risk (31): (1) Wuhan and Hubei provinces were coded as higher-risk areas, (2) the cities around Hubei province but not Hubei (e.g., Chongqing, Henan) were coded as medium-risk areas, (3) large central cities with a large floating population (e.g., Beijing, Shanghai, Guangdong) were coded as lower-risk areas, and (4)

areas far away from high-risk areas of the pandemic and large central cities (e.g., the province of Xinjiang, Qinghai, Ningxia) were coded as low-risk areas.

The COVID-19 pandemic development in China was coded into four stages based on Baidu migration big data and geographic information technology (31): (1) occurrence and recessive spread (from December 2019), (2) rapid spread and outbreak (January 2020), (3) diffusion containment (February 2020), (4) and diffusion attenuation (after March 2020). The study participants were primary school students, middle school students, and university students.

Statistical Analyses

We used a random effects model implemented in R software (Version 3.5.1) (32) to combine the prevalence of anxiety and depression. The results were displayed using a forest plot. Moreover, we used a funnel plot and sensitivity tests to identify publication bias from a qualitative and quantitative perspective. When Egger's linear regression test was non-significant ($p > 0.05$), publication bias was not considered a concern. Trim-and-fill was utilized to examine the publication bias when Egger's linear regression test was significant ($p < 0.05$) (33).

Heterogeneity was assessed through I^2 tests and p. I^2 statistics assessed the magnitude of heterogeneity (34). We considered that there was no obvious heterogeneity if $I^2 < 50\%$ and $p > 0.1$, while there was heterogeneity if $I^2 > 50\%$ and $p < 0.1$. To consider potential moderating factors that may have affected heterogeneity, we conducted subgroup analyses of the pandemic development processes, pandemic area, study grades, and measurement evaluation tools.

RESULTS

Selection of Studies

Initially, 4,396 studies were identified on this topic through nine electronic databases and eight studies through manual searches. Subsequently, we removed 1,545 duplicates and 2,821 studies that did not meet the inclusion criteria of this review. Finally, a total of 31 studies were included in this meta-analysis. The flow process is shown in **Figure 1**.

Study Characteristics

Study characteristics are displayed in **Appendix A**. Thirty-one cross-sectional studies were included: 30 studies of anxiety ($n = 203{,}678$) and 28 of depression ($n = 78{,}330$). The sample sizes ranged from 84 to 70,158 for anxiety and 84 to 17,420 for depression. Studies were conducted from January to March 2020. However, six studies of anxiety and eight studies of depression did not report measuring time. Regarding risk area, the number of studies that covered higher-risk, medium-risk, lower-risk, and low-risk areas were three, 10, seven, and 16, respectively. Moreover, 25 studies involved the pandemic period of occurrence and recessive spread, seven involved the pandemic period of rapid spread and outbreak, five involved the pandemic period of diffusion containment, and two involved the pandemic period of diffusion attenuation. All studies were conducted using online self-completed questionnaires. Most used reliable and valid assessment tools to measure anxiety and depression symptoms. The tools used to measure anxiety included the Self-rating Depression Scale (SDS), the 9-item Patient Health Questionnaire (PHQ-9), the 7-item measure of Generalized Anxiety Disorder (GAD-7), a self-designed questionnaire, the Screen for Child Anxiety Related Emotional Disorders (SCARED), and the Self-Rating Anxiety Scale (SAS). The tools used to measure depression included a self-designed questionnaire, the Self-report Inventory (SCL-90), the Psychological Questionnaires for Emergent Events of Public Health (PQEEPH), and the Children's Depression Inventory (CDI); see **Table 1**.

Quality Assessment

The main features of the 31 articles are summarized in **Appendix B**. The AHRQ scores illustrated that most studies scored seven to nine and were considered high-quality. However, some studies did not explain missing data or clarify whether they conducted a follow-up.

Risk of Bias

The funnel plot was asymmetric in visualization, suggesting that publication bias may have been present, as shown in **Appendix C**. We used Egger's regression test, which demonstrated that the overall prevalence of anxiety ($t = 4.73$, $p > 0.05$) had no publication bias. However, the overall prevalence of depression ($t = 2.70$, $p < 0.05$) was considered to have publication bias. Therefore, the trim-and-fill approach was used to examine the bias of depression which added 12 studies, the overall proportion of studies that identified depression was robust ($p > 0.05$; see **Appendix D**).

Overall Prevalence of Anxiety

The meta-analysis showed that the overall prevalence of anxiety symptoms among Chinese students was 24.0% (95% CI [20.0–29.0%], $I^2 = 100\%$; **Figure 2**).

Overall Prevalence of Depression

The meta-analysis showed that the overall prevalence of depressive symptoms among Chinese students was 22.0% (95% CI [18.0–27.0%], $I^2 = 100\%$; **Figure 3**). After 12 studies were added through the trim-and-fill approach, the overall prevalence was estimated to be 40.1% (95% CI [32.9, 49.1%], $I^2 = 99\%$). This result may imply that we underestimated the prevalence of depression in Chinese students.

Subgroup Analyses

Subgroup analyses illustrated that the prevalence of anxiety and depression was significantly moderated by pandemic area, development process, and study grade. The prevalence of anxiety (37.0%, 95% CI [34.0–41.0%]) and depression (28.0%, 95% CI [24.0–31.0%]) in the highest-risk areas of Wuhan and Hubei provinces was higher than that of other risk areas (e.g., Beijing, Guangzhou, Shanxi, Qinghai). With respect to grade, middle school students (28.0%, 95% CI [14.0–50.0%]) had a higher prevalence of anxiety than did university students (26.0%, 95% CI [19.0–34.0%]) and elementary school students (15.0%, 95% CI [6.0–33.0%]). However, the prevalence of depression in university students (27.0%, 95% CI [0.21–35.0%])

TABLE 1 | Summary of the characteristics of the included studies.

References	Anxiety		Depressive		Participant	Outcome	City	Age (years)	Source	Time	Data	Measure
	Case	*n*	Case	*n*								
Zhao (35)	34	376			Undergraduate	A	N	N	OF	N	N	SMQ > 50
Wang and Zhao (36)	557	3,611			Undergraduate	A	10 provinces	18–24	OF	DC	February	Self-design
Mo et al. (37)	931	4,928			Elementary student	A	Anhui	7–16	OF	DA	March	SCARED ≥ 23
Mo et al. (37)	114	464			Middle student	A	Anhui	7–16	OF	DA	March	SCARED ≥ 23
Lin and Liu (38)	3,986	10,336	3,464	10,336	Middle student	A D	Sichuan, Chongqing, Shandong	N	OF	DA	2.7–3.20	Self-design
Chang et al. (39)	900	3,881	659	3,881	Undergraduate	A D	Guangdong	N	N	DC	1.31–2.3	GAD-7 ≥ 6 PHQ-9 ≥ 5
Xiao et al. (40)			146	471	Undergraduate	D	Wuhan	N	OF	DA	February	PHQ-9 ≥ 5
Xiao et al. (40)			539	2,082	Undergraduate	D	Hubei Province	N	OF	DA	February	PHQ-9 ≥ 5
Xiao et al. (40)			88	302	Undergraduate	D	Around Hubei Province	N	OF	DA	February	PHQ-9 ≥ 5
Xiao et al. (40)			302	1,111	Undergraduate	D	Other provinces	N	OF	DA	February	PHQ-9 ≥ 5
Cai et al. (17)			1,672	17,420	Undergraduate	D	Guangdong	20.1 ± 2.0	OF	DA	1.31–2.4	PHQ-9 ≥ 5
Fan et al. (41)	2,066	4,148			Undergraduate	A	11 provinces	N	OF	DA	2.23–2	SAS ≥ 50
Sun et al. (42)	998	1,682	998	1,682	Undergraduate	A D	Shandong	N	OF	N	N	Self-design
Ma (43)	118	516	138	516	Undergraduate	A D	Taiyuan	N	OF	DC	February	SCL-90 > 39
Tang and Ying (44)	1,047	3,512	924	3,512	Middle student	A D	Sichuan	N	OF	N	N	SAS ≥ 50
Zhang et al. (45)	1,829	7,833			Undergraduate	A	multicity	N	OF	DA	2.4–2.7	GAD-7 ≥ 5 PHQ-9 ≥ 5
He et al. (46)	1,047	2,895	1,410	2,895	Middle student	A D	N	N	OF	DA	2.20–10	PQEEPH ≥ 1
Ding and Hu (47)	1,039	3,055	303	3,055	Undergraduate	A D	Fujian	N	OF	DC	January	Self-design
Wang and Xu (48)	197	410			Middle student	A	33 provinces		OF	OF	March	GAD-7 ≥ 5
Yu et al. (49)	13	2,074	53	2,074	Middle student	A D	Fujian	N	OF	DA	2.9–10	Self-design
Tang et al. (50)	19	640	19	640	Elementary student	A D	N	N	OF	DA	February	SAS ≥ 50 CDI ≥ 19
Tang et al. (50)	46	233	46	233	Middle student	A D	N	N	OF	DA	February	SAS ≥ 50 CDI ≥ 19
Zhou et al. (18)	3,020	8,079	3,533	8,079	Middle student	A D	21 provinces	12–18	OF	OF	3.8–15	GAD-7 ≥ 5 PHQ-9 ≥ 5
Li et al. (51)	87	396			Elementary student	A	Shanxi	8–18	OF	RO	N	SCARED ≥ 25
Liu et al. (52)	86	611	101	611	Undergraduate	A D	Beijing	7–23	OF	N	N	SAS ≥ 50 SDS ≥ 53
Cao et al. (16)	1,778	7,143			Undergraduate	A	Shanxi	N	N	N	N	GAD-7 ≥ 5
Cao et al. (53)	18,568	56,064			Elementary student	A	Chengdu	N	OF	DA	2.6–10	SMQ > 50
Cao et al. (53)	48,870	70,158			Middle student	A	Chengdu	N	OF	DA	2.6–10	SMQ > 50
Yao et al. (54)	9	84	21	84	Undergraduate	A D	N	N	OF	DA	2.27–28	GAD-7 ≥ 5 PHQ-9 ≥ 5
Zhu et al. (55)	687	1,482	894	1,482	Undergraduate	A D	33 provinces	21 ± 3	OF	DC	1.30–2.13	GAD-7 ≥ 5 PHQ-9 ≥ 5

(Continued)

TABLE 1 | Continued

References	Anxiety		Depressive		Participant	Outcome	City	Age (years)	Source	Time	Data	Measure
	Case	*n*	Case	*n*								
Zhang et al. (56)	237	1,538	528	1,486	Undergraduate	A D	Neimenggu	17–33	OF	N	N	GAD-7 ≥ 5 PHQ-9 ≥ 5
Zhang and Chang (57)			255	706	Undergraduate	D	33 provinces	N	OF	N	N	Self-design
Ji et al. (58)	140	1,013	247	1,013	Undergraduate	A D	Sichuan	19.98 ± 1.62	OF	DC	2.14–19	SAS ≥ 50 SDS ≥ 50
Zhang et al. (59)	472	1,209	472	1,209	Undergraduate	A D	Guangdong	N	OF	DA	2.1–8	GAD-7 ≥ 5 PHQ-9 ≥ 5
Wang et al. (60)			41	396	Middle student	D	Shanxi	8–18	OF	DA	February	Self-design
Wang (61)	1,781	3,178	1,781	3,178	Undergraduate	A D	Sichuan, Yunnan, Chongqing	N	OF	DA	February	SAS ≥ 50 SDS ≥ 50
Yang et al. (62)	193	1,667	257	1,667	Undergraduate	A D	Shanxi	18–28	OF	DA	2.7–9	Self-design PQEEPH ≥ 1
Zhu and Li (63)	313	838			Undergraduate	A	Wuhan	N	N	N	N	SMQ ≥ 50

N, number reported; RO, rapid spread and outbreak; DC, diffusion containment; DA, diffusion attenuation; OF, online self-filled; SMQ, self-made questionnaire; MMHI-60, Mental Health Inventory of Middle School Students; GAD-7, 7-item measure of Generalized Anxiety Disorder; SAS, the Self-rating Anxiety Scale; HAMA, Hamilton Anxiety Scale; PQEEPH, Psychological Questionnaires for Emergent Events of Public Health; SCL-90, Self-report Inventory; PHQ-9, 9-item Patient Health Questionnaire; SCARED, the Screen for Child Anxiety Related Emotional Disorders; SDS, Self-rating Depression Scale.

was significantly higher than that of middle (21.0%, 95% CI [10.0–39.0%]) and elementary (3.0%, 95% CI [2.0–5.0%]) school students. Additionally, the prevalence of anxiety decreased from 25.0 to 22.0% as the COVID-19 pandemic developed from rapid spread to the diffusion containment period. The prevalence of depression decreased from 25.0% in the rapid spread stage to 20.0% in the diffusion containment period. However, notably, the level of anxiety and depression increased to (42.0%, 95% CI [35.0–50.0%]) and (44.0%, 95% CI [43.0–45.0%]), respectively, in the period of diffusion attenuation. All detailed information is shown in **Table 2**.

Analysis of the extent to which the measurement tool moderated the prevalence of anxiety and depression of Chinese students revealed that GAD-7 and self-designed questionnaires were associated with a higher prevalence of anxiety compared to SCARED and SAS. Furthermore, SDS, PHQ-9, self-designed questionnaires, and SCL-90 indicated a higher prevalence of depression compared to PQEEPH and CDI. These results imply that the overall prevalence of anxiety and depression of Chinese students was likely overestimated (**Table 3**).

DISCUSSION

To the best of our knowledge, this is the first meta-analysis to provide insights into the prevalence of anxiety and depression in Chinese students during the COVID-19 pandemic. The results revealed a high level of anxiety in Chinese students during (24.0%) vs. before (17.0%) (64) the COVID-19 pandemic. The overall level of depression among Chinese students (22.0%) was similar to that before the COVID-19 pandemic (22.2%) (65). Moreover, the factors of pandemic risk area, pandemic development process, and study grade moderated the prevalence of anxiety and depression.

Prevalence of Anxiety During the COVID-19 Pandemic

The COVID-19 pandemic and the lockdown had an immediate negative impact on the mental health of people worldwide (10, 66). We found the total prevalence of anxiety symptoms in Chinese students during the COVID-19 pandemic (24.0%) was higher than the estimated anxiety in primary school students before the pandemic (17.0%) (64). Ravens-Sieberer et al. (67) also showed that German children and adolescents experienced higher anxiety levels than before the COVID-19 pandemic (24.1 vs. 14.9%). COVID-19 was a risk factor for mental health problems in students (18). The unprecedented "home quarantine" lockdown measures likely caused students' anxiety to increase (68). One study revealed that the sudden pandemic caused 91% of students to worry about their future personal health and that of their loved ones (11), especially students who were isolated in high-risk areas. Saurabh and Ranjan (69) indicated that quarantined children and adolescents in India experienced more anxiety (61.98%) than did non-quarantined children. Moreover, students' anxiety symptoms could be related to parent–child conflicts, poor adaptation to the surrounding environment,

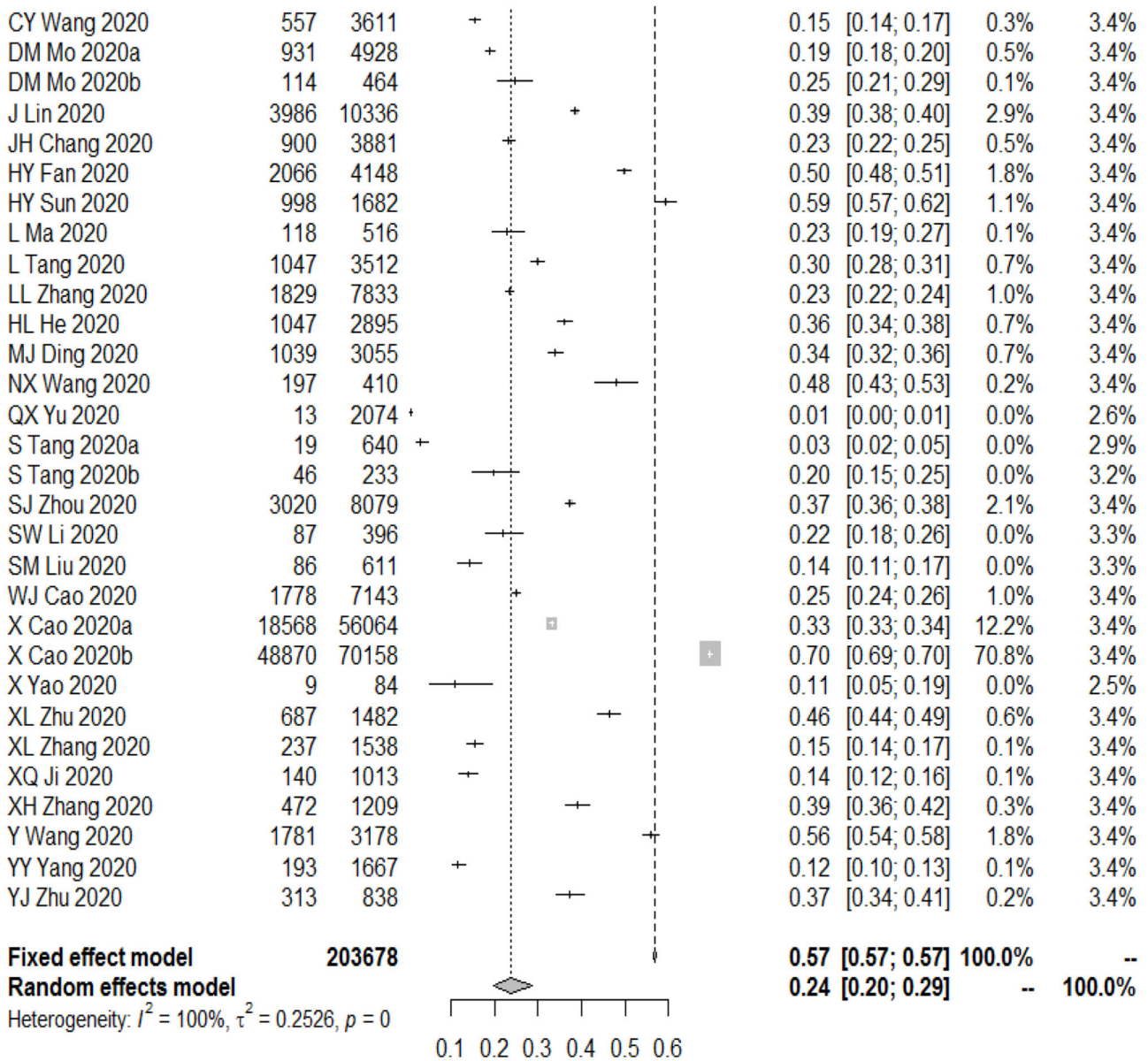

FIGURE 2 | The prevalence of anxiety among Chinese students during COVID-19.

and excessive academic pressure due to the COVID-19 pandemic (70).

Prevalence of Depression During the COVID-19 Pandemic

The prevalence of depression (22.0%) among Chinese students during the COVID-19 pandemic might be double that of the latest global prevalence of depression among adolescents (11.3%) (71). It is noteworthy that the prevalence of depression (22.0%) during COVID-19 was slightly lower than the prevalence (22.2%) among children and adolescents in China in the previous 30 years (65), and the 23.8% prevalence of depression among Chinese university students before COVID-19 (72). A possible explanation for the lower level of depression may be that the different measurement evaluation tools affected the results. We found the SDS, the PHQ-9, self-designed

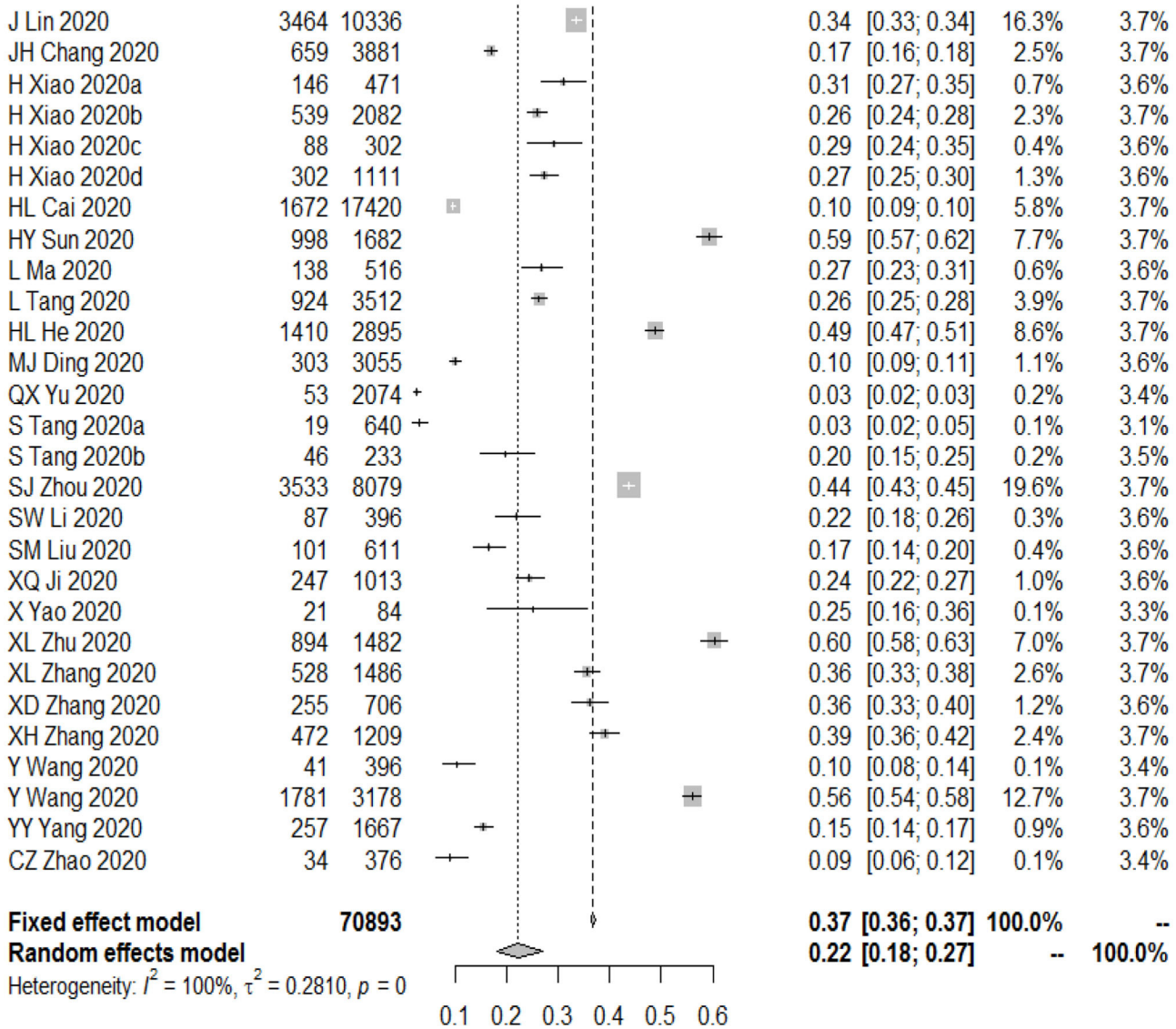

FIGURE 3 | The prevalence of depression among Chinese students during the COVID-19.

questionnaires, and the SCL-90 were associated with a higher prevalence of depression, while the PQEEPH and CDI suggested a lower prevalence. However, Bueno-Notivol et al. (23) suggested that the PHQ-9 was associated with a lower prevalence. Moreover, the online questionnaires during COVID-19 were associated with statistically higher scores than were offline instruments (73).

The reported prevalence of depression among Chinese students during the COVID-19 should be considered with caution. It is possible that the COVID-19 pandemic may be more related to anxiety than depression in students. Anxiety and depression are both emotional states associated with negative affect and have a set of common (non-specific) features. People with depression often experience considerable anxiety, but anxiety does not necessarily cause depression (74). Furthermore, anxiety is related to events that have not happened yet while depression is associated with a past events (75). Oosterhoff et al. (76) indicated that adolescents who preferred to stay at home during the pandemic reported fewer depressive symptoms. The psychological reactions caused by COVID-19 may be more future-oriented than past-oriented. Therefore, COVID-19 may be related to higher levels of anxiety in Chinese students.

TABLE 2 | Subgroup analyses of anxiety and depression.

Variable		Anxiety				Depression			
		k	I^2 (%)	SP (%)	95% CI (%)	*k*	I^2 (%)	SP (%)	95% CI
Study grade	Primary students	4	100	0.15	[0.06, 0.33]	1	NA	0.03	[0.02, 0.05]
	Middle students	10	100	0.28	[0.14, 0.50]	7	100	0.21	[0.10, 0.39]
	University students	16	100	0.26	[0.19, 0.34]	20	100	0.27	[0.21, 0.35]
Pandemic risk areas	High-risk area	1	NA	0.37	[0.34, 0.41]	2	58	0.28	[0.24, 0.31]
	Medium-risk area	7	100	0.33	[0.21, 0.49]	4	0	0.26	[0.25, 0.27]
	Lower-risk area	3	100	0.24	[0.14, 0.37]	4	99	0.19	[0.11, 0.30]
	Low-risk area	8	100	0.17	[0.07, 0.36]	8	100	0.18	[0.09, 0.33]
Pandemic period	Occurrence and recessive spread	1	100	0.22	[0.18, 0.26]	1	NA	0.22	[0.18, 0.26]
	Rapid spread and outbreak	6	99	0.25	[0.17, 0.34]	5	100	0.25	[0.13, 0.42]
	Diffusion containment	15	100	0.22	[0.12, 0.37]	15	100	0.20	[0.13, 0.42]
	Diffusion attenuation	2	89	0.42	[0.35, 0.50]	1	NA	0.44	[0.43, 0.45]

SP, summarized proportion; 95% CI, 95% confidence interval; NA, only one study did not have a value for the heterogeneity test.

TABLE 3 | Subgroup analyses of anxiety and depression.

		k	I^2 (%)	SP (%)	95% CI (%)
Anxiety	SCARED	3	68	21.0	[18.0%, 24.0%]
	SAS	7	100	19.0	[9.0%, 36.0%]
	Self-design	3	100	28.0	[13.0%, 50.0%]
	GAD-7	10	100	29.0	[21.0%, 38.0%]
	SMQ	3	100	30.0	[23.0%, 39.0%]
Depression	PHQ-9	12	100	30.0	[23.0%, 39.0%]
	SDS	3	100	30.0	[15.0%, 52.0%]
	PQEEPH	3	99	6.0	[2.0%, 21.0%]
	Self-design	7	100	26.0	[16.0%, 39.0%]
	CDI	2	96	8.0	[2.0%, 27.0%]
	SCL-90	1	NA	27.0	[23.0%, 31.0%]

SP, summarized proportion; 95% CI, 95% confidence interval NA, only one study did not have a value for the heterogeneity test; GAD-7, 7-item measure of Generalized Anxiety Disorder; SAS, the Self-rating Anxiety Scale; PQEEPH, Psychological Questionnaires for Emergent Events of Public Health; SCL-90, Self-report Inventory; PHQ-9, 9-item Patient Health Questionnaire; SCARED, Screen for Child Anxiety Related Emotional Disorders; SDS, Self-rating Depression Scale.

Moderating Factors of Pandemic Risk Area, Development Process, and Study Grade

Compared to the other age groups, anxiety was highest in middle school students and depression was highest in university students. Concerning the former, one potential reason may be that, compared to elementary and university students, middle school students experienced more academic stress during the COVID-19 pandemic, which made them more anxious. Moghanibashi-Mansourieh (77) indicated that the switch from in-person to online learning may have reduced the learning efficiency of students in Asian countries. Furthermore, in the Chinese context, students have a strong motivation to learn, especially when completing entrance examinations (78). Middle school students are divided into junior (3 years) and senior middle schools (3 years) in the Chinese education system (79). These middle-school students who need to prepare for senior middle school and college entrance examinations experience greater academic pressure. However, online learning may have led to poor efficiency in managing online courses and thereby reduced the effectiveness of students' learning during the pandemic (12). Thus, middle-school students are more likely to have experienced anxiety during COVID-19. Concerning the latter, loss of interest or enjoyment, feelings of guilt or low self-worth, and poor sleep or appetite may increase depression in university students. Islam et al. (80) showed that compared to younger counterparts, university students typically experienced more negative consequences due to the pandemic, both academic (e.g., failure to complete scientific research experiments) and professional (e.g., unemployment). Moreover, an increase in risk factors is likely to lead to increased depression (7). These excessive risk factors may cause older students to exhibit greater depression than younger students during the COVID-19 pandemic.

The results revealed that the levels of anxiety and depression symptoms were higher in high-risk areas (e.g., Wuhan and surrounding areas) than in other areas (medium and low-risk areas). One study indicated that children in high-risk areas

were more prone to fear, anxiety, and depression (81). Further, Shi et al. (82) showed that the independent factor of living in Hubei province was associated with negative mental health outcomes. People in high-risk areas (vs. low) faced a greater risk of infection and isolation, which are established risk factors with psychological impact (83). The diagnosis and mortality rates for people in high-risk areas were very high, but the health care staff and resources to treat them were very limited. These students were likely worried about being infected by other people and how long the crisis would last (84). Furthermore, isolation and control in high-risk areas were stricter than in other areas, which may have resulted in longer periods of isolation experienced by the students (12). Under prolonged lockdown, students may have experienced increased social isolation that affected their mental health.

The results showed that students' depression and anxiety symptoms gradually increased when the pandemic spread from the occurrence to the rapid spread period. This may be due to the students being overly worried about their own lives and health due to the increasing number of confirmed cases in the initial stages of the outbreak and the inadequate response from the government and hospitals (12). Subsequently, China managed to take many measures to control the outbreak (85). With the control of the COVID-19 pandemic, the prevalence of anxiety and depression among Chinese students exhibited a downward trend. This may be due to government support and restrictions—for instance, limiting public gatherings, lockdowns, and mask-wearing mandates—causing the spread of COVID-19 to ease as well as reducing the prevalence of anxiety and depression among students (86, 87). However, interestingly, we found that the level of anxiety and depression of students rebounded in the diffusion attenuation period, even exceeding the levels measured during the outbreak period of COVID-19. The rebound in the prevalence of anxiety and depression may be related to the delayed emergence and long-term persistence of psychological disorders caused by posttraumatic stress disorder (88). Like other traumatic experiences, COVID-19, as a new type of mass trauma, may have led to posttraumatic stress disorder (64). In addition, March is the normal time for Chinese students to start school. However, due to the epidemic situation, students were required to stay at home. This continuous closure and isolation may also lead to a decline in mental health (10).

Research Strengths and Applications

Existing studies of the impact of COVID-19 on the prevalence of anxiety and depression have limitations, such as small sample sizes (6, 54, 60), use of different psychological measures (52, 53), and inclusion of a limited number of factors associated with COVID-19 (40, 89). Furthermore, previous single studies have disputed the prevalence of anxiety (42, 54) and depression (44, 60) among Chinese students during COVID-19. In this study, we synthesized the prevalence of anxiety and depression among Chinese students during the epidemic to provide data support for understanding the mental health of students worldwide during the COVID-19 pandemic. Additionally, we explored the relationship between key factors associated with the spread of the epidemic and the prevalence of anxiety and depression. We found that the COVID-19 pandemic had a differential impact on anxiety and depression among Chinese students at different stages of study. Anxiety and depressive symptoms caused by sudden stress reactions in students due to the pandemic lasted for a long time and may have a delayed rebound. Notably, governmental and medical measures to control and support the outbreak may be important protective factors in reducing students' anxiety and depression. Therefore, during public health emergencies, government, schools, and medical departments should provide targeted psychological interventions for students in different stages, populations, and periods to promote their psychological health.

Limitations and Future Research Potential

This study had some limitations. First, the limited number of reviewed studies restricts the generalizability of the findings. Moreover, this study only investigated the prevalence of anxiety and depression among students in China. Therefore, implications concerning other cultures should be inferred with caution. Future research should focus on differences in the prevalence of anxiety and depression among persons of different cultural backgrounds. Second, it is difficult to assess the magnitude and direction of bias in the pooled prevalence estimate because the studies included in our meta-analysis had different definitions of anxiety and depression. Caution is needed when generalizing our findings. Third, although we assessed the possible source of heterogeneity through subgroup analyses, there was high heterogeneity of anxiety and depression in this study. This heterogeneity was probably caused by other factors associated with the risk of depressive symptoms that were not identified. Future studies should consider the impact of other factors on the prevalence of anxiety and depression during the COVID-19 pandemic. Fourth, some studies had a rated medium quality level. We recommend future studies should pay more attention to study quality, in particular, in the handling of missing data and reporting follow-up. Fifth, although we performed a moderation analysis of the pandemic period, participants were different among studies. In the future, longitudinal data are needed to examine the trajectory of anxiety and depressive symptoms in Chinese students in the pandemic era. Finally, the included studies provided little information on mental health services. Mental health services for students with anxiety and depression are very important for mental health planning and policymaking in the context of the COVID-19 pandemic. Future research should consider the development of mental health services for the students during the COVID-19 pandemic.

CONCLUSION

In conclusion, Chinese students demonstrated a significant increase in anxiety levels as the COVID-19 pandemic progressed. Chinese middle school students were at a heightened risk of anxiety, while university students were at a heightened risk of depression during the pandemic, especially those in higher-risk areas. The government, health, and school systems should adopt a series of effective measures to alleviate anxiety and depression symptoms of students in high-risk areas. Furthermore, mental

health interventions are in urgent demand for students, especially during the diffusion containment and diffusion attenuation periods of the COVID-19 pandemic.

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 in the article/**Supplementary Materials**.

AUTHOR CONTRIBUTIONS

YZ and XB conceived and designed the study and wrote the paper. YZ, XB, and JY performed the statistical analysis. XB and JY conducted the format and tables. YZ, XB, and HM reviewed and edited the manuscript. Moreover, all authors have approved the final manuscript for submission.

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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.2021.697642/full#supplementary-material

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Impact of COVID-19 on Lifestyle, Personal Attitudes, and Mental Health Among Korean Medical Students: Network Analysis of Associated Patterns

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The current COVID-19 pandemic have affected our daily lifestyle, pressed us with fear of infection, and thereby changed life satisfaction and mental health. The current study investigated influencing cascade of changes during the COVID-19 among the lifestyle, personal attitudes, and life (dis)satisfaction for medical students, using network-based approaches. This cross-sectional survey used self-reports of 454 medical students during June and July of 2020. Depressive mood, anxiety, and intention to drop out of school were observed in 11.9, 18.5, and 38.3% of medical students, respectively. Directed acyclic graph that estimated directional propagation of the COVID-19 in medical students' daily lives initiated from the perception of unexpected event, propagated to nervous and stressed feeling, trouble relaxing, feeling like a failure, and were followed by trouble concentrating, feeling loss of control for situation, and fear of infecting colleagues. These six features were also principal mediators within the intra-individual covariance networks comprised of changed lifestyle, personal attitude, and mental health at COVID-19 pandemic. Psychosocial supports targeting nervousness, trouble relaxing and concentrating, fear of spreading infection to colleagues, feelings of a failure or loss of situational control are required for better mental health of medical students during the COVID-19 pandemic.

Keywords: COVID-19, medical students, mental health, directed acyclic graph, intra-individual covariance network, lifestyle changes, fear of infection

INTRODUCTION

In Republic of Korea, after the exponential increase of COVID-19 confirmed cases comprised of the multiple regional clusters including Daegu and Gyeongbuk area during January and February of 2020 (1). When this outbreak occurred, the Korean Centers for Disease Control and Prevention (KCDC) instantly dispatched public health doctors to the frontline of pandemic to enable the screening tests on all suspected COVID-19 patients, to conduct quicker quarantine of confirmed-positive patients, and to provide necessary treatment (2). During this COVID-19 pandemic, the physical and psychological burdens, as well as stresses, have been higher among

medical staff members at the forefront of treating patients with COVID-19, compared with the general population (3, 4). Medical students are currently experiencing lifestyle changes similar to those of the general public, and are undergoing training as medical professionals, with the aim of preparation for future medical practice (5). For example, as a response to the sustained COVID-19 pandemic during 2020, medical schools in Republic of Korea also changed every classes to an online format from first-year to fourth-year courses except the clinical clerkship, clinical skills training, and basic laboratory classes such as anatomy lab sessions (6).

The possible after-effects of the COVID-19 pandemic include a considerably greater incidence of depressive mood and anxiety among college students after the initial pandemic wave (7). In a recent study, a significant level of psychological distress was observed among medical students in Japan who were subjected to home quarantine restrictions; greater distress was associated with reduced self-esteem and enhanced self-efficacy (8). In addition, >20% of medical students who had been quarantined in the Hubei Province of China reported moderate or severe levels of depressive mood (23.3%), anxiety (41.9%), and stress (20.9%) (9). Among medical students in the United Kingdom, considerable proportions have experienced presenteeism (40%) and reported anxiety (37.2%) and depression (46.5%) that affect life satisfaction (10). Thus, there is a need for timely assessment of interacting patterns among pandemic-related stressors [e.g., potential for transmitting COVID-19 to their families (11) and living in locations with greater COVID-19 prevalence (12)], lifestyle changes [e.g., online classes (13, 14), year of medical school (12, 15), perceived social support (16), and spare time activities and exercise (10)], and mental health factors [e.g., perceived stress, anxiety, depressive mood, history of mental health problems (16), and availability of psychological care (17)] among college students, who might be more vulnerable to COVID-19-related distress (9).

Therefore, the current study aimed to examine the interactions among the changed lifestyle (difficulty of online class attendance and use of personal time), cognitive style (perceived threat of infection & proactive coping), mental health (perceived stress, anxiety, and depressive symptoms), and school dropout intention during the COVID-19 pandemic for medical students. In the current study, we hypothesized that the environmental changes during the COVID-19 pandemic would affect the daily routines of medical students in terms of activities such as participation in online classes (rather than on-site lectures in school) and spare time activities (i.e., those influenced by social distancing). Because of the perceived threat of COVID-19 infection, changes in behavioral (social distancing and maintaining personal hygiene) and cognitive (feeling proud of medical personnel at the frontline and a willingness of volunteer) responses were expected. In the context of these ongoing readjustments, the level of life satisfaction might be reduced, thereby leading to a cascade of perceived stress, anxiety, depressive mood, and potential school dropout.

MATERIALS AND METHODS

Participants and Study Design

The current study was conducted for the target population of medical students from the 1st to 4th grade currently enrolled in the Seoul National University College of Medicine (SNUCM) as of June and July of 2020. When students visited the campus and attended the practicum classes or sessions of academic schedule briefing during June or July of 2020, information of the current study was provided. Students with voluntary intension of participating the study could complete anonymous responses for the self-reporting questionnaires distributed in the classroom and submit the anonymous responses upon checking out of the classroom. Exclusion criteria were (1) students who had not been actively enrolled to the SNUCM as of June and July of 2020 or (2) students who did not want to participate the current study. In total, 507 of 597 students (84.9%) responded to the questionnaire. After excluding data for 53 students with missing values, our final dataset included de-identified responses from 454 medical students at Seoul National University College of Medicine during June and July of 2020. The Institutional Review Board at Seoul National University College of Medicine approved the study, and the requirement for written informed consent was waived by the board because this constituted a minimal-risk study protocol (IRB no. 2007-140-1143).

To examine the study hypotheses, the current study used three approaches. First, personal attitudes toward the COVID-19 pandemic, as well as changes in lifestyle and life (dis)satisfaction during the pandemic, were compared among subgroups of students in different years of medical school. Second, directional propagating impacts of the pandemic on the daily lives of medical students were estimated, to derive a group-wise Bayesian network: a model of probabilistic conditional dependencies among the variables of personal attitude toward the COVID-19 pandemic, changes in lifestyle, and changes in life (dis)satisfaction, depicted as a directed acyclic graph. Finally, principal influences on daily life for medical students were deciphered using intra-individual covariance networks, where the edge weights connecting two variables within an individual are proportional to the degrees of (dis)similarities between these variables in terms of the deviation from the group-averaged values of each variable. All procedures were performed in accordance with the ethical standards of the Seoul National University College of Medicine Institutional Review Board concerning human experimentation, as well as the tenets of the Helsinki Declaration of 1975, as revised in 2013.

Difficulty of Online Class Attendance and Use of Personal Time During COVID-19 Pandemic

For more detailed profiling of the impact of COVID-19 on the medical students' daily living, the current study gathered responses concerning difficulties in participating online classes and use of personal time during the COVID-19 pandemic (**Table 1** and **Supplementary Material 1**). First, possible

TABLE 1 | Demographic and clinical characteristics: sub-grouped for grade.

Variable	Grade (*N* = 454)								Stats			
	1st (*N* = 123)		2nd (*N* = 110)		3rd (*N* = 121)		4th (*N* = 100)		χ2/F	df	*P*	*Post hoc*
Demographic: sex, men/women	80	43	70	40	75	46	64	36	0.25	3	0.969	-
Use of personal time during COVID-19, YES/NO												
Sleep	63	60	60	50	82	49	46	54	11.96	3	0.008	3rd > 4th
Computer game	20	103	33	77	31	90	25	75	6.44	3	0.092	-
Reading	9	114	13	97	14	107	9	91	1.84	3	0.606	-
Study	81	42	46	64	58	63	34	66	25.23	3	<0.001	1st > 2nd = 3rd = 4th
Exercise	26	97	42	68	49	72	28	72	13.36	3	0.004	1st < 2nd = 3rd
Spend time with family and friends	40	83	38	72	53	68	35	65	3.90	3	0.273	-
Difficulty of online class attendance during COVID-19, YES/NO												
Maintaining regular daily routine	40	83	32	78	21	100	19	81	10.45	3	0.015	1st > 3rd
Insufficient interaction for understanding	31	92	15	95	23	98	28	72	8.01	3	0.046	NS
restriction of on-site social activities	65	58	62	48	60	61	46	54	2.51	3	0.473	-
Perceived threat of infection during COVID-19, Mean/SD, [−2 = strongly disagree; −1 = disagree; 0 = neither agree nor disagree; 1 = agree; 2 = strongly agree]												
Fear of my getting COVID-19	–0.5	1.1	–0.5	1.2	–0.2	1.2	0.2	1.2	19.22	3	<0.001	1st < 4th, 2nd < 4th
Fear of transmitting COVID-19 to family	–0.2	1.3	–0.2	1.2	–0.1	1.4	0.5	1.2	20.89	3	<0.001	1st < 4th, 2nd < 4th, 3rd < 4th
Fear of transmitting COVID-19 to colleague	–0.2	1.2	–0.2	1.2	–0.1	1.3	0.6	1.3	28.52	3	<0.001	1st < 4th, 2nd < 4th, 3rd < 4th
Proactive coping for COVID-19, Mean/SD, [−2 = strongly disagree; −1 = disagree; 0 = neither agree nor disagree; 1 = agree; 2 = strongly agree]												
My keeping social distance,	1.1	0.7	0.9	0.9	0.6	1.1	0.9	1.0	16.16	3	0.001	1st > 3rd
My keeping personal hygiene	1.3	0.8	1.2	0.7	1.1	0.8	1.2	0.8	5.96	3	0.113	-
Feeling proud for medical staff at frontline	1.7	0.6	1.5	0.8	1.3	0.9	1.3	0.9	21.69	3	<0.001	1st > 3rd, 1st > 4th
My willing to future volunteer at frontline	0.9	0.9	1.0	0.9	0.6	1.1	0.6	1.0	11.91	3	0.008	NS
Perceived stress: PSS total score, Mean/SD	21.0	7.6	19.6	6.2	17.9	6.5	16.6	7.0	8.92	3	<0.001	1st > 3rd, 1st > 4th, 2nd > 4th
Anxiety: GAD-7: total score, Mean/SD	6.6	5.1	5.5	4.3	5.0	4.9	5.0	4.9	3.10	3	0.027	1st > 3rd
Depressive mood: PHQ-9: total score, Mean/SD	5.7	4.6	4.3	4.5	4.0	4.6	3.5	4.6	4.89	3	0.002	1st > 3rd, 1st > 4th
School dropout intention during COVID-19	65	58	51	59	33	88	14	86	45.34	3	<0.001	1st = 2nd > 3rd = 4th

difficulties of attending online classes during the COVID-19 were examined using a question of "If you experienced difficulties due to the online class operation, which of the following did you experience?" Responders were able to choose multiple items among the options of (1) maintaining regular daily routine, (2) insufficient lecturer-students interactions and related difficulties of understanding the study contents, or (3) restricted on-site social activities. For all of these three options separately, responses were binary-transformed into "perceived difficulty" or "difficulty not perceived" prior to further analyses.

Second, pattern of personal time use during the COVID-19 pandemic was measured by way of the single question of "In the last month, which activities did you usually do during private time when you were not involved in school classes or practice?" that allowed multiple choices for a total of six options including sleep, computer game, reading, studying, physical exercise, or spending time with family and friends. Also, for all of these six options separately, responses were binary-transformed into "doing given activity in private time" or "not doing given activity in private time" for further statistical analyses.

Perceived Threat of Infection and Proactive Coping for COVID-19 Pandemic

Seven questions concerning medical students' personal attitudes toward the COVID-19 pandemic were included in the current survey (**Table 1** and **Supplementary Material 1**). First component of "proactive coping for COVID-19 as medical students and to-be medical professionals" was comprised of four items including the (1) compliance for social distancing, (2) taking care of personal hygiene, (3) feelings of pride medical staffs working at frontline, and 4) intention of future

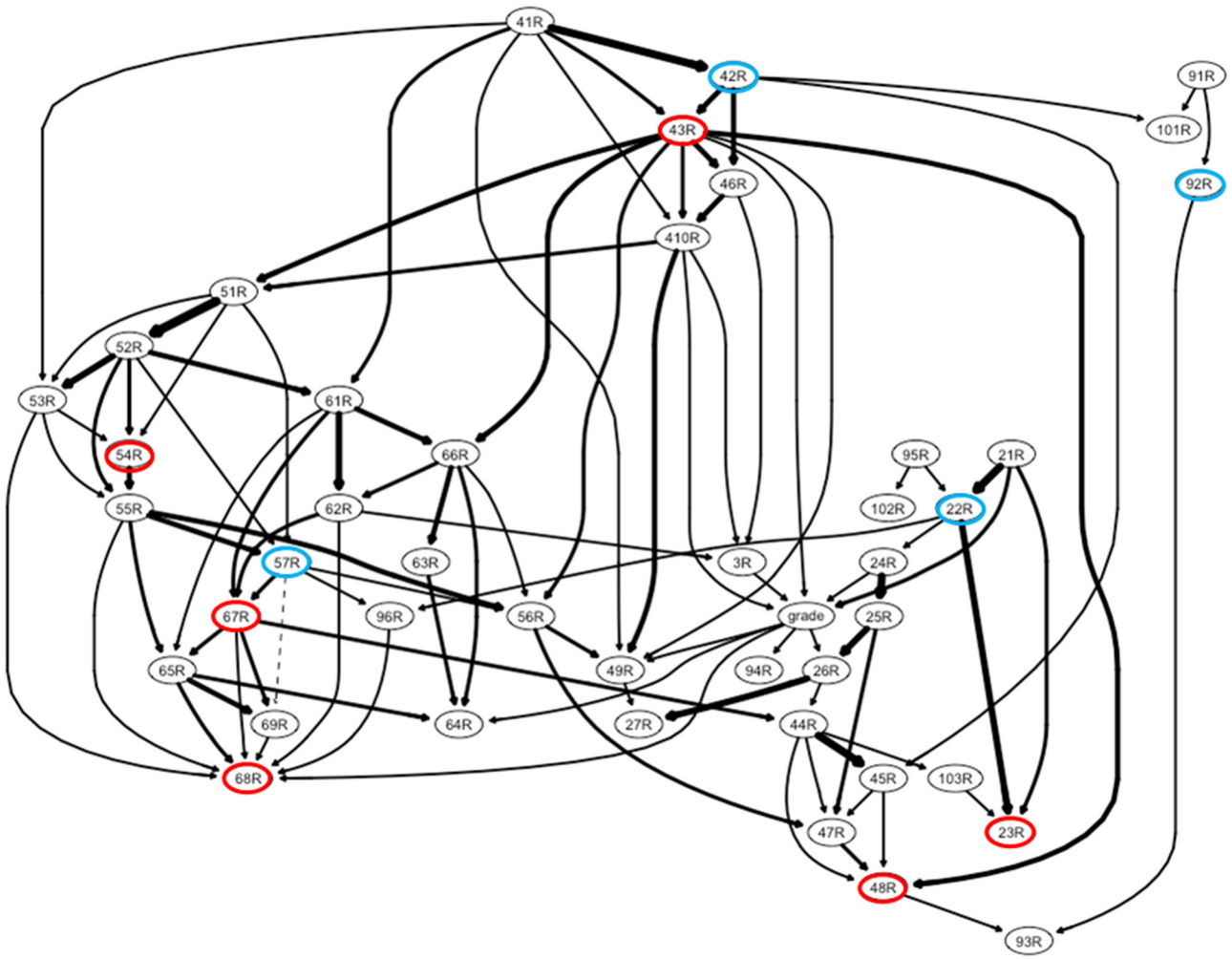

FIGURE 1 | A directed acyclic graph of changes in lifestyle, personal attitudes, perceived stress, anxiety, and depressive mood among Korean medical students during the COVID-19 pandemic. The following six most influential items are marked with red circles: (1) personal attitude, fear of infecting my colleagues (R23); (2) perceived stress, feeling nervous and stressed (R43); (3) perceived stress: feeling "being on top of things" (R48); (4) anxiety, trouble relaxing (R54); (5) depressive mood, feelings of failure or that I have let myself/family members down (R67); and (6) depressive mood, trouble concentrating on things such as reading the newspaper or watching television (R68). [Personal attitude for COVID-19 pandemic] 21R = fear of my getting COVID-19; 22R = fear of my transmitting COVID-19 to family; 23R = fear of my transmitting COVID-19 to colleague; 24R = my keeping social distance; 25R = my keeping personal hygiene; 26R = feeling proud for medical staff at frontline; 27R = my willing to future volunteer at frontline/3R = intension of school dropout within recent 3 months; grade = grade as medical student/[Perceived stress] 41R = upset; 42R = unable to control; 43R = nervous or stressed; 46R = cannot cope with many things have to be done; 49R = angered for things outside of one's control; 410R = felt difficulties piled up could not be overcome; 44R = confidence for personal problems; 45R = things going one's way; 47R = control irritation; 48R = on the top of things/[Anxiety] 51R = nervous or anxious; 52R = cannot stop control worrying; 53R = worrying too much for different things; 54R = trouble relaxing; 55R = restless; 56R = easily annoyed or irritable; 57R = afraid of awful things happen/ [Depressive mood] 61R = feeling down, depressed, or hopeless; 62R = little interest or pleasure in doing things; 63R = trouble falling asleep or staying too much sleep; 64R = poor appetite or overeating; 65R = psychomotor change; 66R = tired or little energy; 67R = feel bad about oneself; 68R = trouble concentrating; 69R = idea of suicide or harming oneself/[Spare time activities in COVID-19 pandemic] 91R = sleep; 92R = computer game; 93R = reading; 94R = study; 95R = exercise; 96R = spend time with family and friends; /[Difficulties of participating in online classes in COVID-19 pandemic] 101R = maintaining regular daily routine; 102R = insufficient interaction for understanding; 103R = restriction of on-site social activities.

volunteering at frontline of epidemic satiations such as COVID-19 as a medical practitioner. Second component that represents "perceived threat of infection" was focused on the (1) students' fear of contracting COVID-19, and their possible roles in the transmission of COVID-19 to (2) family or (3) colleagues. Responses were acquired using a five-point Likert scale (strongly disagree, disagree, neither agree nor disagree, agree, or strongly agree), and re-coded for between-group comparison (**Table 1**) and network analyses (**Figures 1–3**).

A principal components analysis (PCA) was conducted on the seven items with orthogonal rotation (varimax). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis KMO = 0.713 (fair), and all KMO values for individual items were ≥0.5, which is above the acceptable limit. Barlett's

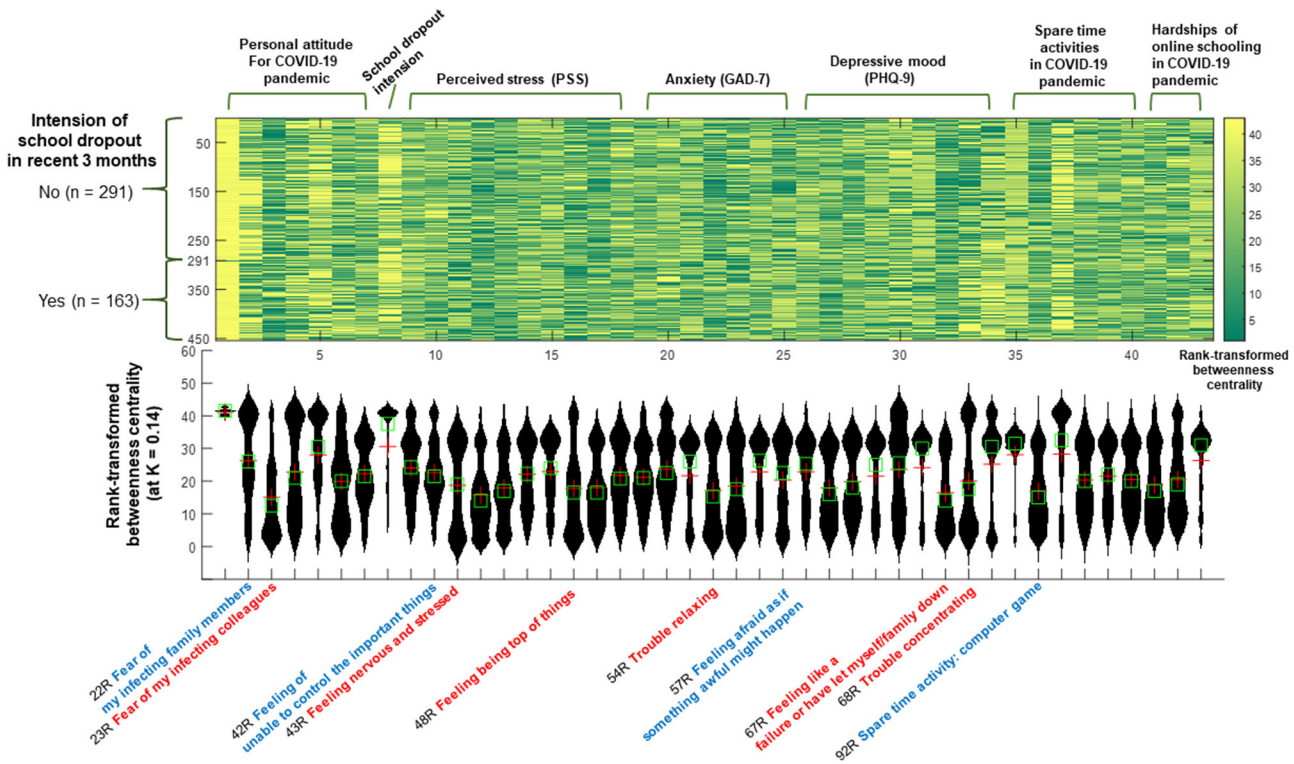

FIGURE 2 | Rank-transformed betweenness centrality calculated from the intra-individual covariance networks of changes in lifestyle, personal attitudes, perceived stress, anxiety, and depressive mood among Korean medical students during the COVID-19 pandemic. In the x-axis of the violin plot (lower), the following six most influential items (hubs; top 12% for the rank-transformed betweenness centrality in ≥25% of participants ($n = 454$) at a network sparsity level of K = 0.14) are written in red: (1) personal attitude, fear of infecting my colleagues (R23); (2) perceived stress, feeling nervous and stressed (R43); (3) perceived stress: feeling "being on top of things" (R48); (4) anxiety, trouble relaxing (R54); (5) depressive mood, feelings of failure or that I have let myself/family members down (R67); and (6) depressive mood, trouble concentrating on things (R68). Items that showed significant relationships with recent intentions to drop out of school, perceived stress, or depressive mood are written in blue.

test of sphericity, χ^2 (21) = 1,235.02, $P < 0.001$, indicating that correlations between items were sufficiently large for PCA. An initial analysis was run to obtain eigenvalues for each component in the data. A total of two components had eigenvalues over Kaiser's criterion of 1 and in combination explained 68.13% of the variance. These two components of "proactive coping" and "fear of infection" had higher reliabilities as reflected in the values of Cronbach's α = 0.762 and 0.865, respectively.

Mental Health: Perceived Stress, Anxiety, and Depressive Symptoms

First, perceived stress during the most recent 1 month was measured using the Perceived Stress Scale (PSS) (18) validated for Korean (19). Response for the items of PSS were retrieved using the 5-point Likert scale. In the current study, value of Cronbach's α for the PSS was 0.859. Second, anxiety during the most recent 2 weeks was evaluated using the Generalized Anxiety Disorder-7 (GAD-7) (20) validated for Korean (21). Third, depressive symptoms were measured using the Patient Health Questionnaire-9 (PHQ-9) (22, 23) validated for Korean (24). Responses to each question in the GAD-7 and PHQ-9 were acquired using a four-point Likert scale. Cut-off scores of moderate depressive mood and moderate anxiety applied in the current study were PHQ-9 total score ≥10 and GAD-7 total score ≥10, respectively, as found in validation studies for Korean population (21, 24, 25). In the current study, Cronbach's α values of 0.922 and 0.859 demonstrated higher reliabilities of GAD-7 and PHQ-9, respectively.

School Dropout Intention During the COVID-19 Pandemic

School dropout intention (26–28) during the COVID-19 pandemic was asked by way of the single question of "Have you ever considered quitting your studies in the past 3 months (=since the start of current semester (March of 2020) as of June 2020)?" Responders could choose either "yes" or "no."

Network Analysis: Directed Acyclic Graph

The directional propagation of the COVID-19 pandemic in medical students' daily lives, observed by means of 43 variables, were estimated as a Bayesian network using the R package named *Bnlearn* (https://www.bnlearn.com/). The 43 variables included personal attitude toward COVID-19 (seven variables of item 02), school dropout intention in

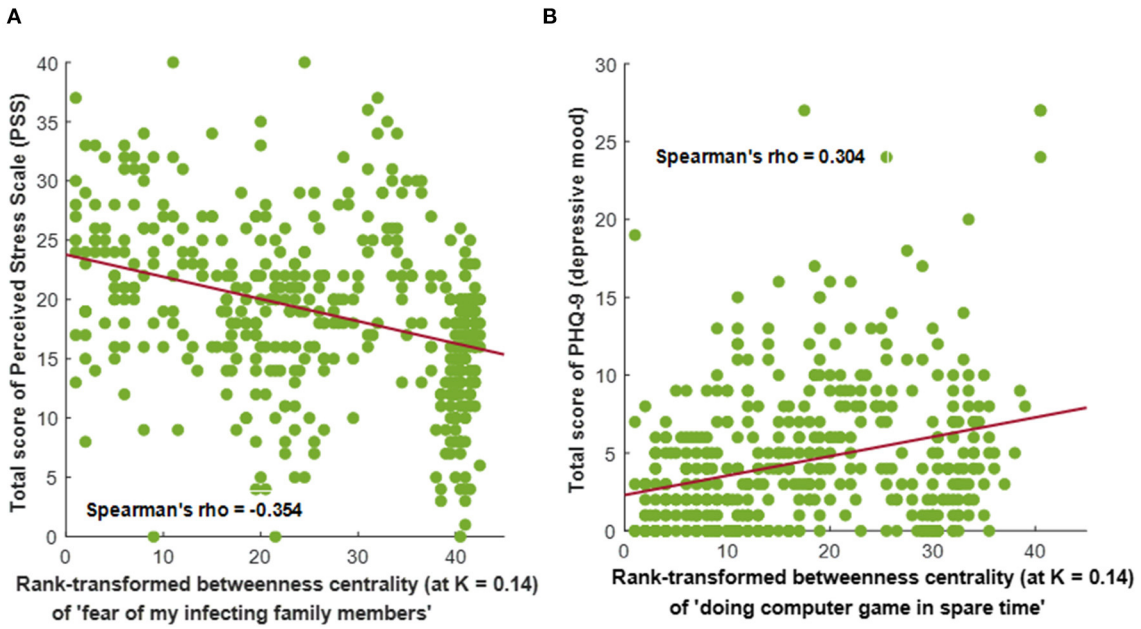

FIGURE 3 | Significant correlations between the intensity of perceived stress or depressive mood vs. rank-transformed betweenness centralities of personal attitudes or changes in lifestyle during the COVID-19 pandemic among Korean medical students ($n = 454$; statistical threshold of |Spearman's rho| > 0.3 and $P < 0.001$). Values of rank-transformed betweenness centrality were calculated from the intra-individual covariance networks (at network sparsity level of K = 0.14) containing the changes in lifestyle, personal attitudes, perceived stress, anxiety, and depressive mood. **(A)** Correlations between the total score of perceived stress scale (PSS) vs. rank-transformed betweenness centrality values of "personal attitude, fear of infecting my family members" (Spearman's rho = −0.354, $P < 0.001$). **(B)** Correlations between PHQ-9 (depressive mood) total score vs. rank-transformed betweenness centrality values of "engaging in computer games in spare time" (Spearman's rho = 0.304, $P < 0.001$).

the most recent 3 months (item 03), spare time activities during the COVID-19 pandemic (six variables of item 09), difficulties participating in online classes during the COVID-19 pandemic (three variables of item 10), perceived stress (10 variables of item 04; PSS), anxiety (seven variables of item 05; GAD-7), and depressive mood (nine variables of item 06; PHQ-9).

First, an optimal network structure for a bootstrapped sample [from the original dataset ($n = 454$)] was estimated using a score-based heuristic local search method, known as the hill-climbing algorithm (29, 30). After the global probability distribution (=factorization of the joint probability distribution) of the network had been determined, the parameters of local probability distributions for each node (conditional on the learned network structure) were estimated. Second, a subset of edges crucial for explaining the given sample were selected based on their higher goodness-of-fit score (e.g., Bayesian Information Criterion) (29, 30). These procedures were repeated 10,000 times, and the most consistent network edges in terms of presence and directionality were selected for the final averaged version of the directed acyclic graph. The directed acyclic graph defined probabilistic dependencies (directional edges) based on the Markov property of Bayesian networks (=direct dependence of each node only on their parental nodes) among the variables (nodes) (**Figure 1**) (30).

Network Analysis: Intra-Individual Covariance Network and Graph Theory Approach

Intra-individual covariance depicts inter-item similarities and differences within each individual to determine the variance from the group-averaged value of each item. In the current study, intra-individual covariance between two different items was defined using the following formula: $\frac{1}{e^{\left(\frac{(x_A - M_A)}{SD_A} - \frac{(x_B - M_B)}{SD_B}\right)^2}}$. Thus, the intra-individual covariance value could be distributed between 0 and 1, where higher values indicate greater similarity in degrees of variance [= differences between raw values (X_A and X_B) and group-averaged values (M_A and M_B, $n = 454$) divided by the group-level standard deviation of each item (SD_A and SD_B, $n = 454$)] between the two items of A and B within an individual (31, 32). By calculating these intra-individual covariance values among the 43 variables described above within each individual, intra-individual covariance networks were constructed for each individual ($n = 454$).

To uncover the principal influences on medical students' daily lives during the COVID-19 pandemic among these 43 variables, the current study applied the graph theory approach to these intra-individual covariance networks. First, network connectedness, small-worldness (σ, degree of balance between the overall network integration vs. network segregation into distinctive subgroups), and modularity (Q, heuristically

estimated degree for a network to be subdivided into clearly delineated and non-overlapping subgroups) were derived using the network density range of K = 0.05–0.20 (with intervals of 0.1; when K = 0.05, only the top 5% largest values of intra-individual covariance survived as edges comprising an intra-individual covariance network). Second, a local network metric, known as betweenness centrality values (variable with higher betweenness centrality might be a "shortcut" among a larger number of variables that showed similar degrees of variance from group-averages within an individual), was estimated at the most sparse level of network density (K) that satisfies (1) network connectedness (>80% of items connected to each other, because they have similar degrees of variance from the group-averaged values of each variable), (2) small-world organization ($\sigma > 1$), and (3) modularity ($Q > 0.3$) for > 95% of participants ($n = 454$). These values were rank-transformed within each individual. All graph theory processing was conducted using the Brain Connectivity Toolbox (33).

Statistical Analyses

According to the year of medical school, between-group comparisons of sex, school dropout intention in the most recent 3 months, spare time activities, and difficulties in online class participation were conducted using the chi-squared test of homogeneity. Concerning personal attitudes toward the COVID-19 pandemic, the Kruskal–Wallis test was applied. Total scores of PSS, GAD-7, and PHQ-9 were compared between groups using one-way analysis of variance (ANOVA). Thresholds of statistical significance were set at $P < 0.05/3$ (=number of domains including personal attitudes, changed lifestyle, and life (dis)satisfaction) = 0.017 (for main analyses) and $P < 0.05/6$ (=number of between-group comparisons) = 0.008 (for *post-hoc* analyses), respectively.

RESULTS

Demographic and Clinical Characteristics

In total, 507 of 597 students (84.9%), higher percentage of response than other recent studies for medical students (34) or public health doctors (35) during COVID-19 pandemic, responded to the questionnaire. After excluding data for 53 students with missing values, our final dataset included de-identified responses from 454 medical students (123 in the first year of medical school, 110 in the second year, 121 in the third year, and 100 in the fourth year) at Seoul National University College of Medicine during June and July of 2020. Participant ages ranged from 20 to 33 years (mean age, 19.1 ± 9.0 years), and participants included 289 men (63.7%) and 165 women (36.3%). **Table 1** describes between-group comparisons of (1) personal attitude toward the pandemic; (2) difficulties in online class participation during the pandemic, as well as spare time activities; (3) intensity of perceived stress-anxiety-depressive mood and school dropout intention in the most recent 3 months. Regarding personal attitudes toward the pandemic, stronger fear of contracting COVID-19 and transferring the infection to their family members or colleagues were reported by fourth-year medical students (slightly worried), compared with other medical students (not very worried; all $P < 0.008$). In addition, the first-year medical students felt greater pride for medical staff members working at the COVID-19 frontline, compared with third- or fourth-year medical students, and maintained better social distancing, compared with third-year medical students (all $P < 0.008$).

Conversely, the percentage of respondents who reported difficulty in the maintenance of a regular daily routine was higher among first-year medical students (32.5%)—who had been enrolled in online classes—than among third-year medical students (17.4%)—who were engaged in on-site hospital training. During their spare time, first-year medical students were more likely to study (65.9%) and less likely to exercise (21.1%), compared with medical students at other points in the program (41.7% for study and 40.0% for exercise). Furthermore, the mean intensity of perceived stress (total score of PSS) and depressive mood (total score of PHQ-9) were higher among first-year medical students (21.0 ± 7.6 for perceived stress and 5.7 ± 4.6 for depressive mood) than among third-year medical students (for perceived stress) and fourth-year medical students (for both perceived stress and depressive mood; all $P < 0.008$). Furthermore, moderate depressive mood (PHQ-9 total score ≥ 10) or anxiety (GAD-7 total score ≥ 10) were found in 11.9% ($n = 54$) or 18.5% ($n = 84$) of the participants, respectively. Finally, school dropout intention in the most recent 3 months ($P < 0.001$ for main analysis) was higher in first- and second-year medical students (49.8%) than in third- and fourth-year medical students (21.3%).

Propagated Impacts of COVID-19 in Daily Lives of Medical Students: Directed Acyclic Graph

Using item-level responses for the whole dataset ($n = 454$), a group-wise directed acyclic graph was established to uncover the propagating patterns among the following items: (1) personal attitude toward pandemic; (2) changes in lifestyle (difficulties in online class participation during the pandemic and spare time activities during the pandemic); and (3) changes in life (dis)satisfaction (perceived stress, anxiety, depressive mood, and school dropout intention in the most recent 3 months). As shown in **Figure 1,** the results indicated that medical students' distress during the COVID-19 pandemic was initiated by the perception of unexpected events related to pandemic (41R). Moreover, it extended to the fear of transferring COVID-19 to colleagues (23R), perceived stress [nervous and stressed feelings (43R) and feeling a loss of situational control (48R)], anxiety [trouble relaxing (54R)] and depressive mood [feelings of failure (67R) and trouble concentrating (68R); all items listed above are marked as red circles in **Figure 1**].

Principal Influences on Medical Students' Daily Lives During the COVID-19 Pandemic: Graph Theory Approach for the Intra-Individual Covariance Network

The principal influences on personal attitudes, changes in lifestyle, and changes in life (dis)satisfaction during the

COVID-19 pandemic were identified using rank-transformed betweenness centrality values (**Figure 2**), estimated from the intra-individual covariance networks (containing items also in the directed acyclic network; **Figure 1**) at the sparsity level of K = 0.14 (in which the top 14% of edges with higher covariance values survived) that satisfied the following criteria for > 95% of participants ($n = 454$): (1) network connectedness (>80% of items connected to each other), (2) small-worldness (sigma > 1), and (3) modularity (Q > 0.3).

Accordingly, the following six items were ranked as top 10% items (=rank-transformed betweenness centrality ≤ 4) for more than 40% of participants: (1) fear of transferring COVID-19 to colleagues (23R; personal attitude), (2) nervous and stressed feelings (43R; perceived stress), (3) feeling a loss of situational control (48R; perceived stress), (4) trouble relaxing (54R; anxiety), feelings of failure (67R; depressive mood), and trouble concentrating (68R; depressive mood). These items were selected as principal influences (marked with red-rimmed circles in **Figure 1**; names written in red color at the bottom of **Figure 2**).

Differential Patterns of Connectedness According to Life (dis) Satisfaction During the COVID-19 Pandemic

Correlation analyses between the severity of perceived stress (total score of PSS), anxiety (total score of GAD-7), and depressive mood (total score of PHQ-9) vs. rank-transformed centrality derived from the intra-individual covariance networks uncovered associations between higher rank of betweenness centrality for the "fear of transmitting COVID-19 to family members (22R)" and higher perceived stress (Spearman's rho = −0.354, $P < 0.001$; **Figure 3A**). In contrast, a higher rank of betweenness centrality for "engaging in computer games in spare time (92R)" was associated with lower depressive mood (Spearman's rho = 0.304, $P < 0.001$; **Figure 3B**).

DISCUSSION

Study Summary

To our knowledge, this study is the first to decipher the influencing cascade of changed lifestyle (difficulty of online class attendance and use of personal time), cognitive style (perceived threat of infection & proactive coping), mental health (perceived stress, anxiety, and depressive symptoms), and school dropout intention during the COVID-19 pandemic for medical students, by means of network-based approaches. For reducing the possible transmission of COVID-19 by way of on-site interpersonal interactions, medical schools in Republic of Korea also changed most of the classes to an online format from first-year to fourth-year courses (6). For basic laboratory classes such as anatomy lab sessions, students were equipped with personal protective equipment students and were divided into smaller groups to reduce the spread of possible infections (6). After the partial loosening of social distancing as of May of 2020 by announcement of government, core clinical clerkship programs were re-opened at training hospitals and conducted in compliance with preventive guideline for COVID-19 pandemic (6).

In the current study, depressive mood, anxiety, and intention of school dropout were observed in 11.9, 18.5, and 38.3% of medical students, respectively. These tendencies were more prominent among junior medical students. The current results are not higher than the prevalence of clinically relevant depressive symptoms measured during the pre-pandemic era for medical students worldwide (27–28%) (36, 37) and in South Korea (10.9–23%) (38–40), who had already been reporting higher levels of depressive mood, anxiety, and psychological distress, compared with the general population (41). However, because the profile of psychological responses to stressful situations can vary among individuals, network analyses were conducted to uncover the possible directional cascade of psychological symptom progression and core influencing components. A directed acyclic graph began from the perception of unexpected events; then transitioned to nervous and stressed feelings, trouble relaxing, and feelings of failure; and finally progressed to trouble concentrating, feeling a loss of situational control, and fear of infecting colleagues. These six features were also highly ranked for betweenness centrality in the intra-individual covariance networks. Of note, perceived stress showed a negative association with rank-transformed betweenness centrality of "fear of infecting my family members (Spearman's rho = −0.354)"; in contrast, a higher rank of "engaging in computer games in spare time" for betweenness centrality was associated with lower depressive mood (PHQ-9 total score; Spearman's rho = 0.304) (all $P < 0.001$).

Influencing Patterns Among Perceived Stress, Personal Attitudes, and Changes in Lifestyle

In the current study, perceived stress in response to the COVID-19 pandemic began from the surprise concerning the unexpected occurrence of the COVID-19 pandemic. After this feeling of surprise transitioned into nervousness and distress, medical students experienced feelings of anxiety ("on edge"), irritability, and fatigue. When medical students who had been using spare time for sleeping felt that they were unable to control the important things in their lives, they experienced difficulty in maintaining a regular daily routine during social distancing. This is consistent with other studies, which showed that college students during the COVID-19 pandemic experienced distress when adjusting to new academic activities and changes in sleeping pattern. Their social isolation and "all-or-none" cognitive style could lead to worsened mental health and life satisfaction (42, 43). Furthermore, when they had not been able to cope with all the tasks they had to complete and felt that difficulties were becoming so extensive that they could not be managed, medical students with little interest or pleasure in doing things sometimes considered taking a leave of absence from school. Timely provision of academic mentoring and networking, as well as psychological care for possible depressive moods, might be crucial in minimizing unintended leaves of

absence from school by medical students during the COVID-19 pandemic (44–47).

In contrast, the level of confidence that they are in control of a situation and aware of changes, and whether they used spare time for computer games, might influence the use of spare time to read books. Notably, reading books has been widely used to aid in coping with sustained adaptation distress among veterans (48), burnout among oncologists (49), and physical illnesses [e.g., hemodialysis (50)]. Furthermore, medical students who have been angered because of things outside of their control, but also felt pride in seeing medical staff members at the COVID-19 frontline, reported a willingness to volunteer to work as a medical professional at the frontline of future epidemic situations. As a possible proactive coping mechanism, some of them volunteered as peer-tutors (51).

Influencing Patterns Among Anxiety, Personal Attitudes, and Changes in Lifestyle

To control the amplification of anxiety among medical students during the COVID-19 pandemic, capacities for voluntary relaxation and maintenance of social ties with family and friends might be helpful. The current study showed that ∼18.5% of medical students reported anxiety (GAD-7 total score $\geq$ 10). Because they already feel distress and experience hopelessness about the increasing difficulties, initial anxiety that involves feeling nervous, anxious, or on edge might escalate. Thus, the students may be unable to stop or control worrying about various things. Because sustained worrying could lead to trouble relaxing and subsequent fear of an awful outcome, preemptive application of progressive muscle relaxation (52) or the therapeutic use of a coloring book (53) might be suggested.

Importantly, medical students who had a fear of transmitting COVID-19 to family members and a fear of an awful outcome used their spare time to see family and friends. Of note, the severity of perceived stress (= total score of PSS) was higher in medical students for whom the transformed z-score value [using the means and standard deviations of given items calculated from all participants ($n = 454$)] of fear for transmitting COVID-19 to family members was similar to most other personal attitude-changed lifestyle-life (dis)satisfaction items (i.e., higher-ranked values of betweenness centrality derived from the intra-individual covariance network; Spearman's rho $= -0.354$, $P < 0.001$). Because a weak sense of coherence is associated with greater risks of mood disturbance and anxiety during the COVID-19 pandemic (54), medical staff members at the COVID-19 frontline also require familial support and social connectedness to mitigate the fear of infection (55).

Influencing Patterns Among Depressive Mood, Personal Attitudes, and Changes in Lifestyle

Lowered self-efficacy could be a principal influence on the progression of depressive symptoms and distress. In the current study, ∼11.9% of medical students reported a depressive mood (PHQ-9 total score $\geq$ 10). Sustained surprise and uncontrollable worrying during the COVID-19 pandemic could result in feeling "down," depressed, or hopeless. Furthermore, if medical students do not experience much interest or pleasure in their tasks and instead exhibit fear of an awful outcome, they might regard themselves as failures and have reduced self-confidence in handling personal problems. As symptoms of depressive mood and anxiety worsen, medical students complain of concentration difficulty. Altered confidence in handling personal problems would be followed by changes in capacity for controlling irritation, life contentment, and feelings of situational control and awareness of changes. To prevent the worsening of depressive moods among medical students during the COVID-19 pandemic, there is a need for balancing of a negative cognitive style and collective evaluation tendencies by means of Socratic questioning and more objective evaluations of tasks based on actual evidence (56, 57).

Limitations

This study had some limitations. First, the current study is cross-sectional, and therefore, comparisons with pre-pandemic period per study participant were not possible. Recent studies showed an increased prevalence of psychiatric symptoms such as distress, anxiety, insomnia, and depressive mood during the COVID-19 pandemic, compared with pre-pandemic assessments (58). Throughout follow-up studies during this pandemic, the prevalence of symptoms was stable (59) or decreasing (60, 61), compared with earlier stages. Further longitudinal cohort studies (62, 63) are needed to understand the long-term after-effects of the COVID-19 pandemic on the interacting pattern among personal attitudes, changes in lifestyle, and changes in life (dis)satisfaction. Second, three items used in the current study in measurements of "difficulty of online class attendance (1 item) & use of personal time (1 item) during COVID-19 pandemic" and "school dropout intention during the COVID-19 pandemic (1 item)" were not validated in the current study. Third, the current study did not explore the possible mediation effect of socioeconomic status between the COVID-19 pandemic and its impact on medical students. Specifically, people with lower socioeconomic backgrounds could find difficulties in adjusting themselves among the changing situation of COVID-19 (64). Fourth, the directed acyclic graph applied in the current study was based on probabilistic and causal modeling, and did not consider the possibility of bidirectional interactions among variables. Future studies might be suitable for exploring such bidirectional interactions by applying newly proposed tools [e.g., interaction directed acyclic graph (65)] that have been sufficiently verified.

Conclusions

Overall, the current study examined the influencing cascade of changes in lifestyle, personal attitudes, and life (dis)satisfaction among medical students during the COVID-19 pandemic using network-based approaches. To minimize distress propagation, timely control is necessary concerning the following principal influences: nervous and stressed feelings, trouble relaxing, feelings of failure, trouble concentrating, fear of infecting colleagues, and feeling a loss of situational control.

DATA AVAILABILITY STATEMENT

The datasets used in the current study are available from the corresponding author (Sun Jung Myung, issac73@snu.ac.kr) on reasonable request.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board at Seoul National University College of Medicine approved the study protocol, and the requirement for written informed consent was waived by the board because this constituted a minimal-risk study. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

J-YY, JK, SMy, HY, SMo, HR, and J-JY conceived and designed the study idea. J-YY and MJ managed literature searches and wrote the manuscript. J-YY, JK, SMy, HY, SMo, HR, and J-JY critically reviewed the manuscript. All authors contributed to and have approved the final 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/fpsyt.2021.702092/full#supplementary-material

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The Effect of Self-Disclosure on Loneliness in Adolescents During COVID-19: The Mediating Role of Peer Relationships

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Long-term home isolation has had a certain impact on adolescents' enthusiasm for interpersonal communication and desire for self-disclosure during COVID-19. The purpose of this study was to explore the relationship between adolescents' self-disclosure and loneliness during COVID-19, and to analyze the mediating role of peer relationship in it. We conducted a cross-sectional study involving 830 Chinese adolescents (males: 47.5%, Mage14.25 years; females: 52.05%, Mage 14.19 years; Age range 12-15). Participants completed a self-reported survey that included sociodemographic, Jourard Self-Disclosure Scale, UCLA, and Peer Relationship Scale. The results showed that in the period of COVID-19, adolescents' self-disclosure affects loneliness through peer relationship, that is, the level of self-disclosure can significantly predict loneliness through peer relationship, and peer relationship plays a complete mediating role.

Keywords: COVID-19, adolescent, self-disclosure, loneliness, peer relationship, mediation

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INTRODUCTION

The outbreak of COVID-19 in 2019 has had a huge impact on people's lives, affecting their work, study, and travel. The pandemic has been a global health emergency, and it may have a serious impact on public health, including mental health. According to the features of its epidemic, COVID-19 is highly infectious and transmits from human-to-human with a certain incubation period (1). After finding out the feature, the Chinese government imposed urgent countermeasures to control the rapid spread of COVID-19. On January 25, 2020, the Standing Committee of the Political Bureau of the CPC Central Committee held a meeting to study the prevention and control of pneumonia in the infection, and it was suggested that such countermeasures as "preventing spread in the domestic and safeguarding imports from foreign countries, having collective quarantine for all patients, undertaking home medicine management for all close-contacting people, and working to prevent the spread of the epidemic" be adopted. The Ministry of Education proposed students should "stop attending class but keep learning" to prevent the spread in campuses. Postponing schooling and imposing home quarantine were important measures (2). Long-term family living and study would cause many negative psychological impacts for many people (such as loneliness, anxiety, depression, depression, fear, stress) because they have no face-to-face class teaching to ensure safe social distance (3). People lock themselves down comprehensively. By using facial protection and maintaining safe social distancing, people may grow more wary of strangers, and find it harder to express their feelings easily.

The COVID-19 pandemic has also changed how we interact. In many countries, people were recommended or required to socially distance. This means people were asked to either physically distance when meeting in-person (i.e., stay at least six feet apart) or stay at home (i.e., leave their home only for essential activities) (4). This change has been abrupt, with some governments initially declaring the measures unnecessary and then suddenly demanding people stay at home (5). The change has also been of uncertain lengths; the initial calls for social distancing were for a few weeks, but the social isolation has extended into several months, and the rules for social distancing seem to be ever evolving (6). And the subsequent home quarantine and social distance requirements increase the loneliness, anxiety, and negative emotion of the whole social experience (7). Teenagers are an important group in the epidemic. The Chinese Ministry of Education proposed a working layout of "stop attending class and keep learning" to ensure students' physical health, but the deep impact of the continued spread of the epidemic on their psychological status is also an issue. The suddenness, aggregation, and diffusion of the pandemic meant teenagers were confined to their homes within a short time, so they were extremely apt to have the psychology of blind obedience and credulity of false information. Long-term home quarantine has imposed a certain impact on their psychology, and some of them would face negative situations such as language barriers and negative emotions from lack of face-to-face communication and exchange, so it would seriously affect teenagers' collective resistance to physical and mental illness (8). Some researchers showed that long-term staying at home would have a bigger influence on emotion. The teenagers who are very active would be in need of direct contact with the outside world, and they would have much more psychological pressure, even triggering such serious psychological issues as anxiety and depression, due to the sense of loneliness. It was found in a domestic study that the occurrence of emotional and behavioral problems in children and adolescents is higher than that before the epidemic. Individuals under 18 years old are a high-risk population (9).

Self-disclosure is an important communication channel between the individual and the outside world, and it is a necessity for individual growth. Self-disclosure would impose an impact on an individual's social adaptation; the individual should have positive self-disclosure to have effective communication with the outside world (9). The epidemic stops the channel for people to communicate with the outside world, and individuals find it hard to have a positive self-disclosure. Against the background of the epidemic, good self-disclosure is helpful to build up good companionship and family relationships to go through the epidemic with a more positive and healthier attitude. Early adolescence is a period of social change. Companionship changes from sharing activities in childhood to the feature of spending much more time in conversation with each other (10). Adolescents would have much more communication with peers and dependence on peers. During the adolescent period, there is internal value to share their own information with friends. It was found from the result of one study that there are neurophysiological and behavioral differences when disclosing information about one's self in different depths to peers. Take girls in adolescence as an example. A task involving self-disclosure currency choice was completed while receiving functional magnetic resonance imaging. In view of behavior, teenagers give up much more money and choose to share superficial self-reference information instead of intimate information with close friends (in real life). According to neuro analysis, the areas of social cognition and emotion regulation are supported to participate in the self-disclosure of intimate information (11). Adults would give up money for the chance of disclosure, and there would be a reward center in their brains when doing so (12). Studies show that self-disclosure is beneficial for the forming and development of companionship and intimacy (13); the production of a sense of loneliness is also related to self-disclosure. In the study by (14), three-quarters of the participants thought that the production of a sense of loneliness is no ability to have self-disclosure.

For the study on self-disclosure and sense of loneliness, the scholar Imai and Imai observed the moderating effect of cross-ethnic self-disclosure on perceived ethnic bias, depression, and loneliness of foreign students; the result shows that the self-disclosure could buffer the negative effects of prejudice on loneliness and depression (15). Franzoi et al. tested the impact of teenagers' self-disclosure on the sense of loneliness with the structural equation, and the result showed that an individual's self-consciousness has an indirect relationship with the sense of loneliness through the self-disclosure with peers, which means that young people with high self-consciousness would prefer to disclose themselves with peers to reduce the sense of loneliness (16). Salono et al. (17) showed that self-disclosing to peers instead of parents is related to less loneliness. Pingxian et al. (18) also conclude from the study of the relationship between self-disclosure and sense of loneliness that there is a significant negative correlation between individual self-disclosure and sense of loneliness. The individual with high self-disclosure would have less sense of loneliness (18). Jiang et al. also make a similar conclusion in the study of the relationship between self-disclosure and loneliness (18, 19).

During the COVID-19 pandemic, Chinese student's average quarantine time was 5 months. In the area of our study, students were required to wear masks and keep a safe distance at the beginning of school and when moving and eating. Due to our government and people's concerted effort, Chinese students have had shorter quarantine periods compared to students from other countries (for instance, Brazilian adolescents have had their face-to-face classes interrupted for more than 1 year). In conclusion, COVID-19 may exacerbate the sense of loneliness, anxiety, and panic of teenagers, and it stops their chance to communicate with peers so that there is an obstacle to their self-disclosure. More importantly, the measures we have adopted during COVID-19 may impact on adolescents, such as the possible impacts on the development of social and communication skills; among other aspects, it is not conducive to the development of the adolescent brain and personality. The study discusses the impact of self-disclosure on an individual's sense of loneliness against the background of COVID-19, and the mediation of companionship. Here are the three hypotheses. (1) There is

a significant correlation between teenagers' self-disclosure and loneliness during the epidemic period; (2) There is a significant negative correlation between the teenagers' peer acceptance and loneliness during the epidemic period, while there is a significant positive correlation between the peer's fear and inferiority and loneliness; (3) In the period of COVID-19, adolescents' self-disclosure affects loneliness through peer relationship, that is, the level of self-disclosure can significantly predict loneliness through peer relationship, and peer relationship plays a complete mediating role.

MATERIALS AND METHODS

Participant and Procedure

The study was approved by the Institutional Review Board of the Northwest Normal University. Participant's parents signed their informed consent. This cross-sectional study was conducted on Chinese adolescents in the context of the COVID-19 pandemic. Data collection was conducted from June to December using an online self-reported survey (Questionnaire Star). We randomly selected 830 junior high school students in Gansu and Shandong. And they volunteered to participate in the study and completed the questionnaire. All questions related to the survey were managed using the Questionnaire Star platform and a shareable link was generated to help teens spread the survey across different online platforms. The online survey details informed consent, purpose, and inclusion and exclusion criteria for the study on the first page.

Measurement

A self-reported and structured online survey included sociodemographic information about the participants, as well as psychological questionnaires measuring three study variables for data collection.

Self-Disclosure Questionnaire

Self-disclosure was measured with the brief version of The Jourard Self-Disclosure Questionnaire (JSDQ); this questionnaire prepared by Jourard in 1958 to measure the degree of people's self-disclosure. A checklist of six dimensions was used to assess participants' experience of COVID-19 related self-disclosure, including attitudes and opinions, interests and hobbies, study or work, money, personality, and body. There were 10 questions for each dimension, and each question responded to the degree of self-disclosure of four target people: father, mother, friends of the same sex, and friends of the opposite sex. A is for saying nothing to others, B is for saying something to others, C is for telling others in details. D is lying to others or revealing oneself incorrectly. A, B, C, and D were scored by 1, 2, 3, and 1 respectively, each participant had 240 scoring items and the higher the score, the higher the degree of self-disclosure. A Chinese scholar Li Linying (20) revised and translated the questionnaire, which showed good reliability and validity. In this study, the Cronbach α coefficients of the six dimensions of self-disclosure were 0.97, 0.97, 0.98, 0.98, 0.97, 0.97, and 0.99 respectively, and the overall value was 0.99.

Peer Relationship Questionnaire

In this study, the revised version of Zou Hong's (1998) Peer Relationship Scale was adopted to investigate individuals' subjective feelings of peer relationship, including two dimensions of peer acceptance and peer fear and inferiority. There were 30 items used to assess participant's peer relationship: peer acceptance scales ranged from 1 to 20 and peer fear and inferiority scales ranged from 21 to 30. The questionnaire was scored by four points. The 30 item scales assessed Peer relationship behaviors with a 4-point scale (1 = completely inconsistent, 2 = not quite consistent, 3 = relatively consistent, 4 = completely consistent). Among them, peer acceptance subscales 1, 3, 7, 11, and 17 are a positive score, and the rest are reverse score. The higher the score, the higher the level of peer acceptance, the better the peer relationship. The subscales of peer fear and inferiority were all positive scores. The higher the score, the higher the individual felt inferiority and fear in the peer relationship, and the worse the peer relationship was. In this questionnaire, the Cronbach α coefficient of peer acceptance was 0.94, and the Cronbach α coefficient of peer fear and inferiority was 0.93.

Loneliness Questionnaire

In this study, the UCLA Loneliness Scale developed by Russell and revised by Wang Xiangdong et al. (21) was used to measure the loneliness level of middle school students, and to investigate the subjective feeling of loneliness. A total of 20 items were used to assess participant's loneliness, which was divided into four points according to the degree of conformity: never, rarely, sometimes, and always. There were scored by 1–4 points, respectively. Among them, 1, 5, 6, 9, 10, 15, 16, 19, and 20 are reverse scores. The final scores are added up, and the loneliness scores range from 20 to 80. The higher the score is, the higher the individual loneliness level is. In this study, the Cronbach α coefficient of this questionnaire was 0.90.

Data Analysis

In this study, Excel was first used to clean, sort, and code the data set, and then the data set was exported to SPSS.

First, descriptive statistics and correlations between the main variables were conducted. Second, to examine the relationship between COVID-19 self-disclosure and loneliness, a serial mediation was performed with COVID-19 self-disclosure as the independent variable, peer relationship as mediators in sequence, and loneliness as the dependent variable. Finally, SPSS 22.0 statistical analysis software was used to conduct variance analysis, independent sample *t*-test, Pearson correlation analysis, and simple effect analysis on the data. Confirmatory factor analysis was conducted on the data through AMOS 21.0 software and Bootstrap software to establish a structural equation model.

RESULT

Demographic Data

A total of 830 participants were included in the final statistical analysis (see **Table 1**). Among them, 47.5% were male and 52.05% were female. The mean age of the samples was 14.21 years old

TABLE 1 | Demographics and responses of participants ($N = 830$).

		Numbers	Percentage (%)
Gender	Male	398	47.95
	Female	432	52.05
Age	12	28	3.37
	13	126	15.18
	14	316	38.07
	15	360	43.38
Grade	1	160	19.28
	2	381	45.90
	3	289	34.82
The one-child	yes	107	12.89
	no	724	87.21
Single parent families	yes	41	4.94
	no	789	95.06
Family location	Cities and towns	357	43.01
	rural	473	56.99
Father education	Junior high school and below	416	50.12
	High school or technical secondary school	265	31.93
	Junior College or University	137	16.51
	Master degree or above	12	1.44
Mother education	Junior high school and below	462	55.66
	High school or technical secondary school	240	28.92
	Junior College or University	120	14.46
	A graduate student	8	0.96

(SD = 0.82 years old), and the age range was 12–15 years old. The sample is middle school students, including 160 students in the first year of junior high school, 381 students in the second year of junior high school, and 289 students in the third year of junior high school. 12.89% of the students are only children; 43.01% are from urban areas and 56.99% are from rural areas.

Correlation Analysis of Adolescent Self-Disclosure, Peer Relationship, and Loneliness

The results of correlation analysis showed that self-disclosure was significantly positively correlated with peer acceptance, self-disclosure was significantly negatively correlated with peer fear inferiority, self-disclosure was significantly correlated with loneliness, peer acceptance was significantly negatively correlated with peer fear inferiority, and peer fear inferiority was significantly positively correlated with loneliness (see **Table 2**).

TABLE 2 | Pearson correlation matrix of variables in Study ($N = 830$).

Variable	1	2	3	4
1. Self-disclosure	1			
2.Peer acceptance	0.118**	1		
3. Peer fear	−0.139**	−0.575**	1	
4. The loneliness	−0.173**	−0.744**	0.608**	1

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

TABLE 3 | Regression analysis of self-disclosure, peer relationship and loneliness.

The variable name	Model a	Model 2
Control variables		
Gender	−0.017	0.484
Age	1.440	0.417
Grade	0.548	−0.104
The one-child	−0.581	0.084
Single parent families	0.842	−1.685
Family location	−2.849	0.093
Father education	−0.115	0.844
Mother education	0.483	−0.755
The independent variables		
Self-disclosure	−0.17**	−0.007**
Company to accept		−0.545**
Companion fear		0.390**
R^2	0.045.	0.610
Adjust ΔR^2	0.035.	0.605
ΔR^2		0.565**
F	4.313**	116.306**

**$P < 0.01$.

Regression Analysis of Adolescent Self-Disclosure, Peer Relationship, and Loneliness

In Model 1, self-disclosure of the regression equation was taken as the independent variable and loneliness as the dependent variable. The coefficient of the influence of self-disclosure on loneliness was 0.017. In Model 1, $R^2 = 0.05$, $P < 0.01$, adjusted $R^2 = 0.04$, $P < 0.01$, F value is 4.31, and it reached a significant level. It shows that self-disclosure has a significant predictive effect on the loneliness model (see **Table 3**).

In Model 2, two dimensions of peer acceptance and peer fear inferiority were added on the basis of Model 1. The influence coefficients of peer acceptance of loneliness were −0.55 and 0.39 respectively. In other words, peer acceptance negatively predicted loneliness, while peer fear inferiority positively predicted loneliness. The $R^2 = 0.61$, $P < 0.01$ in Model 2, and the F value is 116.31 when $R^2 = 0.60$, $P < 0.01$, and it reached a significant level. It indicates that peer acceptance and peer fear and inferiority have significant predictive effects on loneliness model (see **Table 3**).

The Mediating Effect of Adolescent Peer Relationship

Through the above correlation analysis, self-disclosure during the epidemic period was significantly correlated with peer acceptance, peer fear, inferiority, and loneliness, which met the conditions for mediating effect analysis. In addition, according to the correlation analysis, self-disclosure, peer acceptance, peer fear, and inferiority have a significant predictive effect on loneliness. Based on the above results, a structural equation model was established by AMOS 21.0 software to analyze the mediating effect of peer relationship between self-disclosure and loneliness.

Figure 1 shows that during the outbreak of self-disclosure—the path coefficient of peer relationship and peer relations—the path coefficient of loneliness have reached a significant level ($p < 0.001$); the overall effect was 0.173 ($p < 0.01$), direct effect was not significant ($p = 0.176$), the indirect effect was 0.139 ($p < 0.01$), the percentage of the mediation effect of total effect at 80.3%, and the goodness of the fit index is fairly good. It proves that the mediation effect of this model is significant, as the direct effect was not significant, so it is the partial mediating effect (see **Figure 1**).

DISCUSSION

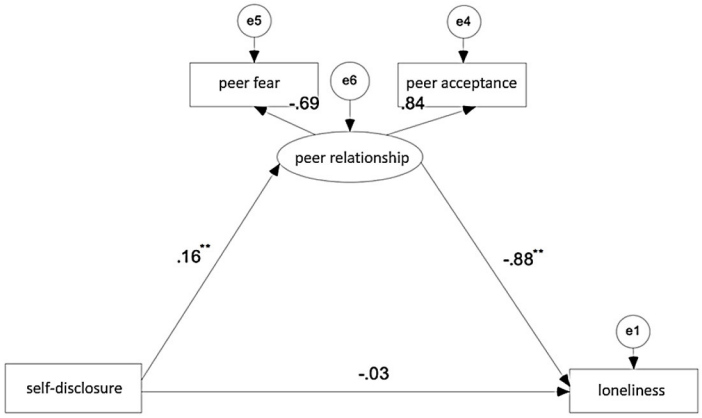
The present study examined the relationship between COVID-19 self-disclosure, loneliness, and peer relationship in a sample of Chinese junior school students. Consistent with our hypothesis, in the period of COVID-19, adolescents' self-disclosure affected loneliness through peer relationship, that is, the level of self-disclosure can significantly predict loneliness through peer relationship, and peer relationship plays a complete mediating role.

The sudden outbreak of COVID-19 has had a great impact on human society and everyone's psychology. The adolescent period is a special period of rapid physiological and psychological changes, and it is more sensitive to external crisis events and more likely to produce various psychological crises due to the impact of the epidemic (19). Because of COVID-19, the youth have experienced home quarantine, online learning, school resumption, and exam schooling changes, among others. Those that cannot adapt to and respond to these changes could possibly enter a state of psychological crisis, and produce a series of emotional and behavioral problems, such as loneliness, anxiety, self-disclosure difficulties, and reductions in peer exchanges (22). As far as we know, this is the first study to relate adolescent's self-disclosure and loneliness during the COVID-19 outbreak. According to the results of the study, during the outbreak of COVID-19, self-disclosure was significantly positively correlated with peer acceptance, self-disclosure was significantly negatively correlated with peer fear inferiority, self-disclosure was significantly correlated with loneliness, peer acceptance was significantly negatively correlated with peer fear inferiority, and peer fear inferiority was significantly positively correlated with loneliness. According to the regression analysis and model test, we concluded that during the epidemic self-disclosure affected loneliness through peer relationship, that is, the level of self-disclosure could significantly predict loneliness through peer relationship, and peer relationship played a complete mediating role. So it validates our hypothesis. This result is consistent with previous foreign research results from Franzoi et al. (23) and Imai and Imai (15), both of which show that self-disclosure significantly affects loneliness. Researchers Feng Feng, Zhou Zongkui et al. also conducted a study on self-disclosure and loneliness in 2011, which is consistent with the results of this study. Individual self-disclosure is significantly negatively correlated with the level of loneliness, and individuals with high self-disclosure have low loneliness.

Individuals who feel a high level of social support believe that they can get help from others when they encounter difficulties and are more willing to establish good contact with others, so as to protect themselves from loneliness and negative emotions (23). Changes in self-disclosure behavior may reflect or support social reorientation, as adolescents become increasingly dependent on their peers for emotional and social support (24), and our research also indirectly demonstrates this. Adolescents with good relationships disclose more frequently to their parents and friends than others, and adolescents at this time are in the peak of peer relationship development and emotional development, and peers or parents are an important source of emotional support for adolescents. From the results of the study, we conclude that adolescents' self-disclosure affects peer relationships and further affects loneliness.

Although much research has focused on self-disclosure about peer relationships during adolescence, the medium of communication has changed dramatically over time. Social networking sites (SNS) play a prominent role, and the number of teenagers who participate in online self-disclosure has grown. Although teenagers come into contact with more strangers through social networking sites, some studies have shown that online disclosure and use of social networking sites have a greater negative impact. Research on face-to-face disclosure has mainly found positive aspects, such as increased relationships, better friendship quality, perceived greater social support, social self-esteem, and belonging (25–27). Although social networks are developing rapidly, self-disclosure through network channels have increased greatly, however, adolescents spend most time face-to face communication with teacher peers and parents in school and home, face to face interpersonal communication occupies the most section in their life. Therefore face-to face self-discloser is more conductive to adolescents overall development. Face-to-face self-disclosure is more advantageous to individual comprehensive development and helps in maintaining positive relationships.

Based on the results of this study, self-disclosure may predict happiness, and the effect of self-disclosure on well-being largely depends on the valence of induced events. Positive emotional disclosure will make people feel more positive, while negative emotional disclosure will make people feel more negative (28). Compared with pain and negative feelings, individuals are more willing to pursue the feelings of happiness and pleasure. The process of interpersonal communication is also a process of benign development, and positive self-disclosure will also indicate the good development of a partner relationship. Positive disclosure tends to occur more frequently and predict positive



Structural equation model fitting index

χ^2/df	NFI	CFI	TLI	RMSEA	IFI	GFI
2.19	0.99	0.99	0.99	0.04	0.99	0.99

FIGURE 1 | Mediating effect model of peer relationship between self-disclosure and loneliness.

feedback and greater social support (29–31), which can increase feelings of connection (32). Similarly, negative disclosure may hinder others from providing public response (33). That is to say, the negative content of disclosure cannot promote the development of peer relationship and makes it difficult for individuals to respond or even produce resistance, which is not conducive to the development of peer relationships. Receiving feedback can enhance self-esteem, while lack of feedback may lead to feelings of rejection and even threaten the basic needs of the individual (34–37), resulting in loneliness and a series of negative emotions. In conclusion, the results of our study also verify the conclusions of previous studies. However, the research on the effect of self-disclosure on loneliness should not be limited to this, and more studies are needed to explain the relationship between self-disclosure and loneliness.

Because of its reach and ferocity, COVID-19 has been characterized as a once in a century pandemic; however, it is not the first pandemic of the modern era. SARs, AIDS, Ebola, and more have struck across the globe, each presenting a risk to public health and limiting how people interact with each other (6). This quarantine particularly has changed adolescent's lifestyle, the decrease of activity space and direct communication may result in communication disorders, loss of interest, fear, tension, anxiety, loneliness, and other negative psychological problems. Understanding the influence of novel coronavirus pneumonia, particularly during COVID-19, and how self-disclosure affects loneliness through peer relationships informs our approach to resolve adolescent's psychological problems. For instance, we suggest that research and practice need to revisit commonly held assumptions about self-disclosure, and what is considered appropriate and necessary to self-disclose. By understanding pandemic-related self-disclosures, we believe researchers will be able to better study the relationships between self-disclosure and loneliness during health emergencies.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study has some important limitations due to sampling techniques. Firstly, this study randomly selected junior high school students in Gansu and Shandong provinces, and only targeted adolescents aged 12–15. Future research can investigate self-disclosure levels of adolescents in different regions, and study different perspectives such as culture, region, ethnicity, and age. Secondly, since we do not have pre-COVID-19 data and this study was a cross-sectional study, the findings obtained cannot infer that the COVID-19 pandemic caused the effects of adolescent self-disclosure on loneliness and peer relationships. Finally, the study was conducted among junior high school students in China and is not representative of other global groups. Therefore, a longitudinal study of different groups is needed. In addition, this research also has certain educational significance. In order to have good mental health development before the arrival of adulthood, and develop a healthy personality and study and live smoothly, families, schools, and individuals should attach importance to adolescents' self-disclosure, help them to adjust their negative emotions, and reveal themselves rationally. Adolescents should learn to seek support and help from others to reduce their negative emotions, stress, and anxiety.

CONCLUSION

This study focused on factors associated with self-disclosure, loneliness, and peer relationships among adolescents during the COVID-19 pandemic. Therefore, it can be concluded that in the period of COVID-19, adolescents' self-disclosure affects

loneliness through peer relationships, that is, the level of self-disclosure can significantly predict loneliness through peer relationships, and peer relationships play a complete mediating role. This helped to educate people about the importance of self-disclosure during the COVID-19 pandemic, enabling adolescents to approach the epidemic in a positive way. Mental health education and consultation schemes should be implemented to prevent and alleviate psychological problems associated with COVID-19, particularly among adolescents.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board at Northwest Normal University, development of Psychology. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

BH conceived the present study, collected the data, and conducted the statistical analyses. RC drafted the manuscript. LC supervised the study and helped to revise the manuscript. All authors read and approved the final manuscript.

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ORIGINAL RESEARCH
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The Mediating Role of Loneliness Between Social Support and Depressive Symptoms Among Chinese Rural Adolescents During COVID-19 Outbreak: A Comparative Study Between Left-Behind and Non-left-behind Students

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Introduction: The COVID-19 pandemic has greatly impacted people's life across the globe. In a public health crisis, rural adolescents are more prone to mental health problems. The current study aimed to investigate the prevalence of depressive symptoms among Chinese rural adolescents during the COVID-19 outbreak, and examine the association between perceived social support and depressive symptoms and its underlying mechanisms.

Method: Perceived Social Support Scale, UCLA Loneliness Scale, Patient Health Questionnaire-9 were administrated to 826 rural adolescents from Anhui Province, China, amid the COVID-19 crisis. Mackinnon's four-step procedure was employed to examine the mediating effect, while Hayes PROCESS macro was utilized to test the moderated mediation model.

Results: The results showed the rate of depressive symptoms among rural adolescents in China was 77.6% during the outbreak of COVID-19. Female left-behind students and non-left-behind students from disrupted families experienced more depressive symptoms (all $P < 0.05$). Loneliness mediated the association between perceive social support and depressive symptoms and the indirect effect was stronger in left-behind adolescents in comparison to non-left-behind adolescents during the COVID-19 pandemic.

Conclusion: Depressive symptoms are extremely prevalent among Chinese rural adolescents during the COVID-19 outbreak, and perceived social support plays a protective role against depressive symptoms. Chinese rural adolescents, especially left-behind students, could benefit from the interventions aimed at enhancing the perceived social support and reducing loneliness during the COVID-19 pandemic.

Keywords: depression, perceived social support, loneliness, left-behind students, non-left-behind students, COVID-19

INTRODUCTION

The outbreak of COVID-19 has brought great challenges for both physical and mental healthcare around the world and disrupted daily life for everyone (1). At present, the outbreak still rages in many regions of the world (2). As of June 10, 2021, COVID-19 has led to more than 3 million confirmed deaths out of 173 million confirmed cases (3). COVID-related stressors, such as enhanced social isolation, decreased prosocial activities, reduced access to mental health services, increased concerns over health, intensified family conflict, were found to be related to higher levels of psychological problems (4). Public health measures to curb the spread of COVID-19 have exerted adverse impacts on the mental health, especially for adolescents. Adolescence is a critical phase for the formation of identity (5). Compared with adults, adolescents are more likely to experience intense emotions with greater frequency and fluctuation (6).

Perceived social support refers to an individual's cognitive appraisal of the quality and quantity of social connections. Evidence suggested that social and community ties played a critical role in the etiology of disease through the underlying psychological and physiologic mechanisms (7). There is a long history in psychological studies which has investigated the association between perceived social support and mental health outcomes. Evidence suggested the protective effect of perceived social support on mental health (8, 9). Previous literature found students with lower levels of social support were six times more likely to experience symptoms of depression than those with higher levels of social support (9). Recently, a substantial body of research has investigated the role of perceived social support during the COVID-19 pandemic (10). Negative associations between perceived social support and depressive symptoms amid the COVID-19 outbreak have been documented (10, 11). Hence, we speculated that perceived social support was negatively associated with depressive symptoms among rural students during COVID-19 pandemic.

Loneliness, also termed perceived social isolation (12), is a common risk factor of depressive symptoms. Loneliness is defined as the disparity between one's desired and actual levels of social relationships (13). Perceived social isolation in humans is associated with enhanced sympathetic tonus, increased HPA activation, reduced inflammatory control and decreased expression of genes regulating glucocorticoid responses, which might further lead to deleterious health outcomes (14). Loneliness is suggested to be a precursor of depression (15, 16). In addition, research evidence also suggested perceived social support could reduce the feeling of loneliness experienced by adolescents (17). Moreover, in a recent study conducted by Liang et al. (18), loneliness partially mediated the association between perceived social support and depressive symptoms among Chinese rural-to-urban migrants. Therefore, we expected that loneliness was not only directly associated with symptoms of depression, but also played a mediation role in the association between social support and depressive symptoms among rural adolescents.

Although perceived social support could influence loneliness among adolescents, not all adolescents with lower levels of perceived social support report higher levels of loneliness. Therefore, it is of great importance to explore the influential factor that might moderate the relationship between social support and loneliness. Over the last three decades, the rapid urbanization of China has led to a large scale of domestic migration (19). Due to the fast development of public transportation systems, rural migrant workers could move from rural to urban areas at relatively low cost and easily stay connected with their sending societies (20). A large number of rural residents migrated from rural to urban settings for better employment opportunities and higher salaries, leaving their children in their hometown on account of high living expenses and huge obstacles to health care and education in urban regions (21). Rapid population mobility has placed tremendous burdens on migrants and their families (22). As the product of this phenomenon, "left-behind children" has aroused great concern. Left-behind students refer to underage students who stayed at rural areas while one or both of their parents leave to work in cities for at least 6 months (23). Non-left-behind students might have experienced more parental supervision and more actual parental company (24), which might reduce the effect of perceived social support on loneliness. Therefore, we hypothesized that the association between perceived social support and loneliness would be strengthened for left-behind students in rural China during COVID-19 pandemic.

To date, there is an absence of the studies on the potential mechanisms underlying the association between social support and depressive symptoms among rural Chinese adolescents during COVID-19 pandemic. Therefore, the present study aimed to investigate (a) the prevalence of depressive symptoms among rural adolescents during COVID-19 pandemic, (b) whether perceived social support is negatively associated with depressive symptoms, (c) whether loneliness mediates the association between perceived social support and depressive symptoms, and (d) whether the path between perceived social support and

loneliness differs between left-behind students and non-left-behind students in rural China during COVID-19 epidemic. A moderated mediation model (see **Figure 1**) is constructed to address the hypotheses that the effect of perceived social support on depressive symptoms was mediated by loneliness and moderated by left-behind status. Specifically, the relationship between perceived social support and loneliness would be more powerful in left-behind students than non-left-behind students.

METHODS

Participants and Procedures

The cross-sectional study was conducted from 28 April to 1 May, 2021 in rural regions of Anhui province, China, which is a one of the principal migrant-sending areas of China (25). A random cluster sampling was employed to obtain a sample of rural students from 15 classes in five senior high schools. The inclusion criteria were (a) age $\leq$ 18 years; (b) no cognitive impairment or/and dyslexia and (c) being born and raised in a rural setting. The exclusion criterion was set for subjects who were previously diagnosed with psychiatric illness. A total of 831 rural students were invited to take part in the study, with one student refusing to answer the questionnaire and 4 students returning incomplete questionnaire. Finally, a total of 826 rural students were included in the analysis (effective response rate 99.4%).

This research was approved by the Research Ethics Commission of Navy Medical University. The participants aged 18 years or the parent or legal guardian of the participants aged under 18 years provided written informed consent before the participants anonymously completed the survey in the classroom. All participants were free to withdraw from the study at any time.

Measures

Demographics

The socio-demographic variables included age ($\leq$16 or $>$16), sex (male and female), parental highest educational attainment (junior middle school or below and high school or above), family structure (intact family and disrupted family), perceived socioeconomic status (blow average and average or above) (26, 27), only-child status (whether they were the only child in their families) and left-behind status (whether one of the parents or both parents migrated to work in cities for at least 6 months). Students from disrupted family referred to students whose parents separated, divorced, deceased or never married (28). Students from intact family was defined as those with both biological parents present and married (29, 30).

Social Support

The Chinese version of Perceived Social Support Scale (PSSS) is a 12-item self-report measure assessing the perception of social support from three domains (31): family (i.e., "I can talk about my problems with my family"), friends (i.e., "I have friends with whom I can share my joys and sorrows") and significant other (i.e., "There is a special person who is around when I am in need"). Each item is scored on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7(strongly agree). The total score is obtained by summing the scores of all items and ranged from 12 to 84 with the higher scores denoting higher levels of perceived social support. The scale has demonstrated satisfactory reliability and validity and been successfully used in adolescents (32, 33). In the present study, the Cronbach's alpha was 0.921, 0.857, 0.841, and 0.815 for total scale, family subscale, friend subscale and significant other subscale.

Loneliness

The 20-item UCLA Loneliness Scale was used to evaluate the feelings of loneliness. Subjects were asked to rate each item on a 4-point Likert-type scale from "0" (I never feel this way) to "3" (I often feel this way). All 20 items were summed up to create a total score ranging from 0 to 60, with higher scores indicating higher levels of loneliness. The measure has been widely used among Chinese adolescents with demonstrated psychometric properties (34). In the present study, Cronbach's alpha was 0.833.

Depressive Symptoms

Depressive symptoms were measured by Patient Health Questionnaire-9 (PHQ-9). Each item is answered on a 4-point Likert scale ranging from "0" (none) to "3" (almost every day). The range for the scale is between 0 and 27, with a higher score denoting greater depressive symptoms. The cutoff score for detecting depressive symptoms was 5 (35, 36). The scale has been used extensively among adolescents and shown adequate reliability and validity (37, 38). In the current study, Cronbach's alpha was 0.855.

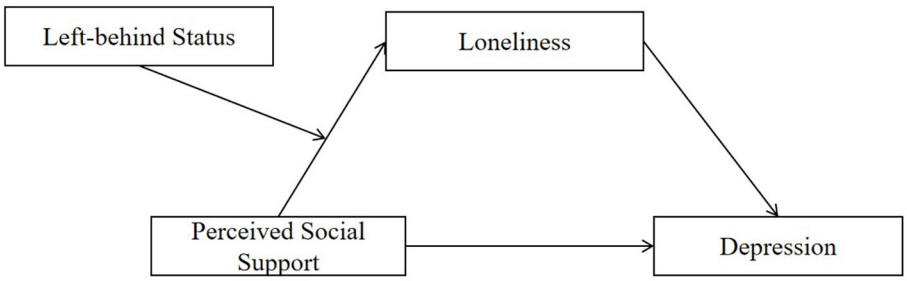

FIGURE 1 | Conceptual model.

Statistical Analysis

Firstly, common method bias was examined using Harman single factor test and descriptive analyses were calculated to describe the sociodemographic characteristics stratified by left-behind status. Secondly, linear regressions were performed to calculate the univariate association between demographic variables and greater depressive symptoms stratified by left-behind status and Pearson's correlation analyses were conducted to investigate the bivariate correlations between the variables of interest. Thirdly, the mediation effect was tested by MacKinnon's four-step procedure (39). Four specific requirements should be met: (1) a significant association between perceive social support and greater depressive symptoms; (2) a significant association of perceived social support with loneliness; (3) a significant association between loneliness and greater depressive symptoms when perceived social support was controlled; (4) the significant coefficient of indirect pathway between perceived social support and greater depressive symptoms via loneliness. Bias-corrected percentile bootstrap method was used to determine the last condition, producing a 95% bias-corrected confidence interval (CI) from 5,000 resamples. Hayes (40) PROCESS macro (Model 4) was employed to estimate the parameter. Finally, Hayes (40) PROCESS macro (Model 7) was utilized to examine the moderated mediation model, followed by simple slope test.

Age, sex, parental highest educational attainment, perceived family economic status, family structure and only-child status were included in all models as potential confounders. We standardized all variables before modeling. Statistical analyses were conducted using SPSS version 26. Statistical significance was considered as $p < 0.05$ (two-tails).

RESULTS

Common Method Bias Test

Given that the research data were obtained by self-report using an online questionnaire, Harman single factor was employed to examine whether common method bias would be a potential validity threat (2, 41). The KMO value was 0.92 ($p < 0.001$), which indicated the research data were suitable for factor analysis. There were seven values with eigenvalue more than 1 and the first factor presented a variance of 23.786%, which did not reach the criterion of 40%. Therefore, the results suggested common method bias was not a serious problem in the study.

Descriptive Statistics Stratified by Left-Behind Status

Table 1 presented the demographic characteristics of the left-behind students and non-left-behind students. Among 826 adolescents, 591 (71.5%) were left-behind students. Most participants were aged between 17 and 18 years (77.2% in left-behind students, 74.5% in non-left-behind students), were male (57.4% in left-behind students, 56.6% in non-left-behind students), reported a parental highest educational level of junior middle school or below (77.5% in left-behind students, 76.3% in non-left-behind students), perceived family economic status to be average or above average (81.7% in left-behind students, 76.6% in non-left-behind students), were from intact family (90.7% in left-behind students, 91.9% in non-left-behind students), and were not the only child in their family (90.0% in left-behind students, 91.5% in non-left-behind students).

TABLE 1 | The demographic characteristics of the left-behind students and non-left-behind students (N = 826).

Variables	Total (n = 826)	Left-behind students (n = 591)	Non-left-behind students (n = 235)
	No. (%)	No. (%)	No. (%)
Total	826 (100)	591 (71.5)	235 (28.5)
Age (years)			
≤16	195 (23.6)	135 (22.8)	60 (25.5)
>16	631 (76.4)	456 (77.2)	175 (74.5)
Sex			
Male	472 (57.1)	339 (57.4)	133 (56.6)
Female	354 (42.9)	252 (42.6)	102 (43.4)
Parental highest educational attainment			
Junior middle school or below	631 (76.4)	458 (77.5)	173 (73.6)
High school or above	195 (23.6)	133 (22.5)	62 (26.4)
Perceived family economic status			
Below average	163 (19.7)	108 (18.3)	55 (23.4)
Average/above average	663 (80.3)	483 (81.7)	180 (76.6)
Family structure			
Intact family	752 (91.0)	536 (90.7)	216 (91.9)
Disrupted family	74 (9.0)	55 (9.3)	19 (8.1)
Only child			
Yes	79 (9.6)	59 (10.0)	20 (8.5)
No	747 (90.4)	532 (90.0)	215 (91.5)

Associations of Demographic Variables With Depressive Symptoms

The prevalence of depressive symptoms was 77.6% among Chinese rural students during COVID-19 pandemic. The prevalence of depressive symptoms was 77.7% among left-behind students, while the rate of depressive symptoms was 77.4% among non-left-behind students. The results of the univariate logistic regression (see **Table 2**) showed that across the overall sample, female adolescents were more likely to experience depressive symptoms than their male counterparts ($\beta = 2.346$, 95% CI = [0.132, 1.483]). Nevertheless, the difference disappeared in non-left-behind students. In the overall sample, students from disrupted family reported more symptoms of depression than those from intact family ($\beta = 2.224$, 95% CI = [0.156, 2.497]). However, the disparity was not significant in left-behind students.

Bivariate Analysis

Table 3 presented the descriptive statistics and correlations among variables of interest. The results showed that perceived social support and all three subscales were all significantly and negatively correlated with loneliness and depression (all $P < 0.001$). Loneliness was significantly and negatively related to depression ($P < 0.001$).

TABLE 2 | Association of demographic characteristics with depressive symptoms stratified by left-behind status ($N = 826$).

Variables	Total sample ($n = 826$)	Left-behind students ($n = 591$)	Non-left-behind students ($n = 235$)
	β (95% CI)	β (95% CI)	β (95% CI)
Age (years)			
≤16	Reference	Reference	Reference
>16	−1.701 (−1.475, 0.101)	−1.629 (−1.723, 0.161)	−0.688 (−1.959, 0.945)
Sex			
Male	Reference	Reference	Reference
Female	2.346 * (0.132, 1.483)	2.153 * (0.077, 1.673)	0.997 (−0.630, 1.922)
Parental highest educational attainment			
Junior middle school or below	Reference	Reference	Reference
High school or above	−0.913 (−1.156, 0.422)	−0.866 (−1.367, 0.530)	−0.274 (−1.638, 1.237)
Perceived family economic status			
Below average	Reference	Reference	Reference
Average/Above average	−1.755 (−1.593, 0.089)	−1.162 (−1.630, 0.418)	−1.510 (−2.631, 0.348)
Family structure			
Intact family	Reference	Reference	Reference
Disrupted family	2.224* (0.156, 2.497)	1.344 (−0.430, 2.294)	2.062* (0.107, 4.715)
Only child			
Yes	Reference	Reference	Reference
No	0.951 (−0.588, 1.691)	0.492 (−0.991, 1.653)	1.083 (−1.020, 3.511)

*$P < 0.05$.

TABLE 3 | Descriptive statistics and correlations among variables ($N = 826$).

	Mean (SD)	1	2	3	4	5	6
1. Left-behind status	1.28 (0.45)						
2. Friend subscale of PSSS	17.29 (5.28)	0.011					
3. Family subscale of PSSS	17.01 (4.91)	−0.015	0.615***				
4. Significant others subscale of PSSS	17.09 (4.91)	−0.029	0.696***	0.763***			
5. Perceived social support (PSSS)	51.38(13.45)	−0.012	0.871***	0.885***	0.917***		
6. Loneliness	47.92 (8.55)	−0.042	−0.381***	−0.477***	−0.459***	−0.459***	
7. Depression	8.16 (4.91)	−0.034	−0.297***	−0.296***	−0.296***	−0.296***	0.425***

***$P < 0.001$.

TABLE 4 | Mediation analysis ($N = 826$).

	Model 1(Depression)		Model 2 (Loneliness)		Model 3(Depression)		Indirect effect of loneliness				
	β	t	β	t	β	t		Indirect effect	SE	LLCI	ULCI
Perceived social support	−0.327***	−9.934	−0.487***	−16.050	−0.163***	−4.533	Loneliness	−0.164	0.022	−0.209	−0.122
Loneliness					0.337***	9.353					
R^2_{adj}	0.125		0.257		0.210						
F	16.751***		40.314***		27.140***						

All models are adjusted for age, sex, parental highest educational attainment, perceived family economic status, family structure, and only-child status.
***$P < 0.001$.

Analysis of Loneliness as a Mediator

To examine the mediating effect of loneliness, MacKinnon's (39) four-step procedure was performed. Firstly, perceived social support was significantly associated with depressive symptoms ($\beta = -0.327$, $P < 0.001$) (see Model 1 in **Table 4**). Secondly, perceived social support was significantly related to loneliness

($\beta = -0.487$, $P < 0.001$) (see Model 2 in **Table 4**). Thirdly, loneliness was significantly associated with depressive symptoms after controlling for perceived social support ($\beta = 0.337$, $P < 0.001$) (see Model 3 in **Table 4**). Finally, the result of the biased-corrected percentile bootstrap method suggested the indirect effect of perceived social support on depressive symptoms through loneliness was significant since the 95% CI does not include zero (ab = −0.164, SE = 0.022, 95% CI = [−0.209, −0.122]). The mediation effect accounted for 49.76% of the total effect. Therefore, all four requirements for the mediating role of loneliness were met and loneliness mediated the impact of perceived social support on depressive symptoms.

Testing for Moderated Mediation

The present study hypothesized that left-behind status would moderate the impact of perceived social support on loneliness.

TABLE 5 | Testing the moderated mediation effect (*N* = 826).

	β	*SE*	LLCI	ULCI
Mediator variable model (Outcome: Loneliness)				
Perceived social support	−0.492***	0.030	−0.552	−0.433
Left-behind status	−0.104	0.067	−0.235	0.027
Perceived social support × Left-behind status	0.174**	0.065	0.047	0.301
Dependent variable model (Outcome: Depression)				
Perceived social support	−0.163***	0.036	−0.233	−0.092
loneliness	0.337***	0.036	0.267	0.408
Conditional indirect effect analysis				
Left-behind students	−0.183	0.025	−0.233	−0.136
Non-left-behind students	−0.124	0.025	−0.178	−0.080
Index of moderated mediation	0.059	0.025	0.010	0.106

All models are adjusted for age, sex, parental highest educational attainment, perceived family economic status, family structure, and only-child status.
***P < 0.01.*
****P < 0.001.*

The results presented that the interaction between perceived social support and loneliness had a significant effect on depression ($\beta = 0.174$, $P < 0.01$), indicating the effect of perceived social support on loneliness was moderated by left-behind status (see **Table 5**). Thus, the moderated mediation model was established as the first stage of the mediation effect was moderated by left-behind status.

The results of the simple slope analysis showed that perceived social support was significantly and negatively associated with loneliness for left-behind students ($\beta_{simple} = -0.542$, $P < 0.001$), while for non-left-behind students, the association between perceived social support and loneliness was still significant, but much weaker ($\beta_{simple} = -0.369$, $P < 0.001$). For descriptive purposes, the current study plotted the association of perceived social support with loneliness, separately for left-behind and non-left-behind adolescents (see **Figure 2**).

Table 5 also showed the conditional indirect effect of perceived social support on depression. The 95% CI that does not contain zero suggested the establish of moderated mediation model. Specifically, the indirect effect of perceived social support on depression via loneliness was stronger for left-behind students ($\beta = -0.183$, 95% CI = [−0.233, −0.136]) in comparison to non-left-behind students ($\beta = -0.124$, 95% CI = [−0.178, −0.080]).

DISCUSSION

The results presented that the overall prevalence of depressive symptoms among rural adolescents in China was 77.6% during COVID-19 epidemic, which is much higher than the previously-reported prevalence among Chinese adolescents (11.8–57.0%) during COVID-19 pandemic (42, 43). In addition, this is also higher than the existing range of the prevalence of depressive symptoms (12.1–51.4%) among rural adolescents in the non-epidemic period (44, 45). In line with the previous literature (46), the difference in the prevalence of depressive

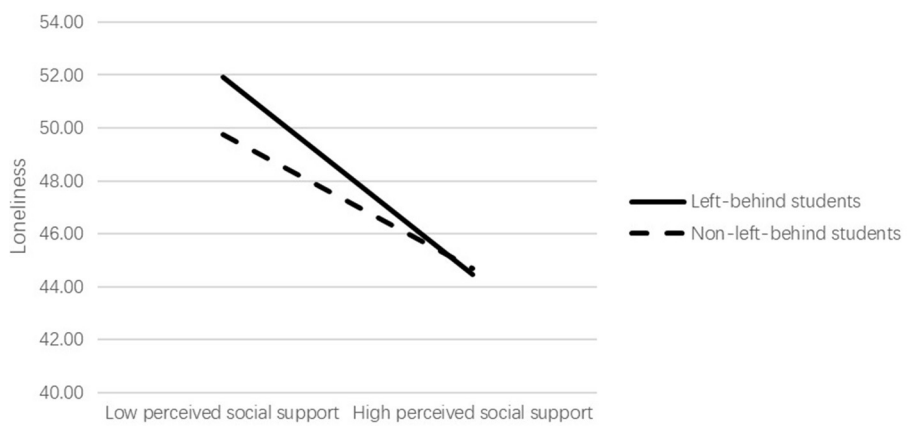

FIGURE 2 | Left-behind status as a moderator of the association between perceived social support and loneliness.

symptoms between left-behind students and non-left-behind students was not significant. Thus, depressive symptoms are very common among both left-behind and non-left-behind students during COVID-19 pandemic because of the unpleasant experiences during the COVID-19 pandemic such as worry about infection, lack of interpersonal contact with friends, limited private space at home and frequent conflict with family members (43).

Our results presented that females reported higher levels of depressive symptoms only among left-behind students. According to ABC model, the sex differences of depression could be attributed to the affective (emotional stability), biological (genetics, pubertal hormones, and neural development) and cognitive (cognitive styles, rumination, and objectified body consciousness) factors (47, 48). Evidence from the previous literature (49, 50) suggested that left-behind students were more likely to use negative coping styles and have emotional problems, which might partially explain why sex differences were only observed in left-behind students. Our findings also showed that family structure was associated with depressive symptoms only among non-left-behind students. Compared with non-left-behind students from intact families, those from disrupted families were more likely to experience depressive symptoms, which is consistent with the previous literature (51). Parental divorce is associated with less parental care and an elevated risk of emotional and behavioral problems (52, 53) such as social problems, withdrawal, juvenile delinquency, which would make them more susceptible to psychological symptoms. For left-behind students from both intact and disrupted families, they do not live with both parents and might lack parental care since at least one of their parents migrates to work (54). Hence, no significant effect of family structure on depressive symptoms was observed among left-behind students.

As hypothesized, loneliness partially mediated the association between perceived social support and depressive symptoms among rural adolescents during COVID-19 pandemic, which was consistent with the previous literature (17, 18, 55). According to the theory of mental incongruity, loneliness occurs when individuals perceived a difference between their expected and actual levels of social support (56). Thus, rural adolescents with lower levels of perceived social support might be more likely to feel loneliness, which would further result in depressive symptoms. In addition, the results of the moderated mediation model also revealed that the left-behind status moderated the indirect impact of perceived social support on depression through loneliness among rural adolescents during the pandemic. Specifically, the association between perceived social support and loneliness was stronger for left-behind students in comparison to non-left-behind students. This might be attributed to the absence of parental care among left-behind students, including physical companionship, parental supervision and parental guidance (57), which might contribute to the strengthened association between perceived social support and loneliness among left-behind adolescents.

The current study has profound implications both theoretically and practically. In theory, our findings shed insight into the underlying mechanisms linking perceived social support to depressive symptoms among left-behind adolescents during the COVID-19 outbreak. In practice, our results could inform healthcare professionals to develop more targeted interventions for preventing depressive symptoms in rural adolescents amid the COVID-19 crisis. Programs to enhance perceived social support may be an important aspect of depression prevention for rural students. Moreover, interventions for alleviating loneliness, such as mediation, mindfulness and social cognitive skills training (58), should also be designed and prioritized for left-behind students.

Several limitations need to be noted when evaluating the findings of our study. Firstly, the study design of the current research is cross-sectional, indicating the causality could not be established since the data only represent a given point in time. Hence, further longitudinal studies should be conducted to validate the results. Secondly, self-reported measurements were employed in the study, which might result in self-report biases. Further research could collect data from multi-informants (i.e., classmates and teachers). Thirdly, students in our study sample were only from Anhui province in China, which might limit the generalization of our results. Currently, our results could generalize to rural students in Anhui province. In the future studies, multicenter approaches are recommended to recruit participants. Finally, depressive symptoms of students in rural China could be influenced by many other variables. The model in the present study could only explain a part of the variance. Therefore, further research is suggested to incorporate more factors for a more comprehensive understanding of depressive symptoms among rural students.

As far as we know, this is the first study reporting the prevalence of depressive symptoms among rural adolescents during COVID-19 pandemic and investigating the potential mechanisms underlying the association between perceived social support and depression among this specific group. Depressive symptoms are prevalent in 77.6% of rural adolescent during the COVID-19 pandemic. Healthcare professionals and the government should pay special attention to rural adolescent, especially female left-behind students and non-left-behind students from disrupted families. Rural adolescents with lower levels of perceived social support, especially left-behind students, could benefit from the interventions aimed at enhancing the perceived social support and reducing loneliness.

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 Second Military Medical University. Written

informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

TH, YX, and XM contributed to the writing of this article and the statistical analysis and are the co-first authors. WC organized the whole study, including carrying out this study, putting forward the study, and were the corresponding authors. YL, JW, YC, and ZL contributed to the design and statistical analysis. All authors contributed for editing the article and have approved the final manuscript.

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Does a Sense of Social Presence During Conversation Affect Student's Shared Memory? Evidence From SS-RIF Paradigm

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People constantly talk to one another about the past, and in so doing, they recount certain details while remaining silent about others. Collaborative or conversational remembering plays an important role in establishing shared representations of the past (e.g., the 911 attacks, Covid-19). According to the socially shared retrieval-induced forgetting (SS-RIF) effect, a listener will forget about relevant but unpracticed information during communication, due to intentional or unintentional selective retrieval of data by the speaker. The SS-RIF paradigm has been applied to explain how collective memory is shaped within the context of conversation/discourse. This study sought to determine if SS-RIF occurred only during face-to-face communication, or whether shared memories could be developed through other types of conversation quite common in modern society. We also investigated whether a level of social interaction in the real-world presence of others is a necessary condition for inducing SS-RIF, and if listeners experience different degrees of SS-RIF due to different levels of perceived social presence. We observed the SS-RIF phenomenon in listeners both in real life and video; the degree of forgetting was the same for the two conditions. These results indicate that social presence may not be associated with SS-RIF. Public silence affects the formation of collective memory regardless of the face-to-face presence of others, and thus physical presence is not necessary to induce SS-RIF.

Keywords: socially shared retrieval-induced forgetting, social presence, presence of others, public silence, collective memory, shared memory

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INTRODUCTION

Often, one can recall an event shared with someone else and form similar memories of that event. Such memories could involve the reunion of classmates, sweet recollections between lovers, or happy stories told by an elderly family member. They might also relate to the 911 attacks in the United States, the massive earthquake in China on May 12, or a major public health emergency like COVID-19, which was experienced around the world. Information exchanged with others forms shared memories in groups large and small, otherwise known as collective memories. These powerful recollections are contributed and shared by others, and exploring them allows us to better understand how a particular group chooses to

remember their past. When asked to recall World War II, for example, people may report a wide variety of events, but most Americans will reference the attack on Pearl Harbor, D-Day, and the bombings of Hiroshima and Nagasaki.Russians are much more likely to recall the Battle of Stalingrad. As Maurice Habwach, the researcher who coined the term"collective memory" has said, all of our memories are recorded through the filters of collective and social memory. Collective memory is "branded" on each individual and group, and has a permeating influence on all kinds of activities. For example, a long colonial history might "shame" a country (in the form of a collective memory) if encounters after independence resulted in damage (even unintentionally). The result is an easy reminder of humiliation and other strong negative emotions.

Collective memory is closely related to public events that affect a variety of aspects on the national, societal, group, and individual levels. Therefore, although the reasons for forming collective memories are complex and different disciplinary systems (e.g., sociology, history, psychology, etc.) have a variety of theoretical frameworks for discussing them, more and more, researchers have begun exploring the formation process and mechanism of collective memory development from the perspective of empirical research in psychology. For example, studies on public silence have found that socially-driven silence in a speaker's narration will lead listeners to forget events specific to themselves, while dialogue-induced forgetting may lead to collective amnesia (1). Conversations often serve as a vehicle by which memories spread throughout a community. In daily communication, the intentional or unintentional selective mention (A, C) of various parts of a body of information (ABCD) referencing an event experienced by listeners and speakers in a certain group may affect their shared memory about that event. Retrieval-induced forgetting (RIF) and socially shared RIF (SS-RIF) are important research paradigms currently being used to explore the process of and factors influencing collective memory formation. However, when the paradigm shifts from individual to group memory, many questions remain unanswered. For example, what are the boundary conditions that trigger collective memory? Will the Internet and virtual characters have the same effect on such memories as they do in real life? Our research attempts to answer these questions.

RIF refers to when an individual selectively practices information related to a cue, other relevant but unpracticed information is forgotten. This phenomenon has been well-demonstrated in the laboratory (2). In real life, people often recall (or retrieve) certain events together with others, such as the reunion of students after graduation or listening to stories told by the elderly. Information shared with others forms similar memories of certain events shared by the group. However, during information transmission, the conversation content will omit some information and selectively retrieve other data, whether intentionally or unintentionally. Does the listener forget the specific information? Cuc et al. (3) introduced a social dimension to Anderson's method, simulating a scene of information exchange between individuals in real life. In the retrieval practice phase, one of the subjects acted as the speaker and the other the listener. In the final recall stage, the speaker and listener were asked to recall all the items discussed, according to certain clues. The researcher found that listening to someone else's memory induced the listener to forget. Cuc called this finding SS-RIF.

Previous studies have shown that SS-RIF has certain levels of stability related to age, learning material, and presentation situation (e.g., face-to-face communication, text, audio, video) (3–6). In these studies, listeners were required to monitor the accuracy of a speaker's information, or "pay close attention to all the information provided" to ensure that the listeners invested certain cognitive processing resources to jointly "implicitly" retrieve the selective memory of the speaker, indicating that a certain level of participation was an important condition for triggering the SS-RIF effect (3, 5). One recent study found that when subjects were required to "listen to monitoring," in cases where others were virtually present (i.e., in the recording situation), the SS-RIF effect was not observed. Only in situations where others were physically present did the SS-RIF effect appear, suggesting that the instruction to "listen carefully" may not decisively induce the SS-RIF effect, but the presence of real others is one of the boundary conditions to induce this effect (7).

According to social facilitation theory, the presence of others can arouse individuals and affect their attitude and behavior (8). Such presence also increases a person's drive or motivation and enhances the efficiency of their activities (9). A study comparing preschoolers' learning of receptive and expressive words with and without adults found support for this view. Even when there was no eye contact or verbal communication between the adults and children, the presence of others enabled the preschoolers accompanied by adults to learn more expressive words than did those who were unaccompanied (10). This indicates that the mere presence of others can promote individual behavioral motivation, promote the co-retrieval between the listener and the speaker, and induce SS-RIF effect in the presence of real others. Mere presence is part of the sense of social presence; that is, an individual does not communicate with others but rather refers to the mere physical presence of others. For example, for long-distance runners, a man sitting on a bench near the track is mere presence, and realizing the presence of the man can bring the runner that mere presence (11). Therefore, when listeners interact with real people, they are likely to perceive the social presence of others, notice that presence, and be more inclined to co-retrieve with the speaker. However, in the recording condition, the listener's perception of other people's social presence is low, so the listener and speaker cannot be encouraged to jointly retrieve, or the degree of joint retrieval is very low.

Social presence refers to the degree of individual exposure in group interactions or interpersonal relationships (12). Short et al. (12) argued that social presence refers to the degree of perception by which a person is seen as a "real person" and perceived to be connected to others in the process of using media to communicate. Previous studies have shown that social presence is composed of copresence (e.g., one person perceiving another person's physical distance with the naked eye), psychological involvement (e.g., interactivity, intimacy, directness of interpersonal relationships, mutual understanding),

and behavioral engagement (e.g., eye contact, non-verbal mirroring, turn-taking, etc.) (13). In this study, based on the literature review of social presence by Biocca et al. (13), four dimensions were selected to measure and discuss social presence according to research needs, namely space, accessibility, intimacy and engagement. The degree to which information is jointly retrieved by the listener and speaker is affected by various factors of social presence, such as intimacy and proximity; namely, this is embodied in physical distance, eye contact, expression language, and the level of psychological reserve between two parties (14). Barber and Mather (15) speculated that when talking with people of the same sex, listeners believed that they were closer to the speaker; people jointly retrieve more information with those close to them, and thus the degree of SS-RIF is higher. In addition, intimate relationships can make past shared conversations present a common presentation (16), while physical distance and non-verbal cues of the speaker (e.g., facial expressions, eye contact) act together on psychological distance, working to further the intimacy and accessibility of the interacting partners. For example, proximity tends to produce affection and make people feel close (17). Therefore, in the case of close face-to-face interactions, listeners perceive a high degree of closeness when interacting with real people, and thus are more inclined to co-retrieve with these others.

Recent studies have shown that there is no SS-RIF effect in virtual confederate (i.e., recording) contexts (7). The reason for this may be that the lack of eye contact between the speaker and listener leads to an insufficient perception of the speaker's sense of social presence and closeness; the lack of closeness could cause inducement of the SS-RIF effect to fail (15). Eye contact, as a non-verbal cue in human interaction, is considered the basis of all social interaction. It marks the initiative and motivation of communication to approach other individuals, and can not only trigger automatic emotional arousal and attention responses (18), but also enhance the cross-brain congruence of interacting parties (19, 20) in social interaction, promoting a level of social intercourse. A real-time eye contact fNIRS study found that compared to a prerecorded dynamic video face, when watching a real partner face-to-face and in real-time, the cross-brain congruence of both interacting parties was enhanced in terms of in the angular gyrus signals. This shows that a real gaze between human partners supports the sharing of interactive behavior, and this kind of dynamic eye contact and face behavior makes the individual's mentality different. The difference in mentality between the two provides additional social information, promoting the activity of the temporoparietal junction (21). The difference in mindset may be due to the closeness of the social presence, since eye contact is a sign of accessibility among interacting parties. Therefore, if the social interaction level of "eye contact" is added to the recording context (i.e., the virtual confederate), the question is: will the presence of the video condition induce SS-RIF under the same premise of closeness?

One study investigating the influence of social networks on the SS-RIF phenomenon argued that increasing the social presence of conversation partners through video interaction may accelerate memory convergence, due to the increase in social pressure to conform (22). Therefore, we argue that, similarly, under the context of "eye contact" and "a real image," the listener will still feel close, a condition brought about by the high degree of social presence with real speakers. In the video presence of others, the listener will feel a slightly reduced sense of social presence; both physical and psychological distance will be greater, thus decreasing approachability. The difference in perceived social presence may result in a difference in SS-RIF.

Overview and Hypotheses

The real presence of others is important for understanding the formation of SS-RIF and collective memory. Currently, people do not need to communicate face-to-face to share information. With the development of modern information technology, we can now speak with others all over the world. Therefore, in the context of real and virtual crowds, a question remains as to which condition is more likely to promote the joint retrieval of listeners and speakers. According to current research, the "careful listening" of a listener while in the physical presence of others can certainly induce the SS-RIF effect. However, can the presence of real people in a video also successfully induce the SS-RIF effect? If SS-RIF can be induced, does the degree of forgetting differ from conditions in which the listener is in the presence of real people? Does the sense of social presence at different levels of social interaction cause different degrees of common retrieval, due to the difference in physical and psychological distance? We compared the SS-RIF effect in real and video confederate contexts with "eye contact" to explore the influence of social presence and its sub-factors (space, accessibility, intimacy, participation) on SS-RIF. We hypothesized that both contexts could successfully induce SS-RIF when social presence is high enough. In the real confederate context with "eye contact," listeners tended to co-retrieve information with the speaker, due to the high degree of closeness brought about by the speaker's strong sense of social presence, resulting in a high degree of SS-RIF. In the case of eye contact between the listener and others through a video, a low degree of SS-RIF was generated in the listener, due to the low degree of closeness caused by the weak sense of social presence from the distant speaker.

MATERIALS AND METHODS

Participants

We used G Power 3.1, referred to the effect size of the main effect of project type ($f = 0.5$, Experiment 1) in the study of (3), and defined the size of effect size by (23) to set the medium effect size $f = 0.3$. A priori power analysis shows that a large effect size of $f = 0.30$ is detected when at least 26 participants are required, with a power set of 0.95 and an alpha set of 0.05. Sixty-two participants were recruited, forming a retrieval group with the experimenter. Thirty-one participants ($M_{age} = 20.45$, $SD = 2.36$, 22 women and 9 men) were randomly assigned to be members of the real speaker context group; the other 31 participants ($M_{age} = 20.10$, $SD = 2.01$, 15 women and 16 men) were randomly assigned to be members of the video speaker context group. To avoid the possible influence of social relationships on memory

results, the participants and experimenter were all strangers and of the same sex. All participants were native Chinese speakers.

Design and Materials

This study adopted a 2 × 4 mixed experimental design with social interaction level serving as a between-subjects variable (real speaker context vs. video speaker context), item type as a within-subjects variable (Rp + vs. Rp – vs. Nrp + vs. Nrp–). We also age-calculated the retrieval accuracy of the subjects in the final memory test.

Materials were selected from the 10 semantic categories in the Chinese sample lexical library developed by (24) (the correlation between each category was low; for example, "vegetable" was selected but not "fruit"). We selected three items with high and three items with low classification frequency under each category, for a total of 60 words. Two category words were selected as filling material. All sample words were low-frequency, and there was no significant difference in familiarity, initial stroke, or final stroke of the sample words in each category (see the **Appendix 1** for details). At the same time, to maximize the degree of the RIF effect and prevent strong samples from being more likely to cause interference in the retrieval practice phase and be easily damaged by the retrieval of weak samples, we adopted the operation method in (25). In the Nrp category, the sample words are divided into high correlation words (Nrp–) and low correlation words (Nrp+). The participants were asked to listen to the low correlation words (Rp+) mentioned by the experiment assistant in the retrieval practice phase. If the final recall rate of Rp+ items was higher than that of the low correlation words (i.e., Nrp+) in the category of unpracticed exercises, this indicated that the retrieval induced a facilitation effect. If the final recall rate of high correlation words (Rp–) was lower than that of high correlation words (Nrp–) in the category of unpracticed exercises, this indicated that a retrieval-induced forgetting effect occurred. After the formal experiment, to prevent the influence of social factors on individual memory, we used the Group Preference Scale (26) and Self-Evaluation Model Scale (27) to measure group preference under different levels of social interaction: (1) The GPS has 10 items which are scored on 5-point Likert scale ranging from 0 ("not at all") to 4 ("very much") with a total score of 40 points, and the higher the score, the more participants preferred to work with others. It should be noted that 2, 5, 8, and 10 are reverse-scored item [e.g., I would rather study alone than in a group (see the **Appendix 2** for details)]. Cronbach's α of the GPS in the present study was 0.81. (2) Self-Evaluation Model Scale has 5 items which are scored on a 5-point Likert scale ranging from 0 ("not at all") to 4 ("very much"). Three and five are reverse-scored item [e.g., The test was boring (see the **Appendix 3** for details)]. Total scores on 5 items indicated the participants' enjoyment of the task. Cronbach's α of the Self-Evaluation Model Scale in the present study was 0.84. Subjective reporting was used to measure four dimensions of social presence (space, accessibility, intimacy, and engagement), with scores for each dimension calculated using a 7-point Likert scale ranging from 1 ("very low") to 7 ("very high"). The higher the score, the higher the individual's perceived social presence (see the **Appendix 4** for details).

Procedure

After listening to the instructions, participants engaged in the formal experiment, which was divided into four stages: learning, retrieval practice, distraction, and testing. Participants in the real speaker context were told before the formal experiment that the experimenter would act as their partner and learn the word pairs with them.

During the study phase, participants were shown all 60 category-exemplar words. Each pair was displayed in the center of a screen for 2,000 ms, with the category label on the left and category members on the right. The presentation of pairs of words was pseudorandom, with the limitation that two words belonging to the same category could not appear consecutively. In the study phase of the real speaker context, the confederate and participant sat facing the computer screen to learn the word pairs. In the video speaker context, the participant sat alone facing a computer screen and learned word pairs.

The practice phase consisted of two cycles, each of which was comprised of 16 category items, 12 Rp+ and four filler item trials. To control for primacy effect and recency effect, the first and last items in each block were filled items. The order of the remaining items was pseudorandom. Randomization of the experimental material was performed by E-prime 2.0. In the retrieval practice phase for the confederate context, the participants sat face-to-face with the experimenter and were asked to look into the eyes of the experimenter and listen to them carefully. At the end of the retrieval practice phase, the participants completed a two-digit addition and subtraction task, and then a recall task. In the video speaker context, the participants were left alone in the lab in front of a computer to complete an experimental task (i.e., watching a video material). The computer plays video material recorded by the same sex lab assistant. In this video, the lab assistant will speak to the camera about the retrieval-practice information. Similarly, we also required the participants to watch the video looking their partners in the eye and carefully listening to the information. After finishing the retrieval phase, the participants engaged in distraction and recall test tasks.

After the formal experiment, the two groups of subjects filled in the group preference and self-evaluation model scales.

RESULTS

Comparison of Mean Values of Variables in Posttest Tasks

We conducted an independent sample t-test on the group preference scores of the participants in the presence of real and video others. The results show that there was no significant difference in the level of group preference scores between the presence of real others ($M = 23.65$, $SD = 7.09$) and the presence of video others ($M = 21.1$, $SD = 8.9$), $t_{(60)} = 1.319$, $p = 0.192$; and then we did the same independent sample t-test for self-evaluation scores, the results show that there was no significant difference in the level of self-evaluation scores between the presence of real others ($M = 15.83$, $SD = 2.95$) and the presence of video others ($M = 15.06$, $SD = 3.74$), $t_{(60)} = 0.905$, $p = 0.369$. This analysis revealed that this experiment controlled for

TABLE 1 | Descriptive statistics for factors influencing Listeners' sense of social presence.

Social interaction level	Social presence	Space	Accessibility	Intimacy	Participation
Real speaker context	20.32 (4.33)	5.26 (1.29)	5.23 (1.36)	4.42 (1.57)	5.42 (1.36)
Video speaker context	13.23 (4.73)	2.83 (1.51)	3.42 (1.59)	2.81 (1.17)	4.16 (1.49)

Mean value are displayed in absolute numbers. Standard deviations are shown between parentheses.

TABLE 2 | The correct recall rate of listeners on item types under different experimental conditions.

Social interaction level	Rp+	Nrp+	Rp-	Nrp-
Real speaker context	0.73 (0.18)	0.35 (0.13)	0.35 (0.17)	0.50 (0.15)
Video speaker context	0.59 (0.18)	0.31 (0.15)	0.35 (0.18)	0.52 (0.17)

Mean value are displayed in absolute numbers. Standard deviations are shown between parentheses.

the influence of social factors such as group preference and self-evaluation on individual memory.

Comparison of Listeners' Social Presence Score and Influential Sub-Factors Under Different Levels of Social Interaction

Table 1 describes the results of the descriptive form of listeners' social presence scores and influential sub-factors at different levels of social interaction. An independent sample *t*-test was conducted for the real and the video speaker groups. The results show that there were significant differences in the sense of social presence between the two, $t_{(60)} = 6.155$, $p < 0.001$, and the sense of social presence in the real speaker context was significantly higher than in the video context. There were also significant differences between the two groups in terms of factors influencing social presence, with the real speaker context being significantly higher than the video speaker context, $t_{spatialsense}$ (60) = 6.788, $p < 0.001$; $t_{accessibility}$ (60) = 4.814, $p < 0.001$; $t_{intimacy}$ (60) = 4.599, $p < 0.001$; $t_{participation}$ (60) = 3.477, $p < 0.001$.

Effect of Practice on Final Recall

Facilitation Effect

In the final recall test, a repeated measure ANOVA was performed on the correct recall rate of Rp + and Nrp + items for the listeners (see **Table 2**). This analysis highlighted the main effect of item type and was found to be significant, $F_{(1,60)} = 203.023$, $p < 0.001$, $\eta_p^2 = 0.772$, *95% CI* = [0.524, 0.654]. This indicates that the correct recall rate of Rp + items was higher than that of Nrp + items in the different experimental conditions. The main effect of the interaction level was significant, $F_{(1,60)} = 6.736$, $p < 0.05$, $\eta_p^2 = 0.101$, as was the interaction between item type and interaction level, $F_{(1,60)} = 5.890$, $p < 0.05$, $\eta_p^2 = 0.089$. By simple effect analysis, we found that in Rp+ items, the performance of real speaker context was significantly higher than that of video context, $F_{(1,60)} = 9.949$, $p < 0.01$, $\eta_p^2 = 0.142$. However, there was no significant difference in interaction level in Nrp+ items, $F_{(1,60)} = 0.781$, $p = 0.380$.

To determine the facilitation effect due to retrieval practice, we performed paired-samples *t*-tests for participants in the two interaction levels separately, contrasting Rp+ and Nrp+ items. The results show that at different interaction levels, the recall rate of Rp + items was significantly higher than that of the Nrp + items, $t_{realspeakercontext}(30) = 12.501$, $p < 0.001$, 95% CI = [0.32, 0.45]; $t_{videospeakercontext}(30) = 7.93$, $p < 0.001$, 95% CI = [0.20, 0.34], as shown in **Figure 1A**. The results indicate that the retrieval-practice effect (RPE) appeared when the subjects acted as listeners under the two experimental conditions.

Retrieval-Induced Forgetting Effect

In the final recall test, a repeated measure ANOVA was conducted on the correct recall rate of Rp– and Nrp– items (see **Table 2**). The results show that the main effect of item type was significant, $F_{(1,60)} = 46.635$, $p < 0.001$, $\eta_p^2 = 0.437$, indicating that under different experimental conditions, the correct recall rate of the Rp– items was higher than that of the Nrp– items. The main effect of the interaction level was not significant, $F_{(1,60)} = 0.028$, $p = 0.868$. The interaction between item type and interaction level was also not significant, $F_{(1,60)} = 0.283$, $p = 0.597$.

To verify whether retrieval practice caused a retrieval-induced forgetting effect, we performed paired-samples *t*-tests for participants in the two interaction levels separately, contrasting Rp– and Nrp– items. The results show that at different interaction levels, the recall rate of the Rp– items was significantly lower than that of the Nrp– items, $t_{realspeakercontext}$ (30) = −4.152, $p < 0.001$, CI = [−0.219, −0.07]; $t_{videospeakercontext}$ (30) = −5.646, $p < 0.001$, CI = [−0.23, −0.11], as shown in **Figure 1B**. This indicates that the level of social interaction was not the boundary condition affecting the appearance of SS-RIF.

RPE/SS-RIF Effect Difference Test

To examine the differences between listeners' levels of the RPE and SS-RIF under different social interaction conditions, we performed independent samples *t*-tests on the extent of the RPE and retrieval-induced forgetting effect for the two interaction levels. The results show that there were significant differences in the RPE between the real speaker context ($M = 0.387$, $SD = 0.171$) and the video speaker context ($M = 0.274$,

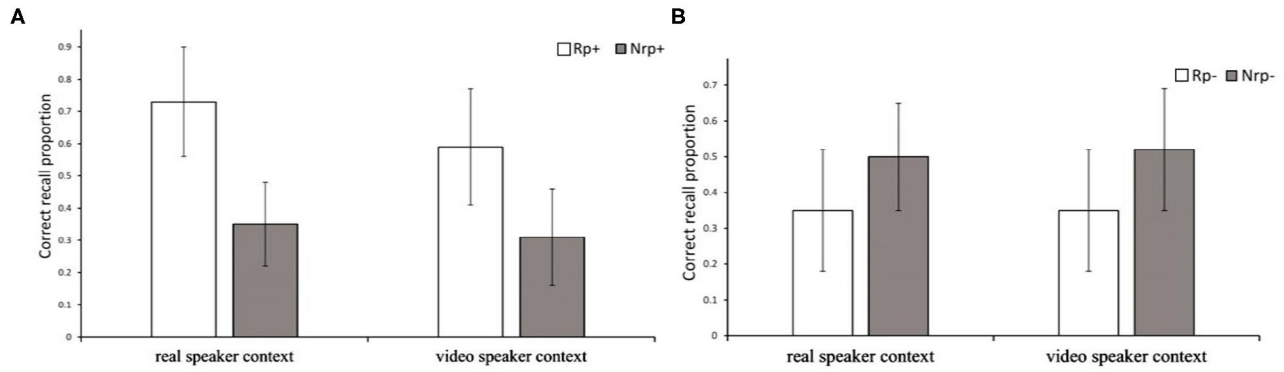

FIGURE 1 | Correct recall rate of RP+, NRP+, RP–, and NRP– items of listeners at different levels of social interaction. **(A)** Recall performance of listeners' Rp^+ and Nrp^+ items in the final test under different levels of social interaction. Rp^+, practiced words from practiced categories; Nrp^+, words from unpracticed categories used as baseline for Rp^+ words. Error bars indicate standard error of the mean. **(B)** Recall performance of listeners' Rp^- and Nrp^- items in the final test under different levels of social interaction. Rp^-, unpracticed words from practiced categories; Nrp^-, words from unpracticed categories used as baseline for Rp^- words. Error bars indicate standard error of the mean.

TABLE 3 | Social presence and factors influencing RPE and SS-RIF: a correlation matrix.

	Social presence	Space	Accessibility	Intimacy	Participation	RPE	SS-RIF
Social presence	1	0.828**	0.893**	0.875**	0.829**	0.348**	0.140
Space		1	0.647**	0.596**	0.547**	0.396**	0.064
Accessibility			1	0.750**	0.658**	0.149	−0.135
Intimacy				1	0.671**	0.346**	−0.241
Participation					1	0.299**	−0.2
RPE						1	–
SS-RIF							1

*RPE: Retrieval Practice Effect; SS-RIF: Socially Shared Retrieval-induced Forgetting. **$p < 0.01$.*

$SD = 0.191$), $t_{(60)} = 2.434$, $p < 0.05$, *Cohen's* $d = 0.623$. This analysis revealed that the RPE of the real speaker context was significantly greater than that of the video speaker context. There was no significant difference in the SS-RIF effect between the real speaker context ($M = 0.148$, $SD = 0.199$) and the video speaker context ($M = 0.171$, $SD = 0.171$), $t_{(60)} = -0.500$, $p > 0.05$.

Various Factors Affecting Social Presence and RPE/SS-RIF

To examine whether individuals perceive different levels of social presence based on social interaction level and if this causes a degree of difference in common retrieval, as well as explore the various factors influencing social presence and determine which enhance listeners' ability to retrieve common motives, a Pearson correlation analysis was conducted on the relationships among social presence, RPE, and SS-RIF. The results show that there was a significant correlation between perceived social presence and the effect of RPE, $r = 0.348$, $p < 0.05$ (see **Table 3** for specific results). Further regression analysis showed that perceived social presence had a significant predictive effect on the effect of the RPE, $\beta = 0.011$, $p < 0.01$. Among the factors affecting social presence, spatial intimacy, and participation had significant correlations with the RPE, while accessibility had no significant correlation (see **Table 3**). There was no significant correlation between social presence and SS-RIF ($p < 0.01$). Among all the factors affecting social presence, only intimacy had a marginally significant correlation with SS-RIF ($p = 0.059$).

DISCUSSION

In this study, we examined the effects of social presence on SS-RIF in real and virtual speaker contexts. The results show that at different levels of social interaction, listeners all demonstrated an SS-RIF effect; there was no significant difference between the two groups. Social presence was not correlated with SS-RIF, but intimacy was slightly correlated with a retrieval-induced forgetting effect.

The above results indicate that the SS-RIF effect is to a certain extent universal (28). When a listener's perception of a speaker's social presence reaches a certain level, SS-RIF can be successfully induced even in the video condition, without real people being physically present (29). This result contradicts the conclusion emphasized by Zhang et al. (7), that "careful monitoring" is not a necessary condition for inducing implicit retrieval, but real speakers are necessary for inducing SS-RIF. According to that study, the SS-RIF phenomenon only occurs in

the real speaker context. However, we found that just by setting up a similar "eye contact" situation, the video speaker context yielded the SS-RIF phenomenon, meaning that the appearance of human figures produced a certain effect, even in situations where there were no real people. Furthermore, it was more important to present a portrait to the listener than to simply allow them to perceive the other's presence. A previous study on the influence of group relations on SS-RIF involved the use of audio recordings. When the researcher played a recording of a student who had participated in an exchange program, the researcher also presented the speaker's photo (4). In this case, audiences from the same social group consistently showed SS-RIF. With the increase in online teaching, the appearance of a "non-human image" is particularly important for research in the field of education, especially multimedia instruction. Increasing the appearance of the teacher's image will enhance learners' sense of social presence (30) and significantly improve the learning effect (31). Therefore, whether is a "portrait" is likely to be one of the boundary conditions to inducing the SS-RIF phenomenon, though this requires further study. In addition, the results of this research support that "careful monitoring" is a decisive condition for listeners performing joint retrieval. According to the retrieval inhibition hypothesis, the speaker will appear to induced forgetfulness because the speaker trying to retrieve a target project at the same time activation as clues to retrieve other related projects, resulting in competition. If an individual is to retrieve the target project, they must suppress competing projects. So as long as the project interferes with the retrieval of another project, the inhibition mechanism will occur. Rp–items are difficult to reach via consciousness retrieval, and recall performance is worse than for Nrp–. However, when the listener and the speaker have positive social interaction, the listener and the speaker will carry out joint retrieve, and the same forgetting phenomenon will appear in the listener and the speaker, so SS-RIF appears. When the listeners face a portrait, they perceived the speaker's high enough social presence. At that time, listeners tend to carefully listen to the other party's information. Once the participation level reaches a certain level, the SS-RIF effect naturally occurs.

Another hypothesis of this study was that the degree of SS-RIF would vary with different levels of social interaction, and the real speaker group would show a higher degree of SS-RIF, due to a greater sense of social presence. However, the experiment results show that there was no significant difference in degree between the two groups, indicating that the condition of social presence had no significant influence on SS-RIF (4–6). This may be because there was no difference between the degrees of successful SS-RIF, only the boundary condition of whether SS-RIF could be induced. At the same time, the experimental materials for this study were relatively simple two-word pairs, and items with high correlation are easier to recall (or guess at) in memory tests. Some individuals likely had a strong level of familiarity with some items, so there was no significant difference in the degree of forgetting between the two groups.

Although social presence did not make a difference for SS-RIF, there was a significant difference in RPE, which was higher in the real speaker's group than in the video speakers group, perhaps due to spatial perception, intimacy, and engagement. One possible explanation is that a true confederate situation would bring the listener a feeling of closeness, and eye-to-eye interaction between human companions is closer to what occurs in nature, thus giving listeners a greater incentive to retrieve the speaker's information. Hence, physical and psychological distance may be the reason for the difference in the degree of common retrieval between listener and speaker. In previous studies, Barber and Mather (15) unexpectedly found that gender-consistent closeness between listeners led to radically different SS-RIF results; individuals were more inclined to co-retrieve with one another when they felt greater closeness. This was confirmed by another study finding that participants rated partners who tended to agree with them as more trustworthy and intimate, and therefore were more likely to be influenced by them during the memory task. Social norms influence individuals' decision making behavior, and the pressure not to destroy intimate relationships makes individuals more prone to memory conformity (32). Another possible explanation is that conformity causes individuals to increase their level of co-retrieval with others. Previous research has found that people tend to conform when working with peers, even if those peers are virtual or gender-neutral. They are more willing to comply with virtual peer responses in memory-based recognition tasks, leading to subsequent memory failures (33). A real speaker context intensifies the formation of conformity psychology, so the pressure of conformity brought about by the presence of others may motivate individuals to retrieve together with the speaker, because in many cases people need to identify information in the presence of others (34).

After controlling for gender and that eye contact may bring listeners different levels of intimacy, this study found that regardless of the presence of real people, social presence could still to a certain extent induce SS-RIF, but the real people context gave listeners stronger motivation to carry out joint retrieval, and more word pairs were remembered. According to social facilitation drive theory, the presence of others gives individuals a certain drive or motivation to improve activity efficiency. A study comparing preschoolers' learning of receptive and expressive words with and without adults found support for this view. Even when there was no eye contact or verbal communication between the adults and children, the presence of others enabled the preschoolers accompanied by adults to learn more expressive words than did those who were unaccompanied (10). Therefore, social presence brought about by the presence of others does affect the extent to which individuals carry out common retrieval.

Our research facilitates the exploration of whether collective memories are formed in virtual networks and how they differ from those formed in the real world. The results confirm that the SS-RIF effect can also be successfully induced when individuals interact with virtual others, and the forgetting degree is the same as that when individuals interact with real others. This suggests that people tend to interact with others when they perceive that the social presence of the person they are talking to is high enough, regardless of whether the person actually exists in the same space. To talk with others in front of my computer screen, memory changes through social interaction may inspire

people to participate in social interaction memory convergence, selective discussion form each other shared memory and silence, which is beneficial to form the collective memory, promoting social cohesion and promote the formation of collective identity (16). It also reflects the possibility of groups forming shared memories through video. Our study focuses on the influence of social presence on SS-RIF, which reminds us that in virtual network, necessary eye interaction and face interaction can enhance the intimacy between individuals and enhance the motivation of individuals to jointly extract with others, which is particularly important for the formation of collective memory in virtual network.

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 Ethics Committee of Psychology of Fujian Normal University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LZ and JZ contributed to conception and design of the study. LZ organized the database, performed the statistical analysis, and wrote the first draft of the manuscript. JZ wrote sections of the manuscript. All authors contributed to manuscript revision, read, 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/fpubh.2021.728762/full#supplementary-material

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Predictive Models of Maternal Harsh Parenting During COVID-19 in China, Italy, and Netherlands

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Background: The COVID-19 pandemic drastically impacted on family life and may have caused parental distress, which in turn may result in an overreliance on less effective parenting practices.

Objective: The aim of the current study was to identify risk and protective factors associated with impaired parenting during the COVID-19 lockdown. Key factors predicting maternal harsh discipline were examined in China, Italy, and the Netherlands, using a cross-validation approach, with a particular focus on the role of allomaternal support from father and grandparents as a protective factor in predicting maternal harshness.

Methods: The sample consisted of 900 Dutch, 641 Italian, and 922 Chinese mothers (age M = 36.74, SD = 5.58) who completed an online questionnaire during the lockdown.

Results: Although marital conflict and psychopathology were shared risk factors predicting maternal harsh parenting in each of the three countries, cross-validation identified a unique risk factor model for each country. In the Netherlands and China, but not in Italy, work-related stressors were considered risk factors. In China, support from father and grandparents for mothers with a young child were protective factors.

Conclusions: Our results indicate that the constellation of factors predicting maternal harshness during COVID-19 is not identical across countries, possibly due to cultural variations in support from fathers and grandparents. This information will be valuable for the identification of at-risk families during pandemics. Our findings show that shared childrearing can buffer against risks for harsh parenting during COVID-19. Hence, adopting approaches to build a pandemic-proof community of care may help at-risk parents during future pandemics.

Keywords: harsh parenting, COVID-19 pandemic, allomaternal support, father involvement, grandparents, cross-validation

INTRODUCTION

The COVID-19 pandemic drastically impacted on family life. Parents worried about their own and their families' health, job losses, and salary reductions, while keeping up their family life in social isolation. Moreover, because of (partial) school closures, families were suddenly faced with additional pressure of homeschooling their children. There may be considerable variability in how families deal with pandemic challenges and the extent to which they were impacted by COVID-19. For some families, the sequelae of the pandemic may lead to heightened psychological distress and, in turn, an overreliance on less effective parenting practices such as a harsh disciplinary style or even child abuse or neglect (1), with negative impact upon children's wellbeing. Other families, however, may manage relatively well. The current study therefore aims to identify risk and protective factors associated with impaired parenting during the lockdown amidst COVID-19. More specifically, we examined key family factors predicting maternal harsh discipline across three countries, China, Italy, and the Netherlands, using a cross validation modeling approach (2, 3). We particularly focused on the role of support from father and grandparents as a protective factor facilitating mothers' adaptability and buffering the effects of pandemic-related distress on caregiving behaviors. Harsh discipline, characterized by parental attempts to control a child using verbal violence (e.g., screaming) or physical punishment (e.g., hitting) (4), can be considered child emotional or physical maltreatment (5, 6). Given the long-term negative consequences of maltreatment for children's development (7) examining the predictive performance of factors contributing to harsh parenting is essential for identifying at-risk families and preventing detrimental effects on children during future pandemics.

Kinship Networks and Harsh Parenting

The traditional African proverb "It takes a village to raise a child" may express an underlying truth (8). Mothers, or fathers, do not rear children on their own, but childrearing is usually embedded in larger kinship networks (e.g., grandparents, relatives, neighbors) and communities (schools, daycare centers) that offer support with childcare and/or education. This shared child care appears crucial for parental well-being and optimal child development. For example, involvement of nonresidential grandparents decreases parental stress and promotes children's well-being by stimulating prosocial behaviors and academic engagement (9). Similarly, support from relatives, friends, or neighbors reduces parental stress and lowers risk for child abuse and neglect (10). However, during COVID-19, support outside the family unit has abruptly been lost due to social distancing, closures of schools and daycare centers, and other pandemic and lockdown restrictions. Parents suddenly needed to rely solely on each other, yet distress triggered by the pandemic may interfere with the ability to provide adequate partner support (11). These circumstances may increase risk for harsh parenting practices.

Pre-existing Vulnerabilities and Harsh Parenting

Families with pre-existing vulnerabilities may be particularly at risk for inadequate or harsh parenting during the pandemic. For example, economic hardship is an important factor contributing to risk for child abuse and neglect (6), but the level of risk that pandemic-related financial insecurities poses for parenting abilities likely depends on families' financial situation prior to the pandemic (11). Similarly, psychological distress induced by the pandemic may be particularly difficult to regulate for parents with pre-existing mental health problems, another well-known factor elevating risk for harsh parenting (6). Further, major life stressors, such as the COVID-19 pandemic, may lead to marital conflicts and dissolution or intimate partner violence (IPV) (11). The first studies on family functioning during COVID-19 report increased rates of IPV (12), which may spillover to and harm the child because violence is modeled as a way to deal with conflicts that may also emerge in the parent–child relationship (6). Lastly, environmental factors, such as overcrowded living conditions and lack of access to private outdoor space, may further elevate risk for abuse (13), in particular during lockdown amidst COVID-19 when families are required to stay home.

Protective Factors and Harsh Parenting

Protective factors may, however, buffer the negative effects of COVID-19 on parenting abilities. These protective factors may either lie at the level of the individual parent, such as good (pre-existing) mental and physical health, or may be located in the family composition. One potentially important factor buffering the impact of crises, such as COVID-19, on maternal caregiving is allomaternal care, that is, childcare by adults other than the biological mother including fathers, grandparents, and other group members. Evidence from studies with high-risk families underscores how much allomaternal support matters. For example, father support reduces the adverse long-term effects of maternal depression during a child's infancy on later child behavior problem (14), suggesting that father involvement may compensate for maternal stress. In contrast, in families where father involvement is low or father is absent, as in the case of single mothers, mothers are at increased risk for abusing or neglecting their children (15, 16). Other family members may also offer allomaternal assistance, such as older siblings (17) and grandmothers (18). Research shows that the presence of a grandmother in the same household with a teenage mother increases the quality of mothering and, in turn, chances of a secure mother-infant attachment relationships (19). Similarly, having a grandmother at hand predicts improved health and cognition among low birth-weight infants (20), although under adverse conditions, such as extreme poverty, presence of grandparents may reduce life expectancy of offspring because they use scarce resources (21). These findings are in line with the grandmother hypothesis (22), stating that extended human female postmenopausal lifespan is an evolutionary adaptation that allows grandmothers to provide allomaternal care to their grandchildren in order to increase their fitness. Based on the grandmother hypothesis, it could be expected that shared childrearing may function as a resilience buffer in times of adversity and may also exert protective effects on mothers' caregiving abilities in the times of pandemics.

Cultural Differences Across the Netherlands, Italy, and China

Although the cooperative nature of human childrearing is universal (23), it is influenced by cultural and economic factors (24). For instance, Western-European families are often only partly supported in child care by grandparents, but for example in low and middle-income countries grandparental involvement is much stronger (25). Moreover, the probability of grandparental co-residence with children and grandchildren is higher in non-western societies with traditions of filial piety (26). In China, co-residence with extended family, including grandparents, is common practice (27) and grandparents are often involved in full-time child care. In particular the grandmother forms an important child care provider for Chinese mothers who need to balance the competing demands of childcare and (full-time) work in the absence of adequate child care provisions (28). Chinese fathers also share care with mothers and are more likely than in the past to emotionally invest in their children because the single-child policy has weakened gender roles (29, 30). In contemporary China, child rearing is therefore considered a joint mission of mothers, fathers, and grandparents who together form an intergenerational parenting coalition (27).

During COVID-19, this extended family may be a source of resilience as the unexpected burden of the pandemic is shared among more people. Indeed, in a previous study with the same sample, we found that support from grandparents during the lockdown was associated with less maternal mental health symptoms (31). From an evolutionary perspective, it has been argued that human childcare practices in the context of extended families enhances children's survival by sharing the costs and load of raising children (18). Exclusive maternal care has even been considered out of step with nature (18) because, according to calculations of evolutionary anthologists, human children consume more than 13 million calories until they reach adulthood (32), which is far more than a mother can provide. Contrasting with extended families in China, in most western societies, including Italy and the Netherlands, the nuclear family is the traditional family, consisting of parents and children, living apart from grandparents and other relatives, e.g., (33). This may be disadvantageous during the lockdown. Non-residential grandparents, among those most vulnerable to COVID-19, were kept at distance from children and grandchildren, which increased their chances of survival but posed a problem for working parents who had grandparental childcare support prior to the pandemic.

For mothers in nuclear families, father involvement in childcare may be an important resilience factor buffering the effects of the pandemic on maternal caregiving. Yet, father involvement varies across cultures and paternal behaviors should not be presumed to have similar influences on mothers' caregiving behaviors across different cultural groups. For example, Craig and Mullan (34) showed that mothers' and fathers' work arrangements only predicted equal distribution of childcare between parents in countries supporting equal gender divisions. In Italy, where gender inequality is high and the rate of female employment is amongst the lowest in Europe (35), fathers do not re-adjust for mothers' working hours (34). Italian fathers tend to stick to unequal shares of childcare, promoting Italian families to rely on additional sources of allomaternal support. Due to modestly available formal child care and a ubiquitous feeling of compliance, it is customary that Italian grandparents assist parents and take care of their grandchildren on a regular basis (36).

Contrasting with Italy, the Netherlands shows a lower prevalence of the male breadwinner family. Dutch mothers often switch to a part-time job while fathers keep working full-time after becoming parents (37). This is also known as the one-and-a-half earner household (38). Although Dutch women still bear the largest part of the burden of household chores and child care activities in daily life (38), levels of gender equality are considered quite high (39). The Dutch formal child care system is used by a large proportion of parents (38, 40). Nevertheless, many parents in the Netherlands prefer to combine formal child care with some kind of informal child care, the most prevalent form of the latter being non-residential grandparents taking care of their grandchildren (40). Co-residence with grandparents is, however, uncommon in the Netherlands and COVID-19 separated many Dutch children from their non-residential grandparents, thus lowering sources of allomaternal support.

In addition to cultural differences in family composition, culture may also shape parenting practices since cultural values and norms may affect attitudes about raising children, which may in turn influence parent-child interaction (41). It is therefore important to take into account the role cultural context (42), when examining parenting during the COVID-19 lockdown. More specifically, parents may acquire certain beliefs on disciplinary styles, such as corporal punishment, within a cultural context and harsh discipline may occur more often in cultures or countries where practice of violence is viewed acceptable or normative. For example, a cross-cultural study on parenting across six countries Lansford, Chang (43) showed that harsh parenting is most prevalent in countries where physical discipline is perceived normative by parents. However, other research shows that there are far more cultural similarities than differences in parenting practices and that differences among cultural groups disappear when socioeconomic status is controlled (44).

Aims and Hypothesis

In the current study we examined risk and protective factors predicting harsh parenting among mothers with children aged 1–10 years during the COVID-19 lockdown in China, Italy, and the Netherlands. Examining harsh parenting during the lockdown is important because expressions of violence in a family context has negative effects on children's development and psychosocial adjustment (45, 46). Our study extends a previous study in which we examined maternal mental health during the lockdown, but did not examine harsh parenting (31). Initial findings of research on the impact of COVID-19 point to increases in harsh parenting, with pandemic-related distress as a mediator (47). However, social and cultural context may either accentuate or minimize the impact of individual-level and family-level factors predicting harsh parenting. Hence, the constellation of parent and family characteristics as predictors of maternal harshness

may not be replicable across countries. In the current study, maternal harsh parenting will therefore be examined across cultures by applying a cross-validation approach (2) for selecting models predicting maternal harshness in each country. Cross-validation allows accurate estimation of how a model would perform on other samples (3). In a predictive modeling context, cross-validation does not select the model predictors based on statistical significance, but based on their predictive performance. Predictive performance is especially important for the purpose of the current study, because in case of future pandemics involving lockdowns, identifying families at risk of harsh parenting or even child abuse is essential.

It can be expected that previously identified antecedents of child abuse and neglect, such as parental psychopathology, marital conflict, low socioeconomic status, low father involvement, a large number of children, and poor housing (6, 15, 16, 48), also enhance risk for harsh caregiving in the time of COVID-19. However, in addition to these previously identified antecedents, risk factors more closely related to acute COVID-19-related stress, such as COVID-19 related concerns about health and work increase, may further elevate risk for maternal harshness, whereas allomaternal support may exert protective effects on mothers' caregiving abilities. Hence, our first hypothesis was that previously identified risk factors for child abuse and COVID-19 related stress about health and work would increase risk for harsh maternal caregiving, whereas involvement of father and (co-residential) grandparents would buffer against risk. Second, we hypothesized, in line with the grandmother hypothesis (22, 49, 50), that grandparental involvement would be particularly beneficial for mothers with young children who are still highly dependent on the physical and emotional availability of caregivers. Thirdly, we expected that high levels of allomaternal support, i.e., support from both fathers and grandparents, facilitate mothers' adaptability and mitigate the effects of pandemic-related distress on caregiving. Lastly, we hypothesize that mothers in the three countries may be differently impacted by the pandemic. This expecation was also based on our previous finding that grandparental support during the lockdown lowers risk for mental health symptoms for Chinese mothers, but not for Italian and Dutch mothers (31). Although child physical abuse is a global phenomenon, unaffected by cultural–geographical factors (51), factors predicting harsh parenting during COVID-19 may differ across countries due to cultural variations in allomaternal support. Thus, we tested the hypothesis that the constellation of factors contributing to maternal harsh parenting during COVID-19 is subject to influences of family composition and may therefore vary across countries.

METHODS

Participants and Design

Dutch, Chinese, and Italian parents aged 18 years or older with children between 1 and 10 years were invited to participate by completing an online survey. In each country, parents were recruited by contacting elementary schools. In the Netherlands and Italy, parents were also recruited by contacting day care centers using social media advertisements (facebook, linkedin, twitter). Dutch parents were also recruited by distributing the questionnaire among parents who were members of the Dutch I&O research panel (www.ioresearch.nl). The minimum sample size was 400 parents in each country, providing sufficient power to detect moderately sized correlation coefficients (power = 0.80, $r = 0.20$) between harsh parenting and each of the predictor variables, but we strived for larger sample sizes. Parents who completed the questionnaire but did not meet the inclusion criteria (e.g., they had only children older than 10 years, $N = 8$ Dutch parents, $N = 47$ Chinese parents) were excluded. The final sample consisted of 1,156 Dutch parents, 674 Italian parents, and 1,243 Chinese parents. Fathers were excluded from the analyses for the purpose of the current study, resulting in a sample of 900 Dutch, 641 Italian, and 922 Chinese mothers for this study. Characteristics of the Dutch, Chinese, and Italian samples are presented in **Table 1**. Permission for the study was obtained from the local ethics committees of the School of Social and Behavioral Sciences of Tilburg University, Department of Psychology of Padua University, and Peking University Medical Ethics Board. Participants gave informed consent and were given a chance at winning a gift voucher.

Procedure

Data was collected using Qualtrics in Italy and the Netherlands, and using a web-based platform (https://www.wjx.cn/app/survey.aspx) in China. Timeframes for data collection were: April 17–May 10 2020 for the Netherlands, April 21–June 13 2020 for Italy, and April 21–April 28 2020 for China. During these timeframes, governmental pandemic measures in the three countries included: remote working, keeping social distance from others, and schools and daycare centers were closed. In each country, in particular older people were advised to keep distance. Dutch people were allowed to leave their home if they had no COVID-19 diagnosis or symptoms and if they had not been exposed to infected others. Also in Italy people were gradually allowed to leave their home during the period of data collection (after May 4). The Chinese data was collected in the aftermath of the COVID-19 peak, but pandemic restrictions were comparable to the Netherlands and Italy. Similar to Italy and the Netherlands, people worked remotely, were allowed to leave their home, but were advised to keep social distance. We focused on recruitment in the regions that were most affected by COVID-19, that is, Northern Brabant (the Netherlands), Lombardy (Italy), and Henan, Hubei, and Shenzhen city (China), although parents from others regions in Italy and the Netherlands were also allowed to participate.

Measurements

Parent-Child Conflict Tactics Scale

The Parent-Child Conflict Tactics Scale (CTSPC) (52) was administered in order to assess maternal harsh disciplinary style. The CTSPC measures psychological and physical maltreatment and neglect of children by parents, as well as sensitive modes of discipline. For the purpose of the current study, we focused on the subscales psychological aggression (five items) and physical assault subscales (four items). An example item of the

TABLE 1 | Characteristics of Chinese, Italian, and Dutch mothers/families during the COVID-19 pandemic.

Characteristic	IT (N=641)	NL (N=900)	CH (N=922)	*p*-value	*Eta*^{2}	*Cramer V*
Age mother	38.1 (5.56)	37.2 (5.18)	35.3 (5.67)	<0.001	0.04	
Marital status				<0.001		0.09
Single	9 (1.4%)	38 (4.2%)	4 (0.4%)			
Living together/Married	612 (95.5%)	828 (92.0%)	876 (95.0%)			
Divorced	13 (2.0%)	17 (1.9%)	26 (2.8%)			
Widow	1 (0.2%)	2 (0.2%)	4 (0.4%)			
Other	6 (0.9%)	15 (1.7%)	12 (1.3%)			
Education				<0.001		0.32
Primary school	0 (0%)	5 (0.6%)	18 (2.0%)			
Secondary school	211 (32.9%)	59 (6.6%)	242 (26.2%)			
College	128 (20.0%)	609 (67.7%)	516 (56.0%)			
University	275 (42.9%)	180 (20.0%)	115 (12.5%)			
Postgraduate	27 (4.2%)	47 (5.2%)	31 (3.4%)			
Employment				<0.001		0.22
Employed	474 (73.9%)	645 (71.7%)	863 (93.6%)			
Unemployed	104 (16.2%)	146 (16.2%)	57 (6.2%)			
Student	10 (1.6%)	22 (2.4%)	2 (0.2%)			
Other/unknown	53 (8.3%)	87 (9.7%)	0 (0%)			
Household income (Euros)				<0.001		0.34
<10.000	25 (3.9%)	13 (1.4%)	129 (14.0%)			
10.000–20.000	67 (10.5%)	49 (5.4%)	171 (18.5%)			
20.000–30.000	134 (20.9%)	57 (6.3%)	154 (16.7%)			
30.000-60.000	220 (34.3%)	315 (35.0%)	226 (24.5%)			
60.000–160.000	64 (10.0%)	309 (34.3%)	197 (21.4%)			
160.000–250.000	0 (0%)	20 (2.2%)	27 (2.9%)			
>250,000	1 (0.2%)	4 (0.4%)	18 (2.0%)			
Unknown	130 (20.3%)	133 (14.8%)	0 (0%)			
House with garden	404 (63.0%)	882 (98.0%)	506 (54.9%)	<0.001		0.44
Marital conflict Median [min, max]	2.00 [1.0, 6.0]	1.50 [1.0, 6.0]	2.00 [1.0, 6.0]	<0.001	0.02	
Number of Children				<0.001		0.19
1	261 (40.7%)	232 (25.8%)	409 (44.4%)			
2	308 (48.0%)	440 (48.9%)	450 (48.8%)			
3	60 (9.4%)	170 (18.9%)	59 (6.4%)			
4	9 (1.4%)	41 (4.6%)	4 (0.4%)			
5	1 (0.2%)	10 (1.1%)	0 (0%)			
6	2 (0.3%)	7 (0.8%)	0 (0%)			
Age youngest child Median [Min, Max]	3 [0, 10]	4 [0, 10]	6 [0, 10]	<0.001	0.06	
Childcare during COVID-19: grandparents	117 (18.3%)	85 (9.4%)	494 (53.6%)	<0.001		0.44
Childcare during COVID-19: other parties	38 (5.9%)	127 (15.1%)	30 (3.3%)	<0.001		0.18
Childcare before COVID-19: other parties	401 (62.6%)	598 (66.4%)	173 (18.8%)	<0.001		0.45
Father involvement	2.23 (0.554)	2.30 (0.620)	2.51 (0.673)	<0.001	0.07	
Harsh discipline median [Min, Max]	5 [0, 32]	2 [0, 32]	4 [0, 40]	<0.001	0.04	
General psychopathology median [Min, Max]	1.89 [1, 4.59]	1.36 [1, 4.74]	1.11 [1, 5]	<0.001	0.28	
Work related changes	3.91 (2.19)	2.74 (1.66)	4.91 (3.66)	<0.001	0.11	
Work related stress	6.90 (2.63)	4.58 (2.83)	4.75 (3.09)			
COVID-19 health concerns	5.44 (2.93)	4.11 (2.48)	5.27 (3.19)	<0.001	0.04	
Mean daily COVID-19 deaths during data collection (WHO)	217	111	0			
Cumulative deaths last day data collection (WHO)	34,223	5,422	4,643			

psychological aggression scale is "I shouted, yelled, or screamed angrily at my child", while an example item of the physical assault scale is "I slapped my child on the hand, arm, or leg". One item of the original 5-item physical assault subscale was excluded in order to prevent feelings of discomfort in parents. Mothers rated how often they used the different types of disciplinary behavior in the past two weeks on a 6-point scale, ranging from never to ≥5 times). A harsh parenting score was calculated by summing the nine items of the psychological aggression and physical assault subscales. Confirmatory factor analyses for ordered categorical item scores indicated that a 1-factor harsh discipline model fitted the data (RMSEA (95% CI) = 0.067–0.08; CFI = 0.969; SRMR = 0.057). The estimated reliability was good (McDonald's Omega $\Omega = 0.99$).

Allomaternal Support

Participants were asked to indicate whether or not they received support in child care from residential or non-residential grandparents. In Italy and the Netherlands, very few mothers reported receiving support from residential grandparents (Italy: 3.0%, $N = 19$, the Netherlands: 1.1%, $N = 10$) whereas approximately half of the Chinese sample reported a cohabitating grandparent (China: 53.1%, $N = 490$). Despite governmental recommendations to keep safe distance from grandparents, some mothers reported child care by nonresidential grandparents (Italy: 15.3%, $N = 98$, the Netherlands: 8.3%, $N = 75$, China: 0.5%, $N = 4$). Since the number of parents receiving support for nonresidential grandparents was very low, we decided to combine support for residential and nonresidential grandparents. In addition, involvement of father in household management/tasks and child care was assessed by asking the degree of maternal and paternal contributions to 20 household chores or child care activities. Activities included: homeschooling, clearing the table, large purchases, loading dishwasher/washing dishes, grocery shopping, cooking, small purchases, paying bills, cleaning up house, chores in and around the house, making beds, washing and dressing up child, cleaning the house, bringing child to bed, soothing child at night, making list for grocery shopping, washing clothes, ironing, washing car, taking out trash. Mothers were asked to rate their own contribution and the contribution of their child's father to these tasks in the past week on a scale ranging from 1 (almost exclusively mother) to 5 (almost exclusively father). Cronbach's Alpha was 0.90. Mean scores were calculated, with higher scores representing greater involvement of father. The average of these 20 item scores was used as a measure of father involvement.

Work Changes and Stress

Participants reported on changes in their employment that occurred due to the COVID-19 outbreak, such as loss of hours or job or decreased job insecurity. Mothers reported on the following work changes: moved to remote working, loss of hours, decreased pay, loss of job, decreased job security, disruptions due to childcare challenges, increased hours, increased responsibilities, increased monitoring and reporting, loss of health insurance, reduced ability to afford childcare, reduced ability to afford rent/mortgage, having to fire or furlough employees, decrease in value of retirement, investments, or savings. A total score was calculated by summing reported negative changes. In addition, participants reported on the level of distress they experienced due to the employment and financial impacts of the COVID-19 outbreak on a Likert scale ranging from 1 (no distress) to 10 (severe distress). The correlation between work changes and work-related distress was $r = 0.35$, $p < 0.001$.

General Psychopathology

Mental health was measured with the Brief Symptom Inventory 18 (BSI-18, omitting suicidality), measuring somatization (six items), depression (five items), and anxiety (six items), and a subset of 10 questions of the posttraumatic stress disorder (PTSD) checklist for DSM-5. Because these four latent mental health constructs were highly correlated (range r 0.776–0.961), aggregate psychopathology scores were computed by averaging all 27 item scores. Confirmatory factor analysis for ordered categorical data supported this decision by indicating that one general psychopathology factor adequately explained the correlational structure of the four latent psychopathology factors (RMSEA = 0.06; CFI = 0.974; SRMR = 0.043).

In addition, health concerns specifically related to COVID-19 were measured. Parents rated the level of distress they experienced due to COVID-19 related symptoms or potential exposure they had or their family or friends had. A score representing general COVID-19-related health concerns was calculated by averaging the two items measuring concerns for self and family and friends. The correlation between health concerns for self and health concerns for others was $r = 0.825$ $p = <0.001$.

Statistical Analysis

All analyses were conducted using the freely available software R [version 4.0.2; (53)]. Means and standard deviations were computed for continuous and normally distributed characteristics, and median and range were used for non-normally distributed continuous variables. Categorical characteristics were expressed in frequencies and percentages. For continuous characteristics, the differences between the three countries were tested using one-way analyses of variance and interpreted using the Eta squared effect size. Chi-square tests were used for categorical characteristics and interpreted using Cramer's V effect size). The 9-item harsh discipline scale was used as the primary outcome measure in all cross validation analyses. The R-package xvalglms (2) allowed for conducting linear regression analyses using K-fold cross validation. Cross validation allows for estimating how a model would perform on other samples. This out-of-sample predictive performance is more accurately determined by cross validation than by traditional model fit measures such as R-squared (3). One advantage of cross-validation is that it more accurately tests out-of-sample predictive performance than by traditional model fit measures such as R-squared. Other advantages of cross validation are that (1) it prevents overfitting the model to the idiosyncrasies of the data collected, (2) often violated regression

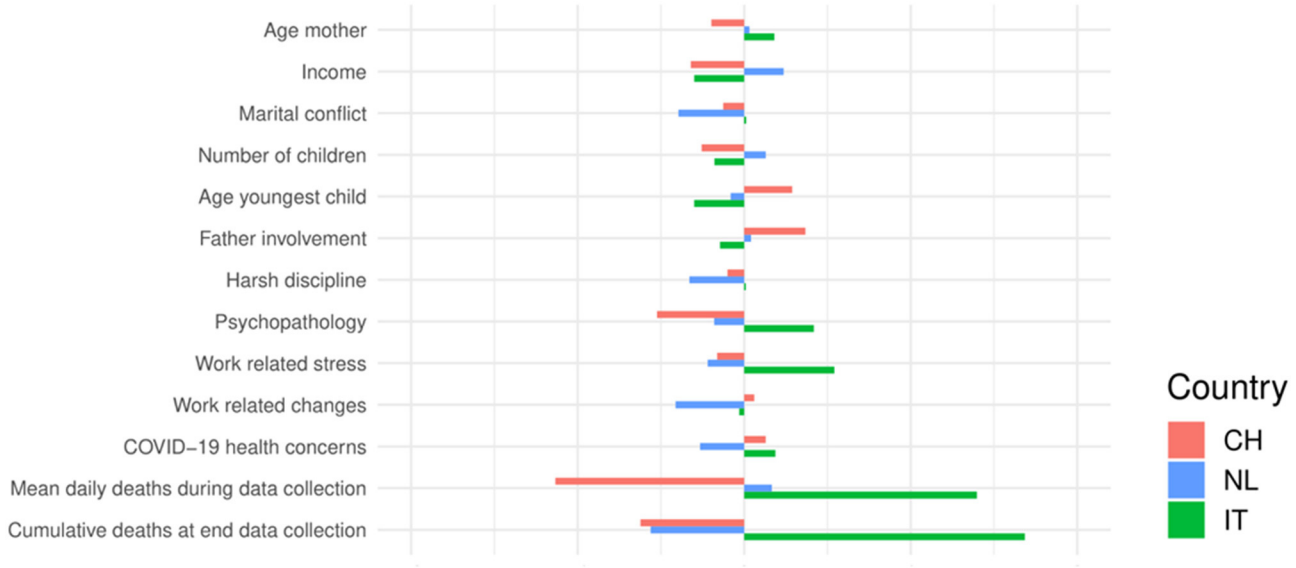

FIGURE 1 | Differences between countries on continuous sample characteristics. Differences between countries were expressed as the deviation from the grand mean in terms of Z-scores.

model assumptions [e.g. linear relation between a predictor and the outcome; homoscedastic and normally distributed residuals; (2)] are no longer required, and (3) it does not rely on *p*-values to determine the significance of a predictor, thereby preventing the problems related to p-hacking [e.g., inflated false positive rates; (54)].Our cross validation analyses involved two steps. In the first step, ten folds and 200 repeats were used to determine which combination of the 15 predetermined effects showed the best predictive performance in each of the three countries. This project's open science framework page includes a list of the predetermined effects, as well as the R-scripts (https://osf.io/9w8td). The inclusion or exclusion of each of those 15 effects corresponds to a total of $2^{15} = 32{,}768$ different regression models. Given that interaction effects were investigated, incorrectly specified models were excluded (i.e., those including interaction effects without the corresponding main effects), resulting in a final amount of 13,311 regression models. For each country, each of those 13,311 models was fit to each of the 200 repeatedly drawn training datasets. In each repeat, the full data was split randomly into ten parts. One of those parts served as the training data, the remaining nine as the test data used to validate the model estimated on the training data. The predictive performance on these test datasets was evaluated in terms of the root mean square error of prediction ($RMSE_p$). For each country, the model that most often showed the lowest prediction error across the 200 repeats was considered to have the best predictive performance. In the second step of our analyses, the best fitting model of each of the three countries was validated on the data of the other two countries, in order to determine the cross-cultural validity of the factors predicting harsh discipline in each country. For each country's winning model, the importance of the predictors was evaluated based on standardized regression coefficients resulting from a robust regression analysis to handle the violation of the homoscedastic residuals assumption in standard OLS regression.

RESULTS

Descriptive Characteristics

Table 1 presents the characteristics of Chinese, Italian, and Dutch families during the COVID-19 pandemic, including age of the mother, marital status, and employment. Significant differences between countries were found for almost all characteristics, because the large sample size of the study makes these statistical tests sensitive to detect very small differences between countries. Effect sizes of between-country differences on socioeconomic/demographic variables (age youngest child, age mother, education, marital status, number of children, employment) were small. However, as expected, there were large differences between countries in childcare involvement of grandparents. In China, 53.6% of the mothers indicated that one or more grandparents provided support, whereas this percentage was considerably lower in both the Netherlands (9.4%) and Italy (18.3%). **Figure 1** provides a visual representation of the differences between countries on the continuous characteristics listed in **Table 1**. See **Supplementary Table 1** for additional information regarding quarantine situation and COVID-19 diagnoses among parents. **Figure 2** shows for each country the distribution of the harsh discipline total scores. Harsh parenting differed significantly between the three countries: Dutch mothers used less harsh parenting than Chinese and Italian mothers. **Supplementary Tables 3**, **4** and **5** present the correlations between the two subscales of the CTSPC (psychological aggression and physical assault), childcare

TABLE 2 | The standardized regression coefficients (β) and Wald test p-values according to robust regression analyses, including for each country only the predictors of the winning model.

Predictor	Italy		Netherlands		China	
	β	*p*-value	β	*p*-value	β	*p*-value
Number of children	0.152	<0.001*	0.077	0.012*		
Education	−0.058	0.131			−0.067	0.041*
Income					−0.05	0.109
House with garden	0.073	0.059				
Work changes mother			0.119	<0.001*		
Work stress mother					0.137	<0.001*
General psychopathology	0.147	<0.001*	0.195	<0.001*	0.266	<0.001*
Marital conflict	0.236	<0.001*	0.072	0.028*	0.123	<0.001*
Father involvement					−0.118	<0.001*
Grandparents childcare					−0.035	0.262
Age youngest child					−0.058	0.066
Grandparents childcare *.					0.076	0.012*
Age youngest child						
Adjusted model R^2	11.4%		7.1%		13.6%	

Adjusted model R^2 based on a linear ordinary least squared regression model.
** Wald test $p < 0.05$.*

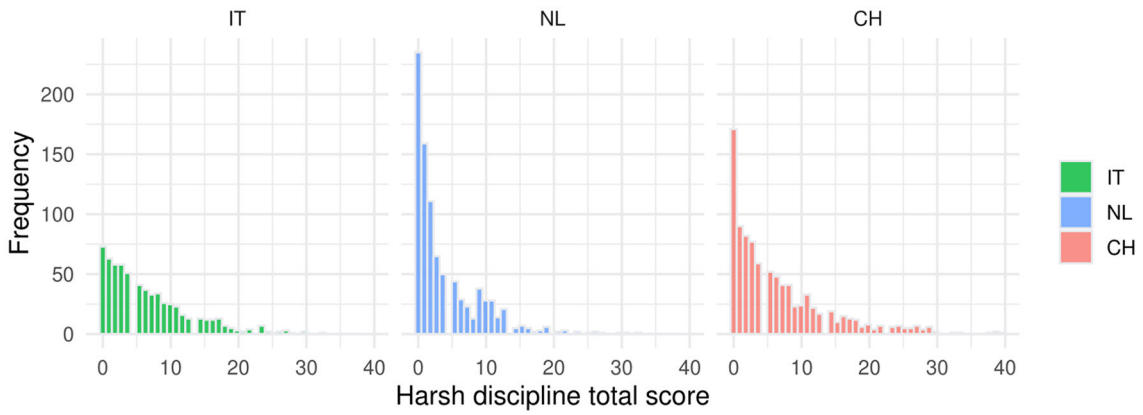

FIGURE 2 | Harsh discipline total score distributions for Italian, Dutch and Chinese mothers.

involvement of fathers, work-related distress, depression, anxiety, and posttraumatic stress disorder in the Dutch, Italian, and Chinese samples.

Cross Validation

Table 2 shows for each country the top three regression models in terms of minimizing the prediction error (RMSE) in the cross validation analyses. The number of wins indicates the percentage of the 200 cross validation repeats a particular model showed the lowest prediction error (RMSE) of all 13,311 investigated models. The cross validation procedure identified a unique winning model for each of the three countries. In Italy, number of children, education, house with garden, general psychopathology, and marital conflict were important predictors. In the Netherlands, the following predictors were found: number of children, work change, general psychopathology, marital conflict. In China, income, education, work stress, general psychopathology, marital conflict, father involvement and the interaction between grandparental involvement and age youngest child were important predictors (see **Supplementary Table 2**).

Table 2 presents the standardized regression coefficients (β) and Wald test p-values according to three robust regression analyses, including for each country the predictors of the winning model identified through cross validation. In all countries, marital conflict and psychopathology showed a substantial positive association with harsh parenting, although there were considerable between-country differences in the identified predictors. In line with our expectations, harsh parenting was partly explained by the interaction between childcare offered by grandparents and age of the youngest child. **Figure 3** illustrates

this interaction effect, showing that grandparental childcare was associated with less harsh parenting by Chinese mothers, especially when the youngest children were still young.

To determine the cross-cultural predictive validity of each country's winning model, a second series of cross validation analyses were conducted, evaluating the predictive performance of each winning model when predicting harsh parenting in the other two countries. **Figure 4** visualizes the resulting prediction error distributions for each of the fitted top models and each of the three datasets. Unsurprisingly, for each dataset, the country's own best model showed the lowest prediction error in 100% of the cross validation repeats. The distributions in the bottom row of **Figure 4** show that the Dutch and Italian models perform poorly in predicting harsh parenting in China. Interestingly, the overlapping distributions of the Dutch and Italian models in the Italian data suggests that the Dutch predictors can reasonably well predict harsh care of Italian mothers.

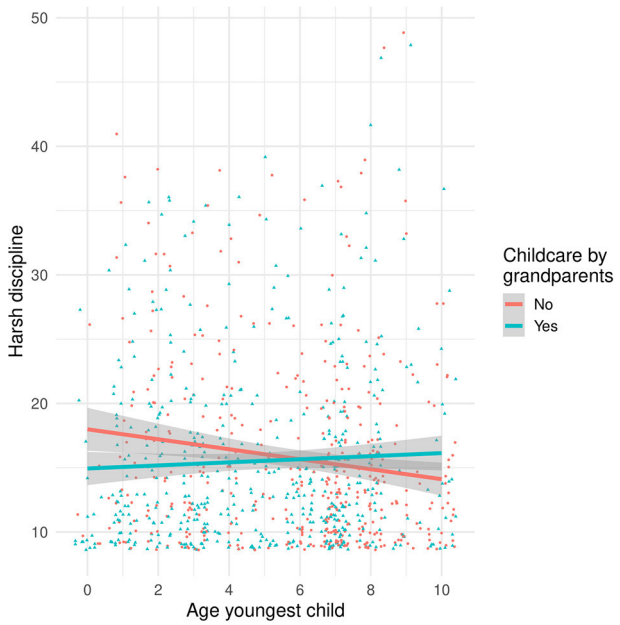

FIGURE 3 | Scatterplot showing the Interaction between age of the youngest child and Chinese grandparental childcare (separate lines) on harsh discipline (y-axis).

DISCUSSION

In the current study we examined risk and protective factors predicting maternal harsh parenting during the COVID-19 lockdown in China, Italy, and the Netherlands. We applied a cross-validation approach (2) for selecting which combination of 15 predetermined effects showed the best predictive performance in each country. Predictive modeling pointed to marital conflict and maternal psychopathology as shared risk factors predicting harsh parenting in each of the three countries. Despite these common factors, cross-validation identified a unique winning model for each of the three countries, thus indicating that the winning models with the best predictive performance differed between countries. In the Netherlands, work changes and number of children in the home predicted harsh parenting in addition to psychopathology and marital conflict, whereas in Italy, number of children, education, and house with garden were considered important predictors of maternal harsh parenting. In contrast, harsh parenting used by Chinese mothers was best predicted by education, income, and work-related stress of the mother. In addition, father involvement and grandparental involvement for mothers with a young child were considered important protective factors lowering risk for harsh parenting in China. Our findings extend our previous study in which we examined maternal mental health during the lockdown in China, Italy, and the Netherlands, but did not assess harsh parenting (31). Results indicate that, in addition to marital conflict and maternal psychopathology as shared risk factors, models predicting harsh parenting during COVID-19 include distinct risk factors that are not replicated across cultures, possibly due to cultural variations in family composition and allomaternal support. Hence, although harsh parenting is a global phenomenon (51), the constellation of factors predicting maternal harshness during COVID-19 is not identical.

First results of COVID-19 studies indicate that the pandemic drastically impacted on family life and that COVID-19 related distress can increases harsh parenting practices [e.g., (47)]. Our cross-validation results extend results of initial studies by indicating that there were considerable between-country differences in the identified predictors of maternal harshness. In our cross-validation approach, model predictors were not selected based on statistical significance, but based on their performance in predicting harsh parenting in each country. This predictive modeling context contrasts with the traditional explanatory data analysis approach used by previous COVID-19 studies and enables the identification of a risk factor model that most accurately predicts harsh care during the lockdown in each of the three countries. Our finding that each country has a unique constellation of factors predicting harsh parenting indicates that we should be careful with generalizing findings on disrupted parenting during the lockdown to other countries. The predictive performance of models predicting harsh care during COVID-19 is not the same across countries, implying that there is no universal risk factor model that can be used for the identification of at-risk families across countries.

In line with our expectations, we found that grandparental involvement lowered the risk for harsh parenting among Chinese mothers. Interestingly, grandparent involvement interacted with age of the child. The grandparent effect was particularly pronounced for Chinese mothers with younger children, which is in line with previous studies showing that grandparental involvement is particularly advantageous for children in the post weaning phase. For example, (50) showed a positive grandmother effect on the nutritional status of Aka children in Congo, with their effect most evident during the critical 9–36 months post-weaning phase. This post-weaning phase may be a critical period demanding high levels of allomaternal support because maternal caregiving decreases while toddlers are still heavily dependent

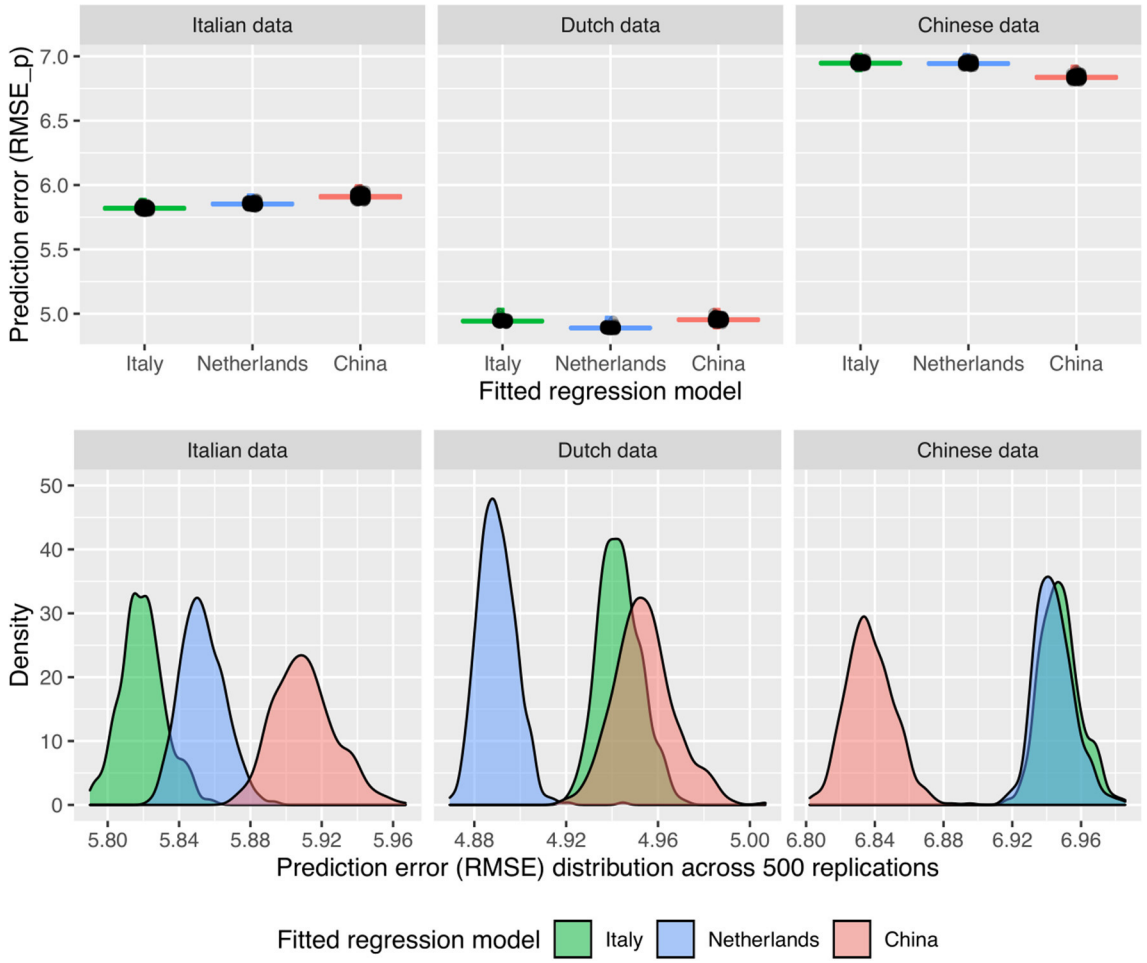

FIGURE 4 | Boxplots (upper row) and density plots (bottom row) showing the distribution of RMSE when fitting each country's best model to the dataset of each country.

on care. Moreover, toddlerhood is also the period characterized by increases in parent-child conflict related to the child's burgeoning autonomy and parental disciplinary strategies (55), thereby increasing caregiving load for parents. According to the grandmother hypothesis (22), the prolonged post-reproductive lifespan of grandmothers is the result of evolution favoring post-reproductive individuals their fitness through assisting their own offspring to reproduce successfully (49). Our results add to these findings and suggest that, under the adverse COVID-19 conditions, grandparents indirectly promote children's well-being by exerting protective effects on the rearing environment.

Grandparental involvement was, however, only an important predictor in the top winning model predicting maternal harshness in China, but not in the Netherlands and Italy. This is consistent with our previous study with the same sample in which we found that grandparental support only lowers mental health problems in Chinese mothers (31). Hence, no grandparent effect was observed in Italy and the Netherlands, possibly because in these countries the nuclear family is the most common family constellation, and nonresidential grandparents were kept at a distance from parents and grandchildren during the lockdown. Another remarkable difference between the Dutch and Italian vs. the Chinese models, potentially related to cultural variations in family structure, was that the number of children contributed to harsh care in the Netherlands and Italy, whereas this factor was considered unimportant in the Chinese model. Although previous research has identified a large number of children in the home as a risk factor for child maltreatment (48), these studies were predominately conducted in Western societies with nuclear families. In extended families, grandparents or other kin may assist with child care in the home environment, thus sharing the caregiving load and allowing parents to have more children without increasing the risk for child maltreatment (49). In China, where the extended family is considered traditional, a large number of children may therefore be a less important predictor for maltreatment. These results suggest that the antecedents of harsh parenting during the lockdown may be different across countries due to cultural variations in family composition. This interpretation is supported by our observation that Dutch risk factors predicted harsh care of Italian mothers reasonably well,

possibly because in both countries the nuclear family is most prevalent, whereas Dutch and Italian models performed poorly in predicting harsh parenting in China. It should be noted that many countries are multicultural and include multiple ethnic groups. Hence, our findings do not only indicate that there is no universal risk factor model that can be used for the identification of at-risk families, but also warrant caution against accepting one model for COVID-19-related risk factors within one country. Cultural variations in family composition may accentuate or minimize the importance of risk and protective factors, possibly leading to between- and within country differences in the constellation of risk factor models.

In addition to the potential role of family composition, employment rates of mothers may also have resulted in a differential constellation of predictors across the three countries. The employment rate of the Chinese mothers sample was very high in the current sample (93.6% of mothers), which matches well with the above world-average record of female labor force participation in China (56). Moreover, the vast majority of women are involved in full-time employment as part-time working has not yet been initiated/stimulated in China (57). As a consequence, the need of allomaternal support may be high in China: Chinese mothers may need support with childcare from either grandparents or father in order to meet the demands from work (58). This may explain why Chinese mothers who benefitted from support from highly involved fathers showed lower levels of harsh parenting, whereas father involvement was not considered an important predictor in Italy and the Netherlands. In line with this explanation, we found that father involvement was higher in China compared to Italy and the Netherlands. Another unexpected finding was that work-related stress or work-related changes predicted harsh parenting in the Netherlands and China, but not in Italy. In Italy, the male breadwinner model is most prevalent and female employment rates are rather low (59). Although work-related changes and stress reported by Italian mothers was quite high and the majority of mothers were employed, her partner's financial and job security may have lowered maternal stress regarding financial resources and buffered the effect of mothers' work stress on parenting abilities.

During COVID-19, in particular older adults were advised to keep social distance and (non-residential) grandparents who were involved in child care prior to the pandemic suddenly refrained from babysitting. Although this may have been a necessary precaution in order to avoid exposure to the virus, loss of allomaternal support from grandparents may have had a negative impact on parents (31) as well as children. The unexpected loss of grandparental support during the lockdown may have increased parenting stress, which may in turn leads to an overreliance on less effective disciplinary strategies, such as harsh discipline. Although grandparental involvement in child care exerts positive influences on children's health and well-being (9), the role of grandparents in caregiving is still sidelined in policy decisions. Research on caregiving also focused mainly on the mother as the primary caregiver and neglected the role of other caregivers such as grandparents. Our finding that high levels of allomaternal support from grandparent and father reduces the risk for harsh maternal caregiving during the lockdown in China underscores the importance of shared care, and may inform policies regarding child care during future pandemics. Adopting approaches to build a pandemic-proof community of care and strengthening networks of support inside and outside the family unit may help at-risk parents during future pandemics.

Some strengths and limitations should be noted. One strength of the study is that we examined the cross-cultural validity of factors predicting harsh care using large samples from three different countries. Examining parenting during the pandemic across countries is important because COVID-19 is a global crisis and understanding factors predicting harsh care will help identifying at-risk families during future pandemics. Yet, it is unclear whether results from individual countries are replicable across countries. Another strength is the use of cross-validation, which enabled us to identify those predictors that best predict maternal harshness in our data, but also perform well in predicting harsh parenting in various random subsets of the data. Cross-validation therefore revealed models that can be used to predict harsh parenting during future pandemics. This contrasts with standard statistical analyses that risk overfitting their regression models, resulting in models that fit the initial data very well, but are difficult to replicate in future research.

Another strength is that allomaternal support from father was measured with a 20-item task division questionnaire, enabling us to study how degree of paternal involvement impacts on maternal caregiving. However, it should be noted that grandparental involvement was measured dichotomously and we were not able to differentiate between maternal and paternal grandparents. Effects of grandparental involvement may be even more pronounced with continuous measures with more power. A second limitation is that some variables did not have sufficient within-country variability to test whether they contributed to harsh care. For example, in the Netherlands almost all parents reported living in a house with a private garden. In contrast with our expectation that lower quality housing would predict harsh care, living in a house with a garden was related to higher levels of harsh parenting in Italy. This effect, however, only approached significance in the robust regression analysis, was absent in China, and may therefore be the result of confounding factors that we did not control for in the current study. In addition, it should be noted that the Chinese, Italian, and Dutch samples showed differences in sociodemographic variables, such as age and employment. However, due to the large sample size, statistical tests were sensitive to detect very small differences between countries. It is not very likely that this has influenced the results, as effect sizes were small and we controlled for sociodemographic variables in all analyses. The analyses also mainly focused on predictive models in which multivariate associations are more important than mean level differences between the countries. Furthermore, Italy was affected to a larger extent by COVID-19 than the Netherlands and China. During data collection, China was in the aftermath of COVID-19, whereas the number of infections were still high in Italy and the Netherlands. Pandemic restrictions concerning closures of schools and day care centers, social

distancing, and remote working were, however, the same across countries. Moreover, our results show that COVID-19-related health concerns did not contribute to the prediction of harsh parenting. It is therefore unlikely that the constellation of factors predicting harsh care differed across countries due to differences in COVID-19 severity. Furthermore, it should be noted that the threshold parameters in the harsh parenting factor model for ordinal items were not invariant across countries, implying that factors other than harsh parenting were influencing the differences between countries on some harsh parenting item scores. The deviation from invariance however seemed small and invariance did hold for factor loadings. This analysis suggests that mean differences between countries on the harsh parenting scale should be interpreted with care. Lastly, we examined only maternal harshness and excluded fathers from the current analyses although we did examine paternal involvement in child care. Future COVID-19 studies should involve fathers. Moreover, future research should also examine the impact of lockdowns in families at risk for maltreatment. Allomaternal support may be particularly important in at-risk families. For example, a high-quality relationship with involved grandparents may play a buffering role for children in at-risk families.

In conclusion, during COVID-19 parents were presented with unprecedented challenges. For some families, pandemic-related distress may interferes with adequate parenting. Examining risk and protective factors for impaired parenting is therefore important and will help identifying at-risk families during COVID-19 and future pandemics. Our study showed that the constellation of factors predicting maternal harsh parenting during the COVID-19 lockdown is not identical across countries. Although marital conflict and maternal psychopathology are shared risk factors, the predictive performance of models predicting harsh parenting during COVID-19 differed across countries. Hence, the constellation of factors predicting maternal harshness during COVID-19 is not universal. This information will be valuable for the identification of at-risk families during future pandemics. Importantly, our results indicate that shared childrearing can buffer against risks for harsh parenting during adverse circumstances such as COVID-19, thus motivating the development of pandemic-proof support approaches, customized for individual countries, to assist parents with childcare and reduce parenting stress during future pandemics. During the lockdown, in the absence of any childcare support from community, the concept "It takes a village to raise a child" (8) may have had more meaning than ever. Mothers do not rear children on their own and allomaternal support from fathers, grandparents, and the community may be needed to establish resilience at a family level. Hence, building a pandemic-proof community of care can be leveraged in efforts to prevent harsh caregiving practices and their detrimental effects on children's well-being during future pandemics.

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 Social and Behavioral Sciences of Tilburg University, Department of Psychology of Padua University, Peking University Medical Ethics Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MR: conceptualization, investigation, validation, data curation, writing—original draft, funding acquisition, supervision, project administration, and resources. PL: software, methodology, validation, data curation, formal analysis, visualization, and writing—original draft. MV-V: investigation, writing—review, and editing. MB-K and MvIJ: methodology, supervision, writing—review, and editing. PDC and JG: investigation, data curation, writing—review editing, resources, 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/fpsyt.2021.722453/full#supplementary-material

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The Impact of Chinese College Students' Perceived Stress on Anxiety During the COVID-19 Epidemic: The Mediating Role of Irrational Beliefs

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Objective: To explore the underlying mechanism of the impact of perceived stress on anxiety of the Chinese college students during the COVID-19 epidemic.

Methods: The Perceived Stress Scale, Irrational Belief Scale, and General Anxiety Scale were adopted in the current study. College students were randomly selected for online questionnaire survey. There were 1,598 valid questionnaires, and the proportion of women was 47.81%.

Results: The perceived stress and anxiety, as well as the three dimensions of irrational beliefs (catastrophizing, low frustration tolerance, and depreciation) were significantly positively correlated; demandingness was not significantly correlated with anxiety. Further analysis found that the perceived stress had a significant positive predictive effect on the anxiety of college students. Catastrophizing, low frustration tolerance, and depreciation played part of the mediating role, and there was no significant difference in the strength of these mediating roles.

Conclusion: The perceived stress of the COVID-19 epidemic had a positive effect on the anxiety of Chinese college students, this was partly mediated by irrational beliefs.

Keywords: perceived stress, anxiety, irrational beliefs, COVID-19, college students

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INTRODUCTION

On January 30, 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 to be a Public Health Emergency of International Concern (PHEIC) (1). COVID-19 spreads quickly around the world with a comparatively high infection rate. It threats the world by the lack of effective vaccines or specific remedies and its high fatality rate (2). Studies have shown that the physical damage caused by such public health emergencies can be recovered in a short period of time, but the psychological damage will exist for a long period (3). After the SARS epidemic in China in 2003, a large number of patients with mental illnesses such as acute stress disorder and post-traumatic stress disorder appeared (4). Therefore, it is very necessary to provide the public with psychological support as soon as possible in response to the COVID-19.

In order to stop the spread of the COVID-19 epidemic into campuses, the Ministry of Education of the People's Republic of China requested universities to postpone the start of the 2020 spring semester (5). For college students, the epidemic changed their previous learning patterns and social styles. Worries about academic performance lead to dual stresses upon students' mental health (6). A volume of literature found that anxiety mostly followed a stressful event (7–10). Previous research found that compared with objective stress, subjective stress could better predict the mental health of college students (11). Therefore, the first question that this research intended to explore was whether college students' perceived stress during the epidemic would cause anxiety.

Perceived stress is a person's perception of threatening stimulus or unfavorable factor (12). It would cause confusion, the sense of being threatened, and challenged on the individual, in turn, the person might be in a state of tension or out of control (13). The development and magnitude of the perceived stress depends on a large extent on the individual's cognitive evaluation of environmental stimuli. Different people have different irritability to the same environmental stimulus based on different extent of their irrational beliefs (14, 15).

Irrational Beliefs (IBS) is the core concept of Rational Emotional Behavior Therapy (REBT) proposed by Albert Ellis, which has been widely used in psychological counseling and clinical treatment (16). Irrational beliefs refer to the rigid beliefs that things "should be" or "must be" based on a distorted understanding of objective things, or on the basis of illogical reasoning. In short, it is the unrealistic appraisal and evaluation of adverse events. Irrational beliefs are the absolute requirements and distorted views of oneself, others, and the surrounding environment. Irrational beliefs are usually divided into four categories: demandingness, catastrophizing, low frustration tolerance, and depreciation (17).

Previous research on the relationship between irrational beliefs and anxiety discovered that negative emotions such as depression and anxiety are closely related to irrational beliefs (18, 19). The fewer the individual's irrational beliefs, the lower the degree of anxiety. Irrational beliefs have impact on individual's interpretation styles (20). Individuals holding irrational beliefs are more likely to have the rigid demandingness belief, catastrophizing belief, low frustration tolerance, and depreciation belief than individuals holding rational beliefs, thus, have higher levels of anxiety (21, 22). Therefore, the second research question of the current study was that, whether irrational beliefs have a mediating effect on the relationship between the perceived stress and anxiety of college students during the COVID-19 epidemic.

As aforementioned, if the perceived stress affected the irrational beliefs of college students during the COVID-19 epidemic, meanwhile, the irrational beliefs affected their anxiety level, we thus hypothesized that irrational beliefs play the mediating role between the perceived stress and the anxiety of college students during the epidemic. Which is that perceived stress affects the anxiety of college students through the mediation role of their irrational beliefs. Previous studies have found that different types of irrational beliefs have different characteristics, which lead to different degrees of impact on mental health (23). The third research question that the current study wanted to explore was whether there were differences in the mediating effects of different types of irrational beliefs between the perceived stress and the anxiety of college students.

In sum, the current research hypothesized a parallel multiple mediation model to analyze the parallel mediation effects of different types of irrational beliefs. By so doing, to investigate the underlying mechanisms of perceived stress on anxiety of Chinese college students during the COVID-19 epidemic. This might evolve our understanding about the destructive factors within college students' responses to the stress caused by the epidemic. The evaluation and measurement of irrational beliefs will have instructive significance for clinical psychological counseling.

METHOD

Procedure and Participant

The current study was conducted in five universities in Beijing City on April 19, 2020. We distributed 1,800 pieces of questionnaires online, among which 202 invalid questionnaires were removed. In total, 1,598 (valid ratio = 89.8%) college students (47.81% were women) ranged from freshman to junior completed this online survey. A consent form was stated at the beginning of each questionnaire. The average age was 19.8 ± 1.3 year-old, median age 20 years old, range 16–25 year.

Measures

The Perceived Stress Scale

The 10-item perceived stress scale was applied to measure the degree of stress experienced by an individual in the past 1 month (12). A sample item was "In the past month, you have been upset by unexpected events." Answers were provided on a 5-point frequency scale, ranging from 0 (never) to 4 (always). The total score of the scale represented the degree of perceived stress: the higher the score, the stronger the perceived stress. The Cronbach's alpha was 0.79.

The Irrational Beliefs Scale

The 15-item Irrational beliefs scale was adopted from Wang Yu's irrational belief scale about college students based on the existing irrational belief scale (24). A sample item was "Any mistake will lead to great disaster." Answers were provided on a 5-point frequency scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The Cronbach's alpha was 0.60 of the dimension of demandingness, 0.61 of the dimension of catastrophizing, 0.70 of the dimension of low frustration tolerance, and 0.78 of the dimension of depreciation.

The Generalized Anxiety Disorder Scale (GAD-7)

The 7-item Generalized anxiety disorder scale was applied to measure the frequency of generalized anxiety disorder symptoms of participants in the last 2 weeks (25). Answers were provided on a 4-point frequency scale, ranging from 0 (not at all) to 3 (nearly every day). The total score of the scale ranged from 0 to 21, the higher the score, the more severe generalized anxiety disorder symptoms. Scores equal to or >10 indicate the diagnose of GAD.

TABLE 1 | Means, SD, and correlations between the study variables.

Variable	M	*SD*	1	2	3	4	5	6	7
1 Gender	–	–	–						
2 Perceived stress	26.743	5.629	0.012	–					
3 Anxiety	11.393	3.954	−0.018	0.654***	–				
4 Catastrophizing	8.621	2.067	−0.028	0.246***	0.274***	–			
5 Low frustration tolerance	12.635	2.692	0.025	0.309***	0.324***	0.414***	–		
6 Depreciation	11.399	3.215	−0.005	0.424***	0.401***	0.468***	0.543***	–	
7 Demandingness	12.401	1.718	0.112***	−0.087**	−0.015	0.213***	0.252***	−0.002	–

$^{**}p < 0.01$ and $^{***}p < 0.001$.

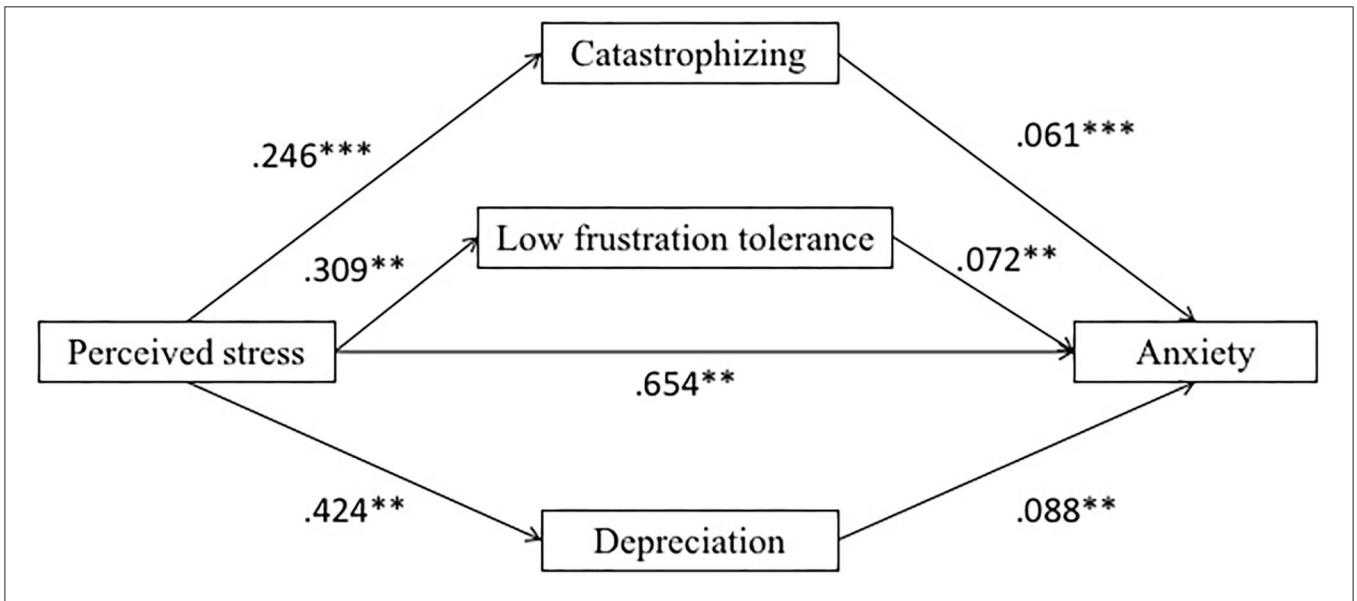

FIGURE 1 | Multiple parallel mediation model of the current study. $^{**}p < 0.01$ and $^{***}p < 0.001$.

Scores ranged from 6 to 9, 10 to 14, 15 to 21 might represent the mild, moderate, and severe levels of anxiety on the GAD-7 (25). The Cronbach's alpha was 0.91.

Data Analysis

SPSS 21.0 was applied to conduct the data analysis. Model 4 of the PROCESS (26) was applied to conduct the multiple parallel mediation analysis in testing the significance of the overall mediation and individual indirect effects of the catastrophizing, low frustration tolerance, and depreciation. The bootstrapping technique was applied to examine the significance of the hypothesized indirect effects. Bias-corrected 95% confidence intervals (BC 95% CIs) were computed based on 5,000 bootstrap resamples.

RESULTS

Harman's single-factor test was applied to detect the possible common method variance (CMV) on the current self-reported data (27). The results showed that there were 11 eigenvalues >1. The first common factor estimated the common method variance to be 21.74%, which is less than the threshold of 40%. Therefore, suggested CMV did not exist (28).

Descriptive Statistics

Means, standard deviations, and correlations among the study variables were presented in **Table 1**. The correlation between demandingness and anxiety was not significant, thus demandingness was removed from the mediation analysis. The correlation between gender and anxiety was not significant, thus gender was removed from the control variables.

Test of the Mediation Effect

Based on the results of correlation analysis, the current study intended to explore the mediating role of irrational beliefs (catastrophizing, low frustration tolerance, and depreciation) during the epidemic period between the perceived stress and anxiety of college students (see **Figure 1** for the multiple parallel mediation model). Anxiety was the dependent variable, perceived stress was the independent variable, and irrational beliefs (catastrophizing, low frustration tolerance, and depreciation) were the mediating variables.

TABLE 2 | Mediation analysis of irrational beliefs between perceived stress and anxiety.

	Estimate	Boot SE	95% CI	
Total indirect effect	0.052	0.008	0.037	0.068
Indirect effect 1	0.011	0.004	0.003	0.018
Indirect effect 2	0.016	0.005	0.006	0.026
Indirect effect 3	0.026	0.009	0.010	0.044
Comparison 1	−0.005	0.006	−0.018	0.008
Comparison 2	−0.016	0.010	−0.036	0.003
Comparison 3	−0.011	0.011	−0.034	0.011

Indirect effect 1, Perceived stress → Catastrophizing → Anxiety; Indirect effect 2, Perceived stress → Low frustration tolerance → Anxiety; Indirect effect 3, Perceived stress → Depreciation → Anxiety; Comparison 1, indirect effect 1—indirect effect 2; Comparison 2, indirect effect 1—indirect effect 3; Comparison 3, indirect effect 2—indirect effect 3.

Results showed that perceived stress was positively related to anxiety ($\beta = 0.65$, $p < 0.001$). Perceived stress was positively related to catastrophizing ($\beta = 0.25$, $p < 0.001$), low frustration tolerance ($\beta = 0.31$, $p < 0.001$), and depreciation ($\beta = 0.42$, $p < 0.001$), respectively.

After integrating irrational beliefs as the intermediary variable, the positive predictive effect of perceived stress on anxiety was significant ($\beta = 0.58$, $p < 0.001$). Catastrophizing was positively related to anxiety ($\beta = 0.06$, $p < 0.01$), low frustration tolerance was positively related to anxiety ($\beta = 0.07$, $p < 0.01$), and depreciation was positively related to anxiety ($\beta = 0.09$, $p < 0.001$).

The total effect of perceived stress on anxiety was 0.459 ($p < 0.001$, LLCI = 0.4334, ULCI = 0.4855). The mediating effects of the three types of irrational beliefs were all significant, respectively. The mediating effect of catastrophizing estimated 2.40% (0.011/0.459) of the total effect; the mediating effect of low frustration tolerance estimated 3.49% (0.016/0.459) of the total effect; the mediating effect of the depreciation estimated 5.66% (0.026/0.459) of the total effect. In total, the mediating effect estimated 11.33% (0.052/0.459) of the total effect (see **Table 2**).

DISCUSSION

The current study examined the relationships between the perceived stress, irrational beliefs, and anxiety among Chinese college students during the COVID-19 epidemic. Results revealed three mediation paths of perceived stress on anxiety through the mediation role of catastrophizing, low frustration tolerance, and depreciation, respectively. This research contributed to educators in reducing the anxiety of college students from the perspective of modifying their irrational beliefs.

Theoretical Implication, Limitation, and Future Research

Individuals' irrational beliefs are closely related to their mental health (15). Previous literature such as Weng et al. (29) found that irrational beliefs could predict the degree of depression in patients with depression. Among college students, stress, and irrational beliefs were significantly related to alcohol issues (30). Irrational beliefs were proved to have a direct restrictive effect on the acquisition of social support and mental health (21). Based on previous studies, the current study advanced our knowledge of how anxiety, which is more common than depression during the epidemic (31), was affected by irrational beliefs.

Previous research has proved that stress had a significant predictive effect on the level of teacher's anxiety, through which irrational beliefs played the mediating role (32). The current study discovered this similar phenomenon among college students. In particular, under the urgent social context of the COVID-19 pandemic, extending our knowledge of how cognitive interpretation of the person-environment interaction influence individuals' mental health. In another study, the "low frustration tolerance" factor of irrational beliefs had the most predictive effect on high level of stress responses (24). Future research could pay more attention in exploring the mechanisms of how these three dimensions affect college students. In addition, the dimension of demandingness was not significantly correlated with students' anxiety, which was inconsistent with the notion of irrational beliefs (33). Future study would be necessary to verify this correlation. Moreover, the current research measured the general irrational beliefs of the college students' instead of their specific irrational beliefs which is closely related to the COVID-19 pandemic. Future research should pay attention to adapt the measure to detect the specific cognitive interpretations on the targeted adverse event.

The current research adopted the survey method in data collection, which belongs to the category of quantitative research in the research paradigm and lacks qualitative analysis. In-depth interviews combined with individual cases and follow-up research will be the direction of future research.

Finally, our results draw on the cross-sectional data in investing the mediation paths, even though we recruited a large sample size, this design is not efficient enough to support the causal relationships (34). Future study should consider the longitudinal survey or intervention design in replicating the current results.

Practical Implication

It is of significant importance to cognitively guide college students to help them detect and change unreasonable cognitive styles and beliefs, and respond calmly and rationally to the psychological impact of the major public health emergency, such as the COVID-19, as well as other future adverse events in daily life. Maintaining a positive and optimistic attitude instead of blindly catastrophizing the results of a stressful event, might reduce their risk of psychological symptoms (18, 20). Improving tolerance about setbacks by rationally understand the causes of stressful events, so as to be able to develop adaptive and effective coping strategies. By so doing to treat setbacks as an important opportunity to practice their mental endurance, and improve their mentality adaptability. Taking a comprehensive view of stressful events, such as to maintain a calm mind, neither underestimate the harm of stressful events, relax vigilance; nor exaggerate the risks of stressful events, and create artificial tension and panic. The current research reveals the cognitive processes of why college students suffer from anxiety during

such a public health emergency, pointing out the foci where practitioners could work with college students to help them suffer less from anxiety.

CONCLUSION

The current study investigated a parallel mediation model of the relationships among perceived stress, anxiety, and irrational beliefs (demandingness, catastrophizing, low frustration tolerance, and depreciation). Results revealed the mechanism of Chinese college students when encountering the outbreak of COVID-19 pandemic. The current research explored the destructive factors of college students' psychological response to the stress caused by the epidemic. On the one hand, it added to our knowledge of the underlying cognitive interpretations between perceived stress and anxiety. On the other hand, it has significant practice value on the interventions about how to maintain individuals' mental health when facing public health emergency.

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 Ethics Committee of Beijing Jiaotong University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

ZC and LQ: conception and design of study. LN, ZC, and LH: acquisition of data. LQ: analysis and/or interpretation of data. LQ and LN: drafting the manuscript. ZC and LH: revising the manuscript critically for important intellectual content. ZC, LQ, LN, and LH: approval of the version of the manuscript to be published. All authors contributed to the article and approved the submitted version.

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Internal Locus of Control and Sense of Coherence Decrease During the COVID-19 Pandemic: A Survey of Students and Professionals in Social Work

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Mental health is severely challenged by the COVID-19 pandemic due to a variety of restrictions in public and private life. Students in particular may face additional and unique stressors: face-to-face classes have been largely replaced by digital formats, leading to further reduced social contacts, thus facilitating the development of psychological symptoms. In this study, we aimed to assess the impact of the current peri-pandemic situation on students' 1) locus of control and 2) sense of coherence, both of which have been linked to mental health in previous work. A total of 403 social work students from Germany participated, providing both retrospective (pre-pandemic) and current (February/March 2021) ratings. Furthermore, 324 social work professionals were included to analyze differences between both groups. Locus of control shifted significantly from internal to external during the pandemic for students and professionals. Furthermore, high mental burden correlated with increased external and decreased internal locus of control. Sense of coherence decreased during the pandemic for the entire sample and correlated with high mental burden. Overall, students showed a stronger drop compared to professionals, primarily due to a more pronounced decrease in perceived meaningfulness (all $p < 0.001$). In summary, students and professionals responded with increased feelings of powerlessness in the absence of sufficient coping strategies—this could lead to further deterioration of mental health as the pandemic continues. In this context, students appear to be particularly vulnerable to a reduction in sense of coherence. We conclude that interventions to improve coping strategies are urgently needed.

Keywords: mental health, locus of control, sense of coherence, feeling of powerlessness, coping strategies

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INTRODUCTION

The COVID-19 pandemic has led to significant changes in public and private life, in part due to extensive restrictions during multiple lockdowns (Castiglioni and Gaj, 2020). These restrictions have severely challenged mental health in general (e.g., Kesner and Horáček, 2020). Because individual resources (in particular: social contacts) may subsequently be lost due to pandemic-related restrictions, individuals may become increasingly vulnerable to "spirals of loss" (Hobfoll, 2001), finally leading to an increased stress response. Accordingly, numerous studies point to a

potential increase in mental disorders as a result of the pandemic, both for the general population (Wang et al., 2020; Rossi et al., 2020), and for health care workers (Tan et al., 2020; Kramer et al., 2021). The pandemic may also negatively impact general well-being (Jung et al., 2020), psychological resilience, and stress levels (McGinty et al., 2020).

The need for control is widely considered as a central human need (Grawe, 1998). Subjective loss of control during the pandemic, as a reaction to extensive restrictions and the unpredictability of the pandemic's dynamics, has negative consequences on mental health, and also increases general stress levels and mental health problems (Kinman et al., 2020; Usher et al., 2020). In this regard, the psychological concept of *locus of control* represents a pertinent framework to operationalize the loss of control during the COVID-19 pandemic. It describes the extent to which individuals are convinced that they can control events themselves as a consequence of their own behavior (*internal* locus of control, in other words: gain of control), or feel powerless or controlled by external factors (*external* locus of control, in other words: loss of control) (Rotter, 1966). Over the past decades, a variety of studies have demonstrated a relationship between high internal locus of control and both mental and physical health (e.g., Jain and Singh, 2015; Kesavayuth et al., 2020). In the context of the COVID-19 pandemic, restrictive measures enacted by governmental authorities potentially shift feelings of locus of control from the internal to the external domain, and may result in negative consequences for mental health (Sigurvinsdottir et al., 2020; Alat et al., 2021).

Besides subjective loss of control, the individual ability to cope with the effects of the COVID-19 pandemic has been reported to have a major influence on mental health (Baloran, 2020). Routine coping mechanisms may prove useless during the pandemic and subsequently may lead to mental health problems (Barni et al., 2020). In this matter, the concept of *sense of coherence* (SOC) describes the individual ability to employ coping strategies to overcome a negative experience (Antonovsky, 1979). A prerequisite for successful coping is the perceived *manageability* of a situation, as well as its *meaningfulness* and the ability to understand the experience (*comprehensibility*). A pronounced sense of coherence has been associated with mental health and quality of life in numerous studies (e.g., Länsimies et al., 2017; Schäfer et al., 2018; del-Pino-Casado et al., 2019). Despite all efforts, individuals potentially perceive the pandemic and associated changes in daily life as being a great challenge to cope with. In this matter, pandemic-related restrictions may not always be perceived as being meaningful and/or completely understandable from the individual point of view. In this light, recent studies suggest that—apart from perceived locus of control—there is a negative relationship between sense of coherence and the COVID-19 pandemic. As a result, psychological stress levels may increase and mental health may deteriorate significantly (Gómez-Salgado et al., 2020; Schäfer et al., 2020; Leung et al., 2021; Ruiz-Frutos et al., 2021).

Young people and students in particular may face unique stressors during the course of the pandemic, as several empirical studies have shown. In general, face-to-face teaching has been widely replaced by digital teaching—this usually results in an additional reduction of social contacts and exchange opportunities for students (Chaturvedi et al., 2021). Most studies noted an increase of psychological symptoms in the context of the pandemic and frequently reported increased stress, anxiety, and/or depressive symptoms (e.g., Wang et al., 2020; Son et al., 2020; Meda et al., 2021). Elmer et al. (Elmer et al., 2020) suggested that COVID-19-specific concerns (including concerns about isolation, limited social networks, family health) may substantially contribute to these findings. Furthermore, there is evidence of increased anxiety about the future and lower well-being, particularly among undergraduate students (Dodd et al., 2021). In addition, online teaching potentially leads to a higher time burden for students and thus acts as an additional stressor (Dost et al., 2020).

Irrespective of the COVID-19 pandemic, it has also been shown for students that a pronounced internal locus of control is generally associated with better mental health (e.g., Sidola et al., 2015; Kurtović et al., 2018). However, studies on the specific influence of the COVID-19 pandemic on the perceived locus of control in students are not yet available. For sense of coherence, one previous study in nursing students has shown that it has been significantly less pronounced during the pandemic (Reverté-Villarroya et al., 2021).

According to the empirical results so far, it is to be expected that students react to pandemic-related restrictions with pronounced feelings of powerlessness in the sense of 1) a reduced internal locus of control and 2) a reduced sense of coherence (and subsequently with mental burden). However, studies assessing the extent to which students are vulnerable in the context of the pandemic are scarce. The present cross-sectional survey aims to fill this research gap. The following hypotheses are empirically tested based on data from 403 social work students. The aim is to examine differences between retrospectively assessed (before the COVID-19 pandemic) and current experiences (approximately 1 year after the pandemic began, i.e., February/March 2021), with respect to locus of control and sense of coherence:

H1a: Students' internal locus of control was higher before the COVID-19 pandemic than during the pandemic (February/March 2021).
H1b: Students' external locus of control was lower before the COVID-19 pandemic than during the pandemic (February/March 2021).
H2: Students' sense of coherence in students was higher before the COVID-19 pandemic than during the pandemic (February/March 2021).

Since there is only insufficient evidence on pandemic-related vulnerability among students in comparison to professionals to date, this study also surveyed 324 social work professionals for all primary endpoints to uncover possible differences between both groups.

METHODS

Sample and Study Design

A Germany-wide cross-sectional online questionnaire study was conducted with social work students and professionals from February 17 to March 7, 2021, via the SoSci platform (SoSci Survey GmbH). The aim of the survey was to capture both the 1) *current* ratings on the selected scales on locus of control and sense of coherence during the COVID-19 pandemic (February/March 2021) and the 2) *retrospective* assessment of the participants before the COVID-19 pandemic (see *Measurement* for details). The use of retrospective measures is a well-established method (Suar et al., 2015). Especially during the COVID-19 pandemic which makes it difficult to conduct prospective studies it is a useful and feasible approach to assess pandemic-related changes (Bäuerle et al., 2020; Van Rheenen et al., 2020; Belz et al., 2021; Robillard et al., 2021). From March 8, 2021, the so-called nationwide "second lockdown" ended in Germany and was followed by easing of pandemic-related restrictions (Federal Government Germany, 2021). The survey was stopped from that date to avoid systematic bias.

Acquisition of online questionnaires was carried out nationwide via three routes: 1) social networks and platforms (e.g., Facebook, XING, or Telegram): Closed online groups and communities consisting of members from the field of social work were selected for acquisition (e.g., "Social Work," "Critical Social Work", and especially student groups from universities). 2) Universities in Germany: E-mail distribution lists for social work students at the University of Applied Sciences and Arts (HAWK) in Göttingen, Hildesheim and Apollon University in Bremen were used. 3) Social work institutions: Specific areas represented by social workers were contacted by e-mail (e.g., residential group areas of the AWO or youth welfare of the Diakonie).

In sum, 881 persons used the link to the online survey. Data entered analysis if the following criteria were fulfilled: 1) data completeness (primary endpoints), and 2) either studying or working in the field of social work. Such, $N = 727$ participants could be included in the study (82.5%). The study was approved on February 15, 2021 by the ethics committee of the University of Applied Sciences and Arts (HAWK) containing the a priori defined hypotheses (1a/1b/2). The survey was completely anonymous; thus, obtaining informed consent was not necessary.

Measurement

In addition to the primary endpoints (see below), demographic information was recorded (age, gender, field of study/semester or occupation). Furthermore, the survey contained the self-developed, exploratory item "Do you currently feel mentally burdened?" to be answered on a scale from 1 = "not at all" to 5 = "very much". This item was added to the questionnaire by request of the local ethics committee during the approval process and is not part of a validated scale. It was used as a control item to generally assess the amount of subjective mental burden of participants, and whether subjective burden correlates with our primary outcomes. It has been recently shown that mental burden is highly correlated with symptoms of a stress response (Belz et al., 2021).

Internal and External Locus of Control

The questionnaire *Internal-External-Locus of Control* (IE-4, Kovaleva et al., 2014) was used to measure the individually perceived locus of control. Here, two items each measure the scales internal and external locus of control (each subscale score is built by averaging the two scale items). For this purpose, the participants provide ratings of statements such as "I'm my own boss." on a 5-point Likert scale (1 = "not at all true" to 5 = "completely true") (see **Table 1** for formulations of all items). In the context of the present study, the items of IE-4 were asked twice: once with reference to the "period before the pandemic" (retrospectively), and once with reference to "the current state" (February/March 2021). Apart from this introductory instruction, the items were not modified.

Sense of Coherence

The *Work-Sense-of-Coherence questionnaire* (Work-SoC, Bauer et al., 2015) was used to assess sense of coherence. A total of nine items measure work-related sense of coherence (total score: average of all items). Participants give ratings of their work situation on 7-point semantic differentials, each with opposing anchor points (e.g., "manageable" vs "not manageable"; see **Table 1** for all formulations). In addition to the total score, three subscales can be formed by averaging the corresponding items: manageability (2 items), meaningfulness (3 items), and comprehensibility (4 items). The items of the Work-SoC were also used twice in the present study, with reference to the "period before the pandemic" (retrospective) and "the current period" (February/March 2021). In addition, the introductory text asked about the "individual *study or work* situation" to specifically address students as well as professionals. Apart from that, the items remained unchanged.

Statistical Analysis

SPSS® statistical software (version 26) was used for data analysis. Descriptive representation of the variables was accomplished using means (M), mean differences (M_{Diff}), standard deviations (SD), frequencies ($Freq.$), and Pearson correlations (r)[1].

As primary endpoints of this study, differences between retrospective and current ratings were analyzed for a total of six scales. Hypothesis 1a/1b: 1) *internal* and 2) *external* locus of control (IE-4), and Hypothesis 2: sense of coherence (Work-SoC); 3) *total score* and three subscales: 4) *manageability*, 5) *meaningfulness*, and 6) *comprehensibility*. Six t-tests for dependent measures were used to analyze differences between retrospective and current ratings exclusively for the student subsample, along with corresponding effect sizes (Cohen's d: d_{emp}).

To analyze possible differences between students and professionals, a general linear model for repeated measures

[1]The four-field correlation coefficient (phi coefficient, r) was calculated for the correlation of the binary variables "student" vs "professional" and "binary gender" ("male" vs "female").

TABLE 1 | Assignment of the translated questionnaire items to the hypotheses (primary endpoints).

Hypotheses 1a/1b: Internal and external locus of control (IE-4)	**Answer options**
Introductory text: "How do you experience your personal situation in general? [. . .]"	
1a: "I'm my own boss." 1b: "If I work hard, I will succeed." 1c: "Whether at work or in my private life: What I do is mainly determined by others." 1d: "Fate often gets in the way of my plans."	Likert scale[1]
Hypothesis 2: Sense of coherence (Work-SoC)	**Answer options**
Introductory text: "How do you experience your personal study/work situation? [. . .]"	
2a[3]: "Unmanageable" vs "manageable" 2b: "Pointless" vs "meaningful" 2c[3]: "Chaotic" vs "structured" 2d[3]: "Uninfluenceable" vs "influenceable" 2e: "Insignificant" vs "significant" 2f[3]: "Unclear" vs "clear" 2g[3]: "Uncontrollable" vs "controllable" 2h: "Not worthwhile" vs "worthwhile" 2i[3]: "Unpredictable" vs "predictable"	Semantic differential[2]

Notes. *All items were answered twice, for (a) the "period before the pandemic", (b) the "current period" (February/March 2021).* [1]*Likert scale (1 = "strongly disagree"; 5 = "strongly agree"), subscales:* internal locus of control *(1a/1b),* external locus of control *(1c/1d);* [2]*Semantic differential (7-point scale with anchors listed in the table),* [3]*inverted in the questionnaire, subscales:* manageability *(2d/2g),* meaningfulness *(2b/2e/2h), and* comprehensibility *(2a/2c/2f/2i).*

TABLE 2 | Correlations and descriptive results.

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	***M* ± *SD*/*Freq***
Sociodemographic variables										
1. Student vs professional	–									s: 403. p: 324
2. Gender (binary)	–0.031	–								m: 110. f: 613
3. Age	–0.496**	–0.065	–							31.06 ± 9.57
4. Current mental burden	0.059	0.087*	–0.052	–						3.61 ± 0.96
Locus of control[1]										
5. Δ^1 Internal locus of control	–0.020	–0.057	0.035	–0.426**	–					–0.72 ± 0.82
6. Δ^1 External locus of control	0.039	0.059	–0.099**	0.299**	–0.493**	–				0.59 ± 0.88
Sense of coherence[2]										
7. Δ^2 Manageability	–0.061	–0.062	0.017	–0.239**	0.375**	–0.301**	–			–1.69 ± 1.66
8. Δ^2 Meaningfulness	–0.240**	0.027	0.184**	–0.276**	0.366**	–0.209**	0.364**	–		–1.03 ± 1.50
9. Δ^2 Comprehensibility	–0.151**	–0.065	0.090*	–0.402**	0.447**	–0.318**	0.605**	0.429**	–	–1.69 ± 1.43
10. Δ^2 Total score	–0.196**	–0.042	0.128**	–0.396**	0.498**	–0.343**	0.769**	0.745**	0.882**	–1.47 ± 1.21

Notes. *Correlations:* *p < *0.05;* **p < *0.01;* M = *mean;* SD = *standard deviation;* Freq. = *frequency; student = 1 vs professional = 0; gender (male = 1, female = 2); mental burden = values from one to 5 ("not at all" to "very much");* Δ = *delta (*Δ *= (current status)—(pre-pandemic status)) of questionnaire scales:* [1]*IE-4 (values from 1 to 5,* N = *727);* [2]*Work-SoC (value from 1 to 7,* N = *648).*

(GLM) was created for each of the six scales. The participants' ratings on the scales ("retrospective" vs "current") were integrated as a two-stage within-subject factor. In addition, the occupational situation ("student" vs "professional") was integrated into each GLM as a two-stage between-subjects factor. Furthermore, within each GLM, the interaction effect between both factors was tested in order to map possible different trajectories between students and professionals on the individual scales. In order to statistically validate possible interaction effects, testing was conducted between both subgroups by means of two pairwise comparisons each at the retrospective and current time point (*t*-tests).

Besides the *t*-tests for the student-sample (6 tests), each GLM contained three *F*-tests and two pairwise comparisons (6 GLM × 5 tests = 30 tests). Because of α-error inflation, all *p*-values reported for the primary outcomes were globally adjusted using the Bonferroni method for the total number of 36 statistical tests. The initial significance level was set at $p < 0.05$ (two-tailed). For additional explorative analyses, the *p*-values were not corrected.

As the Work-SoC scale specifically asked for ratings on the "individual study or work situation", only students who were at least in the third semester of a bachelor's degree were included, since otherwise no retrospective statements could be made about

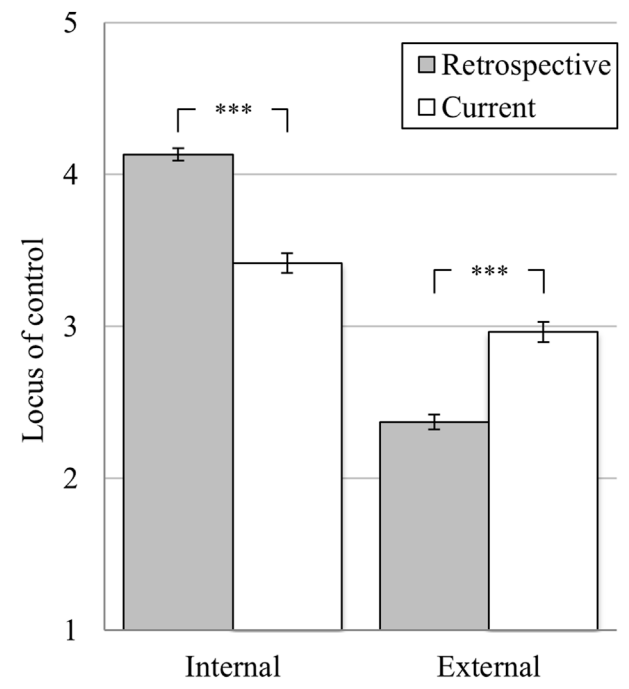

FIGURE 1 | Change in internal and external locus of control. *Notes:* *p < 0.05; **p < 0.01; ***p < 0.001; means with 95% confidence intervals (1 = "strongly disagree" 5 = "strongly agree"); *retrospective* = retrospective rating related to a pre-pandemic time-point; *current* = assessment at the current time point (February/March 2021). N = 727.

their study situation before the COVID-19 pandemic. In this context, the available total N was reduced from 727 to 648 (see degrees of freedom of the statistical tests).

RESULTS

Sample and Descriptive Results

See **Table 2** for a summary of descriptive results. Of N = 727 participants, n = 613 (84.3%) were female and n = 110 (15.1%) were male. In addition, n = 4 (0.6%) reported gender as "diverse." There were n = 403 (55.4%) students, and n = 324 (44.6%) professionals. The vast majority of students were in the bachelor's program (n = 368, 91.3%; master's: n = 35, 8.7%). The mean age of the total sample was M = 31.06 years (SD = 9.57). On average, students were 9.56 years younger (M = 26.81) than professionals (M = 36.37; t (724) = 15.38, p < 0.001). Mental burden resulted in ratings of M = 3.61 (SD = 0.96) for the total sample, thus tending to reach 4 = "quite burdened". There was no statistically significant difference between students and professionals in terms of mental burden (t (722) = 1.58, p = 0.12, not significant: *ns*).

Correlations between the variables are shown in **Table 2**. The status "student" compared to "professional" correlated with a more pronounced decrease in sense of coherence (Work-SoC) from the pre-pandemic to the current state: Significance was achieved for the Work-SoC total score as well as the subscales meaningfulness and comprehensibility (r between −0.151 and −0.240, all p < 0.001). High mental burden also correlated with negative changes in the sense of coherence for all (sub-) scales (r between −0.239 and −0.402, all p < 0.001), as well as with decreasing internal locus of control (r = -0.426, p < 0.001) and increasing external locus of control (r = 0.299, p < 0.001).

Locus of Control (Hypothesis 1)

Students rated their internal locus of control significantly higher at the pre-pandemic (M = 4.15, SD = 0.56) than at the current time point (M = 3.42, SD = 0.88; t (402) = 17.10, p < 0.001, d_{emp} = 0.85). Thus, the assumption made in Hypothesis 1a, that internal locus of control would decrease in students during the COVID-19 pandemic, is accepted. Also, internal locus of control was rated significantly higher at the pre-pandemic (M = 4.13, SD = 0.55) than at the current time point (M = 3.42, SD = 0.88, GLM: F (1, 725) = 541.13, p < 0.001, partial η^2 = 0.43 see **Figure 1**) by the entire sample. Neither a general difference between professionals and students could be found (between-group effect: F (1, 725) = 0.37, *ns*) nor different trajectories between the two groups (interaction effect: F (1, 725) = 0.29, *ns*, all pairwise comparisons *ns*).

External locus of control was rated significantly lower by students at the pre-pandemic (M = 2.42, SD = 0.69) compared to the current time point (M = 3.04, SD = 0.91; t (402) = 13.92, p < 0.001, d_{emp} = 0.69). The assumption that external locus of control would increase among students during the COVID-19 pandemic (Hypothesis 1b) is accepted. External locus of control was also rated lower at the pre-pandemic (M = 2.37, SD = 0.69) compared to the current time point (M = 2.96, SD = 0.92, GLM: F (1, 725) = 320.05, p < 0.001, partial η^2 = 0.31 see **Figure 1**) by the entire sample. Again, neither a different course between students and professionals (interaction effect: F (1, 725) = 1.09, *ns*, all pairwise comparisons *ns*), nor a general difference between both groups (between-group effect: F (1, 725) = 7.61, *ns*) could be found.

Sense of Coherence (Hypothesis 2)

Students rated the sense of coherence (Work-SoC: total score) significantly higher at the pre-pandemic (M = 5.51, SD = 0.72) than at the current time point (M = 3.80, SD = 1.09; t (232) = 23.13, p < 0.001, d_{emp} = 1.28). Comparable reductions were also found for all three subscales (manageability: M_{Diff} = −1.71, meaningfulness: M_{Diff} = −1.39, comprehensibility M_{Diff} = −1.90; all p-values < 0.001). Thus, the assumption made in Hypothesis two that the sense of coherence would decrease in the COVID-19 pandemic for students is accepted for the total score and additionally for all three subscales.

Also, the entire sample rated sense of coherence (Work-SoC: total score) significantly higher at the pre-pandemic (M = 5.48, SD = 0.74) than at the current time point (M = 4.02, SD = 1.07, GLM: F (1, 646) = 978.67, p < 0.001, partial η^2 = 0.60 see **Figure 2**). Again, reductions from the retrospectively assessed time point compared to the current time point were also found for all three subscales of the Work-SoC questionnaire (manageability: M_{Diff} = −1.69, meaningfulness: M_{Diff} = −1.03, comprehensibility M_{Diff} = −1.69). All reductions in the subscales reached significance (GLM: F (1, 646) from 326.37 to 918.61, all p-values < 0.001, see **Figure 2**). A significant interaction effect was found for the total score (GLM: F (1, 646) = 25.71, p < 0.001,

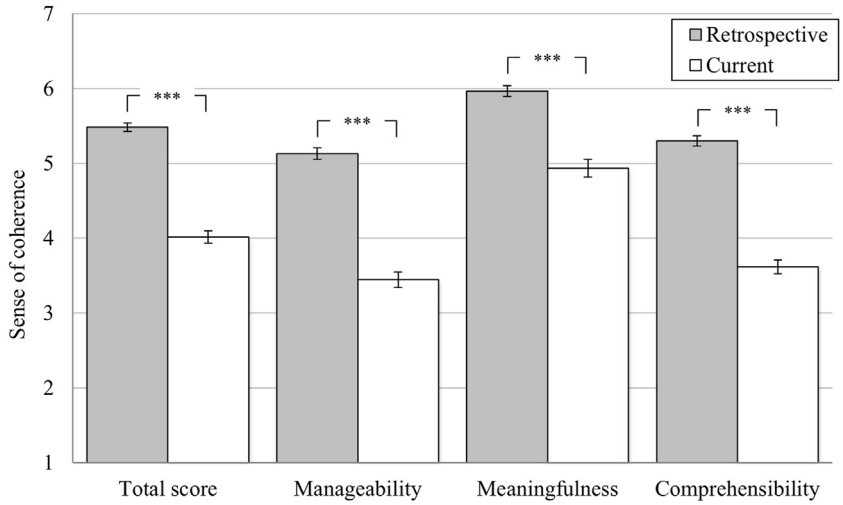

FIGURE 2 | Change in sense of coherence including subscales. *Notes:* **p* < 0.05; ***p* < 0.01; ****p* < 0.001; means with 95% confidence intervals (7-point semantic differentials; see **Table 1** for item anchors); *retrospective* = retrospective rating related to a pre-pandemic time-point; *current* = assessment at the current time-point (February/March 2021). *N* = 648.

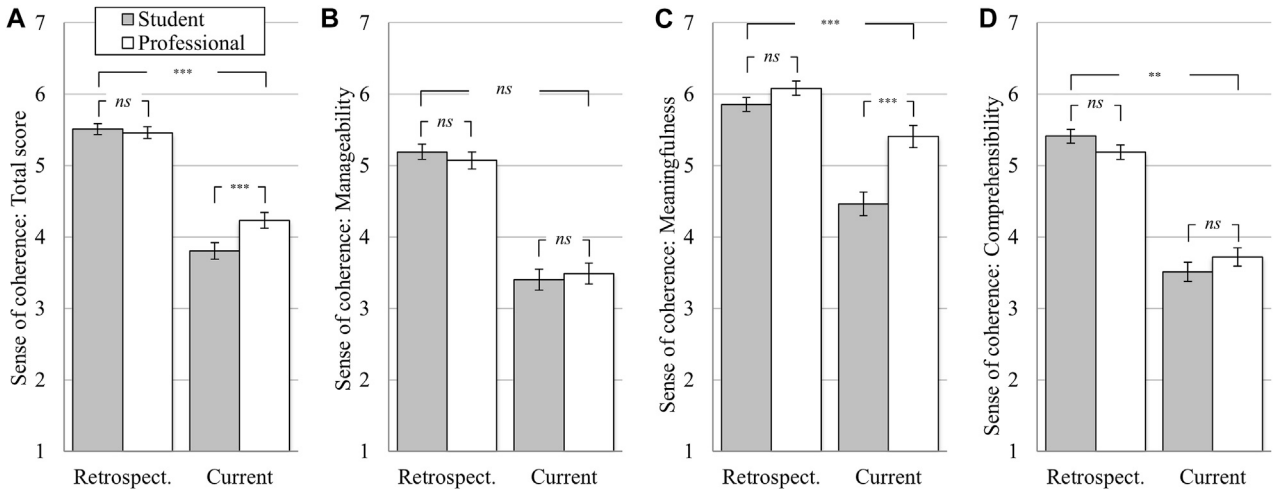

FIGURE 3 | Change in sense of coherence differentiated between students and professionals; **(A)**: total score, **(B)**: manageability, **(C)**: meaningfulness, **(D)**: comprehensibility. *Notes*: between groups (students vs professionals) and interaction effects; **p* < 0.05; ***p* < 0.01; ****p* < 0.001; means with 95% confidence intervals (7-point semantic differentials; see **Table 1** for item anchors); *retrospective* = retrospective rating related to a pre-pandemic time-point; *current* = rating of the current time-point (February/March 2021); *students* (*n* = 324) vs *professionals* (*n* = 324); *N* = 648.

partial $\eta^2 = 0.04$ see **Figure 3A**). While students and professionals did not differ at the retrospectively assessed pre-pandemic time point (M_{Diff} = 0.05, t (646) = 0.88, *ns*), students reported a significantly lower sense of coherence than professionals at the current time point (M_{Diff} = 0.42, t (646) = 5.16, $p < 0.001$). For the subscales manageability and comprehensibility, this interaction effect could either not be found, or could not be corroborated by significant pairwise comparisons (see **Figure 3B/D**). For the subscale meaningfulness, a significant interaction effect was found (GLM: F (1, 646) = 39.44, $p < 0.001$, partial $\eta^2 = 0.06$ see **Figure 3C**). Again, students and professionals did not differ in their retrospective, pre-pandemic assessment (M_{Diff} = 0.23, t (646) = 3.14, *ns*), but students rated the experienced meaningfulness significantly lower than professionals at the current, peri-lockdown time point (M_{Diff} = 0.94, t (646) = 8.18, $p < 0.001$).

DISCUSSION

The present cross-sectional study investigated whether the COVID-19 pandemic has a negative influence on perceived

internal locus of control as well as on the sense of coherence in social work students. For this purpose, retrospective ratings about the time before the pandemic were compared with ratings approximately 1 year after the beginning of the pandemic (February/March 2021). To analyze whether these students are specifically vulnerable to experience these changes, we compared ratings of 403 students to those of 324 professionals.

Central Findings of This Study

As postulated in hypotheses 1a/1b, the internal locus of control decreased significantly in the population of students during the COVID-19 pandemic, while the external locus of control increased in parallel. No difference between students and professionals could be found; both showed a similar, strong response in the context of the pandemic. Furthermore, an increased mental burden was strongly correlated with a shift from internal to external locus of control. In accordance with previous work, participants interviewed here might have reacted with a strong increase of mental burden due to the experience of powerlessness with regard to their own life organization during the pandemic (Jain and Singh, 2015; Kesavayuth et al., 2020; Sigurvinsdottir et al., 2020; Alat et al., 2021). In other words, their need for control as a central human need (Grawe, 1998) may have been neglected due to pandemic-related restrictions. Hence, a persistently high level of subjective powerlessness could intensify mental health problems and general stress levels in the future (Kinman et al., 2020; Usher et al., 2020). Our results also support pre-pandemic findings, suggesting a relationship between internal locus of control and mental health (Jain and Singh, 2015; Kesavayuth et al., 2020): Accordingly in this study, internal locus of control was negatively correlated—in contrast to external locus of control—with mental burden.

As postulated in hypothesis 2, the sense of coherence decreased among students during the pandemic. Similarly, a significant drop was found for professionals. One interpretation would be that neither students nor professionals have sufficient coping strategies to deal with pandemic-related challenges and are thus unable to cope adequately with this stressor (Antonovsky, 1979). This may also be accompanied by serious consequences for mental health (Länsimies et al., 2017; Schäfer et al., 2018; Baloran, 2020; Barni et al., 2020; Leung et al., 2021). For sense of coherence, it has to be considered that this concept was originally defined as a developmental construct or a dispositional orientation (Antonovsky, 1979; Hammond and Niedermann, 2010), and would therefore imply to remain essentially unchanged by environmental factors or interventions. In contrast, several empirical studies showed that sense of coherence within a person is not a stable trait per se. Thus, it has been shown to undergo changes (Smith et al., 2003; Feldt et al., 2011), and does not reach stability depending on a certain age (Feldt et al., 2003). With results of a significantly decreasing sense of coherence during the COVID-19 pandemic, the original assumption is challenged. Thus, the present study supports the idea that environmental conditions can change the individual sense of coherence.

It is of particular note that among students both the total score for sense of coherence and, more specifically, the sense of meaningfulness dropped more sharply than among professionals during the pandemic. These findings may be interpreted as specific vulnerability and bear important implications: A connection between subjective meaningfulness and individual work engagement during the COVID-19 pandemic has already been shown for healthcare workers (Liu et al., 2021). In their study, the implementation of a combined organizational intervention (a supportive letter that stressed the subjective meaningfulness and crisis management via counseling sessions) led to increased individual work engagement. One may thus consider that students who perceive their study to be more meaningful and the COVID-19 pandemic as less interfering would also profit from such interventions and increase their engagement. Consequently, subjective study-related meaningfulness should be increased via the promotion of sense-making processes, and may also lead to a reduction of mental burden in students. Fostering of meaning-making processes ("normalization") in light of the pandemic (i.e., recognition that stress reactions are normal given the current situation) represents a promising approach for psychological intervention (Castiglioni and Gaj, 2020): Promoting the understanding of stressful experiences can be considered as an important coping strategy and can substantially contribute to improving sense of coherence. Complementary pandemic-compatible strategies to improve mental health are already available, such as sports psychology interventions (Bertollo et al., 2021), specific pandemic-related training and preparation (Reverté-Villarroya et al., 2021), and the use of interventions such as mindfulness and a reduction of news consumption (Aughterson et al., 2021).

Limitations

First, in the present cross-sectional study, the assessment of locus of control and sense of coherence was conducted both retrospectively and at a time point approximately 1 year after the beginning of the pandemic, but ultimately it was a post hoc survey. Retrospective assessment is generally more subject to measurement error because it is retrieved from memory and additionally influenced by each participant's personality traits (Ottenstein and Lischetzke, 2020). Accordingly, data must be interpreted with caution. Recently, Belz et al. have shown that a retrospective, questionnaire-based measurement during the COVID-19 pandemic can yield good objectivity, reliability and validity (Belz et al., 2021). In sum, a longitudinal design would minimize this measurement error but was not feasible due to the unpredictability of the pandemic development. Second, the questionnaire was deliberately designed to be short so as not to deter participants from the outset—the mean completion time (min) was $M = 4.84$ ($SD = 1.91$) with a completion rate of 82.5%. Based on the large sample size acquired, it would have been statistically reasonable to collect more items/scales to gain more insights—however, this would have led to a potentially higher dropout rate at the same time. In this light, we only used a single, self-developed item to assess mental burden of participants ("Do you currently feel mentally burdened?"; 1 = "not at all" to 5 =

"very much"). This can be criticized, as—in contrast to the primary outcomes of this study—this item was not derived from an established scale, but simply formulated to record a self-report of mental burden post hoc. The item is thus not theory-driven, which is a clear limitation of this study and why it was only included in the exploratory analysis. In the future, established scales covering multiple facets should be used, even at the cost of a slightly longer questionnaire. Third, although the representativeness of the sample studied here can be considered potentially high due to the large sample size, the survey was conducted online exclusively. This may subject the dataset to inclusion biases that cannot be controlled. It should be noted at this point that due to the increased digitization during the pandemic (e.g., digital teaching, home office) more people have potentially acquired competencies in this area and can thus be widely reached by an online survey. This would in turn be indicative of a good sample representativeness. Fourth, we chose scales to assess locus of control and sense of coherence in this study. Undoubtedly, there are numerous resources which can help to cope with critical life events—like personal traits (e.g., self-efficacy) or energy resources (e.g., money; please see (Hobfoll and Buchwald, 2004) for details). These were neither empirically investigated nor statistically controlled here. It would be worthwhile to consider the relationship between such resources and the main outcomes focused here in future empirical studies.

CONCLUSION

Social work students and professionals react to the COVID-19 pandemic with increased feelings of powerlessness. Due to the currently unpredictable continuation of the pandemic, the negative effects found here may further escalate. In view of an increased vulnerability of students for a deteriorated sense of coherence, longitudinal observations of mental health are urgently needed for this population that has been insufficiently considered so far. Accordingly, the need for appropriate and population-specific intervention strategies would be uncovered.

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 University of Applied Sciences and Arts (HAWK). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

Design and conception: MM JS-K, and MB; Data acquisition and statistical analysis: MM MB; Writing: MM CB JS-K, and MB; All authors approved the final version of the manuscript.

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Family Function, Loneliness, Emotion Regulation, and Hope in Secondary Vocational School Students: A Moderated Mediation Model

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This study explored family function as a key factor of loneliness, hope, and emotion related to secondary vocational school students during the novel coronavirus pandemic. Chinese versions of the Olson Family Function Scale, Russell Loneliness Scale, Snyder Hope Scale, and Gross Emotion Regulation Scale were completed by 5,138 participants. Guardian type significantly predicted family function and loneliness. Family function significantly and positively correlated with loneliness. The relationship between family function and loneliness was mediated by hope, and expressive suppression concurrently moderated the relationship between hope and loneliness. Our study offers meaningful insights into the family function of Chinese secondary vocational school students. The findings supported a moderated mediation model that exemplifies the relationship between family function, loneliness, expressive suppression, and hope. Although the results showed that high hope mediated lower family functioning and loneliness, low expressive suppression led to intense loneliness immediately. This study confirms that emotional strategy is important and associated with mental health. It also suggests that schools should pay more attention to students' emotion regulation and help them rebuild hope or appropriate cognition to relieve loneliness during crisis events.

Keywords: family function, loneliness, hope, emotion regulation, expressive suppression

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INTRODUCTION

A sudden life event can considerably affect adaptability and cohesion among members of a family. According to crisis theory, family members may become more or less cohesive in response to ongoing changes in the environment (1, 2). During the novel coronavirus 2019 (COVID-19) pandemic, every Chinese family faced unprecedented challenges in their daily life; this appeared to enhance family relationships in some, but not all, cases. Furthermore, tension, anxiety, and irritability were more likely to occur in senior students (3). Moreover, during the COVID-19 pandemic, Chinese citizens underwent home quarantine to prevent the spread of the virus; all of these phenomena indicate that family function during the COVID-19 pandemic is a topic worthy of consideration. Considering the reality of the Chinese society, secondary vocational school students remained at home longer than primary and high school students during the pandemic. This duration was based on the decisions made by the Chinese Ministry of Education. Traditionally, secondary vocational schools follow a boarding school model; however, during the pandemic, these students were required to stay at home, suggesting that these students may have faced greater

challenges than other student groups in psychological state and external environment. Meanwhile, traditional Chinese education does not hold a generally positive view of secondary vocational school students; in the public's eye, they are often labeled as the "unsuccessful/underachieving group." Accordingly, members of such groups tend to be affected by negative social identities that influence their cognition, attitudes, behaviors, and values (4). Moreover, a low social status typically affects subsequent employment status, thus forming a vicious circle that fosters lower self-expectations and self-efficacy (5). A study has also shown that secondary vocational school students exhibit relatively poor self-management and high internet addiction, and that 60% of these students do not foster interpersonal relationships (4). Therefore, in the present study we selected secondary vocational school students as our study sample.

THEORETICAL BACKGROUND AND HYPOTHESES

The Correlation of Family Function on Loneliness

Miller et al. (6) and Skinner et al. (7) defined functional families as those that provide the necessary materials for one's survival, and that have family members who provide mental health and/or sustainable social development support. Based on a Western academic viewpoint but in the Chinese context, researchers have found that family function should also include organization in the interactions among members and coordination in responding to external changes (8, 9). Furthermore, according to Olson's circumplex model (10, 11), family function is divided into three dimensions: cohesion, adaptability, and mutual communication.

The denotation of family as a dynamic system suggests that there may be mutual influence pathways among family members. Thus, adverse events could damage a family's dynamic balance (e.g., the death of family members, separation, role transitions, and changing connections between the social environment and family). When family relationships face such challenges, family members must acquire new rules and re-establish these relationships to solve various frictions, contradictions, and thereby maintain balance (12). Moreover, there were gender differences between family function and adolescents' emotional health, and gender acted a mediating role of their relationship (13, 14). Furthermore, research has shown that family function is influenced by whether the parents served as guardians; for example, single-parent households had more family conflicts due to increased behavioral problems of adolescents (15, 16). Therefore, both sex and guardians were considered as variables in this study.

The COVID-19 pandemic represents the most serious human public health challenge since the Spanish flu in 1918. Moreover, the psychological impact of this pandemic is experienced by the general public, such as patients, paramedics, college students, and the elderly (17). Accordingly, this social environment inevitably impacts the dynamic balance of family functions. In line with this view, a Chinese proverb says "seemingly in harmony, but actually at variance;" such a proverb is useful to understand the situation that this pandemic has brought upon families. People have been required to remain isolated at home for a long time during the pandemic, meaning that students have had more contact and opportunity than usual to communicate with their parents. However, although family members have been forced to stick together in the same locations, they may still be experiencing conflicts and loneliness. Particularly, undemocratic families (i.e., families that ignore children's personal preferences and opinions) could experience an aggravation in conflicts and problems. For example, Skinner's process model and McMaster's model of family functioning both assert that better family function leads to better mental health and physical status of family members (6, 7). A study by Kim and Baik (18) indicated that poor family function can increase loneliness levels in older adults. Another study reported that family function correlated with loneliness and that social support could play a mediating role in that relationship (19); moreover, Yang et al. (20) also found that family function was associated with loneliness in undergraduates. Therefore, it is necessary to explore the correlation between family function and loneliness to identify internal family-based factors related to mental health.

Although there are diverse definitions of loneliness, there are commonalities among the definitions. Several studies have indicated that loneliness is an emotional problem, a component of an individual's psychological or emotional experience, and a qualitative abnormality in the process of social interpersonal communication. Specifically, Weiss (21) defined loneliness as a subjective psychological feeling or experience. Perlman and Peplau (22) summarized loneliness as a painful, unpleasant, and negative emotion originating only from interpersonal relationships. Thus, loneliness is an unipolar emotion generated by the discrepancy between desired social communication and reality. It has been suggested that all lonely people understand and experience loneliness similarly (23). Studies have also shown that loneliness can be categorized into two components: (1) emotional loneliness represents emotional alienation that occurs in important, close relationships (e.g., among parents, lovers, or friends), and (2) social loneliness generally comprises emotional alienation from society, which is characterized by individuals being rejected by social groups or organizations (24).

The combination of Olson's circumplex model with this emotional loneliness dimension, leads us to infer that loneliness also occurs in situations where family function—specifically its cohesion dimension—is weak (10, 11). In fact, Deng and Zheng (25) indicated that family function significantly predicts emotional expressiveness, domestic affection, and social loneliness; in their study, undergraduates who scored higher on cohesion and adaptability were more likely to express positive emotions and less loneliness. Therefore, family function can predict the prosocial nature of interpersonal relationships, and a good family environment or better family cohesion can decrease the risk of loneliness (26). Hence, our first hypothesis is that there would be a significant correlation between family function and loneliness.

Abbreviations: CI, confidence interval; COVID-19, novel coronavirus 2019; LSD, least significant difference; SD, standard deviation.

Hope as a Mediator Between Family Function and Loneliness

Hope is a dynamic inner power and subjective experience that helps individuals to reshape their self-confidence and improve their capability, enabling them to pursue a better state (e.g., by addressing dilemmas); it encompasses psychology, physiology, and sociology, enabling individuals to establish positive beliefs, values, and engage in more pro-social behaviors, all of which allow people to overcome difficulties (27). The hope theory by Snyder et al. (28) suggests that the core components of hope are the cognitive mechanisms of pathway thinking and agency thinking. As a method for coping, hope can be useful for solving and buffering crises or pressures that individuals may face. Moreover, high levels of hope-related traits help maintain mental health (29). Subsequently, studies have found that depressed patients with greater dispositional hope gained positive psychological means to relieve stress-related emotions, facilitate physical rehabilitation, and re-integrate into society (30). Additionally, several medical studies have found that hope mediates the relationship between family function and quality of life (31). Gong (32) found that hope also acts as an intermediary between loneliness and quality of life. Further, Sharabi et al. (33) found that loneliness is closely related to hope and family, and that family cohesion is a direct predictor of hope levels. Thus, loneliness, hope, and family atmosphere are key factors for individual development; family atmosphere includes material and spiritual support (34), which facilitate the associations between family function, hope, and loneliness. Hence, our second hypothesis is that hope would mediate the relationship between family function and loneliness.

Emotion Regulation as a Moderator

The core of emotional intelligence is emotional self-management, which involves emotion regulation, expression, motivation, reflection, and cognition (35). In this study, we focus on emotion regulation, which refers to individuals' control over their emotional responses as caused by physiological reactions, subjective experiences, or facial expressions (35). Gross and John's (36) emotional conditional process model proposed that different stages of event development generate different emotions; this model posited five different emotion regulation processes: episodic selection, modification, attention allocation, cognitive change, and response adjustment. In this model, individuals re-evaluate their input information and regulate their emotional response, finally outputting an emotional response that may, in itself, be suppressed or reappraised. For example, if an emotional experience is painful, people's cognition may rationalize the incident and try to minimize the generation of negative emotions (i.e., suppression), albeit it may also transform the character of the emotion and reaction (i.e., cognitive reappraisal).

According to the theory of Snyder (28) and Gross and John (36), hope as cognitive processing is connected with emotion regulation; for example, Peh's et al. (37) findings reported that hope shared a relationship with cognitive reappraisal, but not with suppression among patients with cancer. The construct correlation ($r = 0.5$) reported between the theoretical model of hope and the theory of optimism (38, 39), suggested that they were both positive components of cognitive processing. This means that people with higher hope should be able to sustain positive emotions to pursue goals with full energy and enthusiasm compared to people with lower hope. The higher hope individuals always had higher self-efficacy, meaning that they had enough power to achieve emotion regulation (40). Therefore, it is important to characterize the relationship between emotion regulation and hope.

Meanwhile, hope involves rational cognitive and behavioral tendencies acquired through learning, whereas loneliness is an undesired experience and emotion. During the COVID-19 pandemic, face-to-face social contact has been greatly restricted, and people have been facing challenges in their intimate family relationships. However, although adults have a rational cognitive "storybook" (i.e., hope), the output is not always a positive emotion because of the function of emotion regulation (28, 36). As previously shown, the two dimensions of emotion regulation (i.e., cognitive reappraisal and expressive suppression) have inconsistent relationships with psychological processes (41); accordingly, hope may separately link with cognitive reappraisal and expressive suppression (42). Previous studies showed that a negative event induces adolescents' lower hope level (43) and the higher hope individuals could achieve emotion regulation (40). As a result, people with different levels of hope may experience different emotions depending on the response to a life event: a cognitive reappraisal or an expressive suppression response. Thus, our third hypothesis proposes that cognitive reappraisal or expressive suppression moderates the correlation between hope and loneliness.

This Research

Chinese secondary vocational school students are a special group in that they have the characteristics of adolescence but are also unique. The period of adolescence is characterized by rapid development of physical and mental mechanisms; Chinese secondary vocational school students are especially vulnerable to being despised by peers for having poor awareness, academic failure, and employment-seeking pressures (44, 45). Thus, from the perspectives of mental health and school management, Chinese secondary vocational school students may face more pressure than other student groups.

Consistent with crisis theory, this research considered family function and emotion regulation as important predictors of loneliness. Both satisfied family function and healthy emotion regulation may prove protective during a time of crisis, such as the COVID-19 pandemic. Initially, we constructed a theoretical model shown in **Figure 1**; typically, family is an individuals' most important social support system, and a harmonious family atmosphere is conducive to reducing loneliness. Concomitantly, hope is an important predictor of individuals' physical and mental health and an important cognitive strategy that helps individuals adjust their mental health status during stressful situations (e.g., the COVID-19 pandemic). However, if hope is insufficient, individuals may still rely on emotion regulation, which may help reduce their psychological burden and negative

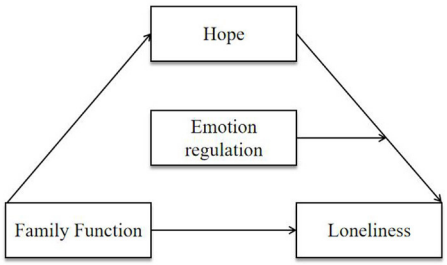

FIGURE 1 | The proposed theoretical model between the interest variables.

TABLE 1 | Demographic characteristics ($N = 5,138$).

Variables	Group	*N*	%
Grade	Grade 1	2,920	56.83
	Grade 2	2,112	41.11
	Grade 3	106	2.06
Sex	Female	2,056	40.02
	Male	3,082	59.98
Guardians	Parents	4,311	83.90
	Non-parents	827	16.10

feelings (e.g., loneliness). Therefore, individuals with a positive emotion regulation could effectively mobilize hope and loneliness to help them establish goals and even ease loneliness.

Thus, we propose the following hypotheses: (1) family function and loneliness have a significant positive correlation; (2) hope mediates the relationship between family function and loneliness; (3) emotion regulation (i.e., expressive suppression or cognitive reappraisal) moderates the relationship between hope and loneliness.

METHODS

Participants

This study was conducted using a questionnaire survey among secondary vocational school students, in late April 2020. Secondary vocational school students underwent home, amidst the pandemic outbreak in China. Thus, teachers provided students with internet-based questionnaires; we collected data via a Chinese online crowdsourcing platform, similar to the Amazon Mechanical Turk. Convenience sampling methods were used to provide the questionnaire survey to those students, who participated voluntarily without reward. About 5,138 secondary vocational school students voluntarily completed survey (effective response ratio: 95.15%). Of these, 262 responses were invalid due to patterned or biased responses. **Table 1** presents the demographic characteristics of the participants.

Procedure

Family Function Questionnaire

The Chinese version of the Family Function Questionnaire has been used in prior research to assess family function in Chinese secondary vocational school students (10, 46). It comprises 30 items divided into the adaptability and cohesion dimensions; it showed high reliability and validity, with a Cronbach's alpha coefficient of 0.926, 0.935, and 0.963 and for the adaptability, cohesion, and overall scale, respectively. The cohesion dimension assesses individuals' emotional connection with family members, whereas the adaptability dimension refers to family members' decision-making and transformation when external factors change. Items of the questionnaire are rated on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*always*), and assess actual and rational family responses; the greater the difference between actual and rational responses, the greater the degree of dissatisfaction.

Loneliness Questionnaire

The Chinese version of the loneliness questionnaire is a self-report measure that assesses satisfaction with the quantity and quality of social networking (23, 47). It comprises 20 items, each of which is rated on a 4-point Likert scale, ranging from 1 (*never*) to 4 (*always*), such that a higher score indicates greater loneliness. The Cronbach's alpha coefficient of the scale was 0.846.

Hope Questionnaire

The Chinese version of the hope questionnaire was used to measure cognitive and behavioral tendencies acquired through learning. During the process of achieving goals, individuals evaluate the internal and external situation to seek practical solutions through pathway and agency thinking (28). Pathway thinking is defined as the generation of a plan or methods for attaining goals, while agency thinking as directional energy or motivation, and both are components of hope (28). The 12 items of this scale are each rated on a 4-point Likert scale, ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). The Cronbach's alpha coefficient for the overall scale was 0.845, while the values for pathway thinking and agency thinking were 0.775 and 0.777, respectively.

Emotion Regulation Questionnaire

The Chinese version of the emotion regulation questionnaire was used to measure the extent of cognitive reappraisal and expressive suppression (36, 48). Cognitive reappraisal is a positive and forward-thinking adjustment strategy used to re-evaluate situational emotional arousal, whereas expressive suppression is a negative behavior or emotional response strategy (41). It comprises 14 items, which are rated on a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Moreover, the Cronbach's alpha coefficients for the overall emotion regulation and its two dimensions (cognitive reappraisal, expressive suppression) were 0.851, 0.877, and 0.801, respectively.

Ethical Considerations

All students voluntarily participated in our survey, and they were informed that they could withdraw from the survey at any time. Additionally, each participants signed an electronic informed consent form before filling the survey questionnaire. Study procedures were approved as exempt by the morality and ethics committee of Guizhou Normal University for human

TABLE 2 | Means, standard deviations, and correlations among the study variables.

	M ± SD	Sex	Guardian	Emotion regulation	Cognitive reappraisal	Expressive suppression	Hope	Loneliness	Family function
Sex	1.40 ± 0.49	1							
Guardian	1.16 ± 0.37	0.029*	1						
Emotion regulation	4.49 ± 0.81	−0.161**	−0.007	1					
Cognitive reappraisal	4.98 ± 0.98	−0.095**	−0.030*	0.818***	1				
Expressive suppression	4.00 ± 0.99	−0.168**	0.019	0.821***	0.343***	1			
Hope	22.58 ± 5.35	−0.011	−0.015	0.138***	0.234***	−0.007	1		
Loneliness	42.61 ± 8.80	0.066**	0.045**	−0.001	−0.221***	0.217***	−0.249***	1	
Family function	10.96 ± 13.35	0.108**	0.061**	−0.009	−0.049**	0.034***	−0.043**	0.176***	1

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, all two-tailed; the same notation is used in the subsequent tables.*

subjects. Present study performed were in line with the principles of the 1964 Helsinki declaration (including its later amendments or comparable ethical standards).

Data Analysis

SPSS 23.0 was used for data processing and analysis. First, invalid data due to patterned or biased responses were deleted after performing the frequency analysis. Second, common method biases were tested by performing factor analysis. Third, descriptive statistics and Pearson correlations were computed among for all the variables. Lastly, we employed Model 4 and 14 of the SPSS PROCESS macro (version 3.0) to examine the mediating role of hope and the moderating role of emotion regulation (including cognitive reappraisal and expressive suppression) in the relationship between hope and loneliness, respectively, based on the bias-corrected percentile bootstrap method [5,000 samples; (49)] with 95% confidence interval (CI), which was used for detecting significance effects. All data were standardized before analyses in Model 4 and 14, except for sex and main guardians, which were added as control variables in the models based on previous studies (50–52).

RESULTS

Common-Method Bias Test

Due to the self-report nature of the data, there was a possibility of common method bias (53). Therefore, we used the Harman single factor test, as per Podsakoff et al. (54), to examine common method bias. Our results showed that the data were suitable for factor analysis (Kaiser-Meyer-Olkin coefficient = 0.95, $p < 0.001$). There were 17 factors with eigenvalues >1; the first factor explained 23.9% of the variance, which was lower than the criterion of 40%. Thus, there was no serious common-method bias in our study.

Descriptive Statistics and Analysis

Table 2 presents the means, standard deviations, and t values for the study variables. Although male students generated higher values for emotion regulation than female students (i.e., Least significant difference test), the latter generated higher values for family function and loneliness ($p < 0.05$ for all values) than the first. When parents were the main guardian, secondary vocational school students had lower loneliness and family function scores, by final *post-hoc* test ($p < 0.05$).

Family function was significantly positively correlated with loneliness ($r = 0.176$, $p < 0.001$)—supporting our first hypothesis. As **Table 2** shows, family function was not associated with emotion regulation; however, the two dimensions of emotion regulation exhibited correlations in opposite directions with family function (Cognitive reappraisal: $r = -0.049$, $p < 0.01$; Expressive suppression: $r = 0.034$, $p < 0.001$).

Loneliness was significantly negatively correlated with hope ($r = -0.249$, $p < 0.001$), while hope was significantly negatively correlated with family function ($r = -0.043$, $p < 0.01$). Additionally, the expressive suppression dimension was positively correlated with loneliness ($r = 0.217$, $p < 0.001$) and family function ($r = 0.034$, $p < 0.001$), and the cognitive reappraisal dimension was positively correlated with hope ($r = 0.234$, $p < 0.001$). This suggests that the two dimensions of emotion regulation represent different, opposing mechanisms.

Testing Hope as a Mediator

Following the determination of a significant interaction, we tested the second hypothesis. The mediation effect of hope on the relationship between loneliness and family function was examined using the SPSS Process macro Model 4 (49) after controlling for the demographic variables of sex and guardian (**Table 3**). Family function predicted loneliness ($\beta = -0.042$, $t = -2.998$, $p < 0.01$). The negative effects of family function on hope ($\beta = 0.159$, $t = 11.832$, $p < 0.001$) and of hope on loneliness were significant ($\beta = -0.241$, $t = -18.127$, $p < 0.001$). The indirect effect of hope on the relationship between family function and loneliness was significant [indirect effect = 0.01, Boot SE = 0.004, 95% CI = (0.003, 0.017)]. Despite the significant indirect effect, the direct effect between family function and loneliness remained significant [95% CI = (0.080, 0.114)], indicating that the mediation was only partial.

Testing for Moderated Mediation

Following the determination of a significant interaction (**Tables 2**, **3**), we examined the estimated conditional effects of hope on loneliness at different levels of expressive suppression by the Model 14 of PROCESS 3.0 macro for SPSS (55). Based

TABLE 3 | Results of the mediation model.

Variance	Model 1 Outcome variable: hope			Model 2 Outcome variable: loneliness		
	β	SE	*t*	*β*	SE	*t*
Sex	−0.012	0.029	−0.433	0.092	0.027	3.386***
Guardian	0.039	0.073	0.536	0.084	0.036	2.309*
Family function	−0.042	0.014	−2.998**	0.159	0.013	11.832***
Hope				−0.241	0.013	−18.127***
R^2		0.002			0.092	
F		3.564*			130.667***	

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

on the above analyses, sex and guardian were chosen as control variables, in line with a previous study (52). Prior to testing the third hypothesis, we examined whether the effect of hope on loneliness was moderated by emotion regulation. The hope × emotion regulation interaction was not significant [$F_{(1,5,131)} = 2.806$, $p = 0.094$]; nor was the interaction between hope × cognitive reappraisal [$F_{(1,5,131)} = 1.403$, $p = 0.236$]. We examined the statistical significance of the moderated mediation effect using the bootstrapping method to generate CIs. This inferential test indicates that if the CI does not contain zero, then the indirect effect is moderated by the moderator variable (56). The analysis indicated that the moderating effect of cognitive reappraisal on the relationship between hope and loneliness was not significant [95% CI = (−0.001, 0.002)]. However, the hope × expressive suppression interaction was significant [$F_{(1,5,131)} = 10.486$, $p = 0.001$].

In line with a previous study (55), we tested four conditions: (1) effect of family function on hope; (2) effect of family function on loneliness; (3) interaction between hope and expressive suppression in predicting loneliness; and (4) different conditional level indirect effects of family function on loneliness, via hope, across low and high levels of expressive suppression. **Table 4** presents the specifications of these models, where family function was negatively associated with hope [$\beta = -0.042$, SE = 0.014, $t = -2.998$, $p < 0.001$, 95% CI = (−0.070, −0.015)] and positively associated with loneliness [$\beta = 0.147$, SE = 0.013, $t = 11.242$, $p < 0.001$, 95% CI = (0.121, 0.172)]. Additionally, hope shared a negative relationship with loneliness ($\beta = -0.238$, $p < 0.001$), while expressive suppression shared a positive relationship with loneliness ($\beta = 0.226$, $p < 0.001$); since the interaction between hope and expressive suppression positively predicted loneliness [$\beta = 0.029$, SE = 0.012, $t = 2.495$, $p < 0.05$, 95% CI = (0.006, 0.051)], expressive suppression had a moderating effect on this relationship. These results supported the aforementioned first to third conditions.

We also conducted a simple slopes test, while considering the interaction effect one standard deviation below and above the mean of the moderator. As shown in **Figure 2, Table 5**, the relationship between hope and loneliness was weaker when expressive suppression was lower [$b_{slope} = -0.419$, $p < 0.001$, 95% CI = (−0.244, −0.174); 1 SD above the mean] and stronger when expressive suppression was high [$b_{slope} = -0.534$, $p < 0.001$, 95% CI = (−0.300, −0.234); 1 SD below the mean]. Namely, higher expressive suppression and loneliness were experienced, when individuals experienced low hope. In summary, the interaction between family function and loneliness was mediated by hope, and the interaction between hope and loneliness was significantly moderated by the observed range of expressive suppression.

DISCUSSION

The overarching intent of this study was to elucidate whether family function had close associations with loneliness, hope, and emotion regulation. Our results revealed that family function was positively correlated with loneliness, and that hope mediated the relationship between family function and loneliness. The results provided strong support for both hypotheses 1 and 2, and reported that expressive suppression could serve as a moderating role between hope and loneliness, that is, individuals with higher hope will have less loneliness than individuals with lower hope when they have higher expressive suppression—the latter moderation being one of the major findings of this study (hypothesis 3).

First, we explored whether parents or non-parents were the main guardians of secondary vocational school students affected loneliness and family function. As a result, we chose guardians as the control variable. However, even when parents were the main guardian, children whose parents tended to neglect them were more likely to report experiencing higher dissatisfaction with family function, psychological illnesses, and loneliness (57). Thus, children with neglectful parents were more likely to experience unpleasant emotions. Contrastingly, a cohesive, adaptable family usually fostered children's attachment and safety (58). Our results also indicated that male students' ability to regulate emotions were greater than that of female students; this was consistent with a previous study (59). Thus, sex was also chosen as a control variable. When female students experienced suppressive emotions, they were more likely to rely on their friends, perhaps sharing their feelings to gain social support. However, the COVID-19 restrictions meant that secondary vocational school students spent more time stay at home; without peer social support, women's emotion regulation may have been

TABLE 4 | Results of the moderated mediation model analysis.

Variance	Model 1 Outcome variable: hope			Model 2 Outcome variable: loneliness		
	β	SE	*T*	*β*	SE	*t*
Sex	−0.012	0.029	−0.432	0.174	0.027	6.443***
Guardian	−0.032	0.038	−0.852	0.071	0.035	2.024*
Family function	−0.042	0.014	−2.998**	0.147	0.013	11.242***
Hope				−0.238	0.013	−18.356***
Expressive suppression				0.226	0.013	17.145***
Hope × expressive suppression				0.029	0.012	2.495*
R^2		0.002			0.142	
F		3.555*			141.396***	

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

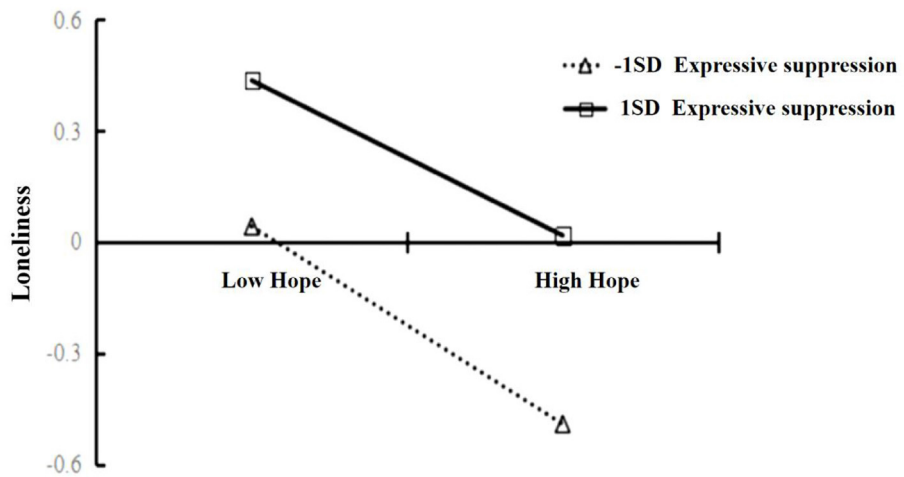

FIGURE 2 | Predictions for the Interaction between loneliness and hope by expressive suppression values.

TABLE 5 | Conditional indirect effects of expressive suppression on hope.

Expressive suppression	Effect	SE	*t*	LLCI	ULCI
M + SD	−0.210	0.018	−11.724***	−0.244	−0.174
M	−0.238	0.013	−18.356***	−0.263	−0.213
M − SD	−0.267	0.017	−15.817***	−0.300	−0.234

*LLCI, Lower Level Confidence Interval; ULCI, Upper Level Confidence Interval; ***$p < 0.001$.*

diminished and rumination may have been promoted, which led to increased attention to negative events and reduced motivation to release emotions (52).

Our results also showed a significant positive correlation between family function and loneliness, suggesting that greater dissatisfied family function can increase the risk of loneliness. Shek (60) previously reported that family function influences the healthy development of family members' minds and body, and that a good family environment could have a great impact on individuals' emotional responses and mental health. Thus, greater satisfaction with family function may be helpful for reducing loneliness, whereas dissatisfaction may intensify it. These results supported hypothesis 1. The basic unit in the ecological model of human development is family and peers (57), who may also be important for secondary vocational school students' development; studies before the COVID-19 pandemic indicated that loneliness promotes interpersonal anxiety (26). Additionally, the increased social isolation during the pandemic may have fostered loneliness to an even greater extent (61). Thus, based on Olson's circumplex model (11), our results highlight the critical role of family function during the pandemic; life uncertainties (e.g., those evoked by a pandemic) usually cause emotional and cognitive problems and damage mental health. Accordingly, we emphasize that further exploration of this topic is necessary.

Our results also reveal that hope mediates the relationship between family function and loneliness in secondary vocational school students, which is consistent with existing research

(62). Thus, hope—as an optimistic state—can alleviate the emotions engendered by negative life events, which reveals a new perspective to explain the link between family function and loneliness in secondary vocational school students. Moreover, higher levels of hope could help maintain mental health and thereby decrease loneliness (29). Medical studies have found that hope mediates the relationship between family function and quality of life (31), and between social support and loneliness (63). Thus, dissatisfied family function could aggravate the experience of loneliness, but holding onto hope in these situations could encourage people to deal with family function and loneliness. These observations are consistent with our second hypothesis.

The most important finding of this study was the verification of hypothesis 3. Some studies have shown that emotion regulation is associated with loneliness (64, 65). However, in this study, only expressive suppression moderated the relationship between hope and loneliness. In line with this finding, our results also verify that individuals try to use emotion regulation strategies to suppress emotions before loneliness occurs. Expressive suppression played an important regulatory role in secondary vocational school students, as it positively correlated with loneliness; meanwhile, cognitive reappraisal was negatively correlated with loneliness. This indicates that the two types of emotion regulation have different underlying mechanisms (66). Although hope was negatively correlated with loneliness, this correlation transformed with expressive suppression; despite the relatively low beta coefficients, they were statistically significant, indicating that the relationship did exist. According to Gross's model (36), expressive suppression is an emotion regulation strategy, which is useful for emotional behavior control, but cannot mitigate physiological reactions or subjective emotional expressions. Expressive suppression has been consistently linked with avoidant attachment and estranged relationships. As our results showed that high hope individuals with lower expressive suppression were also intensely lonely. This indicates that emotional strategy is important and associated with situational flexibility; emotional strategy may help people regulate their states amidst challenging life events (36, 67, 68). Adolescents who adopt expressive suppression decrease negative emotions when they have a stronger social support system (69, 70). This suggests that lower family functioning could exacerbate students' situation, which may explain the important role of expressive suppression in our model. Moreover, we found that a sudden crisis event (i.e., the pandemic) led people to attempt to restrain their emotional intensity and output to maintain physiological and psychological balance. This finding is consistent with existing research on this topic (71). Contrastingly, Snyder (72) posited that hope is a belief of happiness; thus, hope is negatively related to loneliness. Nonetheless, hope levels fluctuated with people's emotions. Our findings showed that the predictive effect of hope on loneliness weakened with an increase in expressive suppression, indicating that higher levels of expressive suppression were closely related to loneliness in secondary vocational school students. Conversely, the predictive effect of hope on loneliness strengthened with lower levels of expressive suppression. Thus, expressive suppression regulated an individual's responsiveness to both loneliness and hope (42). In other words, secondary vocational school students with lower levels of expressive suppression can use hope to overcome loneliness.

Finally, we constructed a moderated mediator model, titled the "family function-hope-loneliness model;" expressive suppression regulated the relationship between hope and loneliness in this model. Most secondary vocational school students in this study were also limited by their age, which may denote a generally greater immaturity and relatively modest ability to self-differentiate. Therefore, because they had insufficient intrapsychic and interpersonal resources to cope with emotional experiences, the particular nature of the pandemic may have aggravated their loss of hope.

Limitations

We collected the data during the COVID-19 pandemic; during this period, secondary vocational school students from diverse countries were differently excluded from school and educational management. Thus, future research is warranted to study the psychological status of different groups using comparative groups with a pre- and post-test design, and we aim to conduct such a study. This analysis would allow for the prediction of different psychological responses to similar crisis events, thereby, allowing for stakeholders to develop protective measures in advance.

Additionally, despite the relatively lower beta coefficients, especially in the interaction between hope and expressive suppression, the relationships between variables were statistically significant, indicating their existence, which may be due to the pandemic. Thus, subsequent research could focus on a longitudinal study to examine the stability of the model, considering the context of the current study.

Moreover, although the current sample was large, the sampling was regional, meaning it might not be representative of general vocational school populations; thus, cross-cultural studies are warranted to further explore behavior and cognitive differences regarding education or teaching methods. Additionally, this was a cross-sectional study at the family level, denoting the need for future studies to explore the influential factors of COVID-19 in schools and society more comprehensively.

Despite these limitations, we still believe that such analyses could help to stimulate or contribute to relative theory development, and even provide rationale for researchers who may invest time in longitudinal analyses that will test suggested processes more robustly. Our study findings make significant theoretical contributions, such as the role of hope as a mediator between family function and loneliness, and that of expressive suppression as a moderator between hope and loneliness. This study also has practical implications, as it is different from existing studies suggesting that emotion regulation affects loneliness (65, 73), and shows that expressive suppression plays an important role in loneliness in secondary vocational school students during the pandemic. Additionally, when these students showed lower levels of expressive suppression, the predictive effect of hope on loneliness strengthened significantly. Therefore, secondary vocational school students would likely benefit

by seeking various strategies of suitable emotion regulation and incorporating hope or positive psychology to cope with life events.

Conclusions

In conclusion, this study presented the role of family function in loneliness in secondary vocational school students. Hope was one pathway through which family function contributed toward reducing loneliness. Further, the effect of family function on loneliness was mediated by hope, which was thereby attenuated via expressive suppression. Our results highlight that family function was critical during the COVID-19 pandemic, as it had a strong relationship with loneliness. Although hope, as positive cognition, could reduce loneliness, expressive suppression decreased hope and increased loneliness.

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 in the article/supplementary material.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by All procedures performed in studies involving human participants were in accordance with the Ethical Standards of Guizhou Normal University and with the 1964 Helsinki declaration and its later amendments or comparable Ethical Standards. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

PY designed and supervised the project. HX analyzed data and wrote up the original draft. YZ designed the structure and performed the calculations. ZZ discussed the results and proofread manuscript. All authors contributed to the article and approved the final manuscript.

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Sibling Jealousy and Temperament: The Mediating Effect of Emotion Regulation in China During COVID-19 Pandemic

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This study aimed to examine first-born children's sibling jealousy and explore the relationships among first-born children's sibling jealousy, temperament, and emotion regulation in China during COVID-19 pandemic. The research hypotheses of this study are empirically examined through online and offline surveys. A sample of 304 two-child families from China participated in the study; the first-born children were aged between 1.17 and 7 years. The results indicated the following: (1) the older the first-born children and the greater the age difference between siblings, the lower the sibling jealousy. (2) Difficult temperament of first-born children could predict sibling jealousy significantly and positively, and emotion regulation could predict sibling jealousy negatively. (3) There was a partially mediating effect of emotion regulation between temperament and sibling jealousy. Compared with intermediate temperament, first-born children with difficult temperament had weaker emotion regulation and higher sibling jealousy. Overall, findings have important implications for psychological interventions for families of first-born children with difficult temperament.

Keywords: preschool first-born children, temperament, emotion regulation, sibling jealousy, COVID-19 pandemic

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INTRODUCTION

The COVID-19 pandemic has greatly changed people's way of life and had a profound impact on people's psychology and behavior. In order to avoid the further spread of COVID-19, many countries, including China, have taken strict containment measures such as quarantine, closure of schools and public entertainment places, and social distancing (1, 2). During the normalization of the COVID-19 pandemic prevention and control in China, although the children have returned to school, they no longer go to public playgrounds and interest classes after school and during holidays as usual. Thus, they spend more time with their families.

Benefiting from the newly revised family planning policy, many Chinese families are transforming from one-child families into two-child families. And in the coming future, even more and more families with three children will appear. Due to the changes in family structure, sibling competition and sibling jealousy have become high-frequency issues of social concern, as well as practical problems faced by many young parents. The birth of the second child often causes some physical and psychological problems compared to that of the first (3, 4). Compared to the parents of two or more children,

parents of only one child need to pay special attention to a new type of relationship that emerges after the birth of the second child, the sibling relationship, which was found in Previous studies can be influenced by the factors including sibling factors themselves (e.g., structural characteristics, temperament) and parent factors (parent-child relations, differential treatment, marital relationship, etc.) (5).

Sibling relationships might influence children's development through the mechanism of attachment, social learning, and social comparison (5). Siblings often develop a range of problematic behaviors due to jealousy (6–8). In the period of the normalization of the COVID-19 pandemic prevention and control, Children of two-child families are spending more time getting along with each other at home than before. Parents not only need to work, but also spend more time taking care of their children. They bear greater pressure and are more prone to anxiety and irritability, resulting in inappropriate treatment of their children (9). According to Volling et al. (8), first-born children may be jealous of their younger siblings because their parents spend more time with or take more care of the latter. Therefore, studying sibling jealousy in Chinese two-child families currently has special significance for the healthy development of children.

From a relationship perspective, jealousy refers to the emotion that an individual experiences when his or her important relationship with someone is threatened or faced with loss due to the intervention of a third party. Jealousy usually exists in the context of a social triangle formed by the jealous, beloved, and rival (10–12). As an emotion with a specific function, the purpose of jealousy is to prevent others from taking away the intimacy formed within relations, and the jealous person needs to take certain actions to protect this relationship (13). In family relationships, sibling jealousy refers to the complex social emotions that arise when the intimate relationship between a child and their parents is threatened by another child (12, 14). To restore intimacy, children may approach and seek the attention of their loved ones, become hostile to their siblings, or even prevent their siblings from having contact with their parents (15). At the psychological level, first-born children usually show emotions such as sadness, anxiety, and anger, and on the behavioral level, there will be manifestations such as seeking closeness, yelling at someone, degradation of behaviors, sleep changes, violent behavior, and decreased appetite (16–18). In families with multiple children, sibling jealousy is more likely to occur because of the relative reduction in the interaction time between the mother and one of the children, the unstable quality of attachment security, and the differentiated treatment of parents (18–20). Transactional models hold that the degree of sibling jealousy is primarily influenced by several factors, including individual characteristics, parental characteristics, family relations, and social environment (21). In this study, we focused on the influence of temperament and emotion regulation on sibling jealousy.

Researchers have found that girls' siblings are more jealous than boys' (22–24), and the age of the first child is negatively correlated with jealousy (25). As far as siblings are concerned, different gender combinations and age differences provide a unique family background for children's social adaptation process in China (5) and are also an important factor for siblings to compete for the limited resources of their parents (26). However, studies have found that the age gap and gender combination are not associated with sibling jealousy (24, 27). Therefore, it is necessary to study the influence of age, gender, gender combination and age gap on the jealousy of first-born children in the Chinese test group.

The temperament of children refers to the individual differences in the emotion, activity level, and attention of children in the early stage, and it is the external manifestation of children's response to the surrounding stimulation. It is more of an innate factor that is less affected by the environment. The temperament of young children seems to be the key factor in understanding the difficulties children face in the transition to sibling relationships and whether sibling jealousy appears in early childhood (28). Bad-tempered children are more likely to protest their mothers taking care of the younger siblings after their birth (29). Children with difficult temperaments tend to be less self-soothing, show more negative emotions such as anger, and are reluctant to take care of younger siblings (30, 31). First-born children with difficult temperaments show clinginess, withdrawal, and problems with eating and sleeping during the transition to sibling relationships (31–35).

Emotion regulation is the internal and external process of regulating, evaluating, and managing emotional responses to achieve expected goals, such as controlling emotional expression and effectively managing negative emotions (36). It is also a process in which individuals exert influence on the occurrence, experience, and expression of emotions (37). Children's emotion regulation includes the process of emotion regulation and emotional instability (38). The effect of emotion regulation on jealousy has been confirmed by many researchers (39–41). For example, researchers have found that the use of diversion strategies can reduce the level of pain after jealousy, which shows that effective emotion regulation strategies can reduce negative emotional experiences associated with jealousy (42). In the "More Fun with Sisters and Brothers (MFWSB)" program, researchers have asked children aged 4-8 to learn strategies (e.g., recognition, monitoring, evaluation, and correction) to improve their emotional and social abilities. The results showed that the emotion regulation ability and sibling relationship of the experimental group improved (43). Some researchers also believe that the first child's emotional regulation ability is higher than that of the second child. At the same time, jealousy is more implicit and flexible (27, 40).

There are some commonalities in the development of children's emotion regulation, but there are still some significant individual differences. One of these inherent differences is temperament, defined by Rothbart and Bates (44). Rothbart and Bates believe that temperament is a biological basis that leads to differences in individual behavior, and it will be affected by heredity, maturity, and experience (44). Murphy's research has found that children with more negative emotions and low control do not show stronger jealousy, which he believes is related to the individual's good emotion regulation ability (45). In early childhood, as a part of the temperament, children's emotions

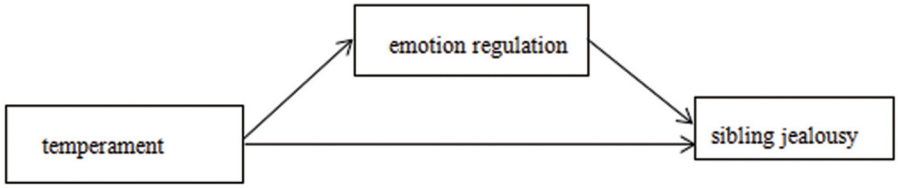

FIGURE 1 | The proposed mediation model.

and emotion regulation are still affected by individual inherent genetic factors (46). Therefore, the abnormal development of different levels of emotion regulation displayed by children can be traced back to differences in children's inherent temperament (47). Temperament can predict and hinder the development of young children's emotion regulation (48).

Based on the above research, we hypothesize that temperament and emotion regulation can jointly predict sibling jealousy and that emotion regulation plays a mediating role in temperament and sibling jealousy (see **Figure 1**).

METHODS

Participants

This study was approved by the Research Ethics Committee of the first author's institution. Online and offline surveys were conducted from January to March, 2021. 304 two-child families were randomly recruited from Hubei, Hunan, Jiangxi, and Beijing. The questionnaire was completed by the mothers of the children. There were 149 male and 155 female firstborns, ranging from 1.17 to 7 years of age ($M = 5.33$, $SD = 1.22$), and their younger siblings, including 162 males and 142 females, ranging in from 1.17 to 6.17 years of age ($M = 2.12$, $SD = 1.32$). The average age gap between firstborns and their younger siblings was 3.29 years. Of the families, 70.7% were three-generation families, and 84.5% of the parents were the main caregivers. Families with a combined income of over $10,000 accounted for 86.2% of the total.

Measures

First-Born Children's Sibling Jealousy

A revised Chinese version of the Children *Sibling Jealousy Questionnaire* developed by Kahriman and Kanak (23) and Chen and Yang (49), was used in this study. It consists of 16 items. A five-point scale, ranging from "my child hardly ever does it" to "my child always does it," was used to estimate the current behaviors and emotions of the first-born child by their main caregiver. The higher the score, the higher the level of sibling jealousy. Cronbach's α for the scale was 0.93.

Temperament Scale

The Children's *Temperament Questionnaire* (50, 51) consisted of 72 items belonging to nine subscales: reaction threshold, avoidance, adaptability, activity level, rhythm, reaction intensity, emotional nature, persistence, and the degree of distraction. The scale adopted a seven-point evaluation, ranging from "1" (never) to "7" (always) of the firstborn children's daily behaviors, which were assessed by mothers. Cronbach's α for the scale was 0.94.

Emotion Regulation

The *Emotion Regulation Checklist (ERC)* was developed by Shields and Cicchetti (52) and revised by Chang et al. (53) from Hong Kong as well as Chinese mainland scholars (52–54). It consists of 24 items divided into two subscales: (1) emotional instability, which was used to assess children's tendency to be volatile, unstable, and have abnormal negative emotions. The higher the score, the more unstable the mood (52); (2) emotional regulation, which assessed children's ability to respond to emotion regulation in different situations, including the appropriateness of emotional expression, empathy, and emotional self-awareness. The higher the scores, the higher the emotion regulation. The questionnaire was scored on a seven-point scale ranging from "1" (never) to "7" (almost always). Cronbach's α for the scale was 0.92.

Data Analysis

Data were analyzed using SPSS 22.0. Pearson correlation analysis and the Marco PROCESS (Model 4) (55) were used to analyze the relationships among sibling jealousy, temperament, and emotion regulation.

RESULTS

Sibling Jealousy of First-Born Children

A univariate regression analysis was used to investigate the predictability of the age of the first child on the jealousy level toward the siblings. The results showed that $R^2 = 0.02$, indicating that the age of the first child could effectively explain a 2% variation in the jealousy level of the first child toward the sibling. The standardized regression $\beta = -0.15$, $t = -2.61$, $p < 0.05$, reaching a significant level, indicated that the greater the age of the first child, the lower the sibling jealousy level, and the unary regression analysis was used to investigate the predictability of the age difference between the first and second children on the sibling jealousy level of the first-born children. In general, $R^2 = 0.04$, which meant that the age difference could effectively explain a 4% variation in the sibling jealousy level of the first child. The standardized regression $\beta = -0.21$, $t = -3.62$, $p < 0.01$, reaching a significant level, indicated that the greater the age difference, the lower the sibling jealousy level of the first child.

A univariate analysis of variance (UNIANOVA) with first-born children's sex (two levels) and second-born children's sex

TABLE 1 | Pearson correlation coefficients of the study variables (n = 304).

	M ± SD	1	2	3
1. Temperament	2.79 ± 1.36	-		
2. Emotion regulation	4.07 ±0.50	0.34**	-	
3. Sibling jealousy	1.83 ± 0.66	−0.19**	−0.21**	-

**$p < 0.01$.

(two levels) as factor variables, first-born children's age and the age difference as controlling variables, and the sibling jealousy score as the dependent variable was conducted. There was a significant main effect of the second-born children's sex, $F_{(1, 303)} = 6.29$, $p < 0.05$, $\eta_p^2 = 0.02$, and the jealousy score of the male second-born children ($M = 1.92$) was significantly higher than that of the female second-born children (M = 1.73). There were no significant main effects of the first-born children's sex [$F_{(1, 303)} = 0.04$, $p > 0.05$, $\eta_p^2 = 0.00$] and first-born children's sex × second-born children's sex interaction [$F_{(1, 303)} = 0.10$, $p > 0.05$, $\eta_p^2 = 0.00$] on siblings' jealousy scores.

Sibling Jealousy, Temperament, and Emotion Regulation

There were four child temperaments: difficult, slow-to-warm, easy, and mixed (51). We set dummy variables for each temperament type, with X1 for "easy to difficult," X2 for "slow-to-warm-to-difficult," and X3 for "mixed to difficult." Pearson correlation analysis was conducted to examine the relationships among sibling jealousy, temperament, and emotion regulation. For the first-born children, sibling jealousy was negatively related to temperament ($r = -0.19$, $p < 0.01$) and emotion regulation ($r = -0.21$, $p < 0.01$), and temperament was positively related to emotion regulation ($r = 0.34$, $p < 0.01$) (see **Table 1**).

Based on the correlation analysis results, Model 4 was used to test the mediating effect of emotion regulation on the relationship between temperament and sibling jealousy. Controlling for the gender combination, age difference, family structure, main caregivers, and familial income of the two children, the results (see **Table 2**) showed that the direct path from X2 and X3 to sibling jealousy ($\beta = -0.24$, $p < 0.05$; $\beta = -0.39$, $p < 0.001$), in the absence of emotion regulation, was significant. Emotion regulation was significantly associated with X1 ($\beta = 0.56$, $p < 0.001$), X2 ($\beta = 0.33$, $p < 0.001$), X3 ($\beta = 0.39$, $p < 0.001$), and sibling jealousy ($\beta = -0.25$, $p < 0.01$). However, only X3 significantly predicted sibling jealousy ($\beta = -0.29$, $p < 0.001$). Therefore, compared with intermediate temperament, emotion regulation partially mediated the relationship between difficult temperament and sibling jealousy.

To assess the size of the indirect effect and confidence intervals (CIs), a bootstrap procedure was applied. For the indirect effect, 95 percent bias-corrected accelerated CIs without "zero" indicated a significant mediation effect. We generated 5,000 bootstrap samples. The indirect effect of temperament on sibling jealousy mediated by emotion regulation [ab = −0.15, $SE = 0.06$, 95% CI (−0.26, −0.06)] was significant. The mediation effect accounted for 38.68% of the total effect. The 95% CI did not contain zero, showing that temperament exerted a significant indirect effect on sibling jealousy via emotion regulation.

DISCUSSION

The present research was framed during the normalization of the COVID-19 pandemic, providing unique empirical evidence regarding sibling jealousy and the relationships among first-born children's sibling jealousy, temperament, and emotion regulation. Major results showed that, for first-born children between the ages of 1.17 and 7, the older they are and the greater the age difference between them and the second children, the lower their sibling jealousy. There were no significant main effects for the sex difference in sibling jealousy, which is consistent with previous studies (5, 25, 27). The sibling jealousy of male second-born children was significantly higher than that of females, which was inconsistent with the results of previous studies (22–24). A possible reason was that, in the socio-cultural context of China, older brothers or sisters should give way to younger ones, so the sex difference in the jealousy of the first-born children was not significant, while the male second children had a stronger attachment to their mothers, so their jealousy was higher than that of the females.

Furthermore, this study found that difficult temperament could positively predict sibling jealousy, and emotion regulation was a negative predictor. This result was consistent with previous studies that showed that first-born children with difficult temperaments exhibited more jealous behaviors such as negative emotions, attachment issues, withdrawal, as well as eating and sleeping problems during the transition to sibling relationships (30–35, 56, 57). Children with low emotion regulation who were in a jealous situation would report a higher level of sibling jealousy because of their inability to regulate their own jealousy response (57). Effective emotion regulation could reduce sibling jealousy (27, 42, 43). Although the triadic laboratory paradigm was mainly used to measure sibling jealousy, that is, to design a jealous situation in which a mother or father interacted with one child while ignoring the other, the experimental object was the neglected children, and researchers observed the jealousy emotion and behavior dissonance that were shown in that respective context. In this study, we used a questionnaire to survey the sibling jealousy of first-born children, which involved the first child's anxiety, distress, sadness, anger, bad sleep patterns and eating habits, degradation of behaviors, and attacking the sibling after the birth of the second child. These emotional

TABLE 2 | Testing the mediation effect of emotion regulation on sibling jealousy.

Predictors (IV)	Model 1 (DV: sibling jealousy)		Model 2 (DV: emotion regulation)		Model 3 (DV: sibling jealousy)	
	β	*T*	*β*	*t*	*β*	*t*
Temperament X1	−0.31	−1.54	0.56	3.77***	−0.16	−0.83
Temperament X2	−0.24	−2.02*	0.33	3.74***	−0.15	−1.31
Temperament X3	−0.39	−4.84***	0.39	6.57***	−0.29	−3.42***
Emotion regulation					−0.25	−3.31**
R^2	0.14 9.55***	0.1611.16***	0.17 10.05***			
F						

*IV, Independent Variable; DV, Dependent Variable; *p < 0.05, **p < 0.01, and ***p < 0.001.*

expressions and behavior performances were consistent with the measurement of sibling jealousy in experimental research. Therefore, the conclusion drawn from the questionnaire survey on Chinese samples was consistent with Western research.

Moreover, this study was the first to explore the mediating role of emotion regulation between temperament and sibling jealousy. As a complex social emotion (12, 14), jealousy is closely related to emotion regulation, while in early childhood, the emotion regulation of children is a part of temperament (46, 47), which, in turn, predicts their emotion regulation (48). Compared with children with intermediate temperament, first-born children with difficult temperament had a weaker emotion regulation ability and higher sibling jealousy. out of 4 domains (i.e., rhythm, avoidance, adaptability, and emotional essence) that were evaluated, difficult children revealed low-scores in at least three domains. They had irregular daily routines, including issues with eating, drinking, sleeping, urinating, and defecating; therefore, children with low temperament rhythms were more likely to be in a changing environment, which was detrimental to their emotional stability. First-born children with an avoidance tendency and poor adaptability to the new environment might be afraid of unfamiliar people and the changes in the environment caused by the new event of the second sibling's birth. Lower scores on emotional nature indicated that first-born children were often in a negative mood, which aggravated the frequency and degree of sibling jealousy occurrence. Therefore, during the normalization of the pandemic, we need to pay special attention to difficult children to help them improve their emotion regulation ability. This will have the effect of reducing sibling jealousy and maintaining a good level of mental health.

This study statically examined the relationships among temperament, emotion regulation, and sibling jealousy during COVID-19 pandemic, but failed to longitudinally investigate the interaction mechanism between siblings in the formation of sibling jealousy and also lacked research on the changes in parenting styles before and after the birth of the second child. Therefore, future research needs to further carry out big data tracking research and in-depth investigations of the interaction mechanism between siblings and that of the parental rearing style and sibling jealousy in different periods. This study used a questionnaire to assess the jealousy toward siblings in first-born children. In the future, it will be necessary to use the triad laboratory paradigm, interviews, and questionnaires to evaluate sibling jealousy more comprehensively and objectively from the perspective of both parents and children.

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 Scientific Research Ethics Committee of School of preschool education, Capital Normal University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

GQ designed the project and supervised the data collection. WY, GQ, and GD collected and analyzed the data. GQ and GD wrote the manuscript with input from all other authors. All authors contributed to the article and approved the submitted version.

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Psychological Status of High School Students 1 Year After the COVID-19 Emergency

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Background: With the control of the epidemic, adolescents' mental outlook might have improved. However, little evidence existed with regard to the psychological status of adolescents in post-COVID-19 era. This present study aimed to explore the psychological status of high school students after the epidemic getting eased.

Methods: A web-based cross-sectional survey was used to obtain data from three high schools, including the demographic information, the Patient Health Questionnaire-9 (PHQ-9), the Generalized Anxiety Disorder-7 (GAD-7), the Self-Rating Scale of Sleep (SRSS), and self-designed general recent-status questionnaire. Correlation analysis was performed to explore potential associations between the depression symptoms, anxiety symptoms, and sleep status. The PHQ-9 and GAD-7 differences between nowadays data and the data enrolled 12 months before were also compared.

Result: A total of 1,108 qualified questionnaires were obtained. The prevalence of depressive and anxious symptoms was 27.5 and 21.3%, respectively, from mild to severe in all students, while 11.8% of these high students got sleep disturbances. Both the rate and the severity of depression, anxiety and sleep problems of female students were higher than male students. Grade three students suffered higher prevalence and severer mental disturbances than the other two grades. There were significant correlations between the depression symptoms, anxiety symptoms, and sleep status. The psychological status has been improved in nowadays high school students compared with the sample enrolled 12 months before.

Conclusion: As a supplement to our former study, this present research provided a perspective on the psychological status of high school students 1 year after the COVID-19 pandemic being well controlled. We should pay attention to the psychological status of high school students, and should also notice the progresses made by this special group after the epidemic.

Keywords: COVID-19, high school students, psychological status, mental health, depression, anxiety

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has swiped around the world for nearly one and a half years, resulting in over 150 million confirmed cases together with 3,159,547 deaths globally as of April 30th, 2021, according to the data from the World Health Organization (https://covid19.who.int/). Besides damages to the respiratory system caused by the severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2), emerging evidence indicated that the virus could also invade the central nervous system (CNS), leaving behind some neurological and psychiatric symptoms (1–3). In order to stop the spread of the epidemic, a range of public health interventions have been applied including containment, quarantine, community control, and school closures, which has achieved remarkable results (4). However, the potential effects of social isolation on mental health should not be ignored (5). Urgent quarantine and isolation measures may have a negative psychological and social impact especially on the most vulnerable people, such as front-line medical workers, the elderly, and children and adolescents (6–9).

Generally speaking, children and adolescents are at a relatively high risk of being depressive and anxious even under the circumstance of no epidemic situation (10, 11). Isolation and distance learning during the epidemic might aggravate potential mental problems. Adolescents were more likely to report moderate to severe symptoms of depression, anxiety, posttraumatic stress disorder, suicidal ideation or behavior, and sleep problems compared to adults since the COVID-19 pandemic (12). Long-time social isolation and dissatisfaction with online learning may worsen emotional problems (13, 14). Some literatures reported the rates of depression and anxiety were between 12.33–57 and 6.26–36.7%, respectively, in Chinese children and adolescents during the COVID-19 pandemic (14–18). Above inconsistencies of different studies might be caused by the heterogeneity of study samples, various time nodes of data collection, and the diversity of measurement scales. Nevertheless, the findings were still astonishing and thought-provoking.

High school students in China are a special group bearing the huge pressure of Chinese National College Entrance Exam, and is thought to have increased risk of psychological distress than students in primary school (18). At the early May last year, we conducted a cross-sectional survey (19) on high school students in Shandong Province, China. We found that the prevalence of depression, anxiety, and the combination of depressive and anxiety symptoms of this special group was as high as 52.4, 31.4, and 26.8%, respectively, during the COVID-19 pandemic outbreak. At that time, the implementation of quarantine in China has lasted for over 3 months, and the epidemic in Shandong Province had tended to be moderated. Grade three students already went back to school normally for 2 weeks, while grade one and grade two students were still in quarantine and studying online. This might account for the reasons that grade three students who were the closest to the college entrance examination suffered less psychiatric symptoms instead. Besides, female students exhibited a higher rate and severity of depression and anxiety than male, which is consistent with some previous studies (16, 20) and the theory that females are more susceptible to stress exposure (21, 22). This study reminded us that sufficient attentions should be paid to the psychological status of high school students.

With the alleviation of the epidemic, the release of isolation, and the resumption of classes, adolescents' mental outlook might have improved. However, little evidence existed with regard to the psychological status of adolescents in post-COVID-19 era. This present study aimed to explore the psychological status of high school students in Shandong Province including depression symptoms, anxiety symptoms, and insomnia symptoms 1 year after they returned to school and resumed classes. We also promoted a self-designed general recent-status questionnaire to investigate the self-evaluation of their study effect and life attitude, as well as knowledge on COVID-19 pandemic. In addition, we further investigated the depression and anxiety symptoms differences between nowadays high school students and the sample which enrolled 12 months before. This will form a sequential study which can provide a comprehensive perspective of the psychological status of high school students both during the pandemic outbreak and after the epidemic getting eased. We speculated that as the epidemic has been under control and with the students returning to school normally, the psychological status of high school students might be improved.

MATERIALS AND METHODS

Participants

The studies involving human participants were reviewed and approved by the Ethics Committee of the Shandong Daizhuang Hospital (Jining Psychiatric Hospital). Written informed consent was received online before the respondents began the questionnaire. This study was in accordance with the American Association for Public Opinion Research (AAPOR) reporting guideline. This was an anonymous survey, and confidentiality of data was ensured.

The cross-sectional online survey was conducted from May 6th to May 14th, 2021 in three high schools in Shandong Province, consistent with our previous study (19). The same investigation tool known as "Questionnaire Star" (https://www.wjx.cn/) was used to send questionnaire and collect data from the participants. Finally, 1,108 students submitted the questionnaire, and all questionnaires were qualified.

Last year's data was collected from high school students in Shandong Province from May 1st to May 7th, 2020, mainly investigating the students' depression and anxiety status at that time (21).

Both studies inclusion criterion was high school students who voluntarily participate in the mental health assessments. Exclusion criteria were (1) present or previous history of other psychiatric or neurological illness or serious physical disease and (2) not in Shandong Province.

Measurement Tools

The demographic and neuropsychological data from the respondents were obtained by using the questionnaire. In addition to the general demographic information (grade, age,

gender, current residence, and history of close contact to SARS-CoV-2), the Patient Health Questionnaire 9-item (PHQ-9) and the Generalized Anxiety Disorder scale (GAD-7) were also applied to obtain the psychological status. The total score indicates different levels of depressive or anxious symptoms: minimal/no depression (0–4), mild (5–9), moderate (10–14), or severe (≥15). We also evaluated the sleep status by using the Self-Rating Scale of Sleep (SRSS). The SRSS is designed to assess the sleep quality in different populations. There are 10 items in total with each item having a 5-point scale (1–5). The higher the score, the worse the sleep problems (23). We defined cases with sleep problems as a total score of SRSS ≥ 23 (24).

We also investigated the general recent-status of these students including their study effects, interpersonal relationship, and life attitudes for a preliminary view. Details could be found in the **Supplementary Material**.

Statistical Analysis

The statistical analyses were performed using IBM SPSS Statistics (version 21.0; IBM, Armonk, NY, USA). Same with our previous research, the categorical variables were expressed as the frequency (%), and the continuous variables were presented as mean ± SD. Differences in PHQ-9, GAD-7, and SRSS scores between male students and female students were evaluated using the Mann-Whitney *U* test. Differences in scores among three grades were assessed using the Kruskal-Wallis test. We also conducted spearman's correlation analysis to explore the association between depression level, anxiety level, as well as recent-status survey scores. A two-tailed $P < 0.05$ was considered statistically significant.

Besides statistical analysis on present data, we further investigated age, gender, PHQ-9, and GAD-7 differences between nowadays data and the data which we collected at last year in the whole group. The Mann-Whitney *U* test and chi-square test were used to achieve above procedures.

RESULTS

Demographic Characteristics

A total of 1,108 qualified questionnaires were obtained. The average age of the respondents was 16.39 ± 0.80 (years); 50.9% of them were female. The respondents all lived in Shandong Province and 88.8% of whom lived in the city. Four students got a history of close contact to SARS-CoV-2. **Table 1** shows the detailed demographic characteristics of the participants.

Psychological Status

The prevalence of depressive and anxious symptoms was 27.5 and 21.3%, respectively, from mild to severe in all students, while 11.8% of these high students got sleep disturbances. Both the rate and the severity of depression, anxiety, and sleep problems of female students were higher than male students. Grade three students suffered higher prevalence and severer mental disturbances than the other two grades. The detailed results were exhibited in **Table 2**.

Among the depressive symptoms revealed by PHQ-9, the most common one is "Feeling tired or having little energy" (41.9%), while the least common one is "Thoughts that you would be better off dead, or of hurting yourself in some way" (10.6%). Among the anxious symptoms revealed by GAD-7, the most common one is "Feeling nervous, anxious or on edge" (37.0%). The least common one is "Feeling afraid as if something awful might happen" (17.3%). See **Supplementary Tables 1**, **2**. The rate of comorbid depressive and anxiety symptoms among the students was 17.7% from mild to severe. Female students got a higher prevalence than male, while grade two students got a higher rate than the other two grades (see **Table 3**).

General Recent-Status

Most of the students (71.3%) considered that the efficiency of studying at school was better than online-study during home quarantine (Question 1). Fifty-nine percent of them thought that the interactions between students and teachers during school time became more active than online-study during quarantine (Question 4). Nearly 2/3 students had a good relationship with their family and classmates since the pandemic being under good control (Question 8 and 9). More than half of the students got a more positive life attitude after the pandemic (Question 10). Most of the students (68.9%) spent little time focusing on COVID-19 related information (Question 11), and few students (1.9%) often or always felt scared or anxious or confused about COVID-19 related news (Question 12). See **Supplementary Table 3** for more details.

Correlations Between Depression Symptoms, Anxiety Symptoms, and Sleep Status

The PHQ-9 score had a strong positive correlation with the GAD-7 score ($r = 0.814$, $P < 0.0001$) and a moderate positive correlation with the SRSS ($r = 0.547$, $P < 0.0001$). The GAD-7 score had a moderate positive correlation with the SRSS ($r = 0.573$, $P < 0.0001$). The detailed results were exhibited in **Table 4**.

Depression and Anxiety Symptoms Differences Between Nowadays Students and the Students in Last Year

Compared with last year's data, both the PHQ-9 (5.49 ± 4.81 vs. 2.91 ± 3.59, $P < 0.0001$) and the GAD-7 (3.25 ± 3.25 vs. 2.15 ± 3.07, $P < 0.0001$) were significantly decreased in nowadays students (see **Table 5** and **Figure 1**).

DISCUSSION

One year after the COVID-19 pandemic being well controlled, high school students in Shandong Province showed that the prevalence of depressive and anxious symptoms was 27.5 and 21.3%, respectively, from mild to severe, while 11.8% of these high students got sleep disturbances. Female students and grade three students suffered more mental distresses than male and other two grades. Most of the students got a high evaluation of their general recent-status, such as feeling better studying at school than online-study during home quarantine and having a more positive life attitude than pandemic time. There were

TABLE 1 | Demographic characteristics of the sample.

Variables	All	Grade one	Grade two	Grade three
Total number	1,108	720	276	112
Gender				
Male, *n* (%)	544 (49.1)	387 (53.8)	109 (39.5)	48 (42.9)
Female, *n* (%)	564 (50.9)	333 (46.2)	167 (60.5)	64 (57.1)
Age (years)	16.39 ± 0.80	16.01 ± 0.56	16.78 ± 0.49	17.86 ± 0.50
Current residence				
City, *n* (%)	984 (88.8)	629 (87.4)	253 (91.7)	102 (91.1)
Rural areas, *n* (%)	124 (11.2)	91 (12.6)	23 (8.3)	10 (8.9)
History of close contact to SARS-CoV-2				
Yes, *n* (%)	4 (0.4)	3 (0.4)	1 (0.4)	0 (0)
No, *n* (%)	1104 (99.6)	717 (99.6)	275 (99.6)	112 (100)

TABLE 2 | The rate of different psychological symptoms in high school students assessed by PHQ-9, GAD-7, and SRSS.

Variables	All	Gender		*P*	Grade			*P*
	(*n* = 1,108)	Male (*n* = 544)	Female (*n* = 564)		Grade one (*n* = 720)	Grade two (*n* = 276)	Grade three (*n* = 112)	
PHQ-9, depression symptoms								
Mean score	2.91 ± 3.59	2.51 ± 3.60	3.29 ± 3.54	<0.0001	2.61 ± 3.38	2.51 ± 3.88	3.33 ± 3.93	0.0006**
Minimal/ No depression	803 (72.5)	422 (77.6)	381 (67.6)		546 (75.8)	181 (65.6)	76 (67.9)	
Mild	252 (22.7)	99 (18.2)	153 (27.1)		147 (20.4)	75 (27.2)	30 (26.8)	
Moderate	41 (3.7)	16 (2.9)	25 (4.4)		21 (2.9)	16 (5.8)	4 (3.6)	
Severe	12 (1.1)	7 (1.3)	5 (0.9)		6 (0.8)	4 (1.4)	2 (1.8)	
Mild to severe	305 (27.5)	122 (22.4)	183 (32.4)		174 (20.2)	95 (34.4)	36 (32.1)	
GAD-7, anxiety symptoms								
Mean score	2.15 ± 3.07	1.81 ± 3.04	2.48 ± 3.07	<0.0001	1.88 ± 2.88	2.58 ± 3.32	2.88 ± 3.37	<0.0001
Minimal/No depression	872 (78.7)	451 (82.9)	421 (74.6)		590 (81.9)	201 (72.8)	81 (72.3)	
Mild	210 (19.0)	81 (14.9)	129 (22.9)		118 (16.4)	64 (23.2)	28 (25.0)	
Moderate	19 (1.7)	7 (1.3)	12 (2.1)		8 (1.1)	9 (3.3)	2 (1.8)	
Severe	7 (0.6)	5 (0.9)	2 (0.4)		4 (0.6)	2 (0.7)	1 (0.9)	
Mild to severe	236 (21.3)	93 (17.1)	143 (25.4)		130 (18.1)	75 (27.2)	31 (27.7)	
SRSS								
Mean score	17.20 ± 4.53	16.72 ± 4.59	17.67 ± 4.43	<0.0001	16.98 ± 4.33	17.41 ± 4.57	18.10 ± 5.54	0.009*
No sleep problems	977 (88.2)	487 (89.5)	490 (86.9)		636 (88.3)	245 (88.8)	96 (85.7)	
With sleep problems	131 (11.8)	57 (10.3)	74 (13.1)		84 (11.7)	31 (11.2)	16 (14.3)	

PHQ-9, Patient Health Questionnaire 9-item; GAD-7, Generalized Anxiety Disorder scale; SRSS, Self-Rating Scale of Sleep.
*$P < 0.01$.
**$P < 0.001$.

TABLE 3 | The rate of comorbid depression and anxiety symptoms in high school students.

Variables	All (*n* = 1,108)	Male (*n* = 544)	Female (*n* = 564)	Grade one (*n* = 720)	Grade two (*n* = 276)	Grade three (*n* = 112)
Comorbid depression and anxiety symptoms (mild to severe)	196 (17.7)	76 (14.0)	120 (21.3)	109 (15.1)	64 (23.2)	23 (20.5)

TABLE 4 | Correlations between PHQ-9, GAD-7, and SRSS.

	PHQ-9		GAD-7		SRSS	
	r	*P*	*r*	*P*	*r*	*P*
PHQ-9	1	-	0.814	<0.0001	0.547	<0.0001
GAD-7	0.814	<0.0001	1	-	0.573	<0.0001
SRSS	0.547	<0.0001	0.573	<0.0001	1	-

PHQ-9, Patient Health Questionnaire 9-item; GAD-7, Generalized Anxiety Disorder scale; SRSS, Self-Rating Scale of Sleep.

TABLE 5 | The demographic characteristics and depression and anxiety symptoms differences between high school students in 2020 and 2021.

Variables	Students in 2020	Students in 2021	$Z/\chi 2$	*P*
	(*n* = 1,018)	(*n* = 1,108)		
Age (years)	16.61 ± 1.06	16.39 ± 0.80	5.546	<0.0001
Gender (male/female)	473/545	544/564	1.475	0.225
PHQ-9 mean score	5.49 ± 4.81	2.91 ± 3.59	−13.887	<0.0001
GAD-7 mean score	3.25 ± 3.25	2.15 ± 3.07	−10.630	<0.0001

PHQ-9, Patient Health Questionnaire 9-item; GAD-7, Generalized Anxiety Disorder scale.

significant associations between their psychological status and general recent-status.

Social isolation and quarantine measures could result in the emergence of psychological disturbances, and worsen existing mental problems among children and adolescents (25). However, with the release of isolation and the resumption of classes, psychological status of high school students might become reversed. Our present research found that compared with last year's data, both the depression and anxiety symptoms were significantly relieved in nowadays students. According to our previous research, during the outbreak of the COVID-19 epidemic, only 47.6% of the high school students in Shandong Province exhibited no depressive symptoms and only 68.9% of them reported no anxious symptoms (19). These rates have increased to 72.5 and 78.8%, respectively, based on our present statistics, close to pre-COVID-19 times (11). The most common depression manifestation in nowadays students is "Feeling tired or having little energy," same with last year. However, the most common anxiety manifestation has changed to "Feeling nervous, anxious or on edge" instead of last year's "Being so restless that it is hard to sit still". Besides, incidence of sleep problems is 11.8% in today's high students, and most of them felt not getting enough sleep and could only sleep <7 h a day. In consideration of the characteristics of this special group, it seems that the major sources of depression and anxiety has changed from the COVID-19 to normal pressure of the Chinese National College Entrance Exam or daily study assignments. The findings that most of the students spent little time focusing on COVID-19 related information and most of them did not feel scared or anxious or confused about COVID-19 related news supported our conjectures. It is noteworthy that the rates of depression, anxiety, and sleep problems were consistently lower with respect to last year, but was still at a relatively high level. Mental health of high school students should still not be neglected.

When talking about the vulnerable groups of this population, it seemed that girls were still more likely to be depressed and anxious than boys. Both the depression and anxiety rate and the symptom severity of female students were higher than male students just like last year. Besides, girls suffered more sleep disturbances, consistent with previous study (21, 22). When it comes to the grade, grade three students became the most susceptible grade to mental distress than the other two grades. By the time we conducted our investigation, it is only 1 month away from the Chinese National College Entrance Exam. Grade three students were bearing more pressure, which might be the cause of more serious psychological problems.

Chronic social isolation and loneliness are associated with lower physical and mental health (26). Normal learning style and healthy social activities are significant to stable emotions and good psychological status. In the present study, there were strong correlations between the psychological status and general recent-status of these students. Most of them considered a better efficiency of studying at school than online-study during home quarantine, and 59% of them thought that the interactions between students and teachers during school time became more active than online-study. Satisfactory study effect and learning atmosphere might bring about the improvement of mental outlook. Positive social interactions in and of themselves may be basic human needs analogous to other basic needs like food consumption or sleep (27). With the release of isolation and the restoration of social contact, nearly 2/3 students had a good relationship with their family and classmates. Despite all the sorrows and damages to the people, the pandemic offered an opportunity for young people to develop and hone their resilience and adaptability, and appreciate the value of life (28). We were gratified that after this special experience, more than half of the students got a more positive life attitude.

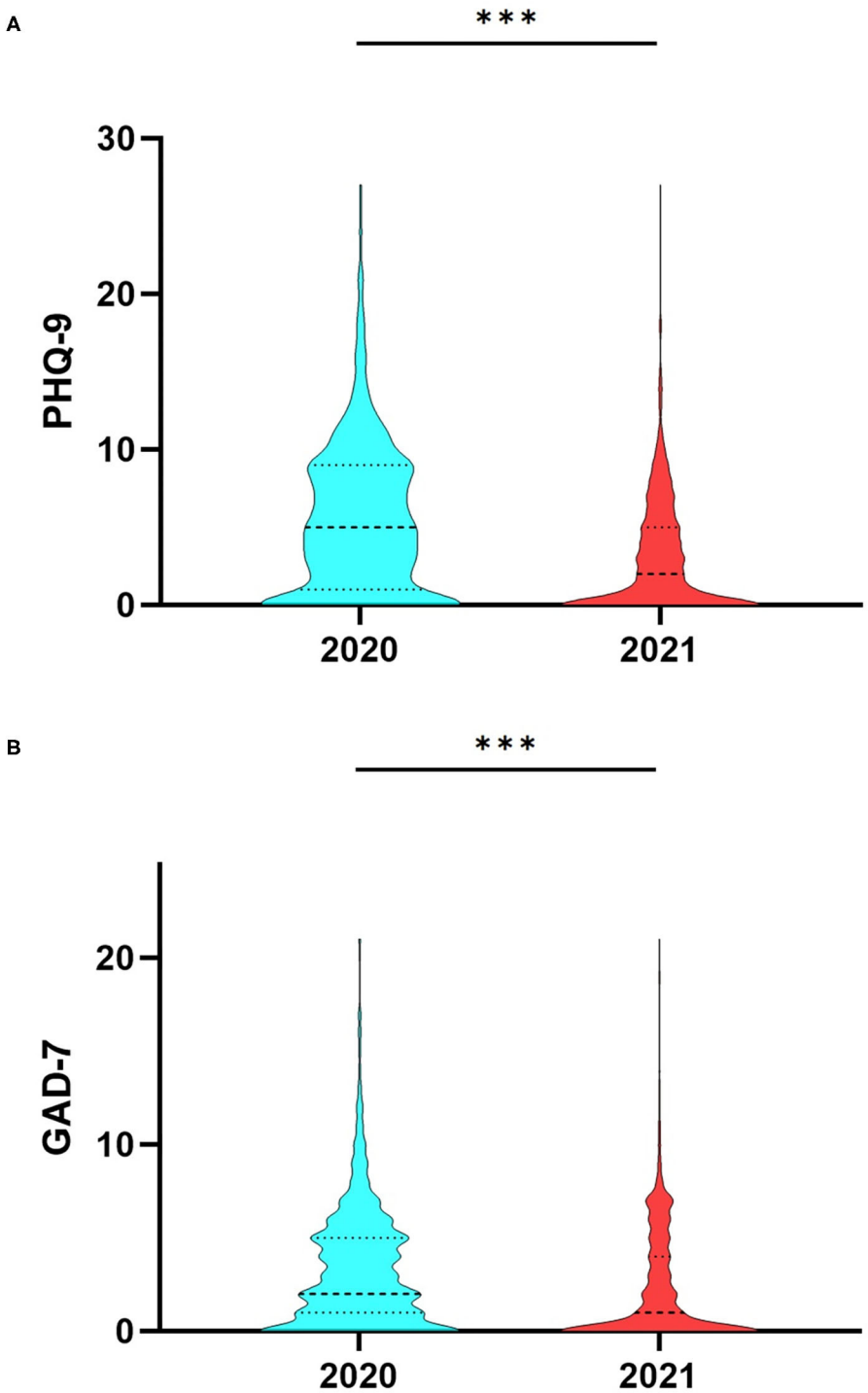

FIGURE 1 | (A) PHQ-9 and **(B)** GAD-7 differences between the students in 2020 and the students in 2021. PHQ-9, Patient Health Questionnaire 9-item; GAD-7, Generalized Anxiety Disorder scale. ***$P < 0.0001$.

There were some limitations that should be addressed. Firstly, the information about the students' parental educational level, socioeconomic status, parental work, and the teachers' psychological status were still not collected. The study would be much more valuable if above contents could be explored. Secondly, the general recent-status was acquired by a self-designed questionnaire, and the psychometric characteristics of the questionnaire were not analyzed, which might have a certain result deviation. Last but not least, though the comparisons between nowadays data and last year's data were performed,

strictly speaking, this study was still not a follow-up study and the investigation was not longitudinal, as the students in each grade had been entered to a higher grade, and the grade three students in last year had been graduated from high school for nearly 1 year at present. So, it is not able to track everyone's psychological status to provide targeted supports and assistants.

CONCLUSION

As an important supplement to our former study, this present research provided a perspective on the psychological status of high school students 1 year after the COVID-19 pandemic being well-controlled. Compared with last year's data, both the prevalence and the severity of mental symptoms were decreased in nowadays high school students. Most of the students showed a more positive attitude of their general recent-status than pandemic time. The psychological status of high school students should attract sufficient attentions. Meanwhile, we should also notice the progresses and improvements made by this special group.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

CZ designed the study, wrote the initial manuscript, and revised the manuscript. RL, MY, and CY collected the data and undertook the statistical analysis. RL and SD interpreted the data and modified the paper. All authors contributed to and have approved the final 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/fpsyt.2021.729930/full#supplementary-material

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Prevalence of and Factors Associated With Depressive Symptoms Among College Students in Wuhan, China During the Normalization Stage of COVID-19 Prevention and Control

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Objectives: The 2019 coronavirus disease (COVID-19) epidemic has led to persistent negative psychological effects on the general public, especially on college students, who are highly susceptible to psychological difficulties, such as fear, anxiety, and depression. Little information is known about depressive symptoms among college students during the normalization stage of COVID-19 prevention and control in China. This study aimed to understand the prevalence of and factors associated with depressive symptoms after a long quarantine time and online learning at home among college students in Wuhan, China.

Materials and Methods: A web-based survey was conducted from July to August 2020 during the Chinese summer holiday to collect data on sociodemographic variables, depressive symptoms, and their potential associated factors using an electronic questionnaire among college students in Wuhan, China. The Patient Health Questionnaire-9 (PHQ-9) was used to measure depressive symptoms. Binary logistic regression was used to explore the factors associated with depressive symptoms.

Results: A total of 9,383 college students were included in the analysis. The prevalence of depressive symptoms was 15.8% (1,486/9,383) among college students. The binary logistic regression showed that the experience of being quarantined for observation or treatment, family members or friends dying of COVID-19, rarely or never seeking help from others, fewer supportive relatives or friends, less support from family in the past month, a worse relationship with parents at home, a longer time spent daily on electronic devices except for online learning, and feeling anxious in the face of returning to school were independently associated with a higher risk of depressive symptoms. Academic stress and concern about the epidemic were the main reasons for their anxiety.

Conclusions: Targeted psychological intervention measures are recommended for college students to improve their mental health during the normalization stage of COVID-19 prevention and control.

Keywords: COVID-19, normalization stage, prevention and control, depressive symptoms, associated factor, college students

INTRODUCTION

The 2019 coronavirus disease (COVID-19) first broke out in China and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (1). Globally, as of July 12, 2021, the WHO had reported 186,638,285 confirmed cases of COVID-19, including 4,035,037 deaths (2). To reduce the risk of transmission, strict quarantine measures were implemented to restrict crowd movement nationally (3). However, quarantine is often considered an unpleasant experience and might cause negative psychological effects, including post-traumatic stress symptoms, confusion, anger, anxiety, and depression, which could last for a long time (3, 4).

Apart from the far-reaching influence on the tourist, catering, hotel, and transportation industries, among others (5, 6), the pandemic also had a huge impact on global education, and school closures were usually implemented. To date, 152,692,641 students have been affected worldwide (7). In China, the government also implemented nationwide school closures during the pandemic outbreak (8). The Ministry of Education in China provided suggestions for "suspending classes without suspending learning" in mid-February 2020, which prompted all students to start online learning in the new spring semester (9).

Wuhan, the provincial capital city of Hubei, was the epicenter of the epidemic in China, where COVID-19 was first reported and most cases were confirmed. This city had the largest number (more than 1 million) of college students in China (10). All students attending colleges and universities in Wuhan had to study at home during the spring semester in 2020 due to the epidemic. However, students in other provinces returned to school in April, 2020, when China moved to the normalization stage of COVID-19 prevention and control (11). Delayed opening, refraining from being outdoors, limited interpersonal communication, and long-term online learning might increase student's psychological stress and cause more mental health problems, such as depression and anxiety (12, 13).

Previous studies show that college students have had higher rates of mental health disorders during the initial stage of the COVID-19 epidemic (13–15). The prevalence of college student's depressive symptoms is reported to range from 4.2 to 23.3% in China (13, 15–18) and from 16.1 to 65.8% in other countries (14, 19–22). One meta-analysis conducted by Chang et al. (23) shows that the prevalence of depressive symptoms was 34% among college students worldwide during the COVID-19 epidemic. In addition, some studies have found that living in Hubei Province was a risk factor for mental health problems, including depression and anxiety, among the general population or college students in China during the COVID-19 epidemic (9, 24).

A large number of studies reveal that some factors are associated with individuals' mental health during the COVID-19 epidemic. COVID-19–related experience is a significant factor of concern. A case-control study found that those who were in centralized quarantine had a higher risk of depression (25), and a similar result was found from a cross-sectional study of college students (26). Moreover, having relatives or friends with COVID-19 was associated with a higher risk of depression among college students (15, 27). In particular, those who had relatives or acquaintances who had died of COVID-19 showed a higher suicide risk (28). In addition, social support was recognized as a protective factor against depression. A previous review shows that support from parents was the most important factor protecting against depression in Western children and adolescents (29). During the pandemic, this protective effect of social support on depression was consistently found in college students (15, 22, 30–32). Furthermore, due to the strategy of staying at home, time spent on electronic devices increased markedly (33). Except for online learning, students spent extensive time browsing social media, watching TV, playing games, and so on (34). Increased screen time was demonstrated to be a risk factor for depression in students (35).

In September 2020, when the Chinese fall semester began, all college students returned to Wuhan from different regions of China. Although the pandemic had been almost completely under control in China, sporadic cases or local partial outbreaks remained (32), and confirmed cases continuously entered China from overseas (6, 36), which might increase the student's uncertainty about the pandemic. Therefore, preventing pandemic resurgences was also very important, which would also increase the workload of universities, especially concerning college students' mental health conditions. To our knowledge, most previous studies focus on college student's psychological problems during the initial stage of the COVID-19 pandemic, and little information is available for student's mental health status during the normalization stage of COVID-19 prevention and control in China. Given that college students are highly susceptible to depression, which is a major risk factor for suicide (19, 37), we conducted the present survey to understand the prevalence of and factors associated with depressive symptoms among college students after a long quarantine time and online learning at home and before they returned to universities.

MATERIALS AND METHODS

Participants and Procedure

All students attending the university in Wuhan under the Ministry of Education of the People's Republic of China and

majoring in economics, law, and management were recruited. Students at the university came from all regions of China, and almost all lived at home during the survey. Data were collected from July to August 2020 during the Chinese summer holiday. Online questionnaires were distributed to students by the "Yiban System," which is a comprehensive interactive community integrating education, teaching, life services, and cultural entertainment. All 15,224 non-graduating undergraduate students were asked to participate in the survey by their instructors. All participants took part in the survey voluntarily and anonymously, and they could quit the survey whenever they wanted. Finally, a total of 9,383 students from all 15 schools of the university completed the questionnaire after written informed consent was obtained, yielding a response rate of 61.6%. This study was reviewed and approved by the Institutional Review Board of Zhongnan University of Economics and Law.

Measures

The questionnaire included three components: sociodemographic variables, including sex, college year, ethnicity, residence and only child status; depressive symptoms (measured by PHQ-9); and a series of potential associated factors (as described below).

PHQ-9

The PHQ-9 was initially developed for depression screening in primary care settings (38) and has been widely used worldwide (39). Yeung et al. (40) first conducted a validation study of the Chinese version of the PHQ-9 among Chinese Americans. Then, Zhang et al. (41) found that the PHQ-9 had acceptable psychometric properties to screen for depression among Chinese college students. During the COVID-19 epidemic, the scale was also adopted in many studies of college students from China (13, 15, 17, 18) and other countries (19–22). The scale consists of nine diagnostic criteria used to diagnose major depressive disorder based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (38). Participants report the frequency of each symptom during the last 2 weeks. Each item is rated on a four-point scale ranging from zero (not at all) to three (nearly every day). The total PHQ-9 score ranged from 0 to 27 with a higher score indicating a higher level of depressive symptoms. A cutoff score of 10, indicating moderate depressive symptoms, was used to screen the clinical level of depressive symptoms (39). Cronbach's alpha of the PHQ-9 was 0.88 in the present study.

Potential Associated Factors

The potential associated factors were measured by nine items. Three items were designed to measure the experience of COVID-19, including a history of quarantine for observation or treatment, family members or friends dying of COVID-19, and family members or friends being cured of COVID-19. Four items were designed to measure the status of social support, including the frequency of seeking help when facing insurmountable difficulties, the number of relatives or friends providing support and assistance, the level of support and assistance that students received from family, and the relationship that students had with their parents at home. Another two items were separately designed to measure the daily time spent on electronic devices except for online learning and the feeling in the face of returning to school. Furthermore, if students felt anxious because of returning to school, an additional multiple-choice item was administered to ascertain the specific reason.

Statistical Analysis

Data analyses were performed using SPSS version 20.0 (SPSS Inc., Chicago, IL). The prevalence of depressive symptoms was calculated based on a cutoff score of 10 and reported as the percentage of cases. Descriptive statistics expressed as frequencies and percentages were computed for all variables. Binary logistic regression analyses were conducted to explore the factors associated with depressive symptoms. All statistically significant variables in the univariate analyses were adjusted in the multivariable analyses using the "enter" method. Unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were computed in the regression models. The Hosmer–Lemeshow test was simultaneously used to measure goodness of model fit, and the criterion of an appropriate logistic regression model was a p value greater than 0.05 (42). All hypothesis tests were two-tailed, and the significance level was set at $\alpha = 0.05$.

RESULTS

As shown in **Table 1**, most participants were female (71.4%), of Han ethnicity (87.6%), and from urban areas (66.3%). Freshman, sophomore, and junior students accounted for 38.9, 35.7, and 25.4% of the study population, respectively. Approximately half of the participants were only children (54.0%) in their families. A total of 1,486 students had moderate-to-severe depressive symptoms, which accounted for 15.8% of the participants.

Regarding the experience of the pandemic, 216 (2.3%) students were quarantined for observation or treatment because of confirmed or suspected COVID-19, 52 (0.6%) reported that their family members or friends had died of COVID-19, and 190 (2.0%) reported that their family members or friends had been cured of COVID-19.

Approximately one third of students rarely (25.0%) or never (6.8%) sought help from others when facing insurmountable difficulties. Nearly 80% of students (78.4%) had more than 3∼5 relatives or friends who could provide support and assistance. In the past month, more than half of students (58.7%) felt fully supported by family, and 35.4, 4.9, and 1.0% felt that they received general, little, and no support from family, respectively. Approximately one third of students (35.7%) and 60.1% separately reported harmonious and normal relationships with parents at home although fewer students reported indifferent (3.3%) and hostile (0.9%) relationships with parents at home. Moreover, most students (67.0%) spent <6 h daily on electronic devices except for online learning, 23.4% of students spent 6–8 h, and 9.6% of students spent more than 8 h.

A total of 1,192 (12.7%) students felt anxious in the face of returning to school. Additionally, as shown in **Figure 1**, the primary reason for their anxiety was academic stress (85.2%),

TABLE 1 | Binary logistic regression analyses on the factors associated with depressive symptoms among 9383 college students in Wuhan, China during the normalization stage of COVID-19 prevention and control.

Variables	*N* (%)	Depressive Symptoms (%)	Unadjusted OR (95%CI) [a]	*p*-value	Adjusted OR (95%CI) [a]	*p*-value
Sex						
Male	2,685 (28.6)	424 (15.8)	Ref.			
Female	6,698 (71.4)	1,062 (15.9)	1.00 (0.89 1.14)	0.939		
College year						
Freshman	3,654 (38.9)	560 (15.3)	Ref.			
Sophomore	3,348 (35.7)	551 (16.5)	0.97 (0.84 1.12)	0.656		
Junior	2,381 (25.4)	375 (15.7)	1.05 (0.91 1.22)	0.473		
Ethnicity						
Han	8,218 (87.6)	1,303 (15.9)	Ref.			
Minorities	1,165 (12.4)	183 (15.7)	0.99 (0.84 1.17)	0.897		
Residence						
Urban	6,220 (66.3)	926 (14.9)	Ref.		Ref.	
Rural	3,163 (33.7)	560 (17.7)	1.23 (1.10 1.38)	<0.001	1.11 (0.96 1.28)	0.154
Only child						
Yes	5,071 (54.0)	740 (14.6)	Ref.		Ref.	
No	4,312 (46.0)	746 (17.3)	1.22 (1.10 1.37)	<0.001	1.06 (0.92 1.21)	0.430
Being quarantined for observation or treatment because of confirmed or suspected COVID-19						
No	9,167 (97.7)	1,431 (15.6)	Ref.		Ref.	
Yes	216 (2.3)	55 (25.5)	1.85 (1.35 2.52)	<0.001	1.52 (1.08 2.15)	0.017
Family members or friends dying of COVID-19						
No	9,331 (99.4)	1,469 (15.7)	Ref.		Ref.	
Yes	52 (0.6)	17 (32.7)	2.60(1.45 4.65)	<0.001	2.35 (1.21 4.57)	0.012
Family members or friends cured of COVID-19						
No	9,193 (98.0)	1,449 (15.8)	Ref.			
Yes	190 (2.0)	37 (19.5)	1.29 (0.90 1.86)	0.167		
Seeking help from others when facing insurmountable difficulties						
Frequently	2,539 (27.1)	264 (10.4)	Ref.		Ref.	
Sometimes	3,860 (41.1)	505 (13.1)	1.30 (1.11 1.53)	0.001	1.06 (0.90 1.26)	0.473
Rarely	2,347 (25.0)	528 (22.5)	2.50 (2.13 2.94)	<0.001	1.57 (1.32 1.88)	<0.001
Never	637 (6.8)	187 (29.4)	3.58 (2.89 4.43)	<0.001	1.71 (1.35 2.18)	<0.001
Number of relatives or friends who could provide support and assistance						
≥6	2,391 (25.5)	195 (8.2)	Ref.		Ref.	
3∼5	4,964 (52.9)	691 (13.9)	1.82 (1.54 2.15)	<0.001	1.45 (1.22 1.73)	<0.001
1∼2	1,923 (20.5)	556 (28.9)	4.58 (3.84 5.47)	<0.001	2.54 (2.09 3.08)	<0.001
0	105 (1.1)	44 (41.9)	8.12 (5.37 12.29)	<0.001	2.19 (1.35 3.55)	0.002
Support from family in the past month						
Full	5,507 (58.7)	546 (9.9)	Ref.		Ref.	
General	3,322 (35.4)	733 (22.1)	2.57 (2.28 2.90)	<0.001	1.58 (1.37 1.81)	<0.001
Little	456 (4.9)	165 (36.2)	5.15 (4.17 6.36)	<0.001	1.97 (1.54 2.53)	<0.001
None	98 (1.0)	42 (42.9)	6.82 (4.52 10.27)	<0.001	2.13 (1.30 3.48)	0.003
Relationship with parents at home						
Harmonious	3,350 (35.7)	283 (8.4)	Ref.		Ref.	
Normal	5,636 (60.1)	1,025 (18.2)	2.41 (2.10 2.77)	<0.001	1.62 (1.39 1.89)	<0.001
Indifferent	308 (3.3)	137 (44.5)	8.68 (6.72 11.21)	<0.001	3.36 (2.51 4.51)	<0.001
Hostile	89 (0.9)	41 (46.1)	9.26 (6.00 14.29)	<0.001	5.45 (3.36 8.84)	<0.001
Daily time spent on electronic devices except for online learning (h)						
<2	299 (3.2)	27 (9.0)	Ref.		Ref.	
2∼4	2,214 (23.6)	221 (10.0)	1.12 (0.74 1.70)	0.605	1.11 (0.71 1.73)	0.641
4∼6	3,769 (40.2)	518 (13.7)	1.61 (1.07 2.41)	0.022	1.43 (0.93 2.20)	0.102
6∼8	2,196 (23.4)	446 (20.3)	2.57 (1.71 3.86)	<0.001	2.10 (1.36 3.25)	0.001

(Continued)

TABLE 1 | Continued

Variables	*N* (%)	Depression (%)	Unadjusted OR (95%CI) [a]	*p*-value	Adjusted OR (95%CI) [a]	*p*-value
≥8	905 (9.6)	274 (30.3)	4.37 (2.87 6.66)	<0.001	3.25 (2.08 5.08)	<0.001
Feeling in the face of returning to school						
Expectant	2,885 (30.7)	392 (13.6)	Ref.		Ref.	
Calm	5,306 (56.5)	708 (13.1)	0.98 (0.86 1.12)	0.757	0.99 (0.86 1.14)	0.886
Anxious	1,192 (12.7)	383 (32.4)	3.05 (2.59 3.58)	<0.001	2.53 (2.13 3.01)	<0.001

[a]*OR, odds ratio; CI, confidence interval; the adjusted OR and 95% CI were computed using multivariable non-conditional logistic regression analyses.*

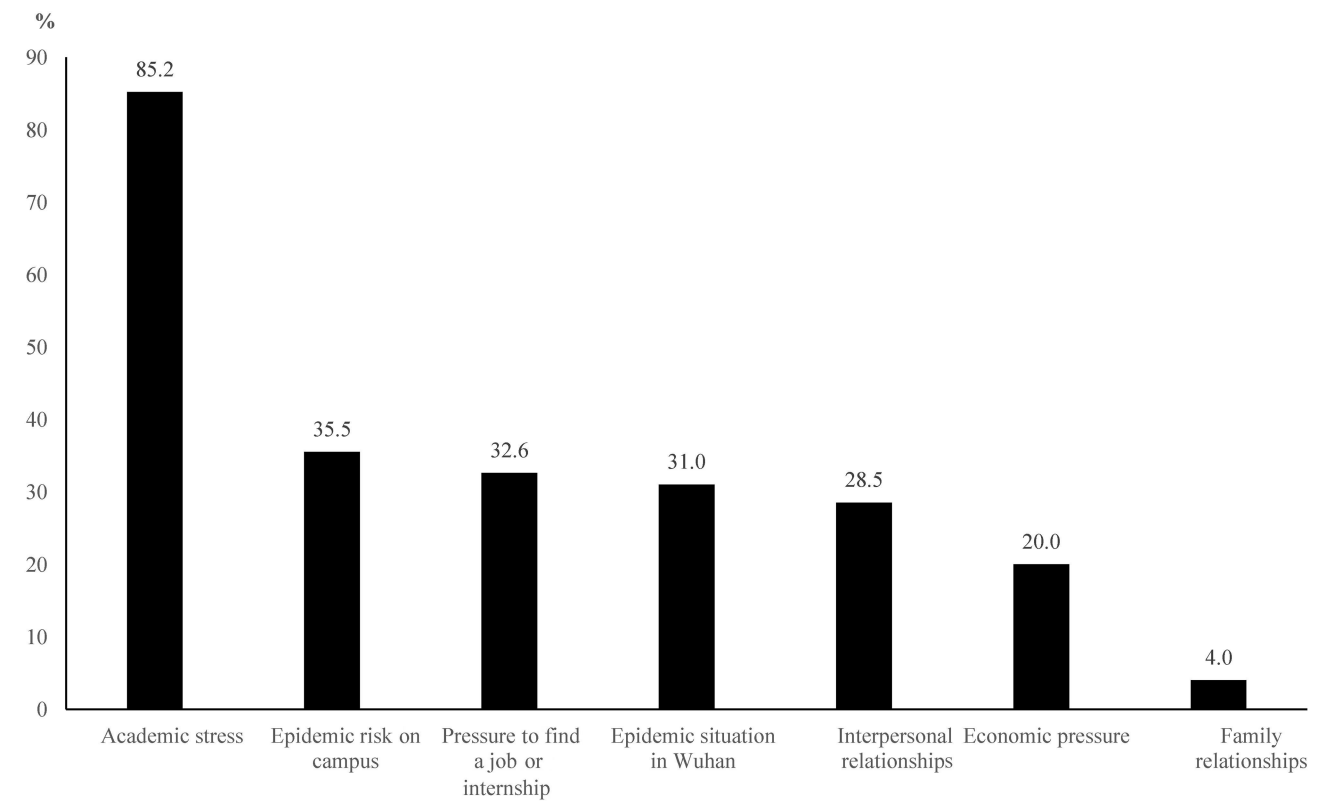

FIGURE 1 | The reasons for anxiety in the face of returning to school among college students in Wuhan, China during the normalization stage of COVID-19 prevention and control ($n = 1{,}192$).

followed by the epidemic risk on campus (35.5%), pressure to find a job or internship (32.6%), and the epidemic situation in Wuhan (31.0%).

The statistical magnitude ($\chi^2 = 8.99$, $P = 0.343 > 0.05$) of the Hosmer–Lemeshow test showed that the binary logistic model was appropriate. As presented in **Table 1**, the experience of being quarantined for observation or treatment for confirmed or suspected COVID-19 was associated with an increased risk of depressive symptoms (OR, 1.52; 95% CI, 1.08 2.15; $P = 0.017$). Having family members or friends dying of COVID-19 was also associated with an increased risk of depressive symptoms. (OR, 2.35; 95% CI, 1.21 4.57; $P = 0.012$).

Students who rarely (OR, 1.57; 95% CI, 1.32 1.88; $P < 0.001$) or never (OR, 1.71; 95% CI, 1.35 2.18; $P < 0.001$) sought help from others when facing insurmountable difficulties were at a higher risk of depressive symptoms. Students with fewer relatives or friends who could provide support and assistance were more likely to have depressive symptoms (3 ∼ 5 vs. ≥ 6: OR, 1.45; 95% CI, 1.22 1.73; $P < 0.001$; 1 ∼ 2 vs. ≥ 6: OR, 2.54; 95% CI, 2.09 3.08; $P < 0.001$; 0 vs. ≥ 6: OR, 2.19; 95% CI, 1.35 3.55; $P = 0.002$). The risk of depressive symptoms increased as the level of support from family in the past month decreased (general vs. full: OR, 1.58; 95% CI, 1.37 1.81; $P < 0.001$; little vs. full: OR, 1.97; 95% CI, 1.54 2.53; $P < 0.001$; none vs. full: OR, 2.13; 95% CI, 1.30 3.48; $P = 0.003$). Students who reported a worse relationship with parents

at home had a higher risk of depressive symptoms (normal vs. harmonious: OR, 1.62; 95% CI, 1.39 1.89; $P < 0.001$; indifferent vs. harmonious: OR, 3.36; 95% CI, 2.51 4.51; $P < 0.001$; hostile vs. harmonious: OR, 5.45; 95% CI, 3.36 8.84; $P < 0.001$).

A longer time that students spent daily on electronic devices except for online learning was associated with a higher risk of depressive symptoms (6 ∼ 8 vs. < 2 h: OR, 2.10; 95% CI, 1.36 3.25; $P = 0.001$; ≥8 vs. < 2 h: OR, 3.25; 95% CI, 2.08 5.08; $P < 0.001$). Feeling anxious in the face of returning to school was associated with a higher likelihood of depressive symptoms compared with feeling expectant (OR, 2.53; 95% CI, 2.13 3.01; $P < 0.001$).

DISCUSSION

The prevalence of depressive symptoms was 15.8% among students attending university in Wuhan during the normalization stage of COVID-19 prevention and control in China. The experience of being quarantined for observation or treatment, family members or friends dying of COVID-19, rarely or never seeking help from others, fewer supportive relatives or friends, less support from family in the past month, a worse relationship with parents at home, a longer time daily spent on electronic devices except for online learning, and feeling anxious in the face of returning to school were associated with a higher risk of depressive symptoms. Academic stress and the risk of the epidemic were the main reasons for students feeling anxious in the face of returning to school.

Based on the PHQ-9 with the same cutoff score of 10, the prevalence of depressive symptoms (15.8%) in the present study was lower than that among college students from other countries, such as Spain (65.8%), Pakistan (45.0%), Ukraine (31.7%), and Switzerland (27.2%) during the COVID-19 epidemic (19–22). These differences between studies might be related to differences in the composition of the sample, cultures, regions, education systems, or survey time nodes as well as different impacts of the pandemic (22, 43). For example, approximately one quarter of students (22.9%) lived in an environment with an infected person in the Spanish sample (19), and more than 20% of students (21.8%) had significant others diagnosed with COVID-19 in the Pakistan sample (21). These situations may lead to a higher level of depressive symptoms among students. However, only 2.6% of students had family members or friends diagnosed with COVID-19 in the present sample. Moreover, almost all of the above surveys were conducted during the lockdown stage of the pandemic, and our survey was conducted during the normalization stage of COVID-19 prevention and control, which may also lead to the varying prevalence of depressive symptoms among the existing literature.

In addition, with the same measure and cutoff score, the prevalence of depressive symptoms in the current study was higher than that in other Chinese regions, such as Guangdong (4.2%) and Fujian (7.7%) Provinces as well as the cities Chengdu and Chongqing (9.0%) during the peak or containment stage of the COVID-19 epidemic (13, 17, 18). To better compare the prevalence of depressive symptoms in our sample with that (21.1%) in a previous Chinese national sample during the COVID-19 outbreak (15), we calculated the prevalence based on a cutoff score of 7, and a similar higher prevalence (52.4%) was found. Regarding experiences in Wuhan when COVID-19 first broke out, many students were urged to centralize or quarantine at home for 2 weeks after they returned home for the winter holiday. This unique experience may have led them to feel greater discrimination in various ways, such as social avoidance and abusive expressions (26, 44). Otherwise, compared with students in other regions, those attending colleges and universities in Wuhan experienced longer online learning and social isolation durations and may have felt more loneliness, spent more time on electronic devices, and engaged in less physical exercise (12, 13, 22). These factors might lead to a higher level of depressive symptoms. Furthermore, our results also imply that the pandemic had persistent negative psychological effects on Chinese college students even after it had been almost completely under control in China.

Therefore, students with moderate-to-severe depressive symptoms, who might need more professional psychological help, should be given more attention (45). However, during the COVID-19 pandemic, the rate of seeking psychological help was very low (0.6%) among college students (46). Meanwhile, we also found that 6.8% of students never sought help from others when facing insurmountable difficulties in the present study. However, for difficulties with respect to face-to-face contact, different forms of online mental health services were provided for the public in China, including online mental health education programs and online psychological counseling services (47), and at each Chinese college or university, the psychological health counseling center also provided online counseling services for students. Therefore, relevant departments should enhance promotion and education strategies to improve student's awareness of these public and scholastic sources of psychological support, reduce negative attitudes toward psychological counseling, and promote positive psychological help-seeking behavior. Additionally, this finding also suggests that the relevant departments should strengthen the mental health screening among back-to-school students in Wuhan, which may be beneficial to prevent psychological crisis events.

Consistent with previous studies (24–26), we found that the experience of being quarantined for observation or treatment was a risk factor for depressive symptoms among students. In the period of quarantine, individuals might experience increased negative emotions, such as fear, helplessness, sadness, stress, anxiety, and uncertainty, which contribute to the development of depressive symptoms (3, 4, 37). Moreover, these psychological impacts might last for a long time and lead to further deterioration of student's physical and psychological health status (3, 4). To address these issues, relevant departments should provide essential psychological support for this group. Furthermore, previous studies showed that having relatives or friends with COVID-19 was a risk factor for depressive symptoms (15, 24). In our study, having relatives or friends dying of COVID-19 was found to be a risk factor for depressive symptoms, indicating that these students should be given more attention. During the pandemic, the

remains of all COVID-19 patients were uniformly disposed of by the government, preventing bereaved individuals from bidding farewell to their loved ones and performing funeral rituals to cope with their grief (48), which may have led to strong feelings of regret and self-blame for the bereaved individuals and increased the risk of depressive symptoms (49). Some psychological interventions, such as grief counseling and online sacramental ceremonies, should be implemented for this group to prevent negative emotional difficulties (50, 51).

The present results emphasize the importance of strong social support to prevent mental health disorders, which has been previously demonstrated (22, 30, 31). Positive social support can not only buffer the effect of uncertainty and stress related to the pandemic on depressive symptoms (30, 32), but also increase the feeling of social connectedness, which could protect students against depressive symptoms (12). However, never or rarely seeking help from others or having fewer supportive relatives or friends may cause students to feel less connected with others and lead to a higher level of depressive symptoms. Even though the company of parents was a primary support source during the pandemic, which played an important role in reducing the risk of depressive symptoms among students (31, 52), the quality of company might have had a further impact on their mental health (53). We found that less support from family and disharmonious relationships with parents were risk factors for depressive symptoms among students, which was in line with previous findings (12, 54, 55). The results provided us with some insight into preventing depressive symptoms among college students during a pandemic event. First, after returning to school, relevant departments should be concerned about the subsequent effect of negative family support on student's mental health and provide essential assistance to them. Second, when students were quarantined or had to learn at home during a pandemic, the content of psychosocial services should include guidance for improving the parent–child relationship and psychological support for parents. Third, relevant departments at colleges can organize online intervention activities to encourage students to connect with peers and further decrease the feeling of loneliness and depressive symptoms. In addition, we found that students who spent more time daily on electronic devices, except for online learning, had a higher risk of depressive symptoms. These students may have more frequently engaged in social comparisons with others (56); had limited opportunities for face-to-face contact with parents, relatives, and friends; and experienced less social support, more emptiness, and low self-worth (57), all of which may increase the risk of depressive symptoms.

Anxiety and depression are two issues that received substantially much more attention during the pandemic, both of which are widely known to have reciprocal positive correlations (37, 58) and can predict each other (59, 60). In the present study, we found that 1,192 (12.7%) students felt anxious when facing returning to school and experienced more depressive symptoms than expected. Regarding anxiety, only one third of students felt anxious about the risk of the pandemic, and more than 80% of students felt anxious about academic stress. The results implied that online learning might increase academic stress and indeed cause a negative impact on mental health among students (12, 61). After students returned to school, relevant departments should provide more academic support, such as academic guidance from teachers or trustworthy peers and lectures on learning methods or time management. Considering that the stage of epidemic prevention and control can last for a long time, colleges should regularly disclose prevention and control measures through official channels, which would be beneficial to decreasing student's feeling of uncertainty and, thus, reducing their anxiety and depression (32, 62). Regarding the pressure of finding a job, the employment guidance department should carry out relevant thematic educational and consultation activities for these students. Meanwhile, more employment information should also be summarized and published for students. For economic pressure, relevant departments should provide suitable financial aid for students according to their needs. For issues related to interpersonal relationships or family relationships, the counseling service center could design professional psychological activities, such as group counseling, lectures, and curricula, to support these students. Furthermore, colleges could also develop evidence-based intervention programs, especially those delivered by online technology, such as mindfulness meditation and cognitive behavioral therapy, to reduce student's anxiety and depression (63, 64).

This study has some limitations. First, the cross-sectional design complicates causal inference. Second, a nonrandom sampling method was used, and the students were from the same college in Wuhan; therefore, the sample was not fully representative of all Chinese college students although these students were from all regions of China. Third, the status of depressive symptoms was determined by an online questionnaire rather than a clinical diagnosis. Fourth, some mediation or moderation effects were not considered in our study. Large-scale studies with longitudinal designs and randomized sampling methods as well as clinical diagnoses for depressive symptoms should be conducted in the future.

CONCLUSION

In summary, 15.8% of non-graduating undergraduate students in Wuhan suffered from moderate-to-severe depressive symptoms during the normalization stage of COVID-19 prevention and control in China. Students with negative experiences of COVID-19, less support from family and friends, longer time spent daily on electronic devices except for online learning and feeling anxious in the face of returning to school had a higher likelihood of depressive symptoms. Academic stress and concern about epidemic control were the main reasons for student's anxiety. Based on these findings, professional psychological support and assistance are urgently needed for these students with a high risk of depressive symptoms. We recommend that targeted psychological intervention measures should also be developed for college students to encourage them to proactively seek professional psychological help and improve their mental health during

the normalization stage of COVID-19 prevention and control in China.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

HJ supervised the study design and statistical analyses, and provided substantial comments to improve the draft. ZY and MG conceptualized of the study and designed the questionnaire. JY, YW, ZY, and MG sorted out the data. JY, YW, and XT conducted the literature search and data analyses. JY drafted the manuscript. YW revised the language. All authors reviewed and approved the submitted version.

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Impact of School Closure Due to COVID-19 on the Social-Emotional Skills of Japanese Pre-school Children

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Objective: This study examines the impact on the social-emotional skills of Japanese pre-school children from downsizing of school activities in conjunction with voluntary school closures due to the first wave of COVID-19, in 2020.

Methods: Participants included 32 children aged 4–5 years old from three pre-schools in Tokyo, Japan, where strict lockdown was not implemented and voluntary school closure was recommended. Child social-emotional skills was assessed by classroom teachers using Devereux Student Strengths Assessment mini (DESSA-mini) three times: November 2019, January 2020 (before the COVID-19), and March 2020 (during the first COVID-19 wave). All pre-schools implemented voluntary school closures from March 2nd, and two schools (school A and B) canceled school recitals, while one school (school C) allowed for it to be held on March 4th, with precautions in place to prevent the spread of infection. Repeated measures ANOVA were performed to examine the difference between the T scores of the DESSA-mini three pre-schools before and during the COVID-19 pandemic.

Results: In school C, children showed stable T scores of the DESSA-mini, whereas children in school A and B showed lower T scores of the DESSA-mini during COVID-19 than before it started. The interaction effects between time and pre-schools were found ($F = 7.05$, $p < 0.001$).

Conclusion: Our findings suggest that school recitals in pre-schools were important to maintaining children's social-emotional skills during the COVID-19 pandemic.

Keywords: COVID-19, pre-school, social-emotional skills, school activity, school closure

INTRODUCTION

The first outbreak of the coronavirus disease in 2019 (COVID-19) impacted pre-school children in many countries in various ways, including school closures and the downsizing of activities such as school recitals to prevent the spread of infection (1). A growing number of studies have examined the short and long-term impacts of school closure on mental health of pre-school children and their caregivers. Increased behavioral problems (2), decreased physical activities (2, 3), weight gain (4), impaired quality of sleep (3, 5), and increased screen time (3) have been found among pre-school children after the closure of schools.

Even though there are studies that summarize possible adverse impacts of pre-school closure on children (6–8), to the best of our knowledge, few studies investigate the impact of school closures by comparing schools which canceled school activities, to schools which implemented school activities despite COVID-19. Japan is a unique country, in that a severe lockdown was not implemented, and pre-school closure was only recommended by the government, not mandatory. In addition, implementation of school activities relied on the discretion of individual pre-school principals. In the Japanese system of pre-school, child aged from 0 to 5 years can go to pre-school with no charge (not always). In 2020, approximately 50% of children attended pre-school. Almost all pre-schools in Tokyo, Japan conduct a school recital (e.g., dancing, singing, and drama activities) as school activities, which is held once per year (9). The aims of the school recital are not only to develop child's creativeness but also to show child's growth for caregivers (9). Thus, the school recital in Japanese pre-school has an important role for children and caregivers, which is also a major event for teachers.

Fortunately, we were able to make contact with three schools that agreed to take part in our research; two of which canceled scheduled school recitals, and one that allowed for the recital as scheduled, on March 4th. In all three schools we were able to assess the children's mental health before and during the first wave of COVID-19. Thus, by using this precious data, we could evaluate the impact of school closures by considering the mental health status of the children before COVID-19, and comparing the schools which canceled school activities with the school which allowed for regular school activities to continue.

Furthermore, to date, previous studies have focused on behavioral changes related to life style such as physical activity and screen time (2–5) and negative aspects of mental health such as behavioral problems (2). Little is known about positive aspects of mental health such as the development of social-emotional skills, which is defined as "skills to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions" (10). The OECD (11) suggests that the development of children's social-emotional competencies is required because it has a significant role within well-being, life satisfaction, healthy life style, and academic success. In Japan, the government guideline for pre-school education also address developing social-emotional skills. It may become more important for children to have the ability of adaptation for unexpected situations, due to the pandemic of COVID-19, than ever before.

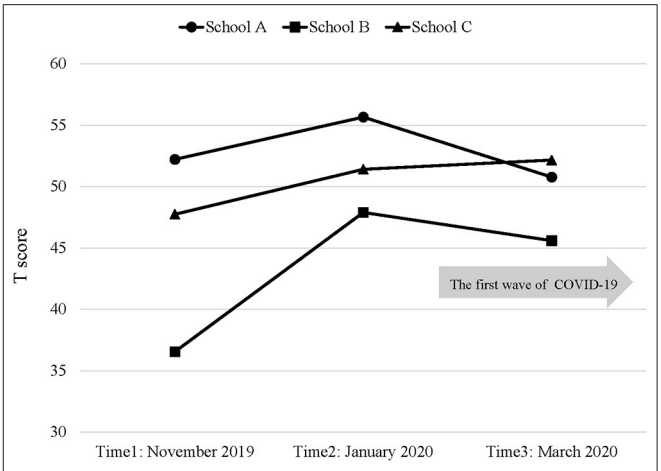

FIGURE 1 | T scores of the DESSA-mini.

This study examines the impact of school closure due to the first wave of COVID-19, in early 2020, on social-emotional skills among Japanese pre-school children.

METHODS

Participants

Participants included 32 children aged 4–5 years old from three pre-schools in Tokyo, Japan, where strict lockdown was not implemented and voluntary school closure was recommended. All pre-schools implemented voluntary school closures from March 2nd to May 30th, 2020, and two schools (school A and B) canceled school recitals during voluntary school closure periods, but one school (school C) had a recital on March 4th, with infection prevention measures in place.

Measures

Child's social-emotional skills was assessed by class teachers using Devereux Student Strengths Assessment-Mini (DESSA-mini) (12–14), which is one of the major assessment tools of child's social-emotional skills and is applicable to children aged 5–14 years old. The DESSA-mini consists of 8 items assessed on a five-point Likert scale (from 0 = "never" to 4 = "very frequently") and has a high internal consistency (Cronbach $\alpha = 0.919$). Educators can rate children's social emotional competence during a 4 week period, within 1 min. Based on raw score sum which ranges from 0 to 32, a T score can be calculated. Furthermore, we can obtain three categories using T score: "strength" (T score > 60), "typical" ($41 <$ T score < 59), and "need for instruction" (T score <40). In this study, the Japanese version of DESSA-mini was developed with permission of the developer of the original English version of DESSA-mini. According to the translation policy provided by the developer of the original English version of DESSA-mini, two authors who are familiar with child development and psychology independently translated the items from the original English to the Japanese. After completing the initial translations, translators discussed any inconsistencies. Two other translators independently back-translated a final

TABLE 1 | Characteristics of sample in this study ($n = 32$).

	Total ($n = 32$)		School A ($n = 9$)		School B ($n = 11$)		School C ($n = 12$)		
	n or mean	% or SD	*n* or mean	% or SD	*n* or mean	% or SD	*n* or mean	% or SD	*p*
Child's sex									
Male	22	68.7	6	66.7	8	72.7	8	66.7	0.831
Female	10	31.3	3	33.3	3	27.3	4	33.3	
Mean age (month)	60.59	3.58	61.89	2.74	60.36	3.55	59.83	3.97	0.069

SD, standard deviation.

TABLE 2 | Results of repeated measures mixed model ($n = 94$).

		T score Mean (SD)	Model 1 Coefficient (95% CI)	Model 2 Coefficient (95% CI)
Time	Time 1 (November 2019)	45.16 (8.78)	−5.93 (−7.89 to −3.96)	−3.44 (−6.52 to −0.37)
	Time 2 (January 2020)	51.52 (8.27)	Ref	Ref
	Time 3 (March 2020)	49.65 (6.99)	−1.87 (−3.84 to 0.10)	−4.89 (−7.96 to −1.81)
School	A	52.89 (6.22)	Ref	Ref
	B	43.13 (8.23)	−9.70 (−14.51 to −4.89)	−7.97 (−13.32 to −2.63)
	C	50.44 (7.55)	−2.44 (−7.13 to 2.24)	−4.25 (−9.43 to 0.93)
Time × School	Time 1 (November 2019) × School B			−7.26 (−11.48 to −3.03)
	Time 3 (March 2020) × School B			2.59 (−1.65 to 6.83)
	Time 1 (November 2019) × School C			−0.22 (−4.29 to 3.85)
	Time 3 (March 2020) × School C			5.64 (1.57 to 9.71)

Child's sex was adjusted.

translation and compared and resolved inconsistencies. All drafts of the translation and back-translation were sent to the original developer. The Cronbach α of this study was 0.919.

Procedure

In the three pre-schools that participated in this study, there were two class teachers per/class. The main teachers were in-charge of assessing each child's social-emotional skills using the DESSA-mini at three times: November 2019 (Time 1), January 2020 (Time 2) (before the COVID-19), and March 2020 (Time 3, during the first wave of COVID-19). Prior to the first assessment, we held orientation meetings for teachers in each pre-school in order to explain the aim of this study and how to assess child's social-emotional skills using the DESSA-mini questionnaire. After the orientation meetings, the DESSA-mini questionnaires were distributed to pre-schools. The main teachers per class completed the DESSA-mini questionnaires for all children in their own class without discussing with other teachers. The main teacher completed child's name, sex, date of birth, age, teacher's name, relationship with a child, the date of response to the questionnaire, pre-school's name, class's name, and 8 items related to child's social-emotional skills. Additionally, they calculated raw score sums and T scores for each child and filled the percentile and category using T score (i.e., strength, typical, or need). In Schools A and B conducted the assessment on November 28th, while school C's assessment was on November 29th, 2019. Schools A and B conducted the 2nd assessments on January 24th, 2020, and school C's assessment was on the 31st. The third assessment was held by schools A, B, and C on March 4th, 27th, and 30th, 2020, respectively. After completing each assessment, pre-schools sent the questionnaires to our office. In Japan, the number of infections increased from March 2020. The Japanese government announced a state of emergency for all prefectures from April 16th to May 25th 2020, in which people were asked to exercise self-restraint. In Tokyo, where infection was widely spread, the state of emergency was declared from April 4th to May 25th (15, 16). During the first wave of the COVID-19 pandemic, the number of infections were fewer than 30 per day in Japan (16).

Statistical Analysis

First, we performed a repeated measures mixed model to examine the association of time (i.e., Time 1: November 2019, Time 2: January 2020, and Time 3: March 2020), schools (i.e., School A, School B, and School C), and the interaction between time and school with T score of the DESSA-mini. In this analysis, the reference time was Time 2 (January 2020 which was before the first wave of COVID-19) in order to compare the differences between before and during the COVID-19, mainly. Second, repeated measures ANOVA was also performed to examine the difference of T scores of the DESSA-mini three schools, at three times. Child's sex was adjusted in the first and second analyses. Third, a Kruskal-Wallis test, which is one-way ANOVA on ranks and a non-parametric method, was conducted due to small sample size as the sensitive analysis. We performed the Kruskal-Wallis tests to compare the mean of the DESSA-mini

score by time and school, respectively. According to the results of the Kruskal-Wallis test, a Dunn's test which is pairwise Mann-Whitney tests with Bonferroni correction was also performed. All analyses were conducted using STATA 15.0.

RESULTS

Table 1 shows the characteristics of the participants in this study. Participants included 22 males (68.7%) and 10 females (31.3%). Their mean age was 60.59 (±3.58) months. Among school A, B, and C, the percentages of females were 33.3, 27.3, and 33.3% respectively (no statistical differences between percentages of each sex, $p = 0.831$). The mean ages were 61.89 (±2.74), 60.36 (±3.55), and 59.83 (±3.97), respectively (no statistical differences in the mean ages, $p = 0.069$).

In **Table 2**, the mean T scores for time and school and the results of repeated measures mixed model were shown. Among all participants, the mean T score of the DESSA-mini by time were 45.16 (SD = 8.78) at November 2019 (Time 1), 51.52 (SD = 8.27) at January 2020 (Time 2), and 49.65 (SD = 6.99) at March 2020 (Time 3). According to the main effect of time (Model 1), the mean T score of the DESSA-mini at November 2019 (Time 1) was lower than in January 2020 (Time 2) (coefficient = −5.93; 95% CI = −7.89 to −3.96). The mean T score of the DESSA-mini by schools were 52.89 (SD = 6.22) in school A, 43.13 (SD = 8.23) in school B, and 50.44 (SD=7.55) in school C. Compared to school A, the mean T score of the DESSA-mini in school B was significantly lower (coefficient = −9.70; 95% CI = −14.51 to −4.89).

Children in school A and B showed lower T scores of the DESSA-mini during the COVID-19 pandemic than before it: 52.22 (SD = 6.12) at November 2019 (Time 1), 55.67 (SD = 6.24) at January 2020 (Time 2), and 50.78 (SD = 5.93) at March 2020 (Time 3) in school A; 36.55 (SD = 5.43) at November 2019 (Time 1), 47.90 (SD = 8.45) at January 2020 (Time 2), and 45.60 (SD = 6.06) at March 2020 (Time 3) in school B. In contrast, in school C, children showed stable T scores of the DESSA-mini: 47.75 (SD = 6.40) at November 2019 (Time 1), 51.42 (SD = 8.58) at January 2020 (Time 2), and 52.17 (SD = 7.40) at March 2020 (Time 3) (**Figure 1**). **Supplementary Table 1** shows T score, raw score sum, each item score of the DESSA-mini, and the numbers of categories. In Model 2, the interaction term between time and school was added. Compared to T score at January 2020 (Time 2, which was before the COVID-19), the T score of the DESSA-mini at March 2020 (Time 3, which was during the COVID-19) was significantly lower (coefficient = −4.89; 95% CI = −7.96 to −1.81). Moreover, the T score of the DESSA-mini at November 2019 (Time 1) was significantly lower compared to that at January 2020 (Time 2) (coefficient = −3.44; 95% CI = −6.52 to −0.37). In terms of the effect of school, children in school B showed a lower T score than those in school A (coefficient = −7.97; 95% CI = −13.32 to −2.63). Similarly, repeated measures ANOVA also showed that the effects of time ($F = 24.37$, $p < 0.001$) and school ($F = 8.41$, $p < 0.001$) were significant in **Table 3**. Furthermore, we found the interaction effects between time and pre-schools ($F = 7.05$, $p < 0.001$).Children in school A and B showed lower T scores of the DESSA-mini during the COVID-19 pandemic than before it: 52.22 (SD = 6.12) at November 2019 (Time 1), 55.67 (SD = 6.24) at January 2020 (Time 2), and 50.78 (SD = 5.93) at March 2020 (Time 3) in school A; 36.55 (SD = 5.43) at November 2019 (Time 1), 47.90 (SD = 8.45) at January 2020 (Time 2), and 45.60 (SD = 6.06) at March 2020 (Time 3) in school B. In contrast, in school C, children showed stable T scores of the DESSA-mini: 47.75 (SD = 6.40) at November 2019 (Time 1), 51.42 (SD = 8.58) at January 2020 (Time 2), and 52.17 (SD = 7.40) at March 2020 (Time 3) (**Figure 1**). **Supplementary Table 1** shows T score, raw score sum, each item score of the DESSA-mini, and the numbers of categories. In Model 2, the interaction term between time and school was added. Compared to T score at January 2020 (Time 2, which was before the COVID-19), the T score of the DESSA-mini at March 2020 (Time 3, which was during the COVID-19) was significantly lower (coefficient = −4.89; 95%CI = −7.96 to −1.81). Moreover, the T score of the DESSA-mini at November 2019 (Time 1) was significantly lower compared to that at January 2020 (Time 2) (coefficient = −3.44; 95% CI = −6.52 to −0.37). In terms of the effect of school, children in school B showed a lower T score than those in school A (coefficient = −7.97; 95% CI = −13.32 to −2.63). Similarly, repeated measures ANOVA also showed that the effects of time ($F = 24.37$, $p < 0.001$) and school ($F = 8.41$, $p < 0.001$) were significant in **Table 3**. Furthermore, we found the interaction effects between time and pre-schools ($F = 7.05$, $p < 0.001$).

TABLE 3 | Results of repeated measures ANOVA ($n = 94$).

	F	*p*-value
Time	24.37	<0.001
School	8.41	0.001
Time × School	7.05	<0.001

ANOVA, analysis of variance and covariance.
Child's sex was adjusted.

As a sensitive analysis, the results of a Kruskal-Wallis test showed a significant difference in the mean T score of the DESSA-mini by time ($\chi^2 = 9.29$, $p = 0.009$, df = 2). Pairwise comparison showed that the mean T score of the DESSA-mini at November 2019 (Time 1) was lower than in January 2020 (Time 2) ($p < 0.005$). The results also showed a significant difference in the mean T score of the DESSA-mini by schools ($\chi^2 = 20.67$, $p < 0.001$, df = 2). Pairwise comparison showed that that the mean T score of the DESSA-mini in school B was significantly lower than school A ($p < 0.001$) and school B ($p < 0.005$). We found similar results with those of the ANOVA.

DISCUSSION

This study found that social-emotional skills in pre-school children increased from November 2019 to January 2020, which was before the first wave of COVID-19 in Japan, and in March 2020, during COVID-19. Furthermore, we found the interaction effects between time and schools on social-emotional skills.

That is, children in school C, which allowed for the school recital as planned on March 4th, during the first wave of COVID-19, showed a stable T score of the DESSA-mini, whereas children in schools A and B, which canceled the school recital due to the COVID-19 pandemic, showed a lower T score of the DESSA-mini during the COVID-19 than before COVID-19. Therefore, our findings indicate that the school recital, with infection prevention measures, was important to keep children's social-emotional skills, under the circumstances of the COVID-19 pandemic.

The changes in social-emotional skills among children can be attributed to the activities of the pre-schools (i.e., the school recital) rather than school closures because schools that participated in our survey did not implement school closures due to COVID-19. The novelty of this study is that this survey could evaluate the impact of school activities during the first COVID-19 wave, using date before the COVID-19 pandemic, and comparing both schools that allowed for a school recital and those that did not. The conducting of a school recital might not cause lifestyle changes such as decreased physical activity and increased screen time which was found in the previous studies that examined the impacts of school closure under the pandemic of COVID-19 (8, 17, 18). Rather than child's lifestyle changes, the implementation of a school recital might lead to increased opportunities to develop a child's skills related to social-emotional skills. Brooks (19) emphasizes the importance of building a child's social-emotional skills by using the opportunities at school, which indicates that maximizing activity opportunities that children can participate in is meaningful in promoting social-emotional skills. The implementation of a school recital, which includes preparation time, could create the opportunities to develop a child's skills which are critical factors to build social-emotional skills, such as skills in communication, control of their emotions, and problem solving (20–22).

Another possible factor for social-emotional skills is the change of parenting behaviors, because, although these pre-schools were not closed, it was recommended that children not attend school, which means the time spent with a parent or other caregiver at home would increase. A previous study in Singapore showed that parental perceived impact of COVID-19 was associated with increased harsh parenting and poor parent-child relationships via parenting stress (23). Thus, increased time spent at home due to COVID-19 might lead to a change in the parent-child relationship. Additionally, the relationship between school and caregivers, which is an important factor for developing a child's social-emotional skills (19), might be promoted via the implementation of school activities. Further study to examine the impacts of the implementation of school activities on not only children, but also caregivers is warranted.

The current study has the following limitations. First, the sample size was small even though this is precious data which allowed us to evaluate the impact of school closure by comparing schools that canceled school activities and a school which continued with school activities. Further study to examine the long-term impacts of COVID-19 and related school factors on child social-emotional skills is needed. Second, we only adjusted for child's sex in the analyses. Unfortunately, we could not assess family factors such as paternal mental health, parenting behaviors, and household income. Our findings need to be re-verified, including potential confounders using available data. Third, generalizability of the current study is limited because the number of infections and school impacts of COVID-19 varied between countries. However, there is a need to further explore the impacts of school closure on child social-emotional skills under different various situations. Fourth, we did not assess other positive mental health aspects such as prosocial behaviors assessed using the Strengths and Difficulties Questionnaire (SDQ) (24) even though this study focused on the changes of children's social-emotional skills. For example, combined assessment, in which caregiver assesses child's prosocial behaviors using the SDQ, may be helpful to figure out the changes in children's positive mental health broadly under the circumstances of the COVID-19 pandemic.

CONCLUSIONS

In conclusion, our findings suggest that school closure might be associated with lower levels of social-emotional skills among pre-school children. However, we also indicate that school activities, with infection prevention measures in place, may be important in maintaining children's social-emotional skills, during the COVID-19 pandemic. Understandably, pre-schools and caregivers want to protect their children against infection. Nonetheless, we need to focus on and care about child's social-emotional skills during the long-term pandemic at the same time. These results may be helpful when deciding during times of emergency, like those of COVID-19, whether a school should close or continue regularly scheduled activities.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is not available. Requests to access these datasets should be directed to fujiwara.hlth@tmd.ac.jp.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board of the Tokyo Medical and Dental University (M2020-380). Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

TF, AI, and SD designed the study and managed administration of the study, including the ethical review process. KM and

SD analyzed data. SD drafted the manuscript. AI and TF provided critical comments on the manuscript related to intellectual content. All authors have read and approved the final 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/fpsyt.2021.739985/full#supplementary-material

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Resilience and Higher Education Support as Protective Factors for Student Academic Stress and Depression During Covid-19 in the Netherlands

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Background: The corona pandemic has forced higher education (HE) institutes to transition to online learning, with subsequent implications for student wellbeing.

Aims: This study explored influences on student wellbeing throughout the first wave of the corona crisis in the Netherlands by testing serial mediation models of the relationships between perceived academic stress, depression, resilience, and HE support.

Methods: The Covid-19 International Student Wellbeing Study (C19 ISWS) was used, with a total sample of 2,480 higher education students studying at InHolland Universities of Applied Sciences in the Netherlands. Student subgroups were created, so that students with low and high perceived academic stress could be assessed, in addition to depressed and non-depressed students. Predictive model fit was tested using Macro PROCESS.

Results: A significant serial mediation model for the total student sample was revealed, including protective mediating effects of resilience and HE support on the positive direct effect of perceived academic stress on depression. At subgroup level, significant (partial) predictive effects of resilience on depression scores were noted. A partial serial effect between resilience and HE support was found for students with low perceived stress levels, whereas a parallel partial mediation model was present among highly academically stressed students. Regarding non-depressed students, a full parallel mediation model was found, whereas the model for depressed students inadequately explained the data.

Conclusions: Overall, resilience and HE support mediate the predictive effect of academic stress on depressive symptoms among students. In addition, substantial differences in model fit arise when inspecting the students on a subgroup level. These findings contribute to the gap in knowledge regarding student wellbeing during the Covid-19 pandemic in the Netherlands, in addition to providing novel insights on student subgroup dynamics. While Covid-19 restrictions continue to demand online learning, student wellbeing may be enhanced overall by targeting resilience and increasing awareness and availability of HE support services. The current study also highlights the need for differential approaches when examining wellbeing for specific student groups.

Keywords: academic stress, Covid-19, depression, higher education, resilience, wellbeing, students, support

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INTRODUCTION

Higher education (HE) students face profound lifestyle changes. Moving away from home, changes in peer support, an increase in decisions regarding personal and professional Opportunities, and elevated levels of stress from relationships can interfere with wellbeing (1–5). During student life, over half of enrolled students experience emotional problems (3) which may result from academic overload, pressure to succeed, peer competition, and less time to spend on leisure or family (6). When students experience psychological distress, academic productivity drops (7). Students who are experiencing depression or other psychological problems are generally found to have trouble maintaining progress, and encounter difficulty adjusting to higher education (3). Academic failure rises with increased psychological problems in students and many students report psychosocial issues prior to dropping out (7, 8).

For 2019 and 2020, Dutch populations aged 18 to 25, reported the highest levels of unhappiness compared to other age groups, in addition to reporting the highest levels of dissatisfaction regarding the state of their mental health (9). In the Netherlands, major depression has been identified as the most common individual mental health disorder (10). Global analyses indicate that psychological disorders will have presented by age 24 in 75% of cases (11). With major depressive disorders, occurrence during earlier life stages increases recurrence rates during early adulthood by 400% (12). With an average age at higher educational graduation of 23.4 years for students in the Netherlands (13), a substantial group will experience psychological problems during student life. The bulk of such problems are predicted to occur among younger students and estimates suggest the prevalence of psychological problems to be over 30% among student populations (3, 7, 14).

Besides psychological problems such as depression, stress is also reported to play a major role in student wellbeing (15–17). Greater perceived academic stress, including increases in perceived academic workload, and higher levels of loneliness within the academic context, reveal a stronger effect on depression than do indicators of cumulative academic demands or academic grades (18). In the Netherlands, an increasingly demanding student life has been reported. Performance pressure, finances, and rigid study continuation criteria are noted as important academic contributors to stress among Dutch students (7). Moreover, students' stress appraisal directly impacts development of psychological problems. For those who feel that stress is negative, and perceive it as involving serious consequences or threat, frequent stress exposure is linked to higher levels of psychological distress and use of support services (16, 19, 20).

To help students effectively cope with stress and mental health issues, support resources are required (21, 22), and studies indicate a potential role for the HE institutes in providing these resources (23–25). In the presence of adequate support, the effect of stress on development of psychological problems is reduced and may even be fully remedied (26). However, for younger people, experiencing psychological distress is often accompanied by perceived stigma, feelings of embarrassment, and a preference for self-reliance, which hamper formal help-seeking behaviours (24). In addition, students with depression or anxiety who fail to seek support frequently report unawareness of available services (27). Students with higher levels of distress are less able to effectively seek help. This highlights the possibility for educational institutes to increase education, awareness, and availability of wellbeing promoting facilities, including online resources (24, 25).

Student wellbeing during the coronavirus (Covid-19) outbreak is heavily impacted, with students reporting higher levels of hardship and vulnerability during this global health crisis. Students, as compared to other population groups, experience added duress due to the educational transition to a predominantly online environment (5, 28–30), and report significant stress caused by changes in teaching methods (31). Grappling with the transition to remote learning presents challenges to students, with the effects of the pandemic described as removing "both the opportunity and the will to be productive" (32). Government-imposed restrictions require social distancing and isolation, with subsequent increases in psychological distress and development of disorders including stress, depression, irritability, and insomnia (33). These emerging threats are inciting higher educational institutes to prioritise questions concerning their duty of care for student wellbeing (34), which motivated investigation of HE support facilities in the current study.

Trends of elevated psychological susceptibility during Covid-19 are found globally among student populations, including students in China, Italy, England, Greece, the United States, Germany, and France (5, 28, 35–42), but have yet to be studied in the Netherlands. The observed declines in wellbeing are attributed to online learning, isolation from peers, strained relationships with teachers and classmates, and relocation following school campus closure (5, 43). A recent meta-analysis estimated the overall prevalence of depression among students to range from 32.9 to 49.1% (44).

The first recorded case of the coronavirus in the Netherlands occurred during early 2020. Following its rapid spread, the government announced restrictions with stringency increases as the Covid-19 virus spread (**Table A1**). Among these restrictions, a call to stop teaching at location was announced. An expansion of government-imposed restrictions continued until May 2020, after which a first tentative step towards limited reopening was introduced, as the first wave of infections receded (45, 46).

Examining students' perspectives on how educational institutes may enhance wellbeing reveals relevant themes for HE student services and support facilities during the Covid-19 restrictions. From students' standpoint, increasing awareness of services, promoting their use, and improving availability, range, and quality of support services is instrumental to increased wellbeing (23). With current restrictions demanding an expansion of online facilities, HE services may seek to expand online support facilities. Reviews of web-based and computer-delivered interventions describe benefits to student mental health, with around 50% demonstrating at least one significant positive outcome following online interventions (47–49).

Resilience is also a much-favoured way to promote student wellbeing, through its positive impact on one's capacity to effectively navigate stressful environments (1). Resilience, defined as the ability to bounce back following stress exposure (50), is portrayed as a vital component to adaptive recovery, and refers to stabilisation following threats to wellbeing (51). In a meta-analysis, it was shown that resilience is positively correlated with indicators of mental health (52). More so, the positive relationship between resilience and mental health is strongest following exposure to significant adversity. Thus, to effectively activate resilience, stress exposure is required (52–54).

Resilience is pivotal to maintaining balance on individual and societal levels and is especially relevant during the Covid-19 pandemic (55). Covid-19 studies on wellbeing emphasise resilience as mediating the negative outcomes related to Covid-19 stress and fears (56, 57). According to the challenge model of resilience (58), an optimal range of stress exposure exists within which individuals can cultivate resilient response. Stress levels that are too low activate sub-optimal resilient responses, and stress levels that are too high predict negative outcomes as stress exposure becomes overwhelming. In addition, strong ties exist between resilience and support, where support promotes resilient recovery following stress exposure, in addition to improving help-seeking attitudes and increasing one's capacity to identify and utilise supportive resources (24, 59, 60).

With evident roles for academic stress, resilience, and support on student wellbeing, the current study proposes an explanatory model to explain the relationships between Covid-19 related academic stress, depression, resilience, and HE support for students studying at HE institutes throughout the Netherlands during the coronavirus pandemic. The Dutch HE system involves two distinct forms of higher education. The first regards academic research oriented higher education, offered by universities (in Dutch: wetenschappelijk onderwijs). The second form includes higher professional education offered by universities of applied science (in Dutch: hoger beroepsonderwijs). The current study included higher professional education students to ensure sample homogeneity.

The hypothesised model of academic stress on depression during Covid-19 used in the current study includes a direct predictive effect of academic stress perception on reported levels of depression, in addition to proposing three predictive indirect effects: (1) a partial mediation effect of resilience, where higher resilience has a stronger protective effect on depression, (2) a partial mediation effect of HE support, where students who report higher identification of support facilities available within the HE context are believed to also experience a stronger protective effect on depression rating, and (3) a partial serial mediation effect where the indirect effect of resilience and HE support in succession offers a protective effect on depression in HE students (see **Figure 1**).

Previous studies indicate a need to focus on differential effects between student subgroups to address gaps in available knowledge (7, 18, 57). As such, the current study included model fit tests for student subgroups. Predictive model fit examinations were carried out for all eligible HE students studying in the Netherlands, and model fit was subsequently analysed for four

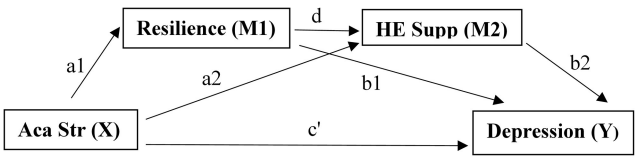

FIGURE 1 | Explanatory serial mediation model with hypothesised direct pathway, independent mediation pathways, and serial mediation pathway between academic stress, depression, resilience, and HE support. Aca Str, academic stress; HE Supp, higher education support.

students subgroups: (1) HE students who report low perceived academic stress during the Covid-19 pandemic, (2) HE students who report high perceived academic stress during the Covid-19 pandemic, (3) HE students whose reported levels of depression approaching clinical diagnoses of depression (61), and (4) HE students whose depressive symptom profiles are below the threshold for clinical depression. Based on available literature (57, 58), we expect that higher levels of stress decrease the protective mechanisms provided by resilience and the ability to identify HE support. In addition, we expect that students reporting depressive levels linked to clinical depression will experience a lower protective effect of resilience and HE support. The current study thus provides a novel model analysis of student wellbeing throughout the Covid-19 pandemic in the Netherlands, and additionally includes novel examinations of wellbeing among student subgroups.

METHOD

Survey

Across 26 countries and 110 higher educational institutes, students were invited to complete the Covid-19 International Student Well-being Study (C19 ISWS). Invitations were sent via email, where participating research groups received a country-specific, or institute-specific link for survey distribution. This approach limited survey distribution and subsequent data collection to respondents studying in the Netherlands (29). The survey was completed online *via* Qualtrics survey tool in accordance with European guidelines on General Data Protection Regulation (GDPR). The study was approved on ethical standards as defined by the Ethics Committee for Social Sciences and Humanities at the University of Antwerp, in addition to meeting standards set by the institutional review board at the InHolland University of Applied Sciences.

The C19 ISWS includes seven domains: (1) sociodemographic information, such as age, gender, and migration status, (2) study-related information such as study field, HE institute, and perceived importance of study, (3) changes due to the Covid-19 outbreak, including financial resources, living conditions, lifestyle, and activity levels, (4) Covid-19 infections, symptoms, and concerns like comorbidity, stigma, and risk perception, (5) stressors, informal support, and mental wellbeing, (6) student-specific questions and concerns such as help-seeking behaviours, perceived stress, and satisfaction

with the HE communication strategies, and (7) Covid-19 knowledge and information, including questions on the students' attitudes towards government-imposed restrictions and communication strategies. The C19 ISWS questionnaire is available elsewhere (62).

The C19 ISWS was designed to measure a broad range of theme's including several widely implemented scales to collect data on wellbeing just prior to, or after, the initial peak in Covid-19 infections. In the Netherlands, participants of the C19 ISWS completed the survey between May 6th 2020 and May 18th 2020. The Dutch government reduced some of the lockdown restrictions following several weeks of an "Intelligent Lockdown" phase on May 11th, 2020, which included a reopening of middle schools, but this ease of restrictions included no changes relevant to teaching methods at HE institutes (see **Table A1**).

Participants

All study participants were HE students, actively enrolled in a study programme at InHolland Universities of Applied Sciences throughout the Netherlands. Participation was voluntary and participants were invited to partake in the study if they were currently enrolled and were aged 17 years or older. Participants were required to give consent prior to proceeding. Of the participants who partook in the study, those who had successfully completed the survey were included in the dataset.

The cohort of students included 2,835 participants. Data homogeneity inspection revealed that enrolment status created a significant impact on the distribution of the dependent variable; $F(3, 2{,}821) = 15.760$, $p<0.001$. *Post-hoc* contrasts indicated that the effect of fulltime enrolment was significantly different from other forms of enrolment. Furthermore, students who identified as gender "x" included 10 individuals who scored significantly higher on dependent variable [mean (M) = 2.675, standard deviation (SD) = 0.753] than students who identified as male (M = 2.193, SD = 0.630) or female (M = 2.273, SD = 0.611) ($t(827) = -2.399$, $p = 0.009$; $t(2{,}104) = -2.071$, $p = 0.019$). As previous examination of the CES-D8 has not validated reliable use for this gender group (63), gender "x" was excluded from the final dataset. Subsequently, fulltime HE enrollers, and those identifying as male or female were included in the final dataset.

The final sample used for analysis included 2,480 students with fulltime, 4 year HE enrolment of mean age 21.78 years (SD = 3.155). Of the respondents 775 were male (30.4%) and the remaining 1,725 were female (69.6%). The study sample is described in further detail in **Table 1**.

TABLE 1 | Sociodemographic characteristics of participants ($N = 2{,}480$).

	N	%
AGE IN YEARS		
<18	260	10.5
18–20	678	27.3
21–23	995	40.1
24–27	426	17.2
>28	121	4.9
GENDER		
Male	755	30.4
Female	1,725	69.6
STUDY YEAR		
First	739	29.8
Second	594	24.0
Third	497	20.0
Fourth	453	18.3
Fifth or more	197	7.9
MIGRATION STATUS		
Born inside the Netherlands	2,219	89.5
Born outside the Netherlands	261	10.5
PARENTAL EDUCATION		
Father		
Less than secondary	132	5.3
Secondary	1,115	45.0
Higher education	1,044	42.1
Unknown	189	7.6
Mother		
Less than secondary	111	4.5
Secondary	1,276	51.5
Higher education	957	38.6
Unknown	136	5.5
HIGHER EDUCATION GENERATION		
First generation	1,075	43.3
Other	1,405	56.7

Measurements

Depression

The level of depressive symptoms was measured with the Centre for Epidemiological Studies-Depression scale (CES-D8) short version, which was integrated in the C19 ISWS and has been tested as a reliable and valid tool to measure depressive symptoms in men and women (63, 64). This 8-item questionnaire asks respondents to indicate to which degree they agree with statements that reflect on thoughts, feelings, emotions, and energy levels over the past week. Responses are given according to a 4-point Likert scale, where 1 indicates "none or almost none of the time", 2 indicates " some of the time", 3 indicates "most of the time", and 4 indicates "all or almost all of the time". The items ask an estimation of "how much of the time during the last week…" followed by specific item content, such as "you felt everything was an effort", "your sleep was restless", or "you felt sad". The total scores are averaged, with higher scores indicating a higher presence of depressive symptoms, and a summed mean of 3.0 or higher indicating depression (61, 65, 66). Cronbach's alpha for the CES-D8 in the sample was 0.860. The sample had an average CES-D8 score of 2.280, with a standard deviation of 0.619. When grouped into a depressed and non-depressed subset according to scoring procedures, 16.3% reported symptom levels in accordance with clinical depression (61) ($N = 404$).

Academic Stress

Covid-19 related academic stress was measured using a 4-item scale included in the C19 ISWS domain on student-specific questions and concerns within the specific context of the

coronavirus pandemic. All four items enquired about perception of changes in academic stress following the coronavirus pandemic and changes in students' academic experiences. Factor analyses conducted by the C19 ISWS consortium revealed four items which adequately assessed perceived academic stress during the transition to online teaching (29). This short assessment included evaluation of academic workload, course expectations, completion of the academic year, and teaching methods (63). Corresponding items included statements such as "my university/college workload has significantly increased since the Covid-19 outbreak" and "I am concerned that I will not be able to successfully complete the academic year due to the Covid-19 outbreak". Responses were required along a 5-point Likert scale were 1 indicated "total agreement", 3 indicated a "neutral" response, and 5 indicated "total disagreement" with the statement. All four item scores had to be reversed to allow intuitive interpretation, and a summed mean score was calculated. As such, a higher mean score indicates higher perceived academic stress following the Covid-19 restrictions and the HE transition to online teaching, with total scores ranging from 4.00 to 20.00, and summed mean scores between 1.00 and 5.00. A reliability analysis on the current dataset resulted in a Cronbach's alpha of 0.730. The respondents scored an average of 3.371 on the summed mean academic stress scale, with a standard deviation of 0.854.

In addition, academic stress scale total scores (range 4.00–20.00) were transformed to subset two groups; those who experienced low levels of academic stress, and those who experienced high levels of academic stress. The average total score on the academic stress scale for the sample was 14.86 (SD = 3.41). Cut-off scores were based on the total scores to allow clean cut-off lines inherent to the use of Likert-scale responses. As such, students scoring between the minimum +1 SD (4.00–7.41) were assigned to the low academic stress group, and the maximum score −1 SD (16.59–20.00) was used to identify the high academic stress group. In practise, as the academic stress scale is based on a 5-point Likert response scale, the low academic stress group scored between 4.00 and 7.00 ($N = 63$, M = 1.480, SD = 0.289) whereas the high academic stress group scored between 17.00 and 20.00 ($N = 839$, M = 4.611, SD = 0.282). Following group allocation, the summed mean scores of the academic stress scale were used for subsequent analyses.

Resilience

Resilience was measured using the Brief Resilience Scale (BRS) which is a short, self-reported 6-item measure of resilience with proven validity and reliability in other cohort studies (50). This scale was included in the C19 ISWS within the country-specific module. An indication of agreement with the statements was required according to a 5-point Likert scale. 1 indicated "total disagreement", 3 indicated a neutral response, and 5 indicated "total agreement" with the provided statements. BRS items included "I tend to bounce back quickly after hard times", "I have a hard time making it through stressful events", and "it does not take me long to recover from a stressful event". Three of the items had to be reversed prior to summing and averaging scores. Within the sample, the reliability analysis of the BRS revealed a Cronbach's alpha of.840. The respondents scored an average on the BRS of 2.952 with a standard deviation of 0.755. Scale summed scores can be grouped to classify resilience levels (65). BRS summed total scores between 1.00 and 2.99 are categorised as low resilience, 3.00–4.30 as normal resilience, and 4.31–5.00 as high resilience. Within the sample, 46,8% ($N = 1{,}160$) could be classified as having low resilience, 49.7% ($N = 1{,}233$) were classified as having normal resilience, and the remaining 3.5% ($N = 87$) had a high level of resilience. Using these group norms, the average resilience level of the final sample could be classified as "low".

HE Support

Definitions of resilience include resilient behaviours through the identification and utilisation of supportive resources (59). The C19 ISWS item assessing students' identification and satisfaction with support facilities; "There are sufficient support facilities within the HE institute (e.g., student counselling, online support)" was included in the model. Responses were required on a 5-point Likert scale. Scores were transformed so that higher scores indicated higher perceived availability of supporting facilities within the HE setting. For the sample, 27.6% indicated strong disagreement, or disagreement with the statement ($N = 156$, $N = 528$, respectively), whereas 26,5% either agreed or strongly agreed ($N = 595$, $N = 61$, respectively). The remainder of the sample maintained a neutral attitude towards the availability of sufficient support facilities at the HE institute ($N = 1{,}140$).

Statistical Analysis

IBM SPSS Statistics for Windows, Version 27.0 was used to carry out statistical analyses. The extension Macro PROCESS (67) version 3.5 was used to test model fit regarding a serial mediation effect by resilience and HE support on academic stress and depression. To estimate power probabilities for the subgroups examined for model estimation differences, G*Power software version 3.1.9.6 was used (68).

The serial mediation analysis was run with Macro PROCESS to estimate effect sizes and model fit for five groups: (1) all HE students, (2) students who report experiencing low levels of academic stress during the Covid-19 pandemic, (3) students who report high levels of academic stress during the Covid-19 pandemic, (4) students with CES-D8 scores indicating the presence of depression, and (5) students whose CES-D8 scale mean indicated the absence of depression.

During each group analysis, the nature of the relationship between X and Y (X: academic stress and Y: depression levels) was assessed directly, in addition to testing the indirect effect resulting from the two mediators resilience (M1) and HE support (M2), and their indirect serial mediation effect (**Figure 1**). The analytical workflow was based on previous work by Preacher and Hayes (69) where multiple mediation analysis is based on two elements. First, an examination is made to conclude whether the set of mediators transmits the effect of X to Y, and second, the specific indirect effect associated with each presumed mediator is tested. Within this framework, total indirect effects

need not be significant for identification of relevant specific indirect effects.

Total, direct, indirect, and partial effects included in the model were described as statistically significant if the corresponding 95% confidence interval of the unstandardised effect size coefficient *b* did not contain zero. If the direct path between X and Y (c′) was significant, and all three indirect pathways (a1 x b1; a2 x b2; and a1 x d x b2) yielded significant results, a partial serial mediation model is present. If the c′ path effect between X and Y is non-significant and the three indirect pathways were significant, a full serial mediation model is present. If any of the indirect pathways fail to reach significance, the remaining indirect pathways were examined to assess the model.

During the Macro PROCESS analyses, bootstrap resampling value was set at 5,000. Each of the pathways was tested by regressing the corresponding variables. If the *b* coefficient of the estimated direct, serial indirect, or independent indirect effects occurred within a 95% confidence interval range excluding zero, the null hypothesis of no significant predictive effect was rejected.

No missing data was present for the sample as only completed surveys were included. More so, due to the Likert-scale response methods employed to measure all included variables within the hypothesised model, no outliers were identified. The final dataset (N = 2,480) was screened for violations that would prevent accurate use of Macro PROCESS. Although normality testing revealed non-normal data (Shapiro-Wilk statistic = 0.76, $p < 0.001$), bootstrapping techniques used in PROCESS are robust against violations of normality by using confidence intervals to assess effect significance (69, 70). *Post-hoc* examination of power revealed that groups had sufficient detection power. All HE students, high academic stress students, and non-depressed students maintained a power coefficient of 1.000. A power coefficient of 0.999 was found for low academic stress students, and the power coefficient was 0.971 for depressed students (68).

Assessments were run to determine the presence of covariates. A two-step approach was used to examine sociodemographic variables for linear effects on depression. First, based on literature (3, 5, 35, 38, 71), age, gender, migration background ("where you born in the Netherlands, or outside of the Netherlands?"), and family educational background of students (first generation HE student, vs. not the first generation) were selected and tested for significant effects on depression. During the second step, tests were run to determine each sociodemographic variable's relation to the independent variables academic stress, resilience, and HE support (72). All sociodemographic variables significantly correlated to at least one of the independent variables. Therefore, none were selected as covariates (see **Table A2**).

C19 ISWS data collection dates collided with government-induced changes in Covid-19 lockdown restrictions in the Netherlands. The survey was completed from May 6th 2020 until May 18th 2020, with a mean completion date of May 9th 2020 and a standard deviation of 3 days. As the introduction of the first steps towards reopening were introduced on May 11th, the dataset was inspected to cheque for date dependent effects on depression or academic stress ratings. Statistical analysis yielded no significant results ($p = 0.089$ and $p = 0.194$, respectively).

TABLE 2 | Descriptive statistics and Pearson's correlation for all students on academic stress, depression, resilience, and HE support measures (N = 2,480).

		M	SD	1	2	3	4
1.	Academic Stress	3.371	0.854	(-)	0.404***	−0.379***	−0.282***
2.	Depression	2.280	0.619	.	(-)	−0.238***	−0.482***
3.	HE Support	2.950	0.895	.	.	(-)	0.149***
4.	Resilience	2.952	0.755	.	.	.	(-)

****significant at p < 0.001.*

RESULTS

All Students

For all students, the total predictive effect of the model was 0.293 (see **Tables 2**, **4**, **Figure 2A**). 64.85% of the effect originated in a direct effect between perceived academic stress and depressive symptoms, where higher levels of perceived academic stress significantly predict higher levels of depressive symptoms. Of the indirect effects, the strongest predictive effect is related to the pathway between academic stress and depression via resilience (at 78.64% of the indirect effects, effect size 0.081). The results confirm a serial mediation model for all HE students in predicting depressive symptoms from academic stress, resilience, and HE support. As the corresponding coefficients demonstrate contrasting directions, the analysis points towards a suppressive role of both resilience and HE support, as was proposed in the model hypothesis. As such, a 10% rise in perceived academic stress is linked to a 4.08–5.40% increase in depression symptom severity, but, through partial mediation of resilience and HE support, the former effect is suppressed by 2.13–3.03%. R^2 indicates that the model predicts 32% of the variance, which is an adequate and substantial model fit (73, 74).

Low Academic Stress Students

When estimating the model effects for students who perceive low levels of academic stress, the total predictive effect of the model was not significant ($p = 0.108$). The result revealed just two significant partial effects (see **Tables 3**, **4**, **Figure 2B**). The first includes a predictive effect of resilience on depression symptoms, with a coefficient of −0.281. For every unit increase in resilience, student depression symptoms were predicted to decrease 2.55–11.50%. The partial predictive effect of resilience on identification of HE support was significant at a threshold of 0.05, with a coefficient of 0.305. This finding suggests that higher resilience also predicts a higher capacity to identify HE support facilities.

High Academic Stress Students

The model effects for students who perceive high levels of academic stress, displayed a total predictive effect of.424 between perceived academic stress and depression (see **Tables 3**, **4**, **Figure 2C**). For every unit increase in academic stress, depression levels rise 5.64–11.30%. Of this effect, 72.64% was related to the direct effect between academic stress and depression, with the remainder predominantly caused by the indirect effect via

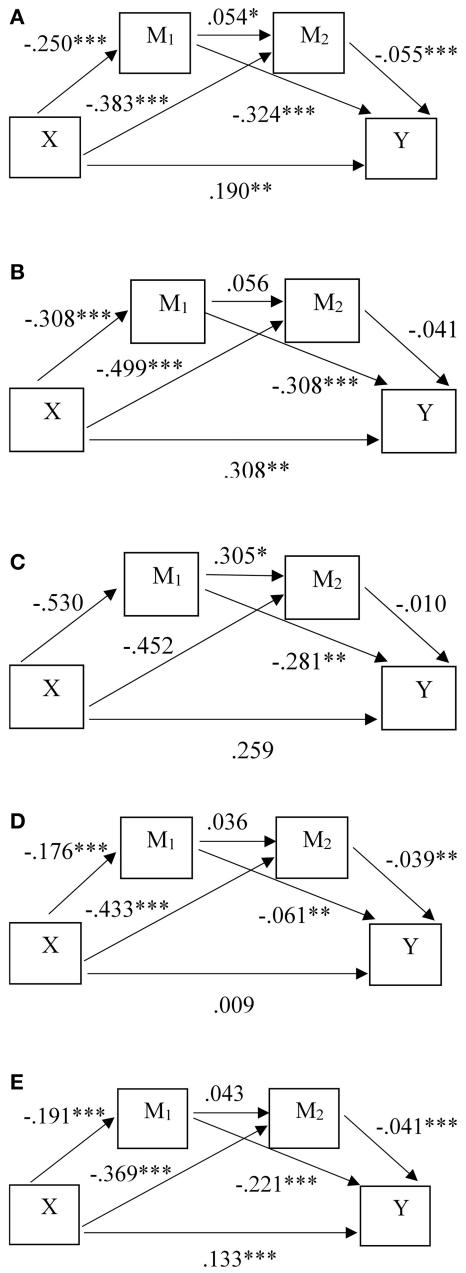

FIGURE 2 | Predictive model effects for the HE student groups: **(A)** all students ($N = 2{,}480$), **(B)** low academic stress students ($N = 63$), **(C)** high academic stress students ($N = 839$), **(D)** depressed students ($N = 404$), **(E)** non-depressed students ($N = 2{,}076$). *significant at $p < 0.05$, **significant at $p < 0.01$, ***significant at $p < 0.001$.

resilience. The protective effect of resilience predicts a 0.98–3.85% decrease in depressive symptoms. The predictive effect of resilience on HE support identification, and the predictive effect of HE support on depression remained insignificant. Results do not support a serial mediation model, but instead propose a single partial mediation model, where resilience partially mediates the relationship between academic stress and depression by acting as a suppressor. For the entire model, R^2 is 0.19, which may be interpretated as an adequate and moderate model fit (73, 74).

TABLE 3 | Descriptive statistics of the student subgroups on academic stress, depression, resilience, and HE support measures.

	M	SD
Low academic stress (*N* = 63)		
Academic stress	1.480	0.289
Depression	1.762	0.568
HE Support	3.670	0.823
Resilience	3.476	0.794
High academic stress (*N* = 839)		
Academic stress	4.611	0.283
Depression	2.557	0.602
HE Support	2.570	0.890
Resilience	2.708	0.746
Depressed (*N* = 404)		
Academic stress	4.209	0.701
Depression	3.277	0.264
HE Support	2.660	0.953
Resilience	2.400	0.710
Non-depressed (*N* = 2,076)		
Academic stress	3.619	0.848
Depression	2.085	0.461
HE support	3.010	0.872
Resilience	3.059	0.716

Depressed Students

Result from the model analysis for depressed students, yielded a low total predictive effect, with an effect size of 0.037 (see **Tables 3**, **4**, **Figure 2D**). In addition, the model explained 5.41% of the variance present in the sample, thus demonstrating a lack of model fit for depressed students. Of the pathways tested to estimate serial mediation effects between academic stress and depression, results indicated no significant direct effect between academic stress and depression, and an insignificant serial effect between resilience and HE support identification. As such, results support complete mediation effects of both resilience and HE support, which implies a parallel mediation model.

The predictive effect of perceived academic stress on depression was predominantly mediated by HE support (60.71% of the indirect effect). However, effect sizes were small. A unit increase in resilience predicts a decrease in depressive symptoms of 0.63– or 2.43%, and a unit increase in HE support identification predicts a decrease in depression of 0.28–1.68%. In practise, the total effects of these mediating pathways predict a drop in mean depression scores ranging between 3.268 and 3.239. Scores thus remain within the range indicating presence of depression (61).

Non-depressed Students

The total predictive effect of the model to assess depression levels in non-depressed HE students was 0.190, with a direct effect size of 0.133 (see **Tables 3**, **4**, **Figure 2E**). This result indicates that

TABLE 4 | Regression coefficients and significance tests for the explanatory model pathways between the five student groups.

Pathway	b	t	p	R	95% CI
All students				0.32	
a1	−0.250	−14.642	<0.001***		−0.283 to −0.216
a2	−0.383	−18.904	<0.001***		−0.423 to −0.344
b1	−0.324	−22.823	<0.001***		−0.352 to −0.297
b2	−0.055	−4.431	<0.001***		−0.080 to −0.031
d	0.054	2.352	0.019*		0.009 to 0.099
c′	0.190	14.114	<0.001***		0.163 to 0.216
X on Y	**Effect**	**se**	**t**	**p**	**95% CI**
Total	0.293	0.013	21.961	<0.001***	0.266 to 0.319
Ind. total	0.103	0.009			0.085 to 0.121
Ind1 (a1 x b1)	0.081	0.007			0.069 to 0.095
Ind2 (a2 x b2)	0.021	0.005			0.011 to 0.032
Ind3 (a1 x d x b2)	0.0007	0.0004			0.0001 to 0.0016
	b	**t**	**p**	**R**	**95% CI**
Low academic stress				0.19	
a1	−0.530	−1.534	0.130		−1.222 to 0.169
a2	−0.452	1.290	0.202		−1.152 to 0.249
b1	−0.281	3.144	0.003***		−0.460 to−0.102
b2	0.010	0.110	0.913		−0.164 to 0.183
d	0.305	2.399	0.020*		0.051 to 0.560
c′	0.259	1.086	0.282		−0.218 to 0.736
X on Y	**Effect**	**se**	**t**	**p**	**95% CI**
Total	0.402	0.247	1.632	0.108	−0.091 to 0.896
Ind. total	0.143	0.119			−0.070 to 0.398
Ind1 (a1 x b1)	0.149	0.105			−0.058 to 0.363
Ind2 (a2 x b2)	−0.004	0.049			−0.094 to 0.115
Ind3 (a1 x d x b2)	−0.0015	0.019			−0.045 to 0.039
	b	**t**	**p**	**R**	**95% CI**
High academic stress				0.19	
a1	−0.308	−3.406	<0.001***		−0.486 to −0.131
a2	−0.499	−4.621	<0.001***		−0.711 to −0.287
b1	−0.308	−12.145	<0.001***		−0.358 to −0.258
b2	−0.041	−1.910	0.057		−0.083 to 0.001
d	0.056	1.378	0.169		−0.024 to 0.137
c′	0.308	4.543	<0.001***		0.175 to 0.441
X on Y	**Effect**	**se**	**t**	**p**	**95% CI**
Total	0.424	0.072	5.872	<0.001***	0.282 to 0.565
Ind. total	0.116	0.033			0.055 to 0.183
Ind1 (a1 x b1)	0.095	0.029			0.039 to 0.154
Ind2 (a2 x b2)	0.020	0.012			−0.001 to 0.048
Ind3 (a1 x d x b2)	0.0007	0.001			−0.0003 to 0.0027
	b	**t**	**p**	**R**	**95% CI**
Depressed				0.05	
a1	−0.176	−3.531	< 0.001***		−0.274 to−0.078
a2	−0.433	−6.640	< 0.001***		−0.561 to−0.305
b1	−0.061	−3.302	0.001**		−0.097 to−0.025
b2	−0.039	−2.712	0.007**		−0.067 to−0.011
d	0.036	0.557	0.578		−0.091 to 0.162
c′	0.009	0.482	0.630		−0.029 to 0.048
X on Y	**Effect**	**se**	**t**	**p**	**95% CI**
Total	0.037	0.019	1.980	0.048*	0.0003 to 0.0739

(Continued)

TABLE 4 | Continued

Pathway	b	t	p	R	95% CI
Ind. total	0.028	0.009			0.011 to 0.046
Ind1 (a1 x b1)	0.011	0.005			0.003 to 0.022
Ind2 (a2 x b2)	0.017	0.008			0.003 to 0.033
Ind3 (a1 x d x b2)	0.0002	0.001			−0.0008 to 0.0015
	b	**t**	**p**	**R**	**95% CI**
Non-depressed				0.24	
a1	−0.191	−10.568	<0.001***		−0.226 to −0.156
a2	−0.369	−17.091	<0.001***		−0.411 to −0.326
b1	−0.221	−17.456	<0.001***		−0.246 to −0.196
b2	−0.041	−3.730	<0.001***		−0.062 to −0.019
d	0.043	1.675	0.094		−0.007 to 0.093
c′	0.133	11.618	<0.001***		0.110 to 0.155
X on Y	**Effect**	**se**	**t**	**p**	**95% CI**
Total	0.190	0.011	16.992	< 0.001***	0.168 to 0.212
Ind. total	0.058	0.007			0.045 to 0.071
Ind1 (a1 x b1)	0.042	0.005			0.033 to 0.052
Ind2 (a2 x b2)	0.015	0.004			0.007 to 0.023
Ind3 (a1 x d x b2)	0.0003	0.0002			−0.0001 to 0.0008

*a1: independent variable (IV) to mediator 1; a2: IV to mediator 2; b1: mediator 1 to dependent variable (DV); b2: mediator 2 to DV; d: mediator 1 to mediator 2; c′: IV to dependent variable. *significant at $p < 0.05$; ***significant at $p < 0.001$.*

70.00% of the model's predictive effect originates from the direct predictive effect of academic stress on depressive symptoms. Both an indirect predictive effect via resilience and HE support proved significant, but the serial mediating pathway did not yield a significant result (effect size 95% Confidence Interval (CI) = −0.0001, −0.0008). The indirect effect was predominantly driven by the pathway of resilience mediation, at 72.41% of the total indirect effect. Results support independent partial mediating effects of resilience and HE support, where they act as suppressors of the relationship between academic stress and depression in parallel mediation. The largest effect originates from a direct predictive effect of academic stress on depression, at an estimated effect size of 0.133. A unit increase in perceived academic stress predicts an increase in depressive symptoms of 2.75–3.88%. Indirect effects collectively decrease depressive symptoms 1.13–1.78%.

DISCUSSION

The current study examined the relationships between Covid-19 related academic stress and depression with mediation effects of resilience and HE support, among students studying at higher education institutes during the corona crisis in the Netherlands. For all student subgroups, predictive suppressive effects of resilience on depression rates were demonstrated. More so, students subgroups experiencing low academic stress, and those experiencing depression, cease to demonstrate a direct effect of academic stress on predicted depression levels, whereas this direct effect is found for other student groups. In addition, a protective predictive effect through identification of HE support was significant for the entire student sample, as well as for subgroups of depressed, and non-depressed students, but not for low and high academic stress groups. Furthermore, serial mediation was demonstrated for all HE students in general, but it ceased to exist in subgroups. The study of these dynamics provides relevant insights as subgroup examinations were conducted based on research recommendations (16, 18). By comparing student groups based on levels of stress and depression, significant nuances and differences appear which give direction to strategies for student wellbeing enhancement at HE institutes.

In keeping with other studies on student wellbeing, the current study demonstrates a significant relationship between academic stress and depression among students (18, 75). When analysing the total sample, both resilience and HE support mediate the effect of academic stress on development of depressive symptoms for HE students, including a serial mediation between resilience and HE support.

A similar model is presented for non-depressed HE students, where approximately one third of the effect of academic stress on depression is mediated though resilience and HE support, though this group lacked serial mediation. Our findings support previous demonstrations of a protective mediating role for resilience and identification of support resources in the development of psychological problems among students (5, 28, 52), and provides corroboration for a link between resilience and the ability to identify helpful resources in the environment for students generally (59, 60).

For HE students experiencing low academic stress, higher resilience predicts lower depression scores, in addition to predicting higher identification of HE support resources. In contrast to other groups, students who experience low academic

stress demonstrate no direct or indirect effect of academic stress on wellbeing due to the educational transition. A plausible explanation for this finding regards the higher resilience levels present among this subgroup, as higher resilience promotes higher levels of adaptive behaviours, in turn reducing negative impacts from perceived stress (58). More so, this subgroup may perceive the Covid-19 related educational transition as non-threatening, which also serves to protect against negative stress effects on student wellbeing (19).

When students do perceive high levels of academic stress during the Covid-19 crisis, the strongest predictive effect originates from a direct effect of academic stress on depression, and a predictive effect of resilience was found with the greatest indirect mediation. In contrast to the entire sample and depressed or non-depressed subgroups, the protective effect of HE support is lost for students with high levels of academic stress. This loss suggests a stress-induced impairment in students' ability to identify support facilities, which is supported by research describing inhibited adaptive behaviours if one's stress response becomes overwhelmed (54, 58). Akin to most student groups, students burdened by high academic stress stand to profit from resilience enhancement strategies and could benefit from programs focussed on the remediation of academic stress perception following the educational transition to online teaching.

As for HE students who experience depression, different outcomes emerge. Among depressed students, a relatively stronger mediation through HE support is found compared to the mediating effect of resilience. This finding indicates that the protective effects for this group are driven predominantly by the ability to identify HE support resources. Results may indicate that depressed students are turning to HE institutes in their search for support resources but remain unaware of their presence or are unsuccessful in locating available support facilities. Alternatively, students enduring psychological problems may experience help-seeking barriers, including the perception that no one will be able to offer the support that they need, which may negatively influence their ability to identify useful resources (24, 25). These students thus stand to benefit from promotion of comprehensive support facilities, a suggestion which has also been made in other studies on student wellbeing during the Covid-19 pandemic (43).

The lack of a strong protective mediation from resilience among depressed students reiterates previous work describing insufficient levels of resilience when psychopathology sets in (54, 58). The current findings suggest that depressed students require a different approach when forming strategies to increase wellbeing. This topic thus requires further attention in future research. For depressed students, the current explanatory model explains little variance, suggesting alternative pathways by which depression would be better predicted. With research demonstrating that 75% of people experiencing depression will have an onset before 24 years of age (11), it seems plausible that the depression rates captured regard recurrence or persistence and are thus not predicted by academic stress caused by the educational transition following the pandemic.

Instead, researchers propose that personality traits, comorbidity, or risk factors relating to hopelessness, and problem-solving capacity are all predictive of depression development (12, 75, 76). The supporting role of educational institutes in facilitating support for this burdened group of students should thus be subject of further investigation, especially given evidence that increased psychological distress is implicated in academic failure and study discontinuation (7, 8, 18).

Limitations

Although the current study furthers understanding of the relationship between academic stress, resilience, and HE support on depressive symptoms for HE students during the Covid-19 pandemic in the Netherlands, there are some limitations. First, the sample contained an overrepresentation of female students. Although higher response rates from female students are often present within examinations of student populations (77), replications with balanced gender groups may provide added insight or nuances. Second, the cross-sectional nature of the current study would be enriched by examining student groups within a longitudinal design, where repeated measures study could examine the temporal persistence of Covid-19 related impacts on wellbeing. Third, with little variation captured for depressed HE students, this group should receive independent focus to identify relevant explanatory pathways, as well as to reveal potential avenues for HE support and intervention. Fourth, this study assessed academic stress *via* four relevant stressors, although additional sources of academic stress are found among students, including time constraints, parental pressures, teachers' expectations, and self-perceptions (78, 79). As such, further study including additional sources of academic stress will serve to improve understanding of the collective and independent effects of academic stressors on student wellbeing. Finally, with resilience scores generally within the lower range in the current student sample, additional study of resilience among HE students will expand collective knowledge and serve to further inform enhancement strategies.

Practical Implications and Future Directions

According to our findings, the greatest overall improvements to HE student wellbeing during the Covid-19 pandemic can be attained by promoting resilience in addition to decreasing perceived Covid-19 related academic stress for specific subgroups. Higher educational institutes should focus on student perceptions of academic workload, expectations, and anticipated study delays, and how to remedy stress elevations which hamper psychological wellbeing through resilient response. More so, expanding perceived academic stress measures will aid research on students' academic stress experiences beyond the confines of the pandemic, as research demonstrates that students also experience academic stressors in non-pandemic academic settings (7, 78). Furthermore, an exploration of means with which to increase resilience should yield fruitful wellbeing enhancement strategies. The Covid-19 related restrictions that preclude live contact, need not act as a barrier for proactive development of tools that promote resilience

among students during this time, as online and informal resources can also offer benefits to wellbeing (24, 25, 47, 48).

With studies proposing that informal support is generally preferred by young adults due to financial considerations, higher availability, and lower associations with stigmatisation (25), their applicability within the currents predictive models deserves further scrutiny. Moreover, research indicates that facilitators of help-seeking among students include increased education and awareness, encouragement, removal of treatment scepticism, and the provision of accessible resources such as student counselling (23, 24, 27). As such, HE institutes could stimulate student wellbeing by exploring relevant facilitators of student support seeking, in addition to scrutinising HE support service accessibility and availability.

The current findings also argue for a differential research approach when examining wellbeing of HE students who are experiencing depression. These students may not receive any notable benefit from perceived academic stress reduction or resilience enhancement, and as such require further research to identify relevant predictors and effective interventions. It may also be the case that this group requires support services that are not typically available *via* HE institutes, or that a lack of academic attendance resulting from psychological distress keeps these students outside of the range of HE support services. Given their difficult disposition, understanding wellbeing dynamics of depressed students warrants continued exploration.

The current study offers HE institutes in the Netherlands enriched understanding on how to best support student wellbeing throughout the remainder of the Covid-19 pandemic, based on group levels of academic stress and depressive symptoms, which had not been investigated previously. If future circumstances demand student isolation, students may continually be required to conduct studies via an online educational environment for extensive periods of time. Under such circumstances, mitigation of perceived academic stress and enhancement of resilience offer protective means with which to positively promote student wellbeing.

CONCLUSIONS

For HE students studying in the Netherlands, model testing demonstrates that perceived academic stress positively predicts depressive symptoms during the coronavirus pandemic and its implications for online education. Moreover, within the model test for the entire student sample, protective serial mediation is present *via* resilience, and HE support. Subgroup examinations demonstrated parallel mediation, partial predictive effects, in addition to a lack of model fit for specific subgroups of students. These findings suggest that HE institutes may increase student wellbeing generally by enhancing resilience and HE support, as well as by decreasing perceived academic stress. However, specific approaches could be required if the aim concerns enhancement of student wellbeing among student subgroups. Wellbeing enhancement among students during of the Covid-19 pandemic should be strategically reviewed by HE institutes and should include focus on support service availability, visibility, and range of services.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because participants of this study did not consent to public availability of their data. Upon request from collaborating researchers within the C19 ISWS consortium, data is available as relevant consent was provided by participants. Requests to access the datasets should be directed to Rutger Kappe, rutger.kappe@inholland.nl.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee for Social Sciences and Humanities at the University of Antwerp and the Institutional Review Board InHolland University of Applied Sciences. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

RK aided in survey design, survey distribution, and contribution of materials. MV analyzed the data and wrote the manuscript. RK and MV conducted literature research. Both authors contributed to the article and approved the submitted version.

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APPENDIX

TABLE A1 | Government response stringency Index for the Netherlands with implementation dates of government-imposed restrictions.

Date	Government response stringency index	Description
February 27th, 2020	5.56	First national case of Covid-19 in Tilburg (Northern Brabant).
March 6th, 2020	11.11	First Covid-19 related death and subsequent first implementations of covid-19 related health advice for Brabant province.
March 13th, 2020	53.70	Introduction of flight restrictions from high-risk countries, restriction on group sizes in all public domains and a ban on teaching at location for all higher educational institutes
March 23rd, 2020	78.70	Start of the "Intelligent Lockdown".
May 11th, 2020	71.30	First ease of government-imposed restrictions, including the reopening of public libraries, middle schools, and some outdoor sport activities.

TABLE A2 | Covariate analysis.

Scale		Sociodemographic variables			
		Gender	Age	Migration status	HE Generation
Depression	*Pearson's r*	0.074	0.101	0.081	0.045
	p-value	< 0.001***	< 0.001***	< 0.001***	0.027*
Aca stress	*Pearson's r*	0.009	−0.012	0.007	0.068
	p-value	0.664	0.550	0.721	0.001***
Resilience	*Pearson's r*	−0.159	−0.041	0.015	−0.041
	p-value	< 0.001***	0.042*	0.466	0.043*
HE Support	*Pearson's r*	0.037	−0.073	−0.046	−0.036
	p-value	0.067	< 0.001***	0.023*	0.072

*A significant independent direct effect on depression was taken as reason to include the sociodemographic variable as a covariate in the final analysis (N = 2,480). *significant at $p < 0.05$; ***significant at $p < 0.001$.*

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Delayed-Onset PTSD and Coping Strategies of Chinese College Students During the COVID-19 Pandemic

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Coronavirus disease 2019 (COVID-19) has become a pandemic, and many Chinese college students both in China and abroad were house-quarantined. This study aimed to investigate the prevalence and symptoms of delayed-onset post-traumatic stress disorder (PTSD) and coping strategies among Chinese overseas and domestic college students during this pandemic. A questionnaire was opportunistically distributed to Chinese college students studying both domestically and abroad six months after the COVID-19 outbreak. The questionnaire consisted of IES-R, SCSQ, and SSRS. The average score of delayed-onset PTSD in our population was 21.411 (full mark, 88 points), which reflected a total high level of delayed-onset PTSD symptoms. Statistical differences were shown between students who have been back to universities during the pandemic or not in the hyperarousal dimension (p = 0.016). Three coping strategies were recognized to influence the respondent's delayed-onset PTSD symptoms, and there was a significant correlation between social support and the coping strategies students chose. A moderate to high level of delayed-onset PTSD was observed among both Chinese overseas and domestic college students 6 months after the COVID-19 outbreak. The useful coping strategies and powerful social supports are significantly important to help them stay mentally healthy and alleviate delayed-onset PTSD during the COVID-19 pandemic.

Keywords: COVID-19, delayed-onset PTSD, psychological health, college students, coping strategies

INTRODUCTION

The coronavirus disease 2019 (COVID-19) outbreak, which began in late 2019, has become a global pandemic. Severe acute respiratory syndrome–related coronavirus 2 (SARS-CoV-2) is a virus transmitted by inhalation or contact with infected droplets with an incubation period ranging from 2 to 14 days (Zhang et al., 2020a). As of September 31, 2020, there have been 33, 145, 948

Abbreviations: Delayed-onset PTSD, delayed-onset post-traumatic stress disorder; COVID-19, coronavirus disease 2019; IES-R, impact of event scale-revised; SCSQ, simplified coping style questionnaire; SSRS, social support rating scale.

confirmed cases worldwide (COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU), 2020). The susceptibility and transmissibility of the virus had a huge impact on many activities around the world, including medical education. It was announced that over 1 billion students across the planet have been affected by school and college closures during this pandemic (Fatani, 2020).

The rapid evolution during the pandemic, including travel restrictions and the closure of educational institutions across the country, has influenced the students of all age-groups (Chaturvedi et al., 2021). Although the epidemic situation in China has been alleviated to some extent and many students have returned to school, the epidemic still affects the mental health status of teachers and students in universities (Hjiej and Fourtassi, 2020). Till now, most universities are still blocked down, disapproved of students going out of school. They need to update their body temperature every day and wear face masks every day when they have classes. We think it might have influences on student's mental situation between Chinese students who have gone back to university at least once and those who never went back to university during the pandemic. In addition, many overseas students are facing the problem of being unable to return to school and continue their online courses (Smith, 2020). Meanwhile, some overseas students were also facing the situation that they cannot come back to China because of travel restrictions or high price tickets (Nicola et al., 2020). Such circumstances might have hatched the delayed-onset post-traumatic stress disorder among students.

Post-traumatic stress disorder (PTSD) refers to an abnormal mental reaction, responding to the severe traumas or disasters. Delayed-onset PTSD is designed to emphasize that "at least six months elapsed between the traumatic event and the onset of symptoms." This is going to be a long-lasting effect. Given that the global COVID-19 pandemic has been lasting for nearly two years, the impact on people from the first outbreak in late 2019 till now would meet the definition of "delayed onset." The death toll from COVID-19 continues to increase, with intermittent regional outbreaks. Such a situation constantly disturbs people's normal work and life, causing people to continue to stimulate, a long-term traumatic stress reappearance state.

There are differences between China's pandemic situation and other countrie's, but we can still find something in common. In the COVID-19-PTSD scoring experiment of Italians, 29.5% of the population had PTSD symptoms. According to this study, the COVID-19 pandemic can be considered as "a traumatic event" (Forte et al., 2020). Liang et al. (2020) found that nearly 40.4% of the sampled youth were prone to have psychological problems, and 14.4% showed PTSD symptoms. Even in the home-quarantined college students, PTSD and depression prevalence were found to be 2.7 and 9.0%, respectively, followed by situations like sleep durations (Tang et al., 2020a). PTSD symptoms often come out 1–6 months after the triggering event. Delayed-onset PTSD, nonetheless, may be easily overlooked and diagnosed over 6 months after the traumatic event or termination of a long-term exposure (Utzon-Frank et al., 2014), and as college students are relatively unstable both physically and mentally, and they are facing some stressors, which are new for them, without enough family supports compared to high school, they are a group which might be easy to get PTSD symptoms or even get delayed-onset PTSD (Read et al., 2011; Ahmad et al., 2018). The study conducted by Fu et al. (2013) found that at one year after the Wenchuan earthquake in China, the PTSD rate in college students in the affected area was relatively higher.

Social support and anxiety levels were found to be negatively correlated during the COVID-19 epidemic (Cao et al., 2020). The previous research results of our research group also suggested that the main appeal of medical students and medical researchers to relieve high pressure is to resume normal scientific research and learning activities as soon as possible (Zhang et al., 2020b). In order to further analyze the situation and possible causes of PTSD after six months of the COVID-19 outbreak, we thus conducted a further questionnaire survey to judge the long-term impact of the epidemic on the student's mental health. We designed this experiment in order to demonstrate the prevalence and symptoms of delayed-onset PTSD during the COVID-19 pandemic, providing relevant data and effective coping strategies for schools and health departments that may prevent delayed-onset PTSD among college students. It may help to provide a new perspective for schools to prevent students from developing delayed-onset PTSD and help students to better adjust themselves.

MATERIALS AND METHODS

Study Participants

A questionnaire was distributed to both Chinese students who study at home and abroad to recruit an opportunity sample, the duplicated entries are not allowed, and each IP can answer only once. All respondents were asked to answer each question on their own. The targets of the questionnaire were identified as "Chinese students both study at home and abroad," including four types: 1) overseas students who are still abroad (including visiting scholars), 2) overseas students who have returned to China (including visiting scholars), 3) Chinese students who studied in China (have been back to university once), and 4) Chinese students who studied in China (never been back to university during pandemic).

Data Collection

Data were collected by a convenience sample method between July 31 and August 9, 2020. Questionnaires were distributed to college students (mainly medical major, as well as other majors), international students, and visiting scholars with Chinese nationalities through WeChat or QQ (the most commonly used mobile applications among Chinese), and they were asked to join anonymously to complete the questionnaire. At the end of the questionnaire, question No. 6 was repeated. If the respondents show different answer in these two questions, their questionnaires would have been excluded. A total of 344 survey copies were collected, and 319 valid questionnaires were recovered. All participants provided written informed consent. It is not required by our institution to obtain ethical approval for a survey with a non-clinical sample and anonymized data, but we did obtain approval for the study protocol from the Institutional

Review Board (Ethics Committee) of the Third Xiangya Hospital of Central South University (20005-IRB).

Questionnaire

Impact of Event Scale-Revised (IES-R)

The PTSD symptoms during the 6-month period following the COVID-19 outbreak were measured by IES-R (Beck et al., 2008). The IES-R has 22 items, each with a Likert scale rating from 0 to 4. The total score has a range of 0–88. The IES-R has been translated into and validated in Chinese (Chong et al., 2004). A score of 20 or more was interpreted here—as suggested by previous studies of populations affected by traumatic events (Hawryluck et al., 2004)—to indicate a high level of PTSD symptoms.

Simplified Coping Style Questionnaire

The coping strategies were measured by SCSQ (Sun et al., 2019). The SCSQ, based on the Ways of Coping Questionnaire (YN, 1998; Wang et al., 2020), is a 20-item instrument consisting of two subscales, positive coping (12 items) and negative coping (eight items). Each item of the SCSQ was ranked on a 4-point Likert scale ranging from 0 point to 3 points. The SCSQ had adequate content validity, internal consistency, and test–retest reliability in Chinese.15 In this study, Cronbach's alpha of the positive coping and negative coping was 0.904 and 0.877, respectively.

Social Support Rating Scale

Social support was measured by SSRS (Xiao et al., 2020). The SSRS was developed by Xiao et al. with an acceptable validity and reliability (SY, 1994). The SSRS is a 10-item instrument consisting of three subscales, objective social support (three items about living conditions in the past year, problem-solving channels in emergency situations, and sources of psychological comfort in the event of stress or resistance), subjective social support (four items about relationship with colleagues, relationship with neighbors, number of friends who can offer assistance, and level of support from family members), and support utilization (three items about the way one talks when in trouble, the way one asks for help when in trouble, and participation in group activities). Higher scores indicate higher levels of social support. In the present study, Cronbach's alpha of the three subscales ranged from 0.678 to 0.756.

Demographic Characteristics and Self-Made Questions

Data such as gender, age, educational attainment, and school locations were collected. Questions No. 6 and 7 aimed at investigating what facts stress students the most. Question No. 19 was the same as the No. 6 to simply test the internal consistency of the questionnaire. Two open questions have been included to collect respondent's individual ways of coping stress and what other support they need to release stress.

Statistical Analysis

First, we described the data using numbers and percentages to demonstrate the demographic characteristics of respondents. Second, the means, standard deviations (SD), and ranges of the IES-R items have been used for continuous variables and proportions for categorical variables. We then conducted the *t*-test to contrast the difference between student's PTSD in different situations. Third, the logistic regressions have been used to explore the association between student's PTSD symptoms and the coping strategies they used. Fourth, we did correlation between the student's social support and coping strategies to dig out the connection between them.

Questionnaire results were summarized from the imported Excel file and analyzed using SPSS version 18.0 software. A p value less than or equal to 0.05 was considered statistically significant.

RESULTS

Basic Information

319 valid questionnaires from 344 respondents were received in our study, and 79.94% of the subjects were aged between 18 and 24 years. The age distribution is broadly consistent with the educational background, which suggests that the majority should be undergraduates or master candidates, the rest being PhD, postdocs, or visiting scholars. 85.90% of the respondents were domestic students, while 14.11% were overseas. Among the 45 overseas students, 91.11% were studying in North America and Europe. The specific information of the respondents is shown in **Table 1**.

The Stressful Factors of the National and International Students

Three main factors were considered by students to possibly stress them (**Figure 1**). The top one factor was "COVID-19 has seriously disrupted my study and work," with 284 of 319 (89.03%) respondents regarding it stressful.

There are 45 respondents who studied international. 33 of 45 respondents reported "it is difficult to buy a ticket back to China" (**Figure 2**). 60% international students worried about the attitude and measures taken by foreign governments to fight against COVID-19, in which 60% students studied in North America. The following factor is the attitude' change toward Chinese students while abroad (20 of 45). But only 35.56% respondents felt stressful from the sudden suspension or closure of schools or research institutions.

The Persistence of Delayed-Onset PTSD Symptoms in Students

After 6 months of the outbreak, the average score of the population's PTSD level was 21.411 (full mark, 88 points), which is more than 20, can be indicating a total high level of PTSD symptoms. 168 of 319 respondents scored more than 20 points. Moreover, 22 respondents scored more than 44 points, which can be identified as severe PTSD symptoms. In the avoidance part, the average score of students was 8.295 points

TABLE 1 | Demographic characteristics of respondents.

Characteristics		N	%
Age (years), *n* = 319	≥18 and <24	255	79.94
	≥24 and <35	60	18.81
	≥35 and <40	3	0.94
	≥40	1	0.31
Gender	Male	123	38.56
(*n* = 319)	Female	196	61.44
Education background	Undergraduates	190	59.56
	Master candidate	80	25.08
(*n* = 319)	PhD candidate	45	14.11
	Post-doctorate candidate	4	1.25
Situations during pandemic	Overseas students who are still abroad (including visiting scholars)	22	6.9
	Overseas students who have returned to China (including visiting scholars)	23	7.21
(*n* = 319)	Chinese students who studied in China (have backed to university once)	82	25.71
	Chinese students who studied in China (never backed to university during pandemic)	192	60.19
Location of overseas students	Asian	1	2.22
(*n* = 45)	The North American	24	53.33
	The European (including Russia)	17	37.78
	Oceania	3	6.67
	Others	0	0

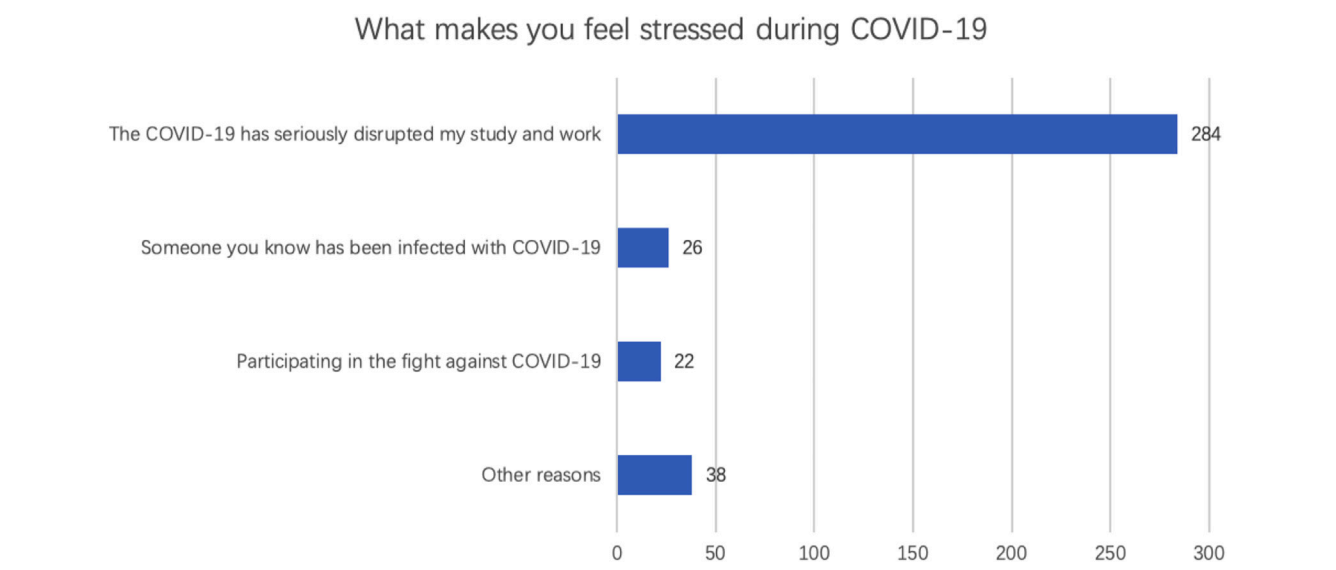

FIGURE 1 | Stressful factors of the national and international students (*n* = 319).

(full mark, 32 points), which is relatively higher than that of other two dimensions. Item 1 in the intrusion dimension got the highest mean score (1.519 score), followed by 1.408 in item 5 (**Table 2**).

Analyzing and comparing Chinese students who have been back to school during the pandemic or not (**Table 3**), it showed that the students who had never been back to their universities during the pandemic got more serious PTSD symptoms (21.95 ± 14.79), and there were statistical differences between these two groups in the hyperarousal dimension (p = 0.016). We did not report the IES-R ANOVA analysis other than these two groups in which there was no significant difference.

The Coping Strategies for the COVID-19 Pandemic

The original SCSQ has divided all the coping strategies to positive and negative sections. The items are listed in **Table 4**. The median of item "I tried to get away from it by eating, drinking, smoking, using drugs or medicine, *etc.*" is 0. 56.1% respondents reported never use this way to cope with stress.

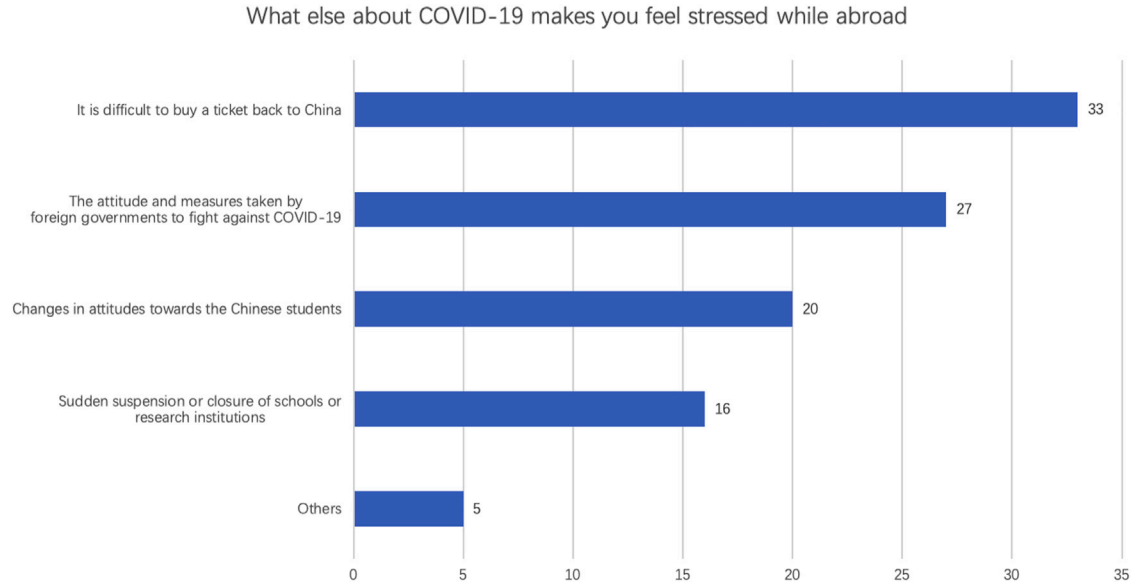

FIGURE 2 | Special stressful factors of the international students (n = 45).

TABLE 2 | IES-R items of the respondents (n = 319).

Items	Range	Mean	SD
Intrusion	0–32	8.016	5.607
1. Any reminder brought back feelings about it	0–4	1.589	0.950
2. I had trouble staying asleep	0–4	0.865	0.957
3. Other things kept making me think about it	0–4	1.113	0.948
6. I thought about it when I didn't mean to	0–4	1.078	0.943
9. Pictures about it popped into my mind	0–4	0.972	0.953
14. I found myself acting or feeling like I was back at that time	0–4	0.821	0.863
16. I had waves of strong feelings about it	0–4	0.887	0.921
20. I had dreams about it	0–4	0.690	0.866
Avoidance	0–32	8.295	5.997
5. I avoided letting myself get upset when I thought about it or was reminded of it	0–4	1.408	1.112
7. I felt as if it hadn't happened or wasn't real	0–4	0.900	0.956
8. I stayed away from reminders about it	0–4	0.834	0.898
11. I tried not to think about it	0–4	0.956	0.983
12. I was aware that I still had a lot of feelings about it, but I didn't deal with them	0–4	0.978	0.976
13. My feelings about it were kind of numb	0–4	1.480	1.129
17. I tried to remove it from my memory	0–4	0.856	0.920
22. I tried not to talk about it	0–4	0.884	0.988
Hyperarousal	0–24	5.100	4.327
4. I felt irritable and angry	0–4	1.041	0.922
10. I was jumpy and easily startled 15. I had trouble falling asleep	0–4	0.715	0.826
15.I had trouble concentrating	0–4	0.765	0.927
18.Reminders of it caused me to have physical reactions, such as sweating	0–4	1.085	1.004
19. trouble breathing, nausea, or a pounding heart	0–4	0.621	0.815
21. I felt watchful and on guard	0–4	0.875	1.005
Total	0–88	21.411	15.016

The whole coping strategie's list can explain the 24.4% students have the PTSD trend. We identified three coping strategies (**Table 5**) which influenced the respondent's PTSD symptoms. In the list of positive items, it showed that the more one made a plan and followed it in one's daily life, the less PTSD one would have ($t < 0$ and $p = 0.033$). The item in the negative coping strategies, if you kept refusing to think anything about COVID-19, the PTSD situation might get worse ($t > 0$ and $p = 0.001$). However, the item "I confided my troubles to my family, friends, or colleagues," which in the positive coping strategies list, also had positive correlation to the PTSD level ($t > 0$ and $p = 0.007 < 0.005$). This result might be related to the special "stay home" policy implemented in China.

TABLE 3 | The comparisons of PTSD between Chinese students who has been back to school during pandemic or not.

IES-R	Chinese students who studied in China (means ± SD)		t	p
	Back to university once (*n* = 82)	Never back to university during pandemic (*n* = 192)		
Avoidance	7.06 ± 5.81	8.49 ± 6.01	−1.827	0.069
Intrusion	6.91 ± 5.01	8.15 ± 5.56	−1.735	0.084
Hyperarousal	3.99 ± 3.90	5.30 ± 4.20	−2.42	0.016*
Total scores	17.96 ± 13.81	21.95 ± 14.79	−2.082	0.038*

*p < *0.05* **p < *0.01*

TABLE 4 | The coping strategies of the respondents (*n* = 319).

Coping strategies	Range	Means	SD	Median
Positive	0–3	1.985	0.652	2
I tried to make myself feel better by working, studying, etc.	0–3	1.912	0.843	2
I asked advice from a relative, friend or classmate	0–3	1.774	0.860	2
I tried to look on the bright side of things	0–3	2.128	0.767	2
I changed something about myself	0–3	2.000	0.834	2
I didn't take it too seriously	0–3	2.044	0.820	2
I made a plan of action and followed it	0–3	2.069	0.774	2
I found new faiths to solve the problem	0–3	2.007	0.794	2
I confided my troubles to my family, friends or colleagues	0–3	1.920	0.865	2
I changed or grew as a person in a good way	0–3	1.934	0.748	2
I drew on others experiences in the similar situation	0–3	1.912	0.751	2
I tried to make myself feel better by engaging in hobbies, leisure activities, and recreation	0–3	1.916	0.875	2
I tried to keep my feelings (e.g., sadness and anger) to myself	0–3	1.865	0.864	2
Negative	0–3	1.369	0.622	1
I tried to get away from it for a while by resting or taking vacation	0–3	1.883	0.835	2
I tried to get away from it by eating, drinking, smoking, using drugs or medicine, etc.	0–3	0.639	0.900	0
I was waiting for time to change the situation	0–3	1.551	0.957	2
I refuse to think too much about it	0–3	0.821	0.934	1
I relied on others to solve the problem	0–3	1.077	0.811	1
I accepted this situation because there is nothing I can do to change it	0–3	1.679	0.881	2
I had fantasies or wishes about how things might turn out	0–3	1.084	0.920	1
I went along with fate, sometimes I just have bad luck	0–3	1.766	0.867	2

The Relationship Between Student's Tendency to Take Positive Measures and Social Support

According to **Table 6**, there is a significant correlation between social support and coping strategy students choose. In particular, the three dimensions of objective social support, subjective social support, and support utilization were positively correlated with the level of positive measures students chose to take ($p < 0.05$). There were also differences in social support between domestic students and overseas students (**Table 7**). The total scores of domestic students (27.07 ± 4.13) were higher than those of foreign students (25.13 ± 4.87), and the scores of objective social support, subjective social support, and support utilization of domestic students are, respectively, higher than the latter.

DISCUSSION

The average score of delayed-onset PTSD in our respondents was high, and in complex stressors for students, most respondents reported "COVID-19 has seriously disrupted my study and work" was stressful. The students who have been back to universities during the pandemic got less score in the hyperarousal dimension of IES-R. After testing the regressions between coping strategies and respondent's PTSD symptoms, our study finds that the best coping strategy is to do planning and manage their life during the pandemic, and there was a significant correlation between social support and the coping strategies students chose.

Delayed-onset PTSD is a real and potentially sizable problem that could easily be overlooked if one only focused on the first one to three months after the outbreak (Andrews et al., 2007). Andrews et al. (2009) found that the delayed onsets were more likely to report the presence of severe stressor before onset than the immediate-onset PTSD. At the beginning of the COVID-19 outbreak, college students were facing complex stressors according to our investigation, including but not limited to the new online study systems, the delay of their research, and home quarantine policy. Thus, the PTSD symptoms caused by COVID-19 cannot be recognized but attributed to other pressure. As time goes by, the students did not recover from the anxiety but reveal more relevant PTSD

TABLE 5 | The regressions between coping strategies and respondent's PTSD symptoms.

	Unstandardized coefficient		Standardized coefficient	t	p	VIF	R^2	Adjusted R^2	F
	B	SE	ß						
Constant	14.125	3.091	–	4.569	0.000**	–	0.242	0.182	F (20,253) = 4.029, P< 0.05
I tried to make myself feel better by working, studying, etc.	0.391	1.307	0.023	0.299	0.765	1.9			
I confided my troubles to my family, friends or colleagues	3.557	1.307	0.21	2.722	0.007**	1.978			
I tried to look on the bright side of things	0.727	1.609	0.038	0.452	0.652	2.383			
I changed something about myself	–2.313	1.584	–0.132	–1.461	0.145	2.734			
I didn't take it too seriously	–1.703	1.387	–0.096	–1.228	0.221	2.025			
I made a plan of action and followed it	–3.369	1.572	–0.179	–2.143	0.033*	2.321			
I found new faiths to solve the problem	0.864	1.774	0.047	0.487	0.626	3.103			
I confided my troubles to my family, friends or colleagues	–0.415	1.354	–0.025	–0.306	0.76	2.147			
I changed or grew as a person in a good way	1.474	1.638	0.076	0.899	0.369	2.353			
I drew on others experiences in the similar situation	–0.764	1.651	–0.039	–0.463	0.644	2.407			
I tried to make myself feel better by engaging in hobbies, leisure activities, and recreation	–0.943	1.405	–0.057	–0.671	0.503	2.369			
I tried to keep my feelings (e.g., sadness and anger) to myself	0.37	1.315	0.022	0.282	0.778	2.023			
I tried to get away from it for a while by resting or taking vacation	2.312	1.258	0.132	1.838	0.067	1.726			
I tried to get away from it by eating, drinking, smoking, using drugs or medicine, etc.	0.948	1.118	0.058	0.848	0.397	1.586			
I was waiting for time to change the situation	–0.67	1.095	–0.044	–0.612	0.541	1.718			
I refuse to think about it	4.136	1.177	0.265	3.514	0.001**	1.893			
I relied on others to solve the problem	–0.587	1.295	–0.033	–0.453	0.651	1.724			
I accepted this situation because there is nothing I can do to change it	0.12	1.163	0.007	0.104	0.918	1.643			
I had fantasies or wishes about how things might turn out	1.71	1.143	0.108	1.495	0.136	1.733			
I went along with fate, sometimes I just have bad luck	1.785	1.209	0.106	1.476	0.141	1.719			

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

TABLE 6 | Correlations between social supports and coping strategies of the participants (*n* = 319).

	Mean	SD	Positive coping	Negative coping
Subjective social support	8.276	1.717	0.169**	0.113*
Objective social support	9.715	2.268	0.242**	0.023
Support utilization	8.803	1.536	0.282**	0.181**
Total scores	26.793	4.288	0.302**	0.122*

*p < *0.05* **p < *0.01*

TABLE 7 | Comparison of social supports between oversea students and students who study in China.

	Students (Mean ± SD)		t	p
	Overseas students (*n* = 45)	Domestic students (*n* = 274)		
Objective social support	7.36 ± 1.80	8.43 ± 1.66	–3.968	0.000**
Subjective social support	9.31 ± 2.26	9.78 ± 2.27	–1.29	0.198
Support utilization	8.47 ± 1.83	8.86 ± 1.48	–1.586	0.114
Total scores	25.13 ± 4.87	27.07 ± 4.13	–2.832	0.005**

*p < *0.05* **p < *0.01*

symptoms (Chi et al., 2020). Our study shows high to moderate levels of PTSD among college students 6 months after the COVID-19 outbreak, while one month after the outbreak, the PTSD prevalence was found to be low according to Tang et al. (2020b). On the one hand, universities in China generally prohibited students from returning universities, which prolong the student's home time. Our research showed that, compared to those students who have been back to school, those who have

never been back had severe PTSD. Henderson and Redshaw (2017) described the negative effects of long-term staying at home for women, including confusion, anger, resentment, and feeling neglected, unsupported, and anxious. We thought the same mental situation was happening on students who have never been back to school during the pandemic 6 months after the outbreak. On the other hand, the disruption to student's study caused by COVID-19 is the top one reason which made all of our candidates feel stressful and anxious. Some universities in China adopt the form of online course teaching, but online education still has some limitation. For example, the internship and the laboratory work for some students majored in medicine or biology have been limited or canceled. Especially for students in the graduation grade, they might need to face the pause or change of their research progress for graduation, which makes them stress a lot (Araz Altay et al., 2020).

For overseas Chinese students, there are some special stressful reasons that occurred, including the shortage of tickets back to China, the different attitude and measures taken by foreign governments, and the change of local's attitude toward them. These long-term persistent stress factors contribute to the overseas student's PTSD as they can hardly leave the country where COVID-19 broke out seriously in a timely manner. How to live through a long period of isolation and how to protect themselves from the virus have become a survival problem for many overseas students.

To help investigate the useful coping strategies for students to alleviate the PTSD symptoms, we asked candidates to evaluate their coping strategies by SCSQ. The action "I made a plan of action and followed it" is also positive to decrease the PTSD. It gave students one more reason to manage their life and do planning. As we all know, the social life and frequent contact with family members are necessary for college students to release pressure. However, in this study, we find that those students who confided their troubles to the family, friends, or colleagues more responded more PTSD symptoms. First, the stress caused by the pandemic is not a personal trouble, it related to everyone. Yuan et al. found that there is a general increase in people' anxiety. When students confided it to the people around, they might get some new stressors instead of being well comfort (Yuan et al., 2020). Second, people have been encouraged to be indoors to prevent virus during the pandemic, which largely increase the family time. For some families, it might tense the family and make everyone anxious. From the college's point of view, we suggest the emphasis on teaching students to balance their social network. Most of the time, confiding the troubles to the family, friends, or colleagues is useful to keep mental health, but students also need to know how to cheer up themselves and people around when general anxiety happened. Karyotaki et al. (2019) mentioned that college students experience a variety of stressors (e.g., exams, living away from family, and financial hardships), which make them prone to mental disorders. As a result, the strategies mentioned above can not only be useful in decreasing PTSD caused by the COVID-19 outbreak but also be consistently used in students' daily life.

We also find that the objective social support is negatively correlated with the PTSD of students. Objective social support focus on the direct material assistance and the presence and participation of social networks and group relationships. Compared to domestic students, overseas Chinese students usually get less objective social support as they are far away from homeland and live by themselves. Back in 2008, Xu et al. demonstrated that when students face the catastrophic earthquake emergency, effective coping strategies can help to protect students' mental health (Xu and He, 2012). In a cross-sectional and longitudinal study of veterans, Matthew et al. found that social support moderated changes in PTSD symptoms, underscoring the important link between social support and symptom improvement during PTSD treatment (Price et al., 2018). On this basis, the impact of social support on the individual becomes particularly important. We suggest the international students to strengthen their subjective social support and support utilization, like creating more chances to feel been respected and supported like doing more volunteer work, contacting their close friends or families, and finding their interests. These are all consistent with our experimental results.

The study has several limitations. First, the opportunity sampling method has been used to select participants from a target group. It is a popular technique, especially among researchers who may have limited resource (like the quarantine strategy in COVID-19 provides us less chance to select a truly random sample). The downside of this method is that the researches may end up with biased results. Second, the COVID-19 outbreak burst not at the same time worldwide, which might cause the delay of the delayed-onset PTSD in overseas students. It is better to evaluate overseas student's delayed-onset PTSD again after 6 months, and the tendency of students to take negative behaviors is also correlated with the degree of social support to some extent, which may result in the unclear definition of negative coping measures in the items of the scale. Third, the limitation of network-based questionnaire survey is that most questionnaires are spread spontaneously in the circle of friends. There is a certain possibility that the psychological changes of people who share the circle of friends may influence each other, leading to the convergence of psychological states presented in the survey. Although we have made the limitation of questionnaire fillers, its coverage is still limited compared with the paper questionnaire we made in the past. In the next experiment, if we try to further explore the correlation between negative behaviors and social measures, it is better to redefine and re-list negative coping measures in a more detailed and clear way.

CONCLUSION

College students show high to moderate levels of delayed-onset PTSD for 6 months after the COVID-19 outbreak. The long-term disruption of the study process is a main reason to student's delayed-onset PTSD. Our study finds that the best coping strategy is to plan and manage their life during the pandemic. The results show that social support is negatively correlated with the PTSD of students. We suggest colleges emphasize the social support

education since the first year of students, and for overseas students, they now might still face an uncontrolled outbreak in other countries and some special stressors, like the lack of back-home ticket and the local's changing attitude toward Chinese. The useful coping strategies and powerful social supports are significantly important to help them stay mentally healthy and alleviate delayed-onset PTSD caused by the COVID-19 outbreak.

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 Institutional Review Board (Ethics Committee) of the Third Xiangya Hospital of Central South University (20005-IRB). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ZL and XZ: investigation and original draft writing; YW, TW, and XL: analysis and methodology; MZ and QZ: supervision, review/editing, project administration, and funding. All authors have read and agreed to the published version of the manuscript.

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Anxiety and Stress Levels Associated With COVID-19 Pandemic of University Students in Turkey: A Year After the Pandemic

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The outbreak of COVID-19 has been affecting the daily lives of almost everyone and puts huge psychological pressure on people worldwide, including Turkey. Anxiety and stress levels among university students were already a public health concern. Our study aims to demonstrate the anxiety and stress levels of university students in Turkey after the outbreak of COVID-19 according to the Coronavirus Anxiety Scale (CAS) and COVID Stress Scale (CSS). CAS is a brief mental health screener to identify probable cases of dysfunctional anxiety associated with the COVID-19 pandemic, and CSS was developed to understand and assess COVID-19-related distress. An online questionnaire was administered to active 1,265 university students in Turkey between February 27 and March 8, 2021, *via* Google forms. The questionnaire consists of three parts that assess participants' demographic information, anxiety, and stress levels related to the pandemic. According to CAS and CSS analysis, anxiety and stress levels were associated with each other and influenced university students during the COVID-19 pandemic. Both were associated with gender and family member loss. The academic year of students had a relationship with anxiety. It was observed that the danger factor was the highest stressor in university students in Turkey related to the novel coronavirus, followed by contamination fears. Both factors were shown as moderate stressors. As a result of the study, it was revealed that anxiety and stress associated with the COVID-19 pandemic are now included in the social, academic, and physical burdens of the university years, which are decisive and important in terms of mental development and psychological health of the person. It is essential to ascertain the long-term effects of COVID-19 and take effective precautions to support the physical and mental health of today's university students accordingly.

Keywords: COVID-19, coronavirus, pandemic, anxiety, stress, university, students, young adults

INTRODUCTION

SARS-CoV-2, now called COVID-19 after its appearance in Wuhan, China in December 2019, is a novel member of the coronavirus family (1). The outbreak of COVID-19 has been affecting the daily lives of almost everyone, especially after the declaration of a global pandemic by the World Health Organization (WHO) in mid-March 2020 (2). The first case of COVID-19 in Turkey was announced on March 10, 2020 (3), and the first death occurred on March 17, 2020 (4). In response to the COVID-19 pandemic, the Turkish Government took a series of preventions to slow the spreading of the disease down, and pausing the countrywide higher education was one of them. Educational activities in all universities were suspended on March 18, 2020 (5). On March 26, 2020, the Turkish Higher Education Council decided that education in universities would be carried out *via* distance and digital learning, i.e., no in-person instruction was to happen (6). On August 13, 2020, the Turkish Higher Education Council announced that education in universities would continue to carry out mainly online after October 1 (7). On December 30–31, 2020, 3 million doses of vaccine that came to Turkey were received and the 14-day safety trials of the Turkish Medicines and Medical Devices Agency (TITCK) began (8). Then, the vaccination schedule was announced, and healthcare workers and older people started to be vaccinated. While the vaccination schedule continued, the controlled normalization process started on March 1, 2021. Although approximately 9 million people were vaccinated, the number of daily cases continued to increase day by day in March (9).

The evolution of COVID-19 has placed enormous stress on healthcare, economic, and social systems in Turkey, as well as in the world (10, 11). In addition to the risk of infection and possible death, the pandemic put huge psychological pressure on people worldwide (12–15). Several studies have discussed the short- and long-term effects of the pandemic on the social and psychological health of the world (15–17). These side effects may depend on the mental health outcomes for people who get infected directly by COVID-19 (18) or be related to preventions (19) and the socio-economic impacts (10).

Anxiety and stress levels among university students are already a public health concern. Uncertainty and worries because of the pandemic made the mental health of the university students worse. Many studies have been added to the literature investigating the relationship between university students and their stress and anxiety levels during COVID-19. Studies investigating stress and anxiety levels have been conducted among university students in China, France, Poland, Bangladesh (20–23), Saudi Arabia (24), and Jordan (25). Also, stress and anxiety levels of medical and non-medical students have been examined in United Arab Emirates (26) and Iran (27). In Pakistan, a study investigated the anxiety and depression of healthcare professionals, medical students, and the general population during the COVID-19 pandemic (28). According to the number of total and new COVID-19 cases founded, Turkey is one of the top 10 countries in the world (29); however, there are only a few numbers of studies emphasizing this connection in the literature (30–33). Furthermore, these studies have been conducted with a limited number of participants (34) and within very specific student groups (such as only medical students included) (32, 33) compared to similar studies in the world (20–28).

Our study aims to demonstrate the significant relationship between the anxiety and stress levels of university students in Turkey and the outbreak of COVID-19 according to the Coronavirus Anxiety Scale (CAS) (34) and the COVID Stress Scale (CSS) (35). Our study also aims to follow up on anxiety and stress levels after the first year of the pandemic. We hypothesize that anxiety and stress levels of university students in Turkey would be associated with the effect of the pandemic directly. According to the possible results, we can reflect the anxiety and stress levels of the Turkish university students in the most realistic way possible; thus, precautions to minimize their anxiety can be taken early and effectively for the future.

MATERIALS AND METHODS

Ethical Considerations

This study was approved by the T.C. Ministry of Health (on February 21, 2021) and the Acibadem University Medical Research Ethics Committee (Protocol Code: ATADEK 2021 04/27). On the first page of the questionnaire, there is informed consent to the participants explaining the purpose of the study and anonymity of their responses.

Study Design and Participants

Our study was conducted between February 27 and March 8, 2021. The questionnaire created *via* Google forms was used as the data collection tool for the study. Participants should be actively enrolled in Turkish universities. Not giving informed consent, not having a university education in Turkey, or having a break from university education are exclusion criteria. The questionnaire link was sent to participants *via* social media tools. Also, participants were asked to send the questionnaire link to other acquaintance university students to reach more participants from different universities. A total of 1,265 university students from 119 different universities located in 44 different cities in Turkey have participated in the study. The questionnaire was in the Turkish language; it consists of three parts and a total of 62 questions. Participants had to answer all the questions at the second and the third part of the questionnaire to submit the form and therefore to be included in the study. Moreover, participants who completed the second and the third part of the questionnaire but did not answer particular questions about background information were excluded for only the questions that they did not answer.

Questionnaire

Demographic/Background Information

The first part asked about the participants' gender, age, which university, faculty, and the year they are enrolled in, their smoking and drinking habits, their psychological and psychiatric well-being, any prescribed drugs they are using, where they were living before the pandemic, and where they are living now.

Stress Scale

In the study, the Turkish version of the CSS (36) developed by Steven Taylor et al. consisting of 36 questions on five dimensions (danger and contamination, economic consequences, xenophobia, traumatic stress symptoms, and compulsive checking) was used to evaluate the stress levels of the participants. The question was rated on a five-point scale ranging from 1 (Not at all) to 5 (Extremely). The sum of the scores for 36 items ranges from 0 to 144. Total scores of 0–47 are considered as low stress level, 48–96 as medium stress level, and 97–144 as high stress level.

Anxiety Scale

In the study, the Turkish version of the CAS was used to determine the participants' anxiety levels. It is developed by Lee S.A. and adapted to Turkish by Biçer et al. (37). The scale consists of five items in total. Participants were asked to reply to each question, which is scored on a five-point Likert-type scale (1 = Not at all, 2 = Rare, less than a day or two, 3 = Several days, 4 = More than 7 days, 5 = Nearly every day over the last 2 weeks). The sum of the scores for five items ranges from 0 to 25. Total scores of 0 to 9 are considered as normal and scores of 10–25 are considered as anxiety.

Statistical Analysis

The data were analyzed using Microsoft Excel (2019). The fitness of the distributions of the variables to the normal distribution was tested with the Shapiro–Wilk Test. $P < 0.05$ was chosen to demonstrate statistical significance. Numbers, percentages, mean, and standard deviation were used as the descriptive statistics for the population. Categorical variables were compared by using the chi-squared test. The multivariate regression analysis was utilized to determine the effects of attributable demographic factors on anxiety and stress.

RESULTS

A total of 1,265 students, from 119 universities, which were from 44 different cities of Turkey, participated in the online survey. A total of 245 students were excluded because they did not meet inclusion criteria. Of the total participants, 646 (63.34%) were female and 372 (36.47%) were male. Their ages were between 16 and 38 (21.06 ± 2.52). The rest of the demographics of the participants are presented in **Table 1**.

According to CAS analysis, 139 (13.63%) participants had anxiety related to the COVID-19 pandemic. However, the rest of them (86.37%) did not. Besides, participants' stress levels were also assessed according to CSS. CSS was a five-point Likert scale, and the results were divided into three groups as "low," "medium," and "high" for interpretation. Although 78 participants (7.65%) were classed as "low," 406 (39.80%) of them had "high" stress levels. Nearly half of them (52.55%) showed "medium" level stress related to the COVID-19 pandemic. Furthermore, there was a strong association [$\chi^2_{(2,\ N=1,020)} = 275.38$, $p < 0.001$] between having anxiety and stress level (**Table 2**).

TABLE 1 | Demographic information of participants.

	Number of students [*n* (%)]*
Gender	
Male	372 (36.5%)
Female	646 (63.3%)
Age (years)	
<18	6 (0.6%)
18–21	617 (61.2%)
22–25	355 (35.2%)
26–29	23 (2.3%)
> 29	7 (0.7%)
Smoking	
Yes	153 (15%)
No	867 (85%)
Alcohol Drink	
Regularly	28 (2.7%)
Socially	389 (38.1%)
Never	599 (58.7%)
Chronic Disease	
Yes	86 (8.4%)
No	925 (90.7%)
Prescription Drugs	
Yes	158 (15.5%)
No	856 (84%)
Mental Disorder	
Yes	224 (22%)
No	791 (77.5%)
COVID-19 Contact	
Yes	630 (61.8%)
No	382 (37.5%)

The total number of valid participants is 1,020. The difference between the total number of participants and the actual number of participants in each subgroup in the table is equal to the number of participants who did not answer that question.

TABLE 2 | Results of chi-square tests of anxiety and stress.

Outcomes	Anxiety (+)	Anxiety (–)	Total
High stress	56	22	78
Moderate stress	77	459	536
Low stress	5	400	406
Total	139	881	1,020
	$\chi^2 = 275.38$		$P < 0.001$

The relationship between demographic features of participants and having COVID-19-related anxiety was investigated. The gender (female/male) of participants was strongly associated with COVID-19-related anxiety [$\chi^2_{(1,\ N=1,018)} = 12.69$, $p < 0.001$] (**Table 3**). Additionally, students who lost a family member due to COVID-19 were significantly associated with having COVID-19-related anxiety [$\chi^2_{(1,\ N=1,012)} = 11.09$, $p < 0.001$] (**Table 4**). Furthermore,

TABLE 3 | Results of chi-square tests of gender and anxiety.

Participants	Women	Men	Total
Had COVID-19-related anxiety	107	32	139
Had no COVID-19-related anxiety	539	340	879
Total	646	372	1,018
	$\chi^2 = 12.69$		$p < 0.001$

TABLE 4 | Results of chi-square tests of had lost a family member due to COVID-19 and anxiety.

Participants	Had lost a family member due COVID-19	Had not lost a family member due COVID-19	Total
Had COVID-19-related anxiety	106	33	139
Had no COVID-19-related anxiety	538	335	873
Total	630	382	1,012
	$\chi^2 = 11.09$		$p < 0.001$

TABLE 5 | Results of chi-square tests of the academic year of students and anxiety.

Participants	First grade students	Intermediate grade students	Final grade students	Total
Had COVID-19-related anxiety	59	51	28	138
Had no COVID-19-related anxiety	311	274	289	874
Total	370	325	317	1,012
		$\chi^2 = 9.05$		$p = 0.01$

TABLE 6 | Results of chi-square tests of gender and stress levels.

Participants	Women	Men	Total
High stress	56	22	78
Moderate stress	373	162	535
Low stress	217	188	405
Total	646	372	1,018
	$\chi^2 = 28.42$		$p < 0.001$

TABLE 7 | Results of chi-square tests of had lost a family member due to COVID-19 and stress levels.

Participants	Had lost a family member due COVID-19	Had not lost a family member due COVID-19	Total
High stress	26	52	78
Moderate stress	89	444	533
Low stress	53	352	405
Total	168	848	1,016
	$\chi^2 = 14.68$		$p < 0.001$

TABLE 8 | Mean and standard deviations of different exploratory factors of CSS.

Types of exploratory factors	Mean	Standard deviation
Danger	3.35	0.94
Contamination fears	3.26	1.12
Xenophobia	2.66	1.16
Compulsive checking and reassurance	2.60	0.93
Traumatic stress	1.87	0.89
Fears of socioeconomic consequences	1.80	0.92

COVID-19-related anxiety has a significant association with the participants' year of study [$\chi^2_{(2,\ N=1,012)} = 9.05$, $p = 0.01$] (**Table 5**). No significant association between COVID-19-related anxiety and remaining demographic parameters was determined.

The association between COVID-19-related stress levels and the factors that may contribute to this is also investigated. The gender (female/male) of participants was found to be associated with stress levels [$\chi^2_{(2,\ N=1,018)}$ =28.42, $p < 0.001$] (**Table 6**). Besides, loss of a relative due to COVID-19 infection reveals an association with COVID-19-related stress levels [$\chi^2_{(2,\ N=1,016)}$ =14.68, $p < 0.001$] (**Table 7**). Use of cigarettes and alcohol, the presence of chronic illnesses and psychological disorders, and regularly taking pills are factors that have not been found to be significantly associated with COVID-19-related stress levels.

The factors that have determined exploratory in the CSS scale are investigated (**Table 8**). Six exploratory factors questioned in the scale were; danger and contamination fears of COVID-19, COVID-19 fears about economic consequences, COVID xenophobia, COVID compulsive checking and reassurance-seeking, and COVID traumatic stress symptoms. The average points of the participants and the standard deviations of each relevant question to factors are assessed. COVID-19 danger fears was found to be the highest ($M = 3.35$, $SD = 0.94$), followed by contamination fears ($M = 3.26$, $SD = 1.12$), xenophobia related to COVID-19 ($M = 2.66$, $SD = 1.16$), compulsive checking and reassurance ($M = 2.60$, $SD = 0.93$), traumatic stress ($M = 1.87$, $SD = 0.89$), and fears of socioeconomic consequences ($M = 1.80$, $SD = 0.92$).

DISCUSSION

Our study indicated that anxiety and stress are related to each other. People who have higher anxiety levels are also having higher stress levels on the scales. This finding is compatible with previous studies (38–40). In addition, anxiety and stress levels are dependent on gender. We found that the points of anxiety and stress are significantly higher in women than in

men. This presents that the psychiatric burden of the COVID-19 pandemic may be greater in particular groups. In our study, we found that anxiety prevalence Rates in males and females are 8.60 and 16.56%, respectively. These rates are relatively higher than other types of anxiety prevalence in former studies (41). This is expected as lockdowns, social and economic restrictions, and rapid changes to online implementations might be regarded as significant stressors for university students. COVID-19 is a traumatic factor that threatens people and their beloved relatives' lives and therefore affects community health physically and emotionally. Besides, females are found with significantly higher COVID-19 prevalence rates. Also in literature, women persistently exhibited higher prevalence rates, as high as two times, for other types of anxiety disorders (42, 43).

In our study, we showed that anxiety and stress levels are associated with losing a family member due to COVID-19. Students who had lost a family member probably are feeling depressed due to their loss and concerned that they have to experience the same situation again, which may lead to anxiety and stress (30, 32). Additionally, there is an association between anxiety and the year of study of the participants. This relationship is probably due to the uncertainty created by the pandemic. Younger students are in a new environment and do not know how long this condition will last exactly. On the other hand, older students may worry about their post-graduate work problems. Moreover, students are not on campuses, and they are taking their classes online. Online classes are a new approach for all students in Turkey and this might also cause anxiety in students (32, 39, 44, 45).

Unlike previous studies conducted in our country, we did not find any significant relationship between anxiety/stress levels and other potential factors such as smoking, alcohol, chronic disease, psychiatric problem, and clinical internship (30, 32). The high density of young participants in this study may be the reason for the difference with previous studies about COVID-19. The fact that young people will catch the disease relatively less and experience a milder illness may explain the unrelated situation between COVID-19-related anxiety/stress and attributable risk factors compared to the general population (46). Our study was conducted nearly 1 year after the pandemic, and thus, this fact may influence participants. Students are more aware of the pandemic and its risk factors and have more mental problems primarily due to limitations and restrictions in the country.

University students are a risk group for mental health disorders with high rates of psychiatric morbidity, primarily depression, and anxiety (47). Prevention and reduction of mental problems in university students are essential to support community health because this period is regarded as a sensitive period of a person's life in terms of psychosocial development (48). Research shows that already before the pandemic, undergraduate students show moderate to moderate-high stress (45, 49). In our study, we examine COVID-19-related stress levels using CSS. Low to moderate level stress for different exploratory factors related to coronavirus is shown. The danger factor is found to be the highest, which questioned worries about catching the virus and getting an infection for the person and beloved ones. Contamination fears come second in the order, which is indeed a subtype of obsessive–compulsive symptoms. Recent studies indicated a significant worsening in the severity of obsessive–compulsive disorders especially in terms of contamination (50). Our findings exhibit moderate levels of contamination fears, supposing obsessive–compulsive disorder incidence may have surged during the pandemic period. Together with the pandemic-related issues like social distancing and isolation, which provoked negative senses such as worry, anger, loneliness, and helplessness, xenophobic attitudes pose a danger to individual lives that even lead to suicide cases (51). COVID-19 was expected to negatively impact the global economy as international trade networks are disrupted. Furthermore, consumers stay at home longer, which results in a decrease in their consumption of services and goods and increases in their savings. While social distancing and lockdown measures affect a person's socioeconomic status such as impact labor status and financial income, mental health and well-being, and environmental factors (52–54), in this study, possible socioeconomic consequences and shortages are shown to be the last concern (avg. 1.80 [low-level stress]) of the students. The reason for this may be that besides the risk of losing one's own life or a loved one, the economic threats of COVID-19 seem to be relatively more tolerable.

In the study Akdeniz et al. (30) conducted about a year before our research, they stated that the anxiety levels of their participants were high in the first days of the pandemic, especially about losing a relative due to the pandemic in the future. As they discussed, it was a matter of interest how the concerns created by the atmosphere of uncertainty in those days would be shaped in the future. In our study a year later and in a similar population, it was shown that although the effects of the pandemic were better understood and settled on a more stable basis, the anxiety was still a concern. Besides, Fawaz et al. (55) investigated the relationship between rapid change to online learning implications and the prevalence of depression, anxiety, and stress, and they revealed that this change has negative effects on the mental health of university students. Our results also support these interpretations.

STRENGTHS AND LIMITATIONS

The multi-centered structure of this study is one of its strongest points. Students participated from different years (ages) and majors, from more than half of the total provinces in Turkey; this could successfully reflect university students of Turkey in terms of anxiety and stress levels related to COVID-19. During the distribution process of the questionnaire, great attention and effort were paid to the participation of students from many cities, universities, and different faculties throughout Turkey, and as a result, the opportunity to analyze the results in a wide population and geography emerged. However, the fact that the study had a non-random design and that the distribution of the questionnaire was made by online social platforms may have caused some biases. First, students who had reached the survey link and filled out the survey may have different characteristics

than those who do not. As a concrete manifestation of this situation, it can be put forward that women participate in the study more than men. Moreover, students who are better planned academically and with a high interest in extracurricular academic activities may have participated more in the study. Secondly, the fact that the answers of the participants completely reflected their own personal expressions, i.e., answers are self-reported, may have caused the distortion of some outcomes; for example, the deliberate incorrect expression of the participants using psychiatric medications may deliberately express incorrectly their usage status due to fear of social stigmatization. Measurement errors related to self-reported outcomes should be limited as the names of participants were not demanded, and questions were answered privately, and seen and analyzed by only researchers. In addition, the study may have been insufficient to reveal causality and the designed and analyzed correlation and the subject did not comply with controlled experimental studies in terms of ethics and structural difficulties. For example, it is unclear whether the fear of contamination, which is found at a moderate level in the study, is affected by COVID-19, or whether individuals who already have obsessive predispositions express their disorder with COVID-19.

In conjunction with the fact that this study started 1 year after the beginning of the pandemic in our country, the vaccinated part of the population was growing/expanding day by day, which might not directly reflect the effects on the first days of COVID-19 that is more panicky and ambiguous. This situation can explain the difference in our study compared to others that were conducted in the first days of the pandemic. However, our study reveals important outputs in terms of exhibiting the differences between the studies at the beginning of the pandemic and in the intervening year. The most important factors affecting the stress and anxiety levels in the students in this process are the new approaches in the treatment of COVID-19 and the development of vaccine technologies.

CONCLUSION

In summary, anxiety and stress levels are related to each other and are high in university students during the COVID-19 pandemic. Both are associated with gender and family member loss. The year of study of the students also has a relationship with anxiety. It was observed that the danger factor is the highest stressor in university students in Turkey related to catching the novel coronavirus, followed by the contamination fears. Both factors are shown as moderate stressors. The factor at the lowest level in the stress scale measurements was determined as the socioeconomic factor. As a result of the study, it was revealed that in addition to the social, academic, and physical burdens of the university years, which are decisive and important in terms of the mental development and psychological health of the person, COVID-19 was also incorporated at the present conditions. Maintaining the physical and mental health of today's university students is critical to creating a healthy community structure after COVID-19 (post-COVID era). Therefore, it is important for public health, especially for young adults, to carry out ongoing studies that will continue to monitor the long-term effects of COVID-19, to provide psychological support to university students, and to shape education channels accordingly.

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 Acibadem Mehmet Ali Aydinlar University Medical Research Review Board (ATADEK). 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

AD, HK, CS, and NK designed the study and wrote and revised the manuscript. ÖE supervised the study. HK, CS, and NK organized the database and resources. AD and HK conceived the statistical approach and performed the statistical analysis. All authors approved the submitted version.

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The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2021.731348/full#supplementary-material

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Prevalence and Predictors of Anxiety and Depressive Symptoms Among International Medical Students in China During COVID-19 Pandemic

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Background: The rapid spread of Coronavirus Disease-19 (COVID-19) infection has been the most important public health crisis across the globe since the end of 2019. Anxiety and depression are the most common mental health problems among people during the pandemic, and many studies have reported anxiety and depressive symptoms in college students. However, information on the mental health status of international medical students during this critical period of time has been scarce, which hinders the efforts in making proper policy or strategies to help these students. The present study aims to explore the prevalence of anxiety and depressive symptoms in international medical students in China and to find out the factors that have potential predictive value for anxiety and depressive symptoms.

Method: A cross-sectional study was carried out for international medical students during November 2020 at China Medical University in Shenyang, China. Five hundred and nineteen international students were interviewed with questionnaires containing demographic variables, Stressors in school, Generalized Anxiety Disorder Assessment (GAD-7), Patient Health Questionnaire-9 (PHQ-9), Simplified Coping Style Questionnaire (SCSQ), Perceived Stress Scale (PSS-10), the Multidimensional Scale of Perceived Social Support (MSPSS), Revised Life Orientation Test (LOT-R) and Resilience Scale-14 (RS-14). Univariate logistic regression and stepwise multiple logistic regression analyses were conducted where appropriate to explore the predictive factors of anxiety symptoms and depressive symptoms.

Results: The prevalence of anxiety symptoms and depressive symptoms in the sample population was 28.5% (148/519) and 31.6% (164/519), respectively. Stressors in school ($\beta = 0.176$, OR = 1.192, CI: 1.102–1.289), negative coping style ($\beta = 0.639$, OR = 1.894, CI: 1.287–2.788) and perceived stress ($\beta = 0.230$, OR = 1.258, CI: 1.184–1.337) were found to be the predictors of anxiety symptoms among the international medical students; while gender ($\beta = -0.594$, OR = 0.552, CI: 0.315–0.968), stay up late ($\beta =$

0.828, OR = 2.288, CI: 1.182–4.431), current place of residence (β = 1.082, OR = 2.951, CI: 1.256–6.931), stressors in the school (β = 0.303, OR = 1.354, CI: 1.266–1.496), negative coping style (β = 0.866, OR = 2.377, CI: 1.516–3.725), perceived stress (β = 0.233, OR = 1.262, CI: 1.180–1.351) were found to be predictors of depressive symptoms.

Conclusion: The prevalence of anxiety symptoms and depressive symptoms was moderate among international medical students in China. The communal predictors of anxiety and depressive symptoms were stressors in school, negative coping style and perceived stress; while demographic factors such as gender (male), stay up late at night and current place of residence were found associated with depressive symptoms. These results suggest that proper stress management and specific interventions are needed to help students maintain their mental health during the COVID-19 pandemic period.

Keywords: COVID-19, international medical students, mental health, anxiety symptoms, depressive symptoms, perceived stress

INTRODUCTION

The rapid spread and frequent resurgence of COVID-19 infection have become the most urgent public health issue across the globe since the end of 2019. As of the beginning of August 2021, over 198 million COVID-19 infections were recorded globally claiming the lives of over 4.2 million people (1). World Health Organization (WHO) has announced the COVID-19 outbreak as a pandemic in 2020 (2). In this situation, governments have been encouraged to establish measures to reduce transmission of COVID-19 from person to person, and a wide range of control measures have been implemented (3). In China, the outbreak of COVID-19 happened in early 2020. The Chinese government took strict measures and quickly brought the outbreak under control. In the meantime, the Ministry of Education of China took actions to guide and require colleges and universities to fully launch online teaching and other teaching measures (4). Although the measures adopted during the epidemic have been effective to various extents, they have greatly impacted on all aspects of the population including the mental health across the globe at the same time (5). Many stressors have been identified such as the fear of exposure to infection, worry of family members and loved ones being infected, fear of relative's death, prolonged quarantine, financial strains, limited physical activities, restricted social entertainment, and sense of loneliness, uncertainty and insecurity (5, 6).

Higher education itself for some college students can be a challenge, and many studies have reported a high prevalence of anxiety and depression in students (7, 8). This is especially true for medical students: although a few studies did not find a higher prevalence of mental health problems in medical students (9), more recent studies have reported that medical students experienced more anxiety and depression compared with students of other subjects (10–12). In particular, the conditions of international medical students deserve special attention. One obvious reason is the trans-cultural adaptation issues such as language barrier and cultural differences which sometimes can be stressful to the international students (13). In addition, because of the pandemic of COVID-19, many international students have been stuck in their residential areas or home countries and can only attend online courses which may become difficult due to time differences or internet accessibility problems (14). Furthermore, clinical rotation and clerkship are a crucial part of medical education (15, 16), but in some cases, this becomes unobtainable for some international students. We could anticipate that stress from the above-mentioned sources may result in mental health problems. However, little study has been done in this area.

Several factors are known related to the occurrence of anxiety and depression among students. For example, age, gender, and education levels had significant associations with anxiety/depressive symptoms among students (7, 8, 13, 14). Coping which was defined as the cognitive attempts and behavioral adaption to deal with stressors (17) was found related to the mental health problems, and people with negative coping style tended to have adverse outcomes (18). Perceived stress is people's self-assessment of the threat from stressors, and has been shown associated with anxiety and depressive symptoms in many studies (19–21). Furthermore, psychological resources such as social support, optimism and resilience may also play some roles. Social support is defined as the material or moral support provided to the individuals under stress or in a difficult condition by the people around him/her. It contributes to the development of individuals' behavioral patterns, social cognition and values (22). Optimism is a personality trait characterized by a general tendency to hold positive expectations about the future; it functions as a psychological resource conferring health benefits (23). Finally, resilience is a person's ability to grow from dealing with stressors or adverse changes (24). All these psychological resources have been shown to have positive effects on anxiety and depression in students (19, 25–28). When dealing with stress and its related mental health problems, it is important to explore these relevant psychosocial factors so that we can provide essential psychological support to the students to alleviate their anxiety

and depressive symptoms. However, so far little investigation has been done to explore their roles in the mental health of international medical students. We hypothesize that negative coping style and perceived stress are positively associated with anxiety and depressive symptoms while positive coping style, perceived social support, optimism, and resilience are negatively associated with the symptoms. The aim of the current study is to first explore the prevalence of anxiety and depressive symptoms in international medical students in China, and then find out the factors that have potential predictive value for these symptoms.

MATERIALS AND METHODS

Settings of the Study

This cross-sectional study on international students was conducted at China Medical University. Data were collected online during November 2020. The research was approved by the Research Ethics Committee at China Medical University.

Subjects

All participates were international medical students from China Medical University. The inclusion criteria were: (1) a current student of the University, (2) can get access to the internet, (3) can read and understand the survey content.

Procedure

The whole process of the study was anonymous and voluntary for respondents. Emails describing the purpose of the study were sent to the potential participants by their class advisors. The emails contained the link for the students to access the online questionnaire, and they were sent out to all the eligible students including undergraduate and postgraduate students. When the participants visited the website to answer the online questionnaire, they were greeted with an informed consent letter stating that the survey was completely voluntary. In the end, 550 students completed the questionnaire. The detailed process of sending and collecting questionnaires is described in **Figure 1**.

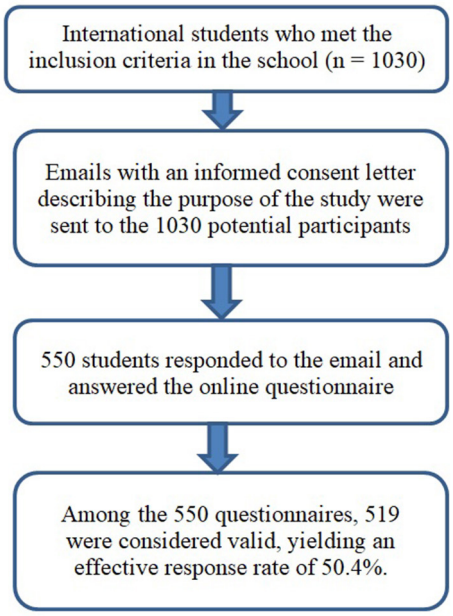

FIGURE 1 | Flow chart of the data collection process.

Tools

Demographic characteristics were recorded with a general questionnaire which included age, gender, educational background, current place of residence, COVID-19 outbreak in the city, residence style, smoking, drinking alcohol, exercise, stay up late, and addicted to the Internet. Stressors in school among international students were assessed in the following seven aspects: academic difficulties, language barrier, interpersonal relation difficulties, health problems, financial pressure, daily life difficulties, and adverse life events.

Measurement of Anxiety Symptoms

Generalized Anxiety Disorder Assessment (GAD-7) (29) was used to assess the anxiety symptoms of the international students. The GAD-7 included 7 items, and each item was rated on a 4-point scale (0–3), with a total score ranging from 0 to 21. A higher score means more severe anxiety symptoms. GAD-7 has been reported with good reliability and validity (30). The Cronbach's α was 0.92 in the current study.

Measurement of Depressive Symptoms

Depressive symptoms were assessed with the Patient Health Questionnaire-9 (PHQ-9) (31). The PHQ-9 is a 9-item tool rating on 4-point scoring system (0–3) with a total score ranging from 0 to 27. A total score of 5 or above was considered depressive tendency. The version has been shown with good reliability and validity (32). The Cronbach's α was 0.90 in the current study.

Measurement of Coping Style

Coping Style was assessed by the Simplified Coping Style Questionnaire (SCSQ) (33). The SCSQ is a 20-item scale with 2 domains: positive coping style and negative coping style. The positive coping style reflected positive coping strategies, such as "looking for suggestions from relatives, friends or classmates." The negative coping style reflected negative coping strategies, such as "relying on somebody else to solve the problem." Each item was scored on a 4-point scale (0–3). A higher domain score reflected a preference for adopting the relevant coping style. The scale had been found with good reliability and validity (34, 35). In the current study, the Cronbach's α was found to be 0.91.

Measurement of Perceived Stress

The level of perceived stress was assessed by the 10-item version of Perceived Stress Scale (PSS-10) (36). Each item was scored using a 5-point scale, with a total score ranging from 0 to 40. Higher scores indicated a higher level of perceived stress. The PSS-10 has demonstrated good reliability and validity (37). The Cronbach's α was 0.87 in this study.

Measurement of Social Support

The Multidimensional Scale of Perceived Social Support (MSPSS) was used to assess the level of perceived social support for

the international medical students (38). It measured perceived support from three social relationships: family, friends and significant others (such as relatives or schoolmates). The MSPSS was a 12-item scale rated on a 7-point scale. The total score ranged from 12 to 84, with a higher score indicating higher social support. The scale had good reliability and validity (39, 40). In this study, the Cronbach's α of the MSPSS was 0.94.

Measurement of Optimism

Optimism was assessed by the 10-item Revised Life Orientation Test (LOT-R) (23). It consisted of ten items using a 5-point rating system, three of which were for optimism; three were for pessimism; the other four items served as fillers. The Cronbach's α was 0.71 in the current research.

Measurement of Resilience

Respondents' resilience was measured with the Resilience Scale-14 (RS-14) (41). The RS-14 included 14 items, and each item was rated on a 7-point scale, with a total score ranging from 14 to 98. Higher scores indicated higher levels of resilience. RS-14 had been used in previous studies, and the reliability and validity had been confirmed (42, 43). The Cronbach's alpha coefficient for the total scale of resilience was 0.96 in the present study.

Operational Definition

The cut-off points of GAD-7 and PHQ-9 were set to differentiate whether the international students had anxiety or depression symptoms, respectively. According to the previous studies (30, 31), students with a GAD-7 score at or above 5 were divided into the anxiety symptoms group, and students with a PHQ-9 score at or above 5 were categorized into the depressive symptoms group.

Statistical Analyses

Statistical Package for Social Sciences (SPSS 20.0 for Windows) was used to conduct data analyses. Significance for all statistical tests was set at the level of 0.05 (two-tailed). Univariate logistic regression was used to explore the relationship between anxiety/depressive symptoms and the categorical demographic variables /continuous variables. Stepwise multiple logistic regression analyses were conducted to find the predictors. The variables with $p < 0.2$ in the univariate logistic regression were entered into regression analysis in order not to overfit the logistic regression models (44). Variables were entered in the regression analysis at $p < 0.05$ and removed from the model at $p > 0.10$. Variables with $p < 0.05$ were not included in the tables of logistic regression. Data provided in the regression models included regression coefficient (β), OR, and 95% CI.

RESULTS

Descriptive Statistics

In the current study, 550 questionnaires were collected. Among them, 519 were considered valid, yielding an effective response rate of 50.4%. Altogether 276 male and 243 female students participated.

All in all, 148 students reported anxiety symptoms; 164 reported depressive symptoms; and the prevalence was 28.5 and 31.6%, respectively. The demographic information of the participants was described in **Table 1**. The median (IQR) age of the respondents was 22 (3) years, ranging from 16 to 42. Most participants ($n = 453$, 87.3%) were undergraduates; 86% ($n = 451$) of the students were not in China at the time of the questionnaire survey. Most respondents ($n = 409$, 78.8%) were experiencing the COVID-19 pandemic.

TABLE 1 | Distributions of anxiety symptoms and depressive symptoms in categorical demographic variables ($n = 519$).

	N (%)	Anxiety symptoms	Depressive symptoms
		N (%)	*N* (%)
Gender			
Male	276 (53.2)	79 (28.6)	94 (34.1)
Female	243 (46.8)	69 (28.4)	70 (28.8)
Educational background			
Undergraduate	453 (87.3)	134 (29.6)	150 (33.1)
Master	32 (6.2)	5 (15.6)	4 (12.5)
Doctorate	27 (5.2)	8 (29.6)	8 (29.6)
Trainees	7 (1.3)	1 (14.3)	2 (28.6)
Current place of residence			
China	68 (13.1)	22 (32.4)	26 (38.2)
Asia outside China	376 (72.4)	111 (29.5)	124 (33.0)
Other continents	75 (14.5)	15 (20.0)	14 (18.7)
Outbreak in the city			
No	110 (21.2)	19 (17.3)	23 (20.9)
Yes	409 (78.8)	129 (31.5)	141 (34.5)
Residence style			
Live alone	170 (32.8)	53 (31.2)	68 (40.0)
Live with family or friends	349 (67.2)	95 (27.2)	96 (27.5)
Smoking			
No	496 (95.6)	140 (28.2)	153 (30.8)
Yes	23 (4.4)	8 (34.8)	11 (747.8)
Drinking alcohol			
No	498 (96.0)	141 (28.3)	155 (31.1)
Yes	21 (4.0)	7 (33.3)	9 (42.9)
Exercise			
No	59 (11.4)	20 (33.9)	22 (37.3)
Yes	460 (88.6)	128 (27.8)	142 (30.9)
Stay up late			
No	149 (28.7)	25 (16.8)	24 (16.1)
Yes	370 (71.3)	123 (33.2)	140 (37.8)
Addicted to the Internet			
No	105 (20.2)	17 (16.2)	14 (13.3)
Yes	414 (79.8)	131 (31.6)	150 (36.2)

N, number.

Distributions of Anxiety and Depressive Symptoms in Categorical and Continuous Variables

The distributions of anxiety symptoms and depressive symptoms in categorical and continuous variables (age, stressors in school, positive coping style, negative coping style, perceived

stress, perceived social support, optimism, and resilience) were presented in **Tables 2**, **3**. Results showed that the distribution of anxiety symptoms were significantly different in some categorical variables (current place of residence, outbreak in the city, stay up late, addicted to the Internet) and all the continuous variables; depressive symptoms were significantly different in some categorical variables (gender, educational background, current place of residence, outbreak in the city, stay up late, addicted to the Internet, smoking, residence style) and all the continuous variables except for positive coping style.

Predictors of Anxiety Symptoms and Depressive Symptoms

Stepwise multiple logistic regression analysis was conducted to identify the predictors of anxiety symptoms and depressive symptoms.

Variables that were significantly associated with anxiety symptoms were included in the logistic regression analysis, including demographic variables (age, current place of residence, outbreak in the city, stay up late, addicted to the Internet), stressors in school, positive coping style, negative coping style, perceived stress, perceived social support, optimism, and resilience. Multicollinearity diagnostic tests showed that there was no multicollinearity between the predictor variables. Stepwise multiple logistic regression was conducted and results were shown in **Table 4**. As a result, stressors in school, negative coping style, and perceived stress were found to be predictors of anxiety symptoms.

Variables that were significantly associated with depressive symptoms were included in the logistic regression analysis, including demographic variables (age, gender, educational background, current place of residence, outbreak in the city, stay up late, addicted to the Internet, smoking, residence style), stressors in school, negative coping style, perceived stress, perceived social support, optimism, and resilience. Multicollinearity diagnostic tests showed that there was no multicollinearity between the predictor variables. Stepwise multiple logistic regression was conducted and results were shown in **Table 5**. As a result, gender, stay up late, current place of residence, stressors in the school, negative coping style, perceived stress were found to be predictors of depressive symptoms.

TABLE 2 | Univariate logistic regression analysis on results of anxiety symptoms ($n = 519$).

	β	S.E	Wals	*P*	OR (95%CI)
Gender	−0.011	0.195	0.003	0.954	0.989 (0.675,1.449)
Educational background			3.392	0.335	
Undergraduate vs. Trainees	0.924	1.085	0.726	0.394	2.520 (0.301,21.137)
Master vs. Trainees	0.105	1.185	0.008	0.929	1.111 (0.109,11.330)
Doctorate vs. Trainees	0.927	1.159	0.639	0.424	2.526 (0.260,24.513)
Current place of residence			3.289	0.193	
China vs. Other continents	0.649	0.388	2.796	0.095	1.913 (0.894,4.092)
Asia outside China vs. Other continents	0.516	0.310	2.771	0.096	1.675 (0.913,3.076)
Outbreak in the city	0.791	0.274	8.358	0.004	2.207 (1.290,3.773)
Residence style	−0.192	0.205	0.876	0.349	0.826 (0.553,1.233)
Smoking	0.305	0.449	0.460	0.497	1.356 (0.562,3.270)
Drinking alcohol	0.236	0.473	0.248	0.618	1.266 (0.500,3.202)
Exercise	−0.285	0.294	0.941	0.332	0.752 (0.422,1.338)
Stay up late	0.904	0.245	13.571	0.000	2.470 (1.527,3.996)
Addicted to the Internet	0.874	0.285	9.387	0.002	2.396 (1.370,4.191)
Age	−0.043	0.029	2.133	0.144	0.958 (0.905,1.015)
Stressors in the school	0.273	0.034	65.055	0.000	1.313 (1.229,1.403)
Health problems	1.319	0.318	17.209	0.000	3.741 (2.006,6.977)
Language barrier	0.530	0.113	21.945	0.000	1.698 (1.361,2.120)
Financial pressure	0.524	0.106	24.701	0.000	1.690 (1.374,2.078)
Academic difficulties	0.713	0.131	29.817	0.000	2.041 (1.580,2.636)
Interpersonal difficulties	1.243	0.169	54.409	0.000	3.467 (2.492,4.825)
Daily life difficulties	0.704	0.125	31.646	0.000	2.023 (1.582,2.585)
Adverse life events	0.589	0.113	27.378	0.000	1.802 (1.445,2.247)
Positive coping style	0.242	0.138	3.087	0.079	1.274 (0.972,1.670)
Negative coping style	0.887	0.157	31.993	0.000	2.429 (1.786,3.303)
Perceived stress	0.288	0.030	89.833	0.000	1.334 (1.257,1.416)
MSPSS	−0.015	0.005	7.351	0.007	0.986 (0.975,0.996)
Optimism	−0.111	0.027	17.458	0.000	0.895 (0.850,0.943)
Resilience	−0.019	0.006	11.727	0.001	0.981 (0.971,0.992)

TABLE 3 | Univariate logistic regression analysis on results of depressive symptoms ($n = 519$).

	β	S.E	Wals	*P*	OR (95%CI)
Gender	−0.244	0.190	1.646	0.200	0.783 (0.540,1.137)
Educational background			5,339	0.149	
Undergraduate vs. Trainees	0.213	0.843	0.064	0.800	1.238 (0.237,6.454)
Master vs. Trainees	−1.030	0.993	1.075	0.300	0.357 (0.051,2.500)
Doctorate vs. Trainees	0.051	0.937	0.003	0.956	1.053 (0.168,6.602)
Current place of residence			7.244	0.027	
China vs. Other continents	−0.230	0.273	0.709	0.400	0.795 (0.466,1.356)
Asia outside China vs. Other continents	−0.992	0.387	6.560	0.010	0.371 (0.174,0.792)
Outbreak in the city	0.688	0.257	7.198	0.007	1.990 (1.204,3.290)
Residence style	−0.564	0.197	8.169	0.004	0.569 (0.387,0.838)
Smoking	0.720	0.429	2.824	0.093	2.055 (0.887,4.760)
Drinking alcohol	0.507	0.451	1.259	0.262	1.660 (0.685,4.021)
Exercise	−0.286	0.288	0.992	0.319	0.751 (0.427,1.319)
Stay up late	1.154	0.247	21.769	0.000	3.170 (1.953,5.148)
Addicted to the Internet	1.306	0.305	18.379	0.000	3.693 (2.032,6.711)
Age	−0..61	0.029	4.365	0.037	0.941 (0.888,0.996)
Stressors in the school	0.375	0.039	90.284	0.000	1.455 (1.347,1.573)
Health problems	1.365	0.324	17.729	0.000	3.916 (2.074,7.392)
Language barrier	0.646	0.113	32.630	0.000	1.909 (1.529,2.382)
Financial pressure	0.584	0.104	31.371	0.000	1.793 (1.462,2.199)
Academic difficulties	0.960	0.138	48.297	0.000	2.611 (1.992,3.423)
Interpersonal difficulties	1.673	0.194	74.062	0.000	5.326 (3.639,7.796)
Daily life difficulties	0.896	0.130	47.619	0.000	2.449 (1.899,3.159)
Adverse life events	0.794	0.115	47.250	0.000	2.212 (1.764,2.773)
Positive coping style	0.098	0.131	0.559	0.455	1.103 (0.853,1.427)
Negative coping style	0.856	0.151	32.091	0.000	2.355 (1.751,3.167)
Perceived stress	0.281	0.029	91.272	0.000	1.325 (1.251,1.404)
MSPSS	−0.016	0.005	9.574	0.002	0.984 (0.974,0.994)
Optimism	−0.112	0.026	18.628	0.000	0.894 (0.850,0.941)
Resilience	−0.020	0.005	13.184	0.000	0.980 (0.970,0.991)

TABLE 4 | Stepwise multiple logistic regression analysis on results of anxiety symptoms ($n = 519$).

	β	S.E	Wals	*P*	OR (95%CI)
Stressors in the school	0.176	0.040	19.339	0.000	1.192 (1.102,1.289)
Negative coping style	0.639	0.197	10.486	0.001	1.894 (1.287,2.788)
Perceived stress	0.230	0.031	55.084	0.000	1.258 (1.184,1.337)
Constant	−8.975	0.866	107.368	0.000	

Percentile 95% CIs for ORs are defined using the values that mark the upper and lower 2.5% of ORvalue.
SE, standard error; CI, confidenceinterval.

DISCUSSION

The Prevalence of Anxiety Symptoms and Depressive Symptoms in International Medical Students

The prevalence of anxiety symptoms in the current study was 28.5%. It was lower than that of students of higher education in other subjects in the world (32%) (7) and that of healthcare workers (30%) (45) during the COVID-19 pandemic. This result was perhaps relatively easy to understand, because, in comparison with students of other subjects, medical students may be better prepared in terms of knowledge and skill on combating the pandemic and, to some extent, they may be in a better position to deal with mental health problems than the former. Moreover, unlike healthcare workers, most of the medical students do not have to face the patients directly so that the anxiety experienced by the healthcare workers at the time of pandemic may not be as pronounced in the medical students. On the other hand, with respect to the prevalence of depressive symptoms (31.6%), which was also lower than that of students

TABLE 5 | Stepwise multiple logistic regression analysis on results of depressive symptoms ($n = 519$).

	β	S.E,	Wals	*P*	OR (95%CI)
Gender (male vs. female)	−0.594	0.286	4.303	0.038	0.552 (0.315,0.968)
Stay up late	0.828	0.337	6.032	0.014	2.288 (1.182,4.431)
Current place of residence			6.331	0.042	
China vs. Other continents	1.068	0.566	3.560	0.059	2.910 (0.959,8.829)
Asia outside China vs. other continents	1.082	0.436	6.167	0.013	2.951 (1.256,6.931)
Stressors in school	0.303	0.051	35.846	0.000	1.354 (1.266,1.496)
Negative coping style	0.866	0.229	14.252	0.000	2.377 (1.516,3.725)
Perceived stress	0.233	0.034	45.632	0.000	1.262 (1.180,1.351)
Constant	−11.223	2.272	24.404	0.000	

Percentile 95% CIs for ORs are defined using the values that mark the upper and lower 2.5% of ORvalue.
SE, standard error; CI, confidenceinterval.

of higher education in other subjects in the world (34%) (7), it was higher than that of medical students (28%) in the world before the pandemic (9) and that of domestic Chinese university students amid the COVID-19 pandemic (26%) (8), similar to that of healthcare workers during the COVID-19 pandemic (31.1%) (45). This information indicates that the COVID-19 pandemic did have an adverse impact on international medical students' mental health. It also indicates that at the time of a public health crisis such as the COVID-19 pandemic, international students may experience more difficulties than their domestic counterparts due to the trans-cultural differences and poor adaptation. In this sense, it is paramount to find proper intervention strategies to help these students.

Predictors of Anxiety/Depressive Symptoms in International Medical Students

In the current study, we were able to identify stressors in school, perceived stress and negative coping style as the communal predictors for anxiety symptoms and depressive symptoms, while gender, stay up late and current place of residence were found to be predictors specific for depressive symptoms among international medical students.

According to the results of stepwise multiple logistic regression analysis, "stressors in school" were associated with both anxiety and depressive symptoms, which was consistent with previous studies both during (46) and before (19, 20, 47) the pandemic. In our study, seven stressors were mentioned including academic difficulties, language barrier, interpersonal relation difficulties, health problems, financial pressure, daily life difficulties, and adverse life events. We found that the distribution of anxiety symptoms and depressive symptoms were significantly different in all those aspects ($p < 0.001$). Studies (48) have found that long-term exposure to stressors would increase levels of anxiety and depression among medical students. Therefore, our study results suggest that during the pandemic, while we focus our attention on dealing with mental health issues directly related to the pandemic, the conventional stressors related to school life should not be overlooked. Sometimes, we may have to investigate whether these conventional stressors are aggravated by the pandemic so as to find proper intervention.

Our result that perceived stress made an important contribution to the anxiety and depressive symptoms was also consistent with previous studies both during (49) and before (19, 20) the outbreak in students and other populations (50, 51). In the current study, the only psychological variable in the regression was perceived stress. Perceived stress is people's self-assessment of the threat from stressors as well as their ability to cope with the threat. A moderate level of stress is beneficial and enables the student to become a more dynamic and better performer. However, persistently high levels of stress may cause considerable psychological and physical glitches (20). Thus, the results of our study suggest that it is imperative to identify the students with a high level of stress and the causes, and give them help if necessary. Stress alleviation strategies may involve stressors as aforementioned as well as the ability and assessment. As to the ability to cope with the threat, we can set up some auxiliary courses/lectures in these areas so that students can master some coping skills and improve their ability to cope with the pressure. Similarly, as assessment is an important determinant of adjustment and adaptation to stress (17), students should be given relevant education and counseling. In short, we should educate students to correctly evaluate difficulties and personal abilities, and if the student still can't solve the difficulties, he or she should be encouraged to ask for help from proper sources in time.

Result with the coping style was also consistent with those of previous studies (25, 52). In fact, in our study, the negative coping style was the strongest predictor for anxiety symptoms and the second strongest for the depressive symptoms. Coping was defined as the cognitive attempts and behavioral adaption to deal with stressors. The negative coping style reflects actual negative coping strategies, such as "relying on somebody else to solve the problem." People with negative coping style tended to have adverse outcomes such as alcohol abuse and suicidal thoughts (18, 53). The strong link of negative coping style with poor mental health of international students in our study should arouse our attention, and students should be given education on how to appropriately cope with the stress or crisis.

On the other hand, it is interesting to note that some of the demographic variables such as gender, stay up late and current place of residence have been demonstrated specifically associated with the depressive symptoms of international students. First, we found that male students had a much higher risk of suffering from depressive symptoms than the female students, which was in discrepancy with results of some previous studies. For example, one study showed that difference in depression between males and females was not statistically significant among medical students (9), and another study found a similar result in students of higher education during the COVID-19 pandemic (7). However, there have been some studies reaching similar conclusions as ours. In particular, one study on overseas medical students during the COVID-19 epidemic in China (14) and one cross-sectional study on domestic medical students in China during the epidemic both showed that male students were more depressed (54), supporting our findings. We speculate that the discrepancy in the reports may be partially due to the special features of the study population. Our study took place during the period when the outbreak of COVID-19 happened in many countries around the world, and the pandemic has caused financial and other crises to many families. Traditionally, Asian male students are expected to be more independent and shoulder more life responsibilities than their female peers. Therefore, they may be more sensitive to the deterioration of family finance or other conditions and under more pressure to deal with situation by them. Indeed, in our study, male students reported more financial pressure ($p < 0.007$) and daily life difficulties ($p < 0.013$) along with academic difficulties ($p < 0.030$) and adverse life events ($p < 0.005$) than the female students did. When the high social expectation and deteriorating situation was coupled with the isolation and inability to deal with the difficulty which was quite a common scenario during the pandemic, more stress and the related depressive symptoms could be anticipated in the male students. Importantly, these results suggest to us that we should pay more attention to the male international students in the school management during this special period of time.

The association of another demographic variable, stay up late, with depressive symptoms came as no surprise to us, because quite many studies have shown that bad lifestyle such as stay up late tend to cause mental health problems in students (55–57). During the COVID-19 outbreak, for most of the time, online courses were the only teaching method. Unlike the offline courses at the university campus when the attendance is usually required, online learning students rely more on self-discipline in their schedule; but when there was local time difference with the school day, students were more likely to stay up late, which made them prone to depression (58). In this sense, in student management, more counseling and instructions are needed to help students develop good study habits and healthy lifestyle.

Finally, current place of residence was found to be an important factor for depressive symptoms, i.e., students staying in Asia outside China had more depressive symptoms compared with other continents. This phenomenon probably reflected the impact of the pandemic: students who stayed in Asia outside China were mainly Indian students, and when this survey was carried out, India was in the outbreak period, which might adversely affect students' mental health status. However, we found that the level of depression among students staying in China was also high. This was somewhat surprising to us, because, when the survey was done, the outbreak of COVID-19 in China already had been brought under control. Accordingly, we had thought that students staying in China might feel safer and therefore have fewer mental health problems than their counterparts staying in other countries. We guess that this finding may be due to several reasons. First, by the time of this study, students who were living in China already had stayed in China for nearly one and half years, so they may become homesick which is commonly seen among international students (59, 60). In addition, they may worry about the safety of their loved ones in their home countries, which is another feature of university students during the pandemic (61). Furthermore, the pandemic prevention measures such as lockdown of the university and the required social distancing at the university campus may lead to a sense of social isolation in the students which may finally result in their depression (5). Nevertheless, this result was very important, because it has reminded us that we should not underestimate the mental health status of the international students who are staying in China, and proper counseling and education on the mental health of these students should be in place.

However, some results of the current study were not consistent with our hypothesis in that positive psychological variables, such as perceived social support, optimism and resilience showed neither significant association with the anxiety symptoms nor with the depressive symptoms. Further research is needed to explore the exact mechanism of those variables and the anxiety/depressive symptoms.

Strengths and Limitations

The current study aims at identifying the possible predictive factors associated with anxiety and depressive symptoms in international medical students in China. The hypothetical socio-demographic and psychological variables have been analyzed, resulting in significant results. The study is important because it has provided useful information on the mental health status of international medical students during the pandemic, which largely has not been explored before. Some of the results such as the roles of gender, stay up late and current place of residence in the development of depressive symptoms may be pandemic specific or related, which may be instrumental to university authority or educators to properly place their attention and efforts to help the international students. In addition, study results have reminded us that the conventional variables related to mental health such as stressors in school, negative coping style and perceived stress are still very important predictors of student mental health during the pandemic. Therefore, intervention measures for dealing with student mental health problems in these areas would most likely be effective and efficient.

Due to the cross-sectional design, the causal relationship couldn't be confirmed. Future research by means of longitudinal studies should be done to address the relationship. Besides, we only focused on the associations of anxiety/depressive symptoms with stressors, coping style, perceived stress, perceived social

support, optimism, and resilience; other factors which may be important to consider for anxiety/depressive symptoms were not included. In addition, "internet addiction" in this study was assessed only by a question instead of a validated instrument, which may affect the validity of the findings. Moreover, a larger and multi-center sample is needed to improve the representativeness of the data. However, despite of these limitations, our study has provided new and useful information on the mental health status of international medical students and suggested potentially effective ways to reduce anxiety and depressive symptoms in the students.

CONCLUSION

The prevalence of anxiety and depressive symptoms of the international medical students was moderate. After adjusting for demographic factors, stressors in school, negative coping style and perceived stress were found positively and significantly associated with both anxiety and depressive symptoms. In addition, male gender, "stay up late" and current place of residence were found to be predictors of depressive symptoms. However, positive psychological variables such as perceived social support, optimism and resilience showed neither significant relation with anxiety symptoms nor with depressive symptoms. Study results suggest that at this time of COVID-19 pandemic, situation-specific intervention measures may be potentially effective to help improve the mental health status of the international 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 Committee on Human Experimentation of China Medical University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

L-LY analyzed the data and drafted the manuscript. LL helped analyzing the statistics. X-HW, X-XG, and HR collected the data. Y-QG helped with the study design and data analysis. B-CP provided the guidance of the study design and reviewed the manuscript. All authors read and approved the final manuscript.

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Analysis of the Mediating Effect of Risk Perception on the Relationship Between Time Perception and Mental Health of College Students During the COVID-19 Epidemic

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Background: COVID-19 has had a wide impact on the mental health of college students. This study aims to explore the relationship between time perception, risk perception, and the mental health of college students during COVID-19 through a questionnaire survey.

Subjects: One thousand two hundred and eighteen college students, 449 male and 769 female, who studied online during the COVID-19 epidemic were selected.

Methods: Time Perception Scale, Risk Perception Scale, and SCL-90 were used to investigate the relationship using correlation analysis.

Results: During the COVID-19 period, mental health problems of college students were widespread, and 65.93% of college students reported moderate to severe mental health problems. The correlation analysis showed that risk perception, time perception, and the mental health of college students were significantly related. Risk perception played a partial mediating role between present enjoyment and mental health, and risk perception played a partial mediating role between future time perception and mental health.

Conclusion: In the case of sudden public crises, we should pay close attention to the mental health of college students, adjust their attitude toward the present and the future, and pay attention to their perception of risk so as to improve their mental health level under crisis.

Keywords: COVID-19, college students, time perception, mental health, risk perception

BACKGROUND

Novel coronavirus (COVID-19 for short) has spread all over the world. Because of its fast transmission speed, wide transmission range, strong infectivity, and lack of targeted treatment, it poses a significant threat to people's physical and mental health (1). Sudden public crisis events can easily lead to psychological reactions such as tension, anxiety, and even panic, which lead to psychological barriers such as stress and depression (2). As a special group in the epidemic, college students are more vulnerable to the impact, because they face double pressure from home isolation and complete online learning, and suffer greater impact and serious mental health problems. Studies have shown that 20–40% of Chinese adolescents were prone to severe psychological issues,

especially anxiety and post-traumatic stress disorder (PTSD) symptoms, during the COVID-19 pandemic (3). However, in a public health crisis, the mental health needs of college students may be ignored, and due to the lack of control over their own environment, they tend to bear more significant mental health pressure (4). For college students, they left school during the COVID-19 pandemic, which has had a significant impact on their physical and mental health. Some college students even experienced poor sleep quality, loss of appetite, increased sedentary behavior, and loss of cardiometabolic health (5). Therefore, it is of great practical and theoretical significance to study the impact of this sudden public crisis on college student's mental health and how to help college students better cope with the crisis and maintain their mental health.

Previous studies have found that individuals' time orientation affects their behavior in major public crisis events. The prospect of the future helps people to formulate effective protection measures to avoid being affected by high-risk activities (6). The perception of time and our perception of the future may affect our physical and mental health. Time perception is an important reflection of individual tendencies, which has a significant impact on individual emotions and behaviors. Research shows that time perception is strongly associated with anxiety, depression, self-esteem, happiness, and life satisfaction (7, 8). Moreover, as a personality trait, insight has an important impact on individual emotions and behaviors. Previous studies have found that time insight is closely related to individual health behaviors (9). Studies have shown that altered perceptions of time and its passage are common experiences of trauma (10, 11). As a basic dimension of constructing psychological time, Zimbardo and Boyd define time insight as an unconscious process, which defines the sequence, relevance, and meaning of these events by dividing the continuous stream of personal and social experience into different time categories (12). Zimbardo and Boyd divided time perception into five dimensions: past negative, past positive, present fatalism, present hedonism, and future. All of these were significantly correlated with individual anxiety level (12). Past negative and present fatalism were significantly positively correlated with anxiety disorder. Future time orientation was negatively correlated with anxiety disorder. Sudden major events may change an individual's evaluation of the present and future, which may lead to a high degree of psychological pain and affect the level of individual mental health. Individuals with a positive time attitude have a positive and optimistic view of the past, present, or future, and are more likely to make positive expectations when facing unknown dangerous events, thus reducing psychological anxiety and anxiety caused by dangerous situations and putting individuals in a lower state of anxiety (10). Moreover, studies have found that time perception is closely related to individual health, and time perception can affect individual psychological experience (9). The stronger an individual's tendency toward future time, the better they can adapt to school life (13). When an individual pays too much attention to the past and is content with the present situation, they will commit more crimes. In contrast, an individual who pays more attention to the present thinks less about the future. This shows that when an individual is confident in the future and has a more positive attitude toward the future, it is easier for them to face difficult situations more positively. Conversely, when individuals are immersed in the past and content with the status quo, they will adopt more negative ways to solve stress events.

During the outbreak period, individuals were faced with the risk of infection. The perceived degree of risk and the uncertainty and uncontrollability of risk will increase the psychological pressure and negative emotions of individuals, seriously affecting the mental health of the public (14). Risk perception refers to an individual's subjective judgment for the risk based on the objective crisis. In the face of the COVID-19 pandemic, the uncertain environment will threaten individuals, and they will subjectively judge the possibility of their infection; this is the core of risk perception (15). Studies have also shown that high risk perceptions can put people in a state of depression and anxiety. The occurrence of risk events will create a stressful environment for people and generate negative emotions such as anxiety and tension, resulting in certain mental health problems (16). Previous studies on risk perception of events such as floods, earthquakes, and terrorist attacks have shown that perception of risk events has an impact on psychological responses (17). The high uncertainty and low sense of control of risk events will induce strong emotions such as worry. High familiarity and high sense of control will reduce emotional and other aspects of the response accordingly. Taking SARS as the object, researchers studied the public's risk perception in epidemic infectious disease crisis events and found that the public's risk perception of information related to public health crisis events significantly affected their mental health (14). Griva et al. found that future time perception was associated with risk perception, and women who considered the future consequences of their actions were more likely to consider health-related risks. As an emotional component of time, time attitude is also associated with risk perception. The higher an individual perceives the risk of an event, the greater the degree of anxiety and panic brought about by the event, which leads to the improvement of anxiety level and lower mental health level (3). To sum up, there may be a relationship between risk perception, time perception insight, and the mental health of college students. Based on this in this study, we propose the following hypotheses:

Hypothesis 1: During the COVID-19 pandemic, future time perception is negatively correlated with the mental health of college students.

Hypothesis 2: There is a negative correlation between the dimension of present hedonism and the mental health of college students during the COVID-19 pandemic.

Hypothesis 3: Risk perception plays a partially mediating role between future time perspective, present hedonism, and mental health during the COVID-19 pandemic.

METHODS

Participants

In this study, questionnaire star was used to issue questionnaires. Questionnaires were issued in Gansu, Sichuan, Guizhou, Henan,

TABLE 1 | Basic information of the respondents.

		N	%
Gender	Male	449	36.9
	Female	769	63.1
National	Han nationality	1,014	83.3
	Ethnic minorities	204	16.7
Family Residence	Rural	900	73.9
	Cities and towns	318	26.1
Grade	Freshman	637	52.3
	Sophomore	300	24.6
	Junior	154	12.6
	Senior	127	10.4

Hebei, Shaanxi, Chongqing, and 12 other provinces (not including Hubei, given that Hubei province is in the midst of the outbreak, and the psychological health problems of college students' mental, time orientation, and risk perception may be extremely influenced. Therefore, the data collection process mainly took place for HuBeioutside college students). A total of 1,335 questionnaires were collected, including 1,218 valid ones. The basic information of respondents is shown in **Table 1**. The age of the subjects was 20.32 ± 1.52 years.

Time Perception Scale

The revised Chinese version of the Zimbardo Time Insight Short-Version Questionnaire (ZTPI) was adopted. The questionnaire consists of 20 items and is divided into five dimensions: Past Negative PN, Past Positive PP, Present Hedonistic Ph, Present Fatalistic PF, and Future F. This questionnaire is a 5-point Likert scale. According to their own situation, the subjects choose from 1 (significantly disagree) to 5 (significantly agree). The Cronbach's α coefficient of the five dimensions ranged from 0.54 to 0.68, and the Cronbach's α coefficient of the whole scale was 0.66 (18).

SCL-90

SCL-90 revised by Zhengyu Wang was adopted, and the scale contained 10 factors. The full scale consisted of 90 items, each of which was rated on a 5-point scale (1–5), with 1 = none and 5 = severe. The statistical indicators of the scale were the total mean score and factor score. In this study, the total coefficient of A of the scale was 0.978, and the coefficient of A of each factor ranged from 0.772 to 0.921 (19).

Risk Perception Scale

The risk perception questionnaire was based on Slovic's risk perception model. Two indicators, familiarity and control, were used to investigate the public's risk perceptions of six risk sources of COVID-19 (the etiology, transmissibility and infectivity of COVID-19, cure rate, preventive measures, effects on the body after treatment, and whether the disease is infective after treatment). It was measured using the Likert 5-point scale. Cronbach's α coefficient of the total amount table is 0.793 (20).

TABLE 2 | Mental health of college students during the COVID-19 pandemic.

Level	*N*	%
160–200	429	35.2
200–250	389	31.9
>250	400	32.8

Level < 160, mental health level is normal, Level in 160–200, mild mental health problems, Level in 200–250, moderate mental health problems, Level > 250, severe mental health problems.

Statistical Analysis

SPSS22.0 and the PROCESS plug-in developed by Hayes were used for analysis. In this study, 5,000 samples were put back from the original samples to estimate the 95% confidence interval of the mediating effect. In addition, model 4 with 76 typical models provided by Hayes was selected for analysis.

RESULTS

Table 2 provides mental health of college students' characteristics. In the present sample, 64.7% of college students have moderate to severe mental health problems, and there is no significant difference in gender, age, and grade ($P > 0.05$). This means that during the COVID-19 pandemic, college students generally have mental health problems.

Table 3 provides means, standard deviations, and Pearson correlations of the main study variables. Here, College Students' Mental Health (MH) is associated with a lower familiarity dimension and controllability dimension of Risk Perception (RP), with more negative past dimension, present hedonism dimension, and fatalism dimension of Time Perspective (TP), but more future time concept dimension of TP. On the other hand, the familiarity dimension of RP is associated with a more positive past dimension, present hedonism dimension, and future time dimension of TP. In contrast, the controllability dimension of RP is associated with a more positive past dimension, present hedonism dimension, and future time dimension of TP.

We first examine the relationship between the dimensions of TP, RP, and MH. Through the correlation analysis, we find that the negative past dimension of TP is not related to RP, the positive past dimension is not associated with MH, and the fatalism dimension is not associated with RP, which is different from previous studies (13). One reason for this is that the mental health level of college students is worse during the COVID-19 pandemic than usual. Furthermore, our research also found that most college students have moderate to severe mental health problems. Another reason for this is that the outbreak makes them more concerned about the current situation, while the past positive experience has less buffering effect on the present. Based on these, to confirm an indirect result of TP on MH through the mediating

TABLE 3 | Correlation analysis between risk perception and college students' mental health and time insight during the COVID-19 epidemic.

	1	2	3	4	5	6	7	8
1. MH	1							
2. Familiarity	−0.130**	1						
3. Controllability	−0.199**	0.462**	1					
4. NP	0.356**	0.003	−0.031	1				
5. PP	−0.041	0.191**	0.208**	0.246**	1			
6. PH	0.114**	0.059*	0.060*	0.466**	449**	1		
7. PF	0.310**	−0.038	−0.014	0.651**	214**	535**	1	
8. FT	−0.129**	0.306**	0.291**	0.145**	590**	317**	0.086**	1
M ± SD	238.3 ± 57.58	22.8 ± 4.06	22.61 ± 3.37	2.9 ± 0.87	3.72 ± 0.67	3.03 ± 0.75	2.80 ± 0.81	2.8 ± 0.81

*$p < 0.05$, **$p < 0.01$.
NP, Negative past; PP, Positive past; PH, Present Hedonism; FT, future time; PF, Present Fatalistic.

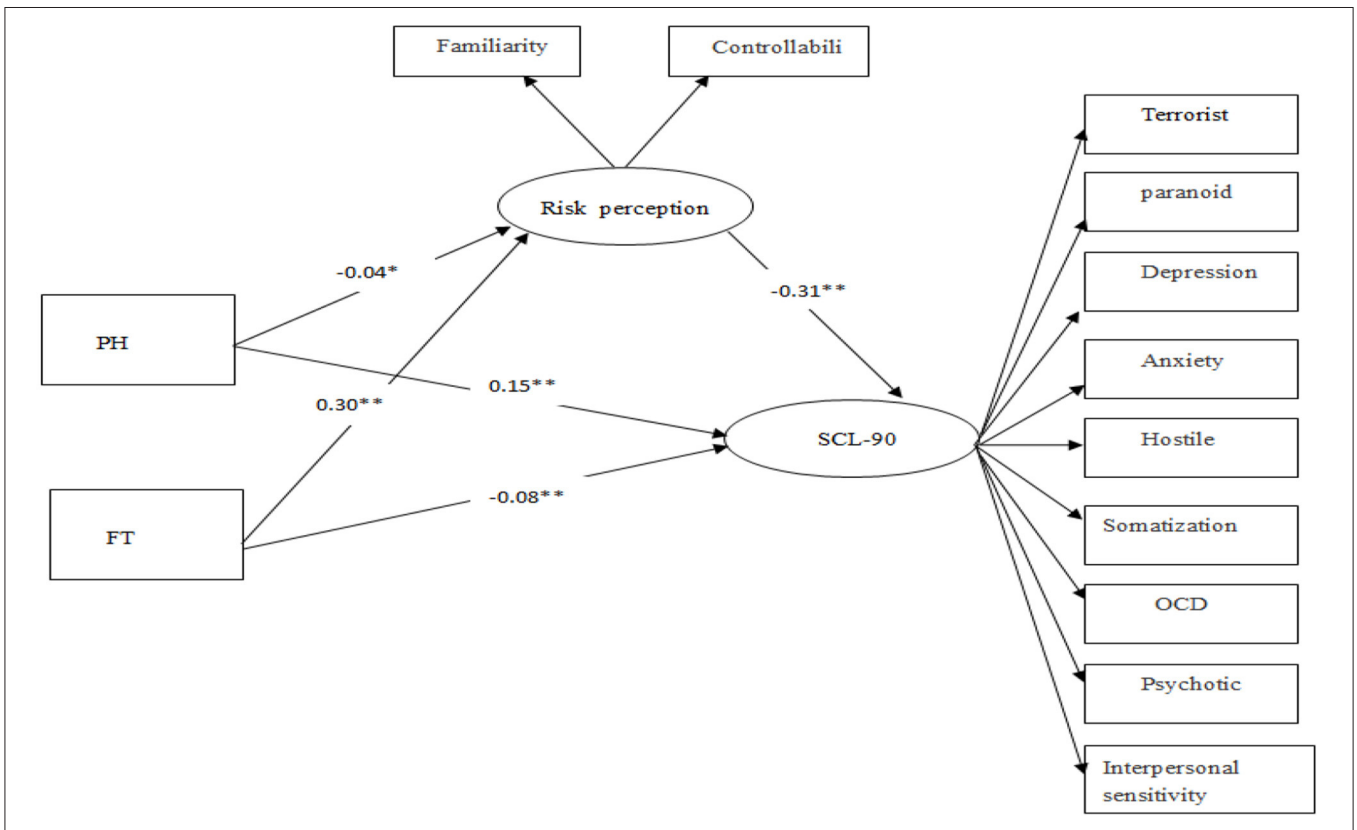

FIGURE 1 | Final model showing moderated mediation; RP mediates TP effect on MH. *$p < 0.05$, **$p < 0.01$.

variable of RP, we propose a mediator model in AMOS20.0 (**Figure 1**).

The results showed that the model fit well ($\chi^2/df = 13.463$, $RMESEA = 0.1$, $IFI = 0.965$, $RFI = 0.948$, $NFI = 0.963$). **Figure 1** shows the indirect bootstrap effects for the mediating effect of RP. The results show that when RP is the mediating variable of FT view and MH, the 95% confidence intervals with indirect effect [−0.144, −0.071] and direct effect [−0.144, −0.027] do not contain zero. Thus, RP's moderation effect is confirmed, accounting for 53% of the total effect. When RP is the mediating variable between PH and MH, the 95% confidence intervals with indirect effect [0.0007, 0.031] and direct effect [0.113, 0.205] do not contain zero, which was statistically significant. Thus, RP's moderation effect is confirmed, accounting for 7.6% of the total effect.

DISCUSSION

This study explored the impact of COVID-19 on the mental health of college students from the perspective of time insight and risk perception. Our research has found that college students generally have psychological health problems during the COVID-19 pandemic. More than 65% of college students have moderate to severe mental health problems. Results of correlation analysis have shown that mental health has a significant positive correlation with the dimension of negative past, the dimension of present-hedonistic, and the dimension of fatalistic view, and has a significant negative correlation with the future-time view. Mediating effect test has found that risk perception plays a part in the mediating effect between the dimension of future time perspective and the mental health of college students. In addition, risk perception has a partial mediating effect between the dimension of present-hedonistic and the mental health of college students.

The high detection rate of mental health problems among college students during COVID-19 is consistent with research results at home and abroad. And research also shows that the closure of schools and colleges harmed more than 91% of students worldwide (21). The COVID-19 quarantine hurts young people's physical and mental health (22). In addition, the delayed beginning of term has led to a lack of a regular learning atmosphere for college students, confusion, boredom, and lack of communication in daily life; all of those will cause college students to have a lower level of mental health (4, 23, 24). This reminds us that the mental health of college students during the COVID-19 pandemic cannot be ignored. Correlation analysis has shown that mental health has a significant positive correlation with the dimension of negative past, the dimension of present-hedonistic, and the dimension of fatalistic view, and has a significant negative correlation with the future-time view. An individual who is full of hope for the future and has a clearer goal has a stronger belief and will to complete their plan. At the same time, they will also have a more positive attitude and way to overcome difficulties (25). Individuals' emotional experience, attitudes, and perceptions for time will affect their own mental health. College students who hold the view of present-hedonistic pay more attention to the feelings of the present and do not have many plans for the future. Therefore, the sudden COVID-19 pandemic has enhanced the negative emotional experience of college students who hold the view of present-hedonistic. They feel the threat of the current environment and think that their future life is gloomy and may disobey the government's measures (home isolation and city lockdown). The lack of a sense of control and security of the present will undoubtedly make individuals have a self-denying attitude and cause psychological problems. Time perception insight has a significant impact on the mental health of college students, especially individuals who hold a view of future time. Their level of mental health is relatively high. This reminds us that whether it is during the COVID-19 pandemic or in daily life, we should all be concerned about the future and have confidence in the future.

During the COVID-19 outbreak, risk perception had a partial mediating effect on the future time perspective dimension, present enjoyment dimension, and college students' mental health. That is, time perception directly affects college students' mental health level and indirectly affects the mental health level of college students through risk perception. The more positive emotional experience, successful experience, self-reflection, and other factors an individual has in the past will affect the individual having more positive memories of the past. It can make the individual more confident, calm, and able to withstand setbacks when facing the current situation. During the COVID-19 epidemic, college students who were full of hope for the future were more likely to believe that COVID-19 was controllable and were more confident in national policies and government measures. As pointed out in previous studies, an important factor affecting risk perception was the perception of government participation attitude and trust (26). When college students perceive the government's commitment to overcoming the outbreak to be high, the more hopeful they are about the future and the more they feel the outbreak is controlled, so their individual psychological health level is higher. When an individual's confidence in the future will produce clear objectives, their behavior will be more positive and active. More and more research has shown that maintaining a hopeful, goal-oriented future direction is good for young people's mental health (5, 23, 24). These changes in our perception of time and our view of the future could significantly impact our health and well-being (27). Abramson, Metalsky, and Alloy proposed hopelessness depression: when adverse events occur, individuals with negative emotions or styles are more likely to make adverse inferences and suffer from depression (28).

In the same way, individuals who enjoy the present are prone to make negative judgments on adverse events such as epidemics because individuals who e pay more attention to the enjoyment of the present make fewer plans for the future. In the face of the sudden COVID pandemic-19, they are prone to feel uneasy and afraid, which will affect their mental health. Therefore, how to intervene in individuals' time attitude and actively conduct epidemic risk expectations becomes key to alleviating personal anxiety and maintaining people's mental health during the epidemic period. The individual emotional response is an essential factor affecting risk perception, and negative emotions play a significant role in risk perception (23). This also explains why risk perception has a mediating effect on future time perspective dimension, negative past dimension, and mental health. When a major public health crisis occurs, the negative subjective perception of the situation is an essential factor leading to a low level of mental health (29). Therefore, attention should be paid to the subjective risk perception of college students because the individual's subjective perception of their risk of infection may not be consistent with the objective situation (24). Since individuals' subjective perception of their risk of infection may be inconsistent with the objective situation, it is necessary to focus on college students' subjective risk perception and guide them to maintain correct and positive subjective perception of COVID-19 risk.

CONCLUSION

This study found that during the outbreak of COVID-19, the present hedonism time perspective and future time perspective could affect college students' mental health not only directly but also indirectly through risk perception. It is also recommended to increase people's familiarity with COVID-19 during the COVID-19 outbreak and increase confidence in the controllability of COVID-19 to reduce the impact of the COVID-19 pandemic on people's mental health.

DEFICIENCIES AND PROSPECTS

This research also has some shortcomings; first of all, the basic information of the participants had no further detailed division, including professional subjects, whether participants had close contact with COVID-19 patients, or whether participants were involved in the pandemic control or prevention, which may all have certain influences on college students' psychological health, It is hoped that the experience of this study can be used for reference in future studies. Secondly, this study only sampled college students from provinces other than Hubei, China, and did not compare with college students nationally and those with COVID-19 infection nearby. Finally, the study is a cross sectional study and did not track how college students' mental health changed as the pandemic progressed. Future studies can continue to track the outbreak era dynamic change and other influencing factors of college students' mental health problems.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

All authors conducted data collection, data processing, article writing, article discussion, and modification.

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BRIEF RESEARCH REPORT
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The Effect of Cyberbullying, Abuse, and Screen Time on Non-suicidal Self-Injury Among Adolescents During the Pandemic: A Perspective From the Mediating Role of Stress

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Adolescence is often a period of turmoil. The COVID-19 pandemic has increased adolescents' difficulty due to mental health consequences that may affect their developmental milestones. This study constructed and empirically tested a theoretical model of three predictive factors (cyberbullying, abuse, and screen time) and stress as the mediating factor in adolescent non-suicidal self-injury (NSSI). Structural equation model (SEM) analysis was applied to investigate stress as a mediating factor in the relationship between adolescent NSSI and cyberbullying, abuse, and screen time. This cross-sectional study used a "crowdsourcing" sample collection method to recruit 464 adolescents aged 11–17 years who were administered a questionnaire comprising scales on cyberbullying, abuse, screen time, stress, and NSSI. All scales had construct reliabilities ranging from 0.759 to 0.958. SEM statistical analysis was performed using Lisrel version 8.8 (Scientific Software International, USA) for Windows (Microsoft Corporation, Redmond, WA, USA). The mean (± SD) age of the cohort was 14.61 ± 1.65 years, and consisted of 66.7% females. Secondary high school was the highest educational background (58%). The study found that cyberbullying and abuse were direct positive predictors (critical t-value for the path > 1.96; $p < 0.05$) of adolescent NSSI; however, screen time did not have any direct relationship. Furthermore, stress was a significant full mediating factor of screen time and a partial mediating factor of cyberbullying and abuse in the relationship with adolescent NSSI (critical t-value of the path $= 5.27$; $p < 0.05$). Cyberbullying, screen time, and abuse with the mediating effect of stress could explain 48% of the variance in adolescent NSSI ($R^2 = 0.48$). Adolescent mental health prevention and promotion programs need to be redesigned during the current COVID-19 pandemic to manage their stress and minimize the mental health consequences of cyberbullying, abuse, and inappropriately increased screen time.

Keywords: COVID-19, adolescents, Indonesia, cyberbullying, abuse, screen time, stress, non-suicidal self-injury

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has continued for more than 1 year. Globally, most schools and public places have been temporarily closed. In several countries, students have been instructed to stay at home, engage in social distancing during daily activities, and study from home (1). They used various Internet devices to stay connected to their schools and peers. Consequently, their screen time may have increased, especially of those living in urban cities in Indonesia. Internet access among adolescents has been estimated at 79.5%, and most of them use the Internet for several purposes such as to seek information for school activities, connect with their peer groups through social media networking (such as Path, Line, Whatsapp, Facebook messenger, etc.), and for entertainment (2). Adolescents have missed several important milestones, including direct social interactions with peers, making new friends, and sports activities, among others (1, 2). Moreover, they have been forced to adapt to new educational styles (i.e., online learning, examination[s], and group work), especially students in their final year of high school. Students entering the new academic year, particularly if they have transitioned to a new school, can only meet their new friends or teachers via online classes (3, 4). Therefore, their screen time has been increased compared to before the COVID-19 pandemic. It may increase the risk of cyberbullying for victims (5, 6). Moreover, adolescents may lose peers and social support, face more internal conflicts, and abuse triggered by less personal space because all family members stay at home, engage in less physical activity due to parental restrictions to leave the home, and disruptions in daily routine activities (7). Additionally, the number of COVID-19 cases and deaths has continued to increase in several countries, including India, Indonesia, the United States, and Brazil (8). In Indonesia, the number of new COVID-19 cases has increased over time. For example, in this study period (August-October 2020), the average number of new cases was estimated to be around 4,200 per day and around 100 deaths occurred due to this infection. However, it increased by 10–15 times in the middle of July 2021, with more than one thousand deaths. The Indonesian government has implemented several policies to minimize the spread of COVID-19 since April 2020, such as extending the policy of restricting public activities at the micro scale and school closures, implementing a 50–100% Work-From-Home policy, while all shopping centers and malls, worship houses, and public parks were partially or totally closed (2, 9). Thus, the COVID-19 pandemic has significantly contributed to stressful life events among adolescents and young adults. It has become a unique stressor and forces everyone, including adolescents, to rapidly acquire new adjustment skills. However, adolescents may face difficulties due to developmental challenges.

Adolescence is a transitional period between childhood and young adulthood, consisting of multidimensional transformations such as biological, psychological, cognitive, and social. From a biopsychosocial perspective, maturation of the hypothalamic-pituitary-gonadal axis marks both puberty and adolescence. Thus, hormonal changes in adolescence are associated with fluctuations in emotional experiences, increased self-esteem, a sense of self-importance, and individuality. However, at the same time, adolescents may experience self-criticism, depression, anxiety, and anger (10). Additionally, prefrontal cortex immaturity may contribute to irrational decision-making and tenuous impulse control, particularly during stressful times (11). Moreover, this can lead to greater experimentation with high-risk behaviors during the COVID-19 pandemic, such as non-suicidal self-injury (NSSI), not only among typical adolescents but also among adolescents with pre-existing mental health problems (12, 13).

In 2018, the International Society for the Study of Self-Injury defined NSSI as conscious and direct engagement in behaviors that produce body tissue damage without deliberate suicidal intention (1). However, NSSI is linked to suicidal ideation and attempt(s), and it has been estimated that individuals with NSSI are four times more likely to attempt suicide in the future (14, 15). In 2015, Plener et al. reported that NSSI typically began during early or mid-adolescence, possibly becoming chronic NSSI over a prolonged period or was carried out a few times in a significantly more discreet period (16, 17). A worldwide study demonstrated that ∼17% of adolescents engaged in NSSI, and it was essentially comparable in boys and girls (18, 19). Moreover, cultural differences may impact the prevalence of NSSI, despite the paucity of prevalence studies in non-Western countries compared to Western countries (20). In the past decade, many mental health-related studies have investigated NSSI. Previous studies have indicated that gender, cyberbullying, screen time, abuse, and stress may be associated with NSSI, especially during the unconventional life events of the COVID-19 pandemic (6–8). On the other hand, several studies before the COVID-19 pandemic revealed other psychosocial and biological risk factors associated with NSSI, such as genetics, changes in brain neurotransmitters, depressive symptoms, stigmas, common misperceptions of mental illness, and family discord (20).

NSSI can be characterized as an improper coping strategy for adolescents, especially to release strong negative feelings due to heightened stress and relief from their intolerable states in a very short time (13). Furthermore, NSSI may predict poorer future psychosocial well-being among adolescents (1). Several studies have reported that closure of schools and public places during the COVID-19 pandemic magnified many negative consequences of adolescents' developmental milestones and possibly increased the risk for NSSI or exacerbated self-injury behavior such as suicidal ideation or attempt in some adolescents due to elevated stress during this unstable period (1, 21). To summarize, NSSI has possibly become a new threat to adolescents' mental well-being during the COVID-19 pandemic. Therefore, the effect of screen time, cyberbullying, abuse, and stress on NSSI that emerged during the COVID-19 pandemic is a critical topic to be investigated and discussed.

The current study constructed and empirically tested a theoretical model that could predict and explain adolescent NSSI during the COVID-19 pandemic in Indonesia. Several studies have reported that NSSI has become a major public health problem worldwide during the COVID-19 pandemic, especially among adolescents (13, 20). However, to the best of

our knowledge, few empirical studies have explored the effects of cyberbullying, abuse, screen time, and stress on adolescent NSSI during the COVID-19 pandemic. Accordingly, the current study developed a questionnaire for adolescents in Indonesia. The questionnaire survey method was adopted to determine how cyberbullying, screen time, abuse, and stress affected adolescent NSSI during the COVID-19 pandemic. Hence, the present study explored several primary antecedents/predictors (cyberbullying, screen time, and abuse) for NSSI among adolescents, and determined whether stress mediated cyberbullying, screen time, and abuse of adolescent NSSI. In this context, the research questions were defined as follows: Is there any possibility that mental health reactions during the COVID-19 pandemic, such as cyberbullying, screen time, and abuse, significantly predict adolescent NSSI? How does stress mediate the effects of cyberbullying, abuse, and screen time on adolescent NSSI during the COVID-19 pandemic? The results were expected to enhance the scholarly understanding of adolescent NSSI during the COVID-19 pandemic and adolescents' mental health reactions, such as cyberbullying, screen time, abuse, and stress, to enhance the knowledge base for health professionals, parents, schools, and government education authorities, and design better adolescent mental health and stress reduction programs, especially during the pandemic.

METHODS

This cross-sectional study used a "crowdsourcing" sample collection method during the COVID-19 pandemic in Indonesia. Data were collected from August 21 to October 10, 2020. A questionnaire link (http://surveymonkey.com) was circulated through social media networks, such as WhatsApp, Facebook Messenger, and Line. The inclusion criteria were adolescents aged 11–17 years with secondary and high school backgrounds. Before completing the survey, participants completed an online informed consent form. During the research period, 744 questionnaires were returned. However, 247 were excluded because they were incomplete, including missing data, not fulfilling the inclusion criteria, or the absence of a signature on the online informed consent form. Therefore, the final analysis included 464 questionnaires. The Ethics Committee of the Faculty of Medicine of Universitas Indonesia approved the study protocol in April 2020 (KET-375/UN2.F1/ETIK/ PPM.00.02/2020).

Instruments

The questionnaire was developed specifically for this study. It contained information from a previously published study with multi-item scales that demonstrated good psychometric properties. The questionnaire items were determined after a thorough review of several relevant studies that addressed cyberbullying, screen time, abuse, stress, and NSSI. The item dimensions were modified to fit the context of adolescent mental health reactions during the COVID-19 pandemic and study design. Questionnaire development followed the recommendations of MacKenzie et al. and the development procedures suggested by Devellis for standard psychometric scales (22, 23). The questionnaire consisted of 24 items measured in six sections: the cyberbullying scale (three items), screen time scale (three items), abuse scale (three items), stress scale (seven items), NSSI scale (three items), and sociodemographic questions. All questions were modified into the Indonesian language and had good construct reliability (CR ranged from 0.759 to 0.955) for this study.

Cyberbullying Scale

The cyberbullying scale was developed using three items modified from Patchin and Hinduja (24), Sourander et al. (25), and Hinduja et al. (26), Sourander et al. (25), and Wiguna et al. (27). The questions were as follows: "During the past 6 months, how often have you been cyber-bullied?" "During the past 6 months, how often have you cyber-bullied others?" "During the past 6 months, how often have you been cyber-bullied and being cyber-bullied others?" Items were rated on a four-point Likert scale, scored as follows: never = 1, < 1 per week = 2, > 1 per week = 3, and almost daily = 4. The construct reliability (CR) of these three items was 0.958, which was satisfactory in terms of measuring the constructs of interest because it exceeded 0.5.

Screen Time Scale

Screen time was measured using three items modified from the Youth Screen Time Survey. The method used to measure screen time in this study followed the standard methods used in several other peer-reviewed studies. Adolescents were asked to report the number of minutes devoted to the following three typical activities on weekdays and weekends: (1) "television (movies/videos/YouTube, playing console/video games)," (2) "using personal computers (such as, laptops/tablets/iPads either for browsing, YouTube, and/or social media activities)," and (3) "smartphone devices (for online games, browsing, social media connections, and/or online shopping)." The daily time spent on each screen time activity was calculated by averaging the weekday and weekend screen times of the three typical activities and dividing by 7. The average total weekday and weekend screen time for each type of activity was divided by 7 and categorized into a six-point Likert scale as follows: < 2 h = 1, 2–4 h = 2, 4–6 h = 3, 6–8 h = 4, 8–10 h = 5, and ≥ 10 h = 6. The CR for screen time measurement was 0.759, which was satisfactory in terms of measuring the constructs of interest.

Abuse Scale

The construct of abuse was measured using three items from the Adverse Childhood Experiences (ACE) scale in the CDC-Kaiser Permanente Adverse Childhood Experiences Study (28). The three modified questions were as follows: "In the past 3 months, did a parent or other adult in the household often or very often push, grab, slap, or throw something at you? or ever hit you so hard that you had marks or were injured?" "In the past 3 months, did an adult or person at least 5 years older than you ever swear at you, insult you, or put you down?" and "In the past 3 months, did you often or very often feel that you did not have enough to eat, had to wear dirty clothes, and had no one to protect you? or your parents or anybody else in your home were not taking good care of you or giving you enough love as you

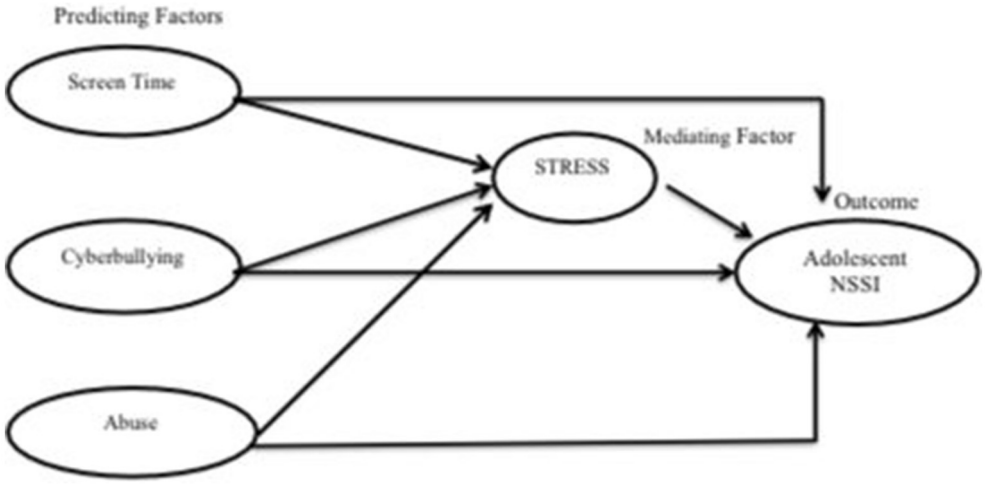

FIGURE 1 | The pattern of construct interaction pathway of predictors (screen time, cyberbullying, abuse), stress as the mediating variable, and adolescents' NSSI as the dependent variable (outcome).

needed?" The items were scored as yes = 1 and no = 2. The CR of the abuse scale was 0.955, which was satisfactory in terms of measuring the constructs of interest.

Stress Scale

The stress scale was developed using seven items modified from the Depression Anxiety Stress Scale-21 (DASS-21) (29). It is a quantitative measure of the general symptoms of stress in the past 7 days across clinical, community, and non-clinical samples (30–32), and different countries, cultures, and languages (33–36). The seven modified items consisted of the following: "I find myself getting upset because of minor issues," "I have a tendency to over-react to different situations," "I find it is hard to relax," "I find myself easily getting upset," "I feel that I am using a lot of energy to feel worry," "I find myself getting impatient when something needs to be postponed (i.e., queuing, waiting for class, traffic jams, etc.)," and "I am easily getting irritated." Items were scored on a four-point Likert scale, as follows: never = 1, sometimes = 2, always = 3, and almost always = 4. The CR of the stress scale was 0.766, which was satisfactory in terms of measuring the constructs of interest.

NSSI Scale

Non-suicidal self-injury (NSSI) was measured using three items modified from Wiguna et al. and Sourander et al. (25, 27). The modified questions were as follows: "In the past 6 months, did I ever hurt myself deliberately, such as intentionally self-injured," "In the past 6 months, did I ever seriously consider killing myself," and "In the past 6 months, did I ever try to defeat myself." The items were scored as yes = 1 and no = 2. The CR of the NSSI scale was 0.953, which was satisfactory for measuring the constructs of interest.

Sociodemographic Questions

The sociodemographic questions included eight items that inquired about the participants' age, sex, level of education, home-based and parental socioeconomic background. The questions were designed for nominal and categorical responses.

Data Analysis

The present study determined the primary predictors of NSSI (screen time, abuse, and cyberbullying) and confirmed that stress had a mediating effect on these predictors of adolescent NSSI during the COVID-19 pandemic. Therefore, structural equation modeling (SEM) analysis was performed using Lisrel version 8.8. The SEM analysis primarily aimed to explain the pattern of construct interaction pathways of several inter-related independence predictors simultaneously (screen time, cyberbullying, and abuse), stress as the mediating variable, and adolescent NSSI as the dependent variable or outcome (**Figure 1**). The SEM analysis is a strong technique for effectively addressing multicollinearity (when $\geq$ 2 variables are highly associated), which is one of the advantages of SEM over multiple regression and factor analysis. The mediating effect of stress can be described as follows: full mediation (a mediator fully explains the interaction of the predictor variable to predict the outcome, and there is no relationship without the mediator in the model), partial mediation (predictor variable has a direct significant interaction to predict the outcome, even when the mediator is removed from the model; the mediator only partially explained the inter-relationship), or no mediation (predictor variable does not have any direct significant interaction to predict the outcome and is not statistically significant even when the mediator is included). The construct interaction pathway to predict the adolescent NSSI in this study was considered to be statistically significant if each predictor and mediator exceeded the critical value of indicator's loading for $p < 0.05$ (critical t-value for the path >1.96) (37, 38).

Lisrel version 8.8 was used to analyze CR, which reflects the internal consistency reliability of the variable measurement scale. Reisinger and Turner reported that the CR coefficient

TABLE 1 | The construct reliability of the scales.

Construct	Items	Mean (SD)	Construct reliability (CR)
Cyberbullying	3	3.44 (1.56)	0.958
Abuse	3	4.34 (0.66)	0.955
Screen time	3	8.34 (3.21)	0.759
Stress	7	14.41 (4.64)	0.766
NSSI	3	3.5 (0.78)	0.953

of each measurement scale should be $\geq$ 0.6 as a prerequisite for further SEM analysis (36). The obtained CR coefficient in this study ranged from 0.759 for the screen time scale to 0.958 for the cyberbullying scale, and all CR coefficients were > 0.6 (**Table 1**). Hence, the reliability of all scales in the present study was acceptable for further SEM analysis using Lisrel version 8.8.

RESULTS

This study included 464 adolescents selected using a crowdsourcing sample collection method. The mean ($\pm$ SD) age of the cohort was 14.61 $\pm$ 1.65 years, and consisted of 66.7% females. Secondary high school was the highest educational background (58%), followed by senior high school (38.8%) and elementary school (3.2%). Participants were from several provinces in Indonesia; the greatest proportion was from Jakarta (68.5%), followed by West Java (10.6%), Banten Province (6.7%), East Java (4.5%), Central Java (2.8%), and Sumatra (2.5%). Most participants had parents with middle to high economic backgrounds (83.8%), while the remainder had a lower economic background (16.2%) (**Table 2**).

Results demonstrated that cyberbullying and abuse became significant positive direct predictors of adolescent NSSI during the COVID-19 pandemic (critical *t*-value for cyberbullying: 2.82; critical *t*-value for abuse: 4.38). However, screen time was not a direct predictor of adolescent NSSI (critical *t*-value: 1.85). Additionally, stress had a significant mediating effect on cyberbullying, screen time, and abuse in the relationship with adolescent NSSI (critical *t*-value: 5.27). Stress also had a full mediating effect on screen time in predicting adolescent NSSI, but only had a partial mediating effect on cyberbullying and abuse. Furthermore, cyberbullying, screen time, and abuse without the mediating effect of stress predicted 38% ($R^2 = 0.38$) of the variance in adolescent NSSI. Meanwhile, cyberbullying, screen time, and abuse with the mediating effect of stress could explain 48% of the variance in adolescent NSSI ($R^2 = 0.48$) (**Table 3**). Thus, stress as a mediator variable significantly multiplied the interaction between predictors (cyberbullying, screen time, and abuse) to predict adolescent NSSI during the COVID-19 pandemic in Indonesia (**Figure 2**). The mediating effects of stress were determined according to the significance of the interaction model (critical *t*-value for the path >1.96; $p < 0.05$). Hence, the research questions (i.e., Is there any possibility that mental health reactions during the COVID-19 pandemic, such as cyberbullying, screen time, and abuse, significantly predict adolescent NSSI? How does stress mediate the effects of cyberbullying, abuse, and screen time on adolescent NSSI during the COVID-19 pandemic?) were answered based on the SEM analysis.

TABLE 2 | Characteristic of research subjects ($n = 464$).

Characteristics	*n* (%)	Mean (SD)	Median (Range)	95% Confidence Interval of the mean
Age	464 (100)	14.61 (1.65)	14 (11–17)	14.45–14.76
Gender				
Boys	155 (33.4)			
Girls	309 (66.6)			
Home-based				
Jakarta	318 (68.5)			
West Java	49 (10.6)			
Central Java	13 (2.8)			
East Java	21 (4.5)			
Banten	31 (6.7)			
Yogyakarta	6 (1.3)			
Bali	2 (0.4)			
Sumatera	12 (2.5)			
Kalimantan	12 (2.5)			
Educational background				
Elementary school	15 (3.2)			
Secondary high school	269 (58)			
Senior high school	180 (38.8)			
Parental socio-economic level				
Low level income	75 (16.2)			
Moderate level income	183 (39.4)			
High level income	206 (44.4)			

TABLE 3 | Structural equation modeling (SEM) analysis results.

Construct	Model 1		Model 2	
	β	Critical *t*-value	β	Critical *t*-value
Cyberbullying → NSSI	0.14	2.82*	0.10	2.15*
Abuse → NSSI	0.35	4.38*	0.47	7.25*
Screen time → NSSI	−0.12	−1.85	0.22	3.50*
Mediating effect				
Stress → NSSI			0.41	5.27*
R^2 NSSI	0.35		0.48	

*p-value 0.05.

The structural equation path modeling in this study followed the recommendations of Turner and Reisinger (37) and Muller et al. (38) to select goodness-of-fit to measure the fitness of the structural model (37, 38). Based on confirmatory factor analysis of the structural path modeling, the construct showed a significant model of fitness (root mean square error of approximation = 0.038; normed fit index = 0.95; comparative

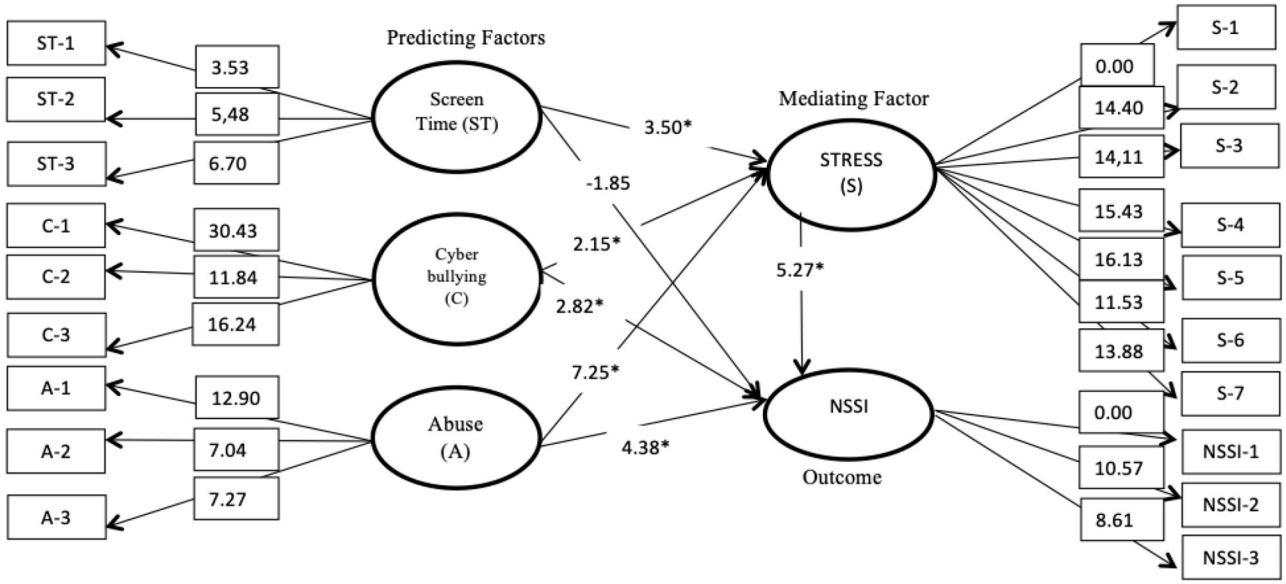

FIGURE 2 | The construct theoretical model of adolescent NSSI based on the SEM analysis including the critical *t*-value (Statistically significant on critical *t*-value >1.96 and $p < 0.05$). The analysis showed that stress significantly and fully mediated the relationship between screen time and adolescent NSSI. However, it only had a partial significant mediating effect on cyberbullying and abuse. The theoretical construct analysis was significantly fit to the model. *$p < 0.05$; Root Mean Square Error of Approximation = 0.038, Normed Fit Index = 0.95, Comparative Fit Index = 0.98, Relative Fit Index = 0.94, Non-Normed Fit Index = 0.98, Standardized Root Mean Square Residual = 0.049, Goodness-of-Fit Index = 0.95, Adjusted Goodness-of-Fit Index = 0.93).

fit index = 0.98; relative fit index = 0.94; non-normed fit index = 0.98; standardized root mean square residual = 0.049; goodness-of-fit index = 0.95; and adjusted goodness-of-fit index = 0.93).

DISCUSSION

The COVID-19 pandemic is ongoing, and mental health consequences cannot be avoided by everyone. Adolescence is a period of turmoil, as young people seek independence and struggle to find their identity. The major developmental task during this period is to improve social skills, become empathetic individuals, and find their true identity. These developmental tasks arise through connections with peers. Therefore, disrupted connections with social contexts and peers may have several implications for their mental well-being. Moreover, the immaturity of the prefrontal cortex during adolescence may make these individuals significantly more vulnerable to various mental health consequences during this pandemic (11).

During the COVID-19 pandemic, the lack of direct social connectedness with peers due to stay-at-home policies may have strengthened feelings of loneliness and social isolation. Therefore, adolescents alternatively engaged in more screen time during their daily activities (1). This study revealed that screen time did not directly predict adolescent NSSI, but demonstrated that stress was a perfect mediating factor of screen time and adolescent NSSI. Screen time is defined as the quantity of time spent and the diverse activities performed online using digital devices (39). This study found that the average screen time was around 4–6 h per day and was used for (1) watching television (such as movies/videos/YouTube and/or playing console/video games), (2) personal computers (such as laptops/tablets/iPads for browsing, YouTube, and/or social media activities), and (3) smartphone devices (for online games, browsing, social media connections, and/or online shopping). We found that the average screen time among adolescents was in keeping with the screen time prescribed by the American Academy of Child and Adolescent Psychiatry (from the recommended hours to more than 6 h). Hamilton et al. explained that an appropriate amount of screen time devoted to social media or other activities may act as a protective factor for mental health among adolescents because it can provide appropriate physical and mental health information, academic materials, maintain social connections with peers, and facilitate self-expression (40). On the other hand, several studies have focused on the potentially harmful mental health effects of increased screen time, such as high exposure to false or misinformation on physical and mental health related to the COVID-19 pandemic, cyberbullying, and age-inappropriate media programs. Moreover, many adolescents may have insufficient basic knowledge, understanding, and perception to assess the accuracy of this information because of prefrontal cortex immaturity (38–41). Thus, the cognitive processes that follow screen time for television, personal computers, or smartphones may trigger adolescents to feel stressed, leading them engage in NSSI behavior to cope with these uncomfortable feelings.

Interestingly, stress was found to be a partial mediating factor for cyberbullying and abuse (as a predictor factor) of NSSI. Cyberbullying and abuse directly and significantly predicted adolescent NSSI; however, the association was more

significant through the mediator effect (stress). Cyberbullying is defined as a type of bullying exerted through devices such as computers, laptops, or smart phones on Internet and social media applications (25). In 2012, Langos explained that it can occur either directly or indirectly depending on privileged or public posts, including negative content that embarrasses others on private text messages or pictures through social media platforms (Whatsapp, Path, and Line, or private e-mail) (42). Extensive Internet use during the COVID-19 pandemic can heighten loneliness and impulsive behaviors toward other adolescents, such as domestic abuse, cyberbullying, and other high-risk and self-injurious behaviors (43–45). In 2018, Wiguna et al. found that cyberbullying increased the risk for high-risk behaviors such as self-harm, suicidal ideation, and attempted suicide (25). This process is related to brain networks. First, the socio-emotional network reacts to the reward processing part of the brain and subtle emotional stimuli. The second network is cognitive control, which plays an important role in planning, rational thinking, and self-regulation. During adolescence, the socio-emotional network becomes more dominant compared to the cognitive control network due to the immaturity of the prefrontal cortex (46). Hence, adolescents may be more easily engaged in impulsive and hostile behaviors.

The COVID-19 pandemic is a global crisis affecting every sector of life, such as health, economies, and family quality of life (47). Thus, it may cause disruptions in many family systems, not only due to lockdowns, stay-at-home orders, school from home, social distancing, and difficulties with access to health services, but also because of the sudden and possibly long-term family poverty and uncertainty (48, 49). Moreover, Martinkevich et al. explained that pandemics produce a deviant situation in which adolescents' socio-ecological systems are disrupted and, consequently, the incidence of abuse is likely to increase (50). The socio-ecological model explained that the COVID-19 pandemic may alter adolescents' cognition, emotions, behaviors, and fundamental mechanisms due to limited access to their developmental needs. Hence, these mutual interaction processes manifest as changing psychological, interpersonal, well-being, and environments, and in the ways in which adolescents adapt to and modify these environments (51). At the microsystem level, it may possibly increase oppositional and impulsive behaviors and limit testing among adolescents. This hostile behavior may elicit punitive responses from parents (52). They may also experience parental burnout, either constrained or worsened by the consequences of the pandemic. Adolescents' own stress and uncertainty regarding the pandemic may worsen the feeling of tension and they may become violent toward themselves due to limitations in their capacity to make decisions (53).

The study findings revealed that stress significantly mediated the predictors and, thus, the effects on NSSI behavior were more heightened. Liu and Miller (54) reported that stress is theoretically and empirically associated with an increased risk of self-injury, particularly in the form of suicidal ideation and behavior (55). The finding that stress possibly acts as a primary mediator of adolescent NSSI was supported by several theoretical conceptualizations that originally came from the two distinct processes with four functional elements of NSSI (56). NSSI behavior was strengthened by two distinct processes that consisted of four functional elements: positive and negative reinforcements in intrapersonal emotional regulation processes and interpersonal function processes. Intrapersonal emotional regulation processes include negative reinforcement that releases the conflict or a decrease in the negative affect following engagement in NSSI and positive reinforcement that is involved in the urge to feel pain or act on the feelings of guilt through self-punitive behavior. Interpersonal function processes include positive reinforcement wherein NSSI serves as a means of communicating with the unconscious mind for help and support and negative reinforcement that interrupts negative interpersonal interactions following NSSI. Such interpersonal functions may be relevant to adolescents because of the immaturity of brain's cognitive networks that impair interpersonal problem-solving skills and deprive them of general communication abilities (54, 57, 58). Nevertheless, stress during the COVID-19 pandemic became a mediating presence of a form of distress across the four functional elements, which could be the reason behind adolescents' engagement in NSSI to cope with this distress.

Based on the study findings, expanding adolescent mental health programs that can promote better coping strategies to manage stress related to cyberbullying, abuse, and increased screen time, such as coping with stress and positive attitudes toward stress, may be redesigned to ensure adequate self-adjustment during this pandemic. Furthermore, adolescent stress-reduction programs may be developed to improve coping strategies on these difficult days. Adolescent mental health programs are usually conducted at schools because adolescents spend most of their time at school. However, during the pandemic period, this program may be conducted online. Hence, adolescent mental health intervention programs that promote effective coping strategies to manage stress during the COVID-19 pandemic, such as active solution-orientation, stress resolution, conflict with stress, mindfulness, and positive attitude instead of holding back problems to one self may be designed to ensure adequate emotional adjustment (59). Several studies reported that sufficient regulation of emotions, including correct problem-solving skills and creating positive emotions in daily life through shared actions using networks and information and communication technologies (ICT) were very helpful to reduce stress during this COVID-19 pandemic (60, 61). Alternatively, psychoeducation programs may be developed in a very small group of adolescents in a "safe-haven" environment to enhance coping strategies and emotional regulation toward stress (62). Even for adolescents learning from home, schools should strive to intensify social support, encouragement, reassurance, and offer mental health services and programs, especially to those with existing mental health issues that enhance their vulnerability to stress (63).

Nevertheless, this study had several limitations. First, other factors that may be associated with adolescent NSSI, such as genetics, parenting, the role of devices, subjective feelings during the COVID-19 pandemic, and previous mental health history were not addressed. Therefore, further studies can elaborate these using a similar model. Second, the questionnaire relied on adolescents' self-reporting recruited through crowdsourcing, which may introduce biases related to misunderstanding or misreporting to avoid stigma and forgetting experiences that

have already happened that triggered the recall/response bias. However, the study minimized these biases by providing detailed text explanations before the participants started the survey and provided a detailed explanation of each question. Third, the study was conducted online and may have only covered adolescents with access to the Internet. Future studies may be designed with mixed method data collection (i.e., online and offline surveys) so that it can include more adolescents, especially those without access to the Internet. Data were collected from August to early October 2020. This period was considered to be the second wave of the COVID-19 pandemic, and it came together with the beginning of the new online academic semester; therefore, the participants may have been overwhelmed. Future studies should consider the time period required for data collection to reduce unpredictable bias. Meanwhile, the study was conducted with a cross-sectional design, and it may not reflect the cause-and-effect relationship. Therefore, future studies can be designrd to determine the cause-effect relationship between adolescent NSSI, stress, cyberbullying, and other related factors.

To our knowledge, this study was the first in Indonesia and, perhaps, in Southeast Asia, to construct and analyze a theoretical model that can predict and explain adolescent NSSI during the COVID-19 pandemic. Stress was found to be a mediating factor in the relationship of adolescent NSSI with screen time, cyberbullying, and abuse. Therefore, the theoretical model can be applied further to design adolescent mental health programs, especially those associated with coping with stress in daily life.

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 Ethics Committee of the Faculty of Medicine of Universitas Indonesia. Informed consent to participate in this study was provided by the study participants.

AUTHOR CONTRIBUTIONS

TW: designing, analyzing, and writing the results and discussion. KM: designing, writing discussion, and results analyzing. FK and RI: designing and writing discussion. EW: results analyzing and wrting discussion. BM: designing and results analyzing. KP: editing the document and contributing in the table analyzing. All authors contributed equally for this paper.

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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.2021.743329/full#supplementary-material

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Factors Influencing Residents' Psychological Status During Standardized Training in COVID-19

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Objectives: To explore the influencing factors of residents' psychological status during standardized training in COVID-19 for finding ways to promote their mental health.

Methods: A total of 760 residents were surveyed with a structured questionnaire. Correlation analysis was used to analyze the influencing factors of psychological status of the residents, and a mediation model was constructed to verify the mediating role of satisfaction.

Results: Age, willingness to study medicine, and satisfaction were positively correlated with negative psychological status ($P < 0.05$). And gender, only child or not, and annual household income (RMB) were negatively correlated with negative psychological status ($P < 0.01$). Residents' satisfaction with standardized training mode plays a complete mediating role between annual household income and negative psychological status.

Conclusions: Our findings emphasize the importance of concentrating on resident's psychological status and family economic situation. And relative departments should take action to optimize the standardized training mode to improve the satisfaction.

Keywords: residents, psychological status, standardized training mode, family economic, satisfaction

INTRODUCTION

The world has been facing a pandemic of Corona Virus Disease 2019 (COVID-19), and this public health emergency was first reported in Wuhan, China, at the end of 2019 (1). At present, some countries have entered a stable period, but some countries are still in the epidemic period. Plenty of experts and scholars pointed out that this disease not only affects physical health, but also seriously affects mental health (2), such as depression, anxiety, mood disorders, sleep disorders, post-traumatic stress disorder, and so on (3). Some scholars paid special attention to the medical staff (4), standardized training residents of whom are a special group. They are in the process of standardized training while preventing and controlling infection. However, due to the competitive pressure, insufficient economic ability, heavy learning and family burden, their psychological pressure will be much higher than that of the general medical staff. A previous study evaluated

the impact of the COVID-19 pandemic on the training program for obstetrics and gynecology residents in Italy, and the results showed that 84% of residents reported anxiety about their career future (5).

Standardized training in China started late and the system is not yet comprehensive, causing many residents to be dissatisfied with the training model, then lead to psychological pressure. According to a survey in 2015, only 33% of trainees were satisfied with the standardized training mode in Shenzhen, China (6). Similarly, 183 students do not support the standardized training system among the 600 undergraduate students who majored in clinical medicine. The main reason is that the income during the standardized training cannot meet their expenses (7). Smith et al. reported that Oral and Maxillofacial Surgery Residents' increased stress was related to significantly decreased odds of satisfaction (8). And job satisfaction has the strongest association with mental/psychological problems, such as burnout and depression (9).

Family factors are also often reported to be associated with negative attitudes, with family economic situation being most often concerned. Family income instability was shown to worsen depression among college students during COVID-19 epidemic (10), which is similar to Fadilah et al.'s findings (11).

Standardized training is an important part of post-graduation education for medical students and is extremely important for training high-level clinical physicians and improving the quality of medical care. Residents can experience the whole standardized training process most directly, and their satisfaction with the training model and mental health are very worth exploring and improving, but there are few researches on the mechanism. This study focuses on the psychological status of residents during standardized training in the public health emergency, and aims to analyze the impact of residents' family economic situation and their satisfaction with the training model on their psychological status, for providing the guidance for promoting mental health.

METHODS

Participants

This study was a cross-sectional study using non-probability convenience sampling to select samples among residents during standardized training in four tertiary hospitals in Wuhan, Hubei Province (Tongji Hospital, Union Hospital, Zhongnan Hospital and Renmin Hospital) from January 2021 to April 2021. The sample size was estimated using the calculation formula of cross-sectional survey: $N \geq Z^2_{1-\alpha/2}p(1\text{-}p)/\delta^2$, $\alpha = 0.05$, $Z_{1-\alpha/2} = 1.96$, $p = 35\%$ [according to a research in 2021(12)], $\delta = 0.1p$. Respondents completed an online self-designed anonymous questionnaire and a total of 760 residents participated in this survey, which meets the requirement for sample size. And our questionnaire response rate was good (100%). This study was approved by the Ethics Committee of Wuhan Municipal Health Committee (KY2018.26) and we had obtained informed consent from the interviewees before conducting the survey.

Measures

Annual family income, psychological status, and satisfaction of standardized training mode (henceforth referred to as satisfaction) were assessed by different items.

Annual family income (RMB) $1 \leq 50{,}000$, 2 = 50,000–100,000 (including 50,000), 3 = 100,000–150,000 (including 100,000), 4 $\geq$ 150,000.

Psychological status was measured using the DASS-42 (test-retest reliability: 0.884, interval is 2 weeks) (13). DASS-42 was developed in 1995 by Lovibond and Lovibond (14) and Chinese version of DASS-42 was provided by the original author with good internal consistency, face, and content validity. The DASS-42 are divided into three subscales and each subscale consists of 14 questions, which are the depression subscale, the anxiety subscale, and the stress subscale. Each item was scored using a Likert four-point scale ranging from 0 = Did not apply to me at all to 3 = Applied to me very much or most of the time. **Table 1** presents the scoring criteria for the degree of depression, anxiety and stress.

Satisfaction Respondents were asked about their satisfaction with standardized training mode (1 = very satisfied and 5 = very dissatisfied).

Other variables Family factors include only child (1 = Yes, 2 = No), marriage (1 = Married, 2 = Unmarried), willingness to study medicine (1 = My will, 2 = Not my will), family members with a medical background (1 = Yes, 2 = None).

Statistical analysis was conducted using the SPSS 24 version program. The descriptive analysis was used to determine the demographic characteristics of the participants. Pearson correlation analyses of the study variables were conducted. The SPSS Process was used to test the effects of family income on psychological status through satisfaction. The bootstrapping method was used to verify mediation effects. In this study, we bootstrapped 5,000 samples from the data, and 95% bootstrap confidence intervals (CI) were calculated. The conceptualized model was shown in **Figure 1**.

RESULTS

Sample Characteristics

The mean age of the participants was 26.60 years (SD = 1.92). The sample consisted of 760 residents. 49.1% (n = 373) were male. A total of 508 (66.8%) participants were only child. Majority of respondents followed their own wishes when choosing a medical specialty. Over 80% participants were not satisfied or very dissatisfied with the standardized training mode. **Table 1** shows the detail of sample characteristics.

Negative Psychological Status of Residents

Of all respondents, 47.0% were depressed, 49.3% were anxious, and 48.4% were stressed. And more than 10% were in very terrible condition, of which 83 were in a very severely depressed state, 105 were extremely anxious and 97 were extremely nervous. Specific scores and degrees of depression, anxiety and stress (**Table 2**).

TABLE 1 | Sample characteristics ($N = 760$).

Categorical variables	Mean ± SD/n (%)
Age (years)	26.60 ± 1.92
Gender	
Male	373 (49.1)
Female	387 (50.9)
Only child or not	
Yes	508 (66.8)
No	252 (33.2)
Married or not	
Married	118 (15.5)
Unmarried	642 (84.5)
Willingness to study medicine	
My will	596 (78.4)
Not my will	164 (21.6)
Annual household income (RMB)	
<50,000	289 (38.0)
50,000–100,000 (including 50,000)	297 (39.1)
100,000–150,000 (including 100,000)	112 (14.7)
>150,000 (including 150,000)	62 (8.2)
Family member with medical background	
Yes	157 (20.7)
None	603 (79.3)
Satisfaction with standardized training mode	
Very satisfied	1 (0.1)
Satisfied	43 (5.7)
Doesn't matter	61 (8.0)
Not satisfied	319 (42.0)
Very dissatisfied	336 (44.2)

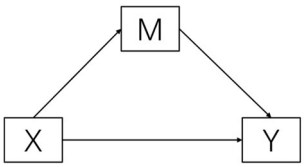

FIGURE 1 | Conceptual diagram.

TABLE 2 | Scores and degrees of depression, anxiety, and stress.

	Score	Degree	*n* (%)
Depression	11.92 ± 9.87	1	403 (53.0)
		2	93 (12.2)
		3	115 (15.1)
		4	66 (8.7)
		5	83 (10.9)
Anxiety	10.34 ± 8.876	1	385 (50.7)
		2	45 (5.9)
		3	139 (18.3)
		4	86 (11.3)
		5	105 (13.8)
Stress	16.21 ± 12.450	1	392 (51.6)
		2	67 (8.8)
		3	118 (15.5)
		4	86 (11.3)
		5	97 (12.8)
Total	38.471 ± 30.651		760 (100)

TABLE 3 | Correlation analysis.

	Depression	Anxiety	Stress
Age	0.085*	0.103**	0.097**
Gender	−0.248***	0.222***	0.235***
Only child or not	−0.215***	0.226***	0.221***
Married or not	−0.068	−0.095**	−0.075**
Willingness to study medicine	0.189***	0.174***	0.204***
Annual household income	−0.108**	−0.098**	−0.098**
Family member with medical background	0.060	0.065	0.046
Satisfaction with standardized training mode	0.239***	0.233***	0.237***

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

TABLE 4 | Total, direct, and indirect effect.

	Effect	BootSE	BootLLCI	BootULCI
Indirect effect	−0.711	0.282	−1.306	−0.226
Direct effect	−1.996	1.182	−4.333	0.301
Total effect	−2.707	1.159	−4.950	−0.400

Correlation Analysis

In our study, gender, only child or not, willingness to study medicine and satisfaction with standardized training mode were most significant influencing factors ($P < 0.01$). Age was positively correlated with negative psychological status ($P < 0.05$). And annual household income (RMB) was negatively correlated with negative psychological status ($P < 0.01$). More details were presented in **Table 3**.

Mediation Analysis of Satisfaction on Negative Psychological Status

Table 4 showed total effect, direct effect and mediation effect, which revealed a mediation role of satisfaction in the relationship between annual household income and negative psychological status. The direct effect of annual household income on negative psychological status was negative and not significant, with the CI from −4.333 to 0.301. However, the indirect effect through satisfaction is significant with CI from −1.306 to −0.226, indicating the role of complete intermediary of satisfaction.

DISCUSSION

Psychological Status of Residents

The results of the study showed that the psychological status of medical students during COVID-19 was not very optimistic

in general. There may be three obvious reasons for such a result. The most direct reason is that the workload has increased and the work process has become complicated during COVID-19. Compared with healthcare workers who have not been in contact with COVID-19 patients in the workplace, those who encountered COVID-19 patients faced more task load among Iranian medical staff (15). For instance, the application of personal protective equipment is very necessary for preventing infection, but the use of protective equipment greatly increases the workload and fatigue of healthcare workers (15, 16). Simultaneously, Liu et al. emphasized that intensive work can increase physical and emotional stress (17). In addition to daily medical work, residents also need to participate in regular training, while preparing various types of examinations. The exam pattern was changed because of the epidemic and medical courses or training programs are difficult and challenging, they need to contend with new test formatting in a short period, which may cause higher levels of examination anxiety (18, 19). Second, the income of residents is low during the training period (20). Low personal income may lead to dissatisfaction with life (21). And low socioeconomic status (SES), which includes per capita household income, is directly associated with increased mental health problems in children and adolescents (22, 23). Children and adolescents with low SES are two to three times more likely to have mental health problems than their peers with high SES (24). Finally, it is worth mentioning that we speculate that age may also be an influencing factor. Non-medical peers may already have independent financial capacity and work achievement. In contrast, medical students may feel additional pressure.

Factors Influencing Psychological Status of Residents

Age

Numerous studies have demonstrated that younger individuals are more likely to produce negative psychological status (3). For example, Losada-Baltar et al. found that older adults reported lower levels of anxiety and sadness than middle aged adults, and middle-aged adults reported lower levels than younger participants (25). Moreover, Liu et al. indicated that larger (more negative) error-related negativity associated with more anxiety in older girls, whereas smaller error-related negativity associated with more anxiety symptoms in younger girls (26).

Gender

It seems that people all have a mindset that women always seem to be perceived as emotional, so their emotions are usually unstable and more likely to be negative (27). But our study showed the opposite results. Some experts believe that males may suppress the expression or release of emotions, but in fact they are experiencing psychological pain (28). So, our results may be more real.

Only Child or Not

Residents with siblings perform better when socialized and also cope better in crisis situations (29), and non-only children will receive more support when encountered difficulties.

Marriage

Studies have shown that married patients show better psychological adaptation and physical health (30). People with a spouse may be more likely to receive trustworthy emotional support in a dilemma. Specifically, research on help-seeking behavior has demonstrated that people think of their partners when they need help (31). The result is similar to Becker et al.'s study, who found that in both the children's network and the family network, the second major support comes from the partner (32).

Willingness to Study Medicine

Gu (33), from Shihezi University, found that when Chinese high school students choose college majors, they will finally prefer parental decisions rather than their own decisions. That is, some medical students may be reluctant or have insufficient interest when they enter the medical field at the beginning. Interest in learning is the starting point of education, as it can motivate students to learn, and students' learning performance can be significantly improved through their interest in learning. If a person's interest in learning can be improved, then the person's cognitive function, perseverance, and affect can be enhanced (34). Consequently, it may not be enough to support them to maintain a good positive attitude in subsequent learning if the medical specialty is not their own will.

Annual Household Income

Emotions can be directly or indirectly influenced by household income. Najman et al. found that family poverty is a risk factor for children to feel anxious and depressed. Namely, the higher the frequency of exposure to poverty, the higher the child's risk of feeling anxiety and depression (23). An empirical analysis showed that family income impact children's health by being significantly associated with parents' emotional well-being (35).

Family Member With Medical Background

Contact with family members with medical background enables residents to receive more professional support. When seeking help, people tend to trust people who have the same experience as themselves (36). Family members with medical background have similar knowledge structure and learning experience to residents, which is conducive to providing effective support and advice and can greatly alleviate the pressure.

Satisfaction With Standardized Training Mode

Satisfaction has been shown to be related to psychological status. Women who are dissatisfied with relationships (such as intimacy) have higher levels of postpartum depression symptoms (37). College students' satisfaction with academic performance in Hong Kong was negatively associated with mild to severe depression (38). What's more, job satisfaction is also related to mental health (9).

The Mediation Role of Satisfaction

The mediation result of the study showed that satisfaction was a very important mediator between annual household income and negative psychological status. Actually, economic situation is the basis of a family, and different economic

conditions may lead to different family structures and family atmosphere. Moreover, a wide variety of family factors can affect a person's personality characteristics and then probably influence a people's thoughts and behaviors (39). For example, extraversion and neuroticism significantly mediated family conflict and life satisfaction in a research conducted by Xi'an Jiaotong University (40). And another study analyzed the influence of personality on psychological health and provided evidence on considering personality traits as a relevant predictor of differences in health conditions of adults during COVID-19 epidemic (41). Therefore, annual household income can have a great impact on residents' satisfaction with standardized training mode.

There were several limitations in our study. First, our study used convenience sampling, and a more precise sampling method may need to be used in future studies. Second, given the study's cross-sectional design, it is difficult to draw definitive causal conclusions regarding the long-term effect of the current pandemic. Third, selection bias cannot be excluded, and the results may not be applicable to all countries. However, the results are in line with those reported by previous similar cross-sectional study on psychological state of residents. Indeed, the study that examined the psychological impact of COVID-19 on Italian orthopedic residents found that the pandemic had an important social impact on residents' perceptions and emotional well-being (42), manifesting in the worsening by the HADS score and the depression subscale of this score after the national lockdown.

CONCLUSION

The present study verified the fully mediating effect of satisfaction. Relevant departments also need to improve the training model for improving the satisfaction of residents. And Hospitals need to care about the family economic situation of residents and pay targeted attention to their psychological status.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Wuhan Mental Health Center, Huazhong University of Science and Technology. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DX and BLia: writing-original draft, writing-review and editing, and analyses. YW and BC: methodology. CX and SZ: conceptualization, writing-review and editing, and supervision. BLi, JP, and CY: conceptualization and analyses. All authors contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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The Mental Health Impact of COVID-19 Racial and Ethnic Discrimination Against Asian American and Pacific Islanders

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Hate crimes against Asian American/Pacific Islanders (AAPIs) have surged in the United States during the COVID-19 pandemic to alarming new levels. We analyzed data from the Healthy Minds Study, and found that COVID-19 related racial/ethnic discrimination was associated with greater odds of having depression, anxiety, non-suicidal self-injury, binge drinking, and suicidal ideation among AAPI university students (N = 1,697). Findings suggest that the COVID-19 pandemic precipitated discrimination, which has been linked to mental health problems, calling for more preventive interventions to address the AAPI population, especially given their low rates of formal treatment utilization.

Keywords: racism, COVID-19, pandemic (COVID-19), Asian American (AA), discrimination, mental health, college

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INTRODUCTION

Racism against Asian American Pacific Islanders (AAPI) is not a new phenomenon in the United States, but reports of discrimination and hate crimes against this community have surged to new heights during the COVID-19 pandemic. The term "AAPI" refers to any individuals living in the United States who identify as Asian or Pacific Islander, including both US citizens and non-US citizens. According to the Pew Research Center (1), about 40% of Asian American adults reported that other people were visibly uncomfortable around them since the start of the pandemic. According to the Center for the Study of Hate and Extremism (2), anti-Asian hate crimes increased by almost 150% across 16 of the country's largest cities in the year 2020. And between March 19, 2020 and February 28, 2021, the Stop AAPI Hate reporting center documented 3,795 hate incidents, ranging from online harassment to physical assault (3). One example of these hate incidents occurred at a metro station in Washington, DC when a man punched and/or pushed two Asian individuals while yelling racial slurs; this same man was later seen entering a Chinese tea store and pepper spraying the owner (3). The list of hate crimes is harrowing and continues to grow (4); we should note that many hate crimes go unreported. Much of this racism has been fueled by a xenophobic narrative that AAPI's are somehow responsible for the COVID-19 pandemic, underscoring a long-held view that AAPIs are perpetual foreigners who do not belong in the country (5). This racialization of COVID-19 has the potential to produce long-lasting effects on attitudes toward AAPIs, which is alarming since a substantial body of research has linked racial discrimination to adverse mental health outcomes as well as lower use of formal psychiatric treatment (6). In this study, we analyzed a sample of AAPI university students from across the

country to examine the associations between COVID-19 related racial/ethnic discrimination and mental health outcomes during the pandemic.

METHODS

We analyzed data the 2020 Healthy Minds Study (HMS), which is a cross-sectional, web-based survey examining mental health and related factors in students enrolled at one of 29 universities. Among participating institutions, eight are Associate's Colleges, three are Baccalaureate Colleges, four are Master's Colleges and Universities, and 14 are Doctorate-granting Universities. Six of the colleges and universities are private institutions, and the remaining 23 are public institutions. The HMS is designed to protect the privacy and confidentiality of participants, and has been approved by the Health Sciences and Behavioral Sciences Institutional Review Board at University of Michigan. To further protect respondent privacy, the study is covered by a Certificate of Confidentiality from the National Institutes of Health. The study survey was administered between September through December of 2020.

While COVID-19 related ethnic/racial discrimination was reported by multiple racial/ethnic groups, AAPIs were by far the most impacted. Using the entire sample of respondents who completed the COVID-19 module, we found that being AAPI students were more than 17 times as likely as white students to have experienced racial/ethnic discrimination in the context of COVID-19, adjusting for age and gender (aOR: 17.45; 95% CI: 12.25–24.86). Thus, for the purposes of this report, we restricted our analysis to AAPI students ($N = 1{,}697$). The mean age of this AAPI sample was 23.78 years old (95%CI: 23.15–24.41), and the majority was cis-gendered women (67.88%; $n = 1{,}152$).

To adjust for potential differences between responders and non-responders, sample probability weights were applied. HMS obtains administrative data from participating institutions, including gender, race/ethnicity, academic level, and grade point average to construct response weights, equal to 1 divided by the estimated probability of response, using a logistic regression to predict the likelihood of response associated with each variable.

Respondents were asked a single binary item (yes/no): *As a result of the COVID-19 pandemic, have you experienced any discriminatory or hostile behavior due to your race/ethnicity (or what someone thought was your race/ethnicity)*? We examined this question in relation to several mental health outcomes: depression, anxiety, binge drinking, non-suicidal self-injury, and suicidal ideation. We conducted multivariate logistic regression models, adjusting for age and gender, to assess the impact of discrimination on these mental health outcomes.

We focused on binary measures of mental health because most of the measures have been validated based on standard cutoffs. We examined symptoms of depression using the Patient Health Questionnaire (PHQ-9). The PHQ-9 has been validated as internally consistent and highly correlated with clinical diagnosis, including among people of color (7). We used the standard cut off of >15, indicating moderately severe to severe depression. Anxiety was measured using the Generalized Anxiety Disorder-7 scale which has been used in racially diverse samples (8). We used the standard cut off of a score higher than 10, which has been shown to have high specificity and sensitivity in indicating moderate to severe anxiety (8). Binge drinking was assessed dichotomously, with a positive endorsement if respondents reported binge drinking (4 if female and 5 if male alcoholic drinks in a row) at least once during the past 2 weeks. This item originated from the College Alcohol Study and validated in college populations (9). Non-suicidal Self-injury was dichotomized using a positive endorsement of the following item developed for the Healthy Minds Study: In the past year, have you ever done any of the following intentionally: Cut myself, burned myself, punched or banged myself, scratched myself, pulled my hair, bit myself, interfered with wound healing, carved words or symbols into skin, punched or banged an object to hurt myself, other? Suicidal ideation was assessed using the single binary item (yes/no): In the past year, did you ever seriously think about attempting suicide?

RESULTS

Among the AAPI students, over a quarter reported experiencing COVID-19 related racial/ethnic discrimination (**Table 1**). Over two-thirds of respondents who endorsed this item met the criteria for at least one clinically significant mental health condition. Using multivariable logistic regression models, we found that COVID-19 related racial/ethnic discrimination was associated with greater odds of having moderately severe or severe depression, moderate to severe anxiety, any binge drinking over the past 2 weeks, non-suicidal self-injury, and suicidal ideation, adjusting for age and gender (**Table 2**). Findings are summarized in **Figure 1**.

DISCUSSION

While considerable literature has shown that exposure to racial/ethnic discrimination increases odds of having mental health problems (6, 10–12), a growing body of literature has documented the increase in discrimination and stigmatization during the pandemic, especially against Asians across the globe (13, 14). The current study builds on emerging literature by showing the potential mental health effects of racial/ethnic discrimination specifically in the context of COVID-19 pandemic among Asian American college students, which should be factored into the overall health and economic burden of the pandemic. To the best of our knowledge, the specific impact of pandemic-related discrimination has not been studied at the national level, in young and emerging adults who identify as Asian American.

These findings should be interpreted bearing in mind that racial/ethnic discrimination was self-reported, which is prone to both under- and over-reporting (15). Moreover, the study used a non-probability sampling strategy that yielded a response rate of 14%, which is admittedly low but common for these types of online surveys (8). We did however use sample probability weights to adjust for non-response using the following administrative data on full student populations: gender, race/ethnicity, academic level, and Grade Point Average. Still, it remains to be seen whether these associations are generalizable

TABLE 1 | Associations between COVID-19 related racial/ethnic discrimination and mental health outcomes among American/Pacific Islander students from the Healthy Minds Study, September–December 2020.

	Descriptive statistics			
	Total ***N* = 1,697**	**No discrimination** ***N* = 1,262 (74.37%)**	**Discrimination** ***N* = 435 (25.63%)**	***P*-value**
Depression				
No	1,395 (83.88%)	1,073 (86.95%)	322 (75.06%)	<0.001
Yes	268 (16.12%)	161 (13.05%)	107 (24.94%)	
Anxiety				
No	948 (76.58%)	1,203 (72.30%)	255 (59.86%)	<0.001
Yes	290 (23.42%)	461 (27.70%)	171 (40.14%)	
Binge drinking				
No	1,372 (80.85%)	1,039 (82.33%)	333 (76.55%)	<0.001
Yes	325 (19.15%)	223 (17.67%)	102 (23.45%)	
Non-suicidal self-injury				
No	1,364 (81.68%)	1,050 (84.54%)	314 (73.36%)	<0.001
Yes	306 (18.32%)	192 (15.46%)	114 (26.64%)	
Suicidal ideation				
No	1,545 (91.26%)	1,172 (93.09%)	373 (85.94%)	<0.001
Yes	148 (8.74%)	87 (6.91%)	61 (14.06%)	

P-values reflect t-test for continuous variables and Chi^2 test for binary/categorical variables.
(1) Depression was measured using the Patient Health Questionnaire 9, which is a scale ranging from 0 to 27. We dichotomized the scale to reflect individuals who reported a score higher than 15, indicating moderately severe to severe depression.
(2) Anxiety was measured using the Generalized Anxiety Disorder 7, which is a scale ranging from 0 to 21. We dichotomized this scale to reflect individuals who reported a score of higher than 10, indicating moderate to severe anxiety.
(3) Binge drinking was assessed using the item: Over the past 2 weeks, did you have 4 (if female)/5 (if male) or more alcoholic drinks in a row?
(4) Self-injury was assessed using the item: In the past year, have you ever done any of the following intentionally: Cut myself, burned myself, punched or banged myself, scratched myself, pulled my hair, bit myself, interfered with wound healing, carved words or symbols into skin, punched or banged an object to hurt myself, other?
(5) Suicidal ideation was assessed using the single binary item (yes/no): In the past year, did you ever seriously think about attempting suicide?

TABLE 2 | Multivariable logistic regression models showing the relations between COVID-19 related racial/ethnic discrimination and mental health outcomes among American/Pacific Islander students from the Healthy Minds Study, September–December 2020.

	Multivariable logistic regression models
	aOR [95% CI]
Depression	
No	1.00
Yes	2.02 [1.55–2.62]
Anxiety	
No	1.00
Yes	1.97 [1.58–2.44]
Binge drinking	
No	1.00
Yes	1.46 [1.17–1.83]
Non-suicidal self-injury	
No	1.00
Yes	1.78 [1.40–2.27]
Suicidal ideation	
No	1.00
Yes	2.02 [1.43–2.85]

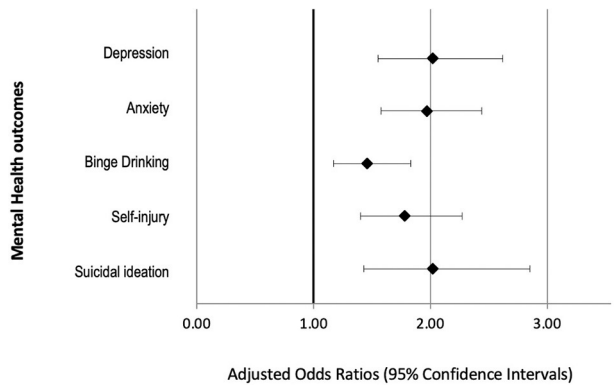

FIGURE 1 | Adjusted odds ratios depicting associations between COVID-19 related racial discrimination and mental health outcomes among Asian American/Pacific Islander students in the Health Minds Study, September–December 2020. All models adjusted for age and gender.

to the larger AAPI population and global Asian population; it is possible that the associations may be even stronger outside of the university context, especially among immigrants with limited English proficiency.

Historically, based on data collected in prior years of the HMS survey, less than a third of AAPI students with a clinically significant mental health condition are engaged in mental health treatment, which is the lower than other racial groups (16). Preventive interventions are needed to eliminate this treatment gap. Undoubtedly, anti-Asian discrimination and hate crimes continue to devastate individuals and communities across the world, and so as AAPI researchers, we urge our colleagues and institutions to speak out publicly against this hatred, to design interventions that mitigate the pernicious effects of racism on population health, and to call for the removal of barriers that prevent racial and ethnic minorities from accessing appropriate mental health treatment.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: https://healthymindsnetwork.org/hms/.

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

SZ contributed to the data collection and writing. RB contributed to the writing and editing. HO contributed to the writing and conceptualization. All authors contributed to the article and approved the submitted version.

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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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Posttraumatic Stress Symptoms Among Chinese College Students During the COVID-19 Pandemic: A Longitudinal Study

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A longitudinal assessment of the prevalence of posttraumatic stress symptoms (PTSS) and risk factors is indispensable for further prevention and/or treatment. The longitudinal web-based survey enrolled 1,164 college students in China. Measured at two time points (February and August 2020), PTSS, demographic information, adverse childhood experiences (ACEs), resilience and self-compassion information were collected to explicate the prevalence and predictors of PTSS concurrently and over time. Results showed that although PTSS generally declined throughout the 6 months after the outbreak of COVID-19, the prevalence remained relatively high. Resilience and self-compassion negatively predicted PTSS concurrently and longitudinally. While subjective family socioeconomic status (SES) and ACEs at Wave 1 did not predict PTSS under COVID-19 at Wave 1, but both significantly predicted PTSS at Wave 2. Findings implicate potential targets for detecting and intervening on symptoms of trauma in this vulnerable population.

Keywords: COVID-19, PTSS, longitudinal study, Chinese college students, descriptive survey study

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INTRODUCTION

Posttraumatic stress symptoms (PTSS) are commonly reported after experiencing or witnessing major stressful or distressing events. Its primary symptoms involve flashbacks of related memories, memories, avoidance of reminders of trauma and hypervigilance (1). Notably, in addition to direct exposure to life-threatening events, witnessing traumatic events may also cause PTSS (2). Existed studies of severe infectious respiratory diseases demonstrated that being threatened with infection or witnessing the death or serious injuries of others may conduce to PTSS (3–5). Indeed, the catastrophic consequences (e.g., a surge of critically ill patients, and the paralysis of medical systems) generated by the outbreak of COVID-19 were frequently reported by media (6), which were widely accessed by college students through the mass media, generating vicarious traumatization (7). In addition, due to the infectivity and high fatality rates of COVID-19, governments imposed shut-down measures. Students were confined to home with uncertainties and fear toward the future, which may result in mental health problems, including PTSS (8). Different from most studies on PTSS caused by one-off events, COVID-19-related PTSS is a global

major public health event, which is found to be mutagenic and highly infectious, causing recurrent outbreaks which still affect people's lives. Furthermore, social media coverage of malignant consequences, such as sudden medical collapse, increases people's awareness of risk and may become chronic stressors.

Frequent and intense PTSS is a core criterion for the diagnosis of posttraumatic stress disorder (PTSD) (9). Furthermore, continually experiencing these symptoms results in weaker social functioning, lower quality of life, and a higher risk for self-harm and suicide (10). After 6 months of the SARS epidemic, the prevalence of PTSS was roughly 32% among the uninfected Chinese population and 55.1% among SARS patients (11). Likewise, the coronavirus disease 2019 (COVID-19), has affected many countries as a rapidly spreading infectious disease (12), inflicting substantial mental health problems (13). Studies on PTSS during COVID-19 have indicated that 23–37% of the general public worldwide are experiencing symptoms of PTSS (14, 15). A nationwide survey in China with more than 50 thousand participants found that the prevalence of COVID-related PTSS was 35% (16). Given the fact that COVID-19 may have long-lasting negative effects (17), longitudinal tracking of PTSS is essential as results can help policy-makers implement timely interventions for preventing high-risk behaviors and associated health outcomes.

To mitigate the psychological impacts of the COVID-19 pandemic, it is critical to clarify both the risk factors and protective factors associated with developing PTSS. According to the dynamic stress-vulnerability model (18), many factors can be identified as potential risk factors for the development and persistence of psychopathology (e.g., PTSS). The stress-vulnerability model is also known as the diathesis-stress model. The diathesis-stress model was firstly proposed by Meehl (19) to interpret the incidence of schizophrenia. After that, this model was widely used as to investigate other mental health problems (20, 21). As research has progressed, diathesis-stress factors have been broadened. No longer limited to biological factors only, multiple factors (e.g., psychological, biological, familial, and social) have also been included. It has prompted a more extensive and systematic examination of the determinants of specific psychiatric disorders. Likewise, the development of PTSS is not due to a single factor, but the result of a combination of multiple factors (22). Therefore, this study attempts to investigate the factors influencing the occurrences and changes of PTSS symptoms in college students using the dynamic stress-vulnerability model as the theoretical framework. These determinants mainly include demographic factors (e.g., age and gender), social vulnerability factors (e.g., socioeconomic status, family structure), and psychobiological vulnerability factors (e.g., adverse childhood experiences, high neuroticism, low resilience and self-compassion). These mentioned variables can be utilized as PTSS predictors among Chinese college students. Females may be more at risk than males for developing PTSS after traumatic events (23). With regard to age, one study found that older adults were more likely to develop post-earthquake PTSS (24).

As for social vulnerability, individuals from non-intact families were observed to be at higher risk for developing psychiatric disorders compared to those from intact families (25). A recent meta-analysis ($n = 26{,}715$ participants) examining the relationship between the family socioeconomic status (SES) and psychopathology found that individuals with low SES were more vulnerable to developing mental health problems (26). Chinese youths in rural areas also showed a higher prevalence of PTSS compared to their urban counterparts (27) which are the opposite of a study in Ireland during COVID-19 (3). However, research on the relationships between socio-demographic factors and PTSS under COVID-19 concurrently and over time remained limited.

Regarding psychological vulnerability, adverse childhood experiences (ACEs), as previous studies have shown, are positively correlated with higher PTSS (28). Individuals with childhood adversities are expected to be at greater risk for developing PTSS under COVID-19. However, longitudinal studies of ACEs on PTSS during the pandemic are limited and require further investigation.

Notably, self-compassion has been recognized as one of the most important positive factors in recent years. Self-compassion is the capacity to deliver love, kindness, and caring inward, particularly in distress (29, 30). Self-compassion involves being mindfully aware and kind toward oneself and viewing suffering as a larger part of the human experience following exposures to difficulties and hardships (31). High self-compassion is related to less maladaptive coping strategies (32), and presumably an emotion regulation strategy to cope with mental health problems (33). Individuals with high self-compassion tend to have fewer PTSS symptoms (34). Individuals with low self-compassion may be unable to down-regulate the brain's automatic survival response to the fight or flight response after major stressful events (35), resulting in psychological vulnerabilities. According to emotional processing theory (36), trauma information is often not processed appropriately due to avoidance of distress (e.g., triggering fear, which leads to emotional over-arousal). Notably, the level of self-compassion may be an important factor contributing to the development of the PTSS (34). Importantly, self-compassion promotes kind, mindful acceptance of negative emotions, which may be constructive to the gentle exposure of traumatic events as a way to reduce the corresponding PTSS symptoms. This portrays how establishing and maintaining a compassionate perspective may be conducive to developing healthy emotion regulation strategies that help alleviate the negative impacts of trauma.

In addition to self-compassion, resilience is another modifiable factor that attracted researchers' interest. Previous study has observed that individuals with low resilience demonstrated more psychological vulnerabilities to developing PTSS after major negative events (37). In comparison to self-compassion, the definition of resilience is more complex (38). One of the widely accepted definitions of resilience is the capacity to have hardiness, flexibility, and self-efficacy to adapt under stress (39–41). Individuals with high resilience may have an optimistic attitude toward adversities, helping them cope with negative events and reducing the risk of mental health issues (40). In contrast, low psychological resilience can contribute to more distress (42). Regarding potential psychological factors that may have an influence on PTSS, the emotional processing theory of PTSD suggested self-compassion may alleviate the

negative influence of COVID-19 on PTSS. Furthermore, a considerable amount of studies showed the importance of resilience on the progression of PTSS (43, 44). Clinically, self-compassion and resilience are two important psychological variables which may serve as a way for the intervention of PTSS (45, 46). However, research on the longitudinal association between self-compassion, resilience, and COVID-19-related PTSS remains limited. Therefore, this study aims to examine which factors influence PTSS among college students in the context of the COVID-19 pandemic. In addition, to investigate the effect of psychological factors (in the present study resilience and self-compassion) on PTSS symptoms after controlling for demographic and familial factors.

Although previous studies of PTSS in China during stressful events including the COVID-19 outbreak provided valuable information, there are distinct research gaps that require scientific inquiries. Most of the available studies adopt a cross-sectional design, which cannot show the change in PTSS after stressful events such as the COVID-19 outbreak. Current longitudinal studies in China only cover a relatively short time frame (e.g., 1 or 2 months) (47, 48). Understanding the prevalence of PTSS during COVID-19 and its subsequent change longitudinally with a longer time period may promote more suitable approaches to address these problems. Most studies also focus on the mental health of the general public rather than PTSS in a specific population (e.g., college students). College is an important transition period from late adolescence to adulthood. During this period, young people are prone to encountering psychological crises that can involve feelings of insecurity, suspicion, and disappointment in life, sometimes referred to as a quarter life crisis (49). Thus, it is important to follow the mental health status of this group in a stressful situation such as COVID-19.

Thereby, based on the dynamic stress-vulnerability model and emotional processing theory, two waves of longitudinal data were collected over 6 months (February to August 2020) to develop the following study that has three main goals. The first goal is examining the incidence and variations of COVID-19-related PTSS among college students in China. The second is further investigating whether socio-demographic circumstances predict Chinese college students' PTSS under COVID-19 concurrently and over time. The third goal is to explore whether psychological variables (in this study, ACEs, self-compassion and resilience) are correlated with PTSS among Chinese college students concurrently and longitudinally.

METHODS

Participants

Data for the present study was collected mid to late February in 2020 (Wave 1), ∼1 month after the COVID-19 pandemic outbreak. After 6 months, the same subjects were called for the next round of survey in late August, 2020 (Wave 2). Participants were recruited from more than 100 colleges/universities across the country. All students who agreed to take part signed a consent form before filling out the questionnaires. In Wave 1, 1,218 students agreed to participate in the survey and 1,164 students eventually completed the questionnaire. The sample consisted of 410 (35.22%) males and 754 (64.78%) females (mean age = 20.56 years; SD = 1.90). From Wave 1 to Wave 2, 992 participants stayed in the study out of the original sample size. These participants were verified as the same participants from Wave 1 by matching their phone numbers with our original records. Further demographic information about the participants is summarized in **Table 1**.

TABLE 1 | Comparisons of psychosocial variables and PTSS of the participants measured at Wave 1 by loss to follow-up.

Variables	Follow-up		Loss to follow-up		*p*
	N/M	%/SD	N/M	%/SD	
Age	20.48	1.80	20.64	1.99	0.17
Gender					0.82
Male	351	35.40	59	34.30	
Female	641	64.60	113	65.70	
Siblings					0.42
One child	317	32.00	60	34.90	
Non-one child	675	68.00	112	65.10	
Family intactness					0.56
Intactness	909	91.60	160	93.00	
Non-intactness	83	8.40	12	7.00	
SES	4.86	1.36	4.84	1.37	0.90
Residence					
Urban	557	56.10	90	52.32	0.59
Rural	435	43.90	82	47.68	
Resilience	35.19	6.20	36.41	5.71	0.44
Self-compassion	3.24	0.47	3.26	0.48	0.45
ACEs	1.33	1.79	1.27	1.64	0.48

p obtained from Chi-square tests and t-tests.

Procedure

We recruited participants through an online survey. The invited students were asked to complete a questionnaire that included socio-demographic information and scales for subjective SES, self-compassion, adult attachment, and resiliency. After completing the questionnaire, participants received a compensation of ∼10 RMB (∼1.5 USD) which was provided online. There were no missing values due to the setup of the electronic questionnaire that required participants to answer each question. The project obtained ethical clearance from the Human Research Ethics Committee of the first author's affiliation.

Instruments

Sociodemographic Characteristics

Participants were invited to report their age, gender (0 = male and 1 = female), family type (intact family or non-intact family), type of residence (urban areas = 0, rural areas = 1), and sibling status (no = 0, yes = 1).

Subjective Socioeconomic Status

The widely-used subjective SES scale was adopted to assess participants' subjective socioeconomic status (50). Participants were given a drawing of a ladder with 10 rungs and asked to choose a number that best represented their family's socioeconomic status.

PTSS

We revised the abbreviated PTSD Checklist-Civilian Version (PCL-C) to assess COVID-19-related PTSS. Item example: "*Repeated, disturbing memories, thoughts, or images of COVID-19 from the past?*" There are 6 items with 5 response options (from 1 = *not at all* to 5 = *extremely*). Scores range from 6 to 30, with higher scores indicating higher PTSS. As previous research studies characterized a score of at least 14 as an indication of PTSD (sensitivity 92%, specificity of 72%) (22). The Cronbach's α coefficient for the scale in this study was 0.81 in Wave 1 and 0.86 in Wave 2, respectively.

Self-Compassion

Participants were given the 26-item self-compassion scale (51) which assesses three aspects of self-compassion (negative aspects are reverse coded), including self-kindness, common humanity and mindfulness. Responses are identified on a 5-point scale from "*Almost Never*" to "*Almost Always*." Higher scores indicate higher level of self-compassion. The questionnaire was validated in China previously (52). The Cronbach's α coefficient for the scale in this study was 0.87.

Resilience

The Abridged Connor-Davidson Resilience Scale is a self-administered questionnaire with a single dimension (53). It has 10 items with 5 response options (from 0 = *never* to 4 = *almost always*). The scale reflects the ability to tolerate stress and adversities. The final score is the sum of the responses for each item (range 0–40) where higher scores indicate higher resiliency. The scale's reliability was validated previously (54) and the Cronbach's α coefficient of the scale in this study was 0.92.

Adverse Childhood Experiences

Childhood trauma was assessed by the Chinese version of the Revised Adverse Childhood Experiences Scale (55). There were 14 items in the scale and were dichotomously coded (1 for presence and 0 for absence). Higher scores presented severer childhood adversities.

Statistical Analyses

First, in order to check whether the loss of subjects had an impact on our results, we compared the data of the lost and retained subjects. Next, the percentages of participants who had PTSS based on screening procedures in the two waves were compared using related-samples McNemar tests to investigate the change in student PTSS after 6-months. Finally, the first hierarchical regression analysis was carried out to investigate the predictive effects of sociodemographic and psychological factors on PTSS concurrently. Specifically, PTSS was treated as a dependent variable, and demographic variables (i.e., age and gender) were considered independent variables, which were placed in the first step. After the controlled for age and gender, familial variables (i.e., family intactness, subjective SES, and residence) were placed in the second step. Thirdly, psychological factors (i.e., ACEs, resilience, and self-compassion) as independent variables were placed in the third step to assess their association with PTSS after controlled for variables in the first and second steps. Likewise, the second hierarchical regression was performed to explore their longitudinal relationships after the control for T1 PTSS in the first step. Statistical analyses were carried out using SPSS 23.0. The statistical significance was set at $p < 0.05$ (two-tailed) for the interpretation of the results.

TABLE 2 | Prevalence and change of PTSS in Waves 1 and 2 (February 2020 and August 2020).

PTSS total score		PTSS (Cut-off ≥ 14)		
Wave 1 (M/SD)	Wave 2 (M/SD)	Wave 1 (%)	Wave 2 (%)	x^2
11.79 ± 4.25	11.38 ± 4.27	30.80	27.40	3.35†

$^{\dagger}p = 0.06$.

RESULTS

Comparisons of Followed-Up Participants and Attrition

14.78% ($n = 172$) of the baseline participants did not complete the study in Wave 2 (**Table 1**). Differences were not statistically significant between the retained and dropped participants. Of the retained participants, the mean age was 20.48 years old (SD = 1.80). Thirty-five point four percent of participants were male and 68.00% reported having sibling(s). Approximately 8.40% of students reported coming from non-intact families and ∼56.10% of participants were from urban areas.

Screening for PTSS

As can be seen in **Table 2**, 30.80% of the college students in Wave 1 were identified as having PTSS while 27.40% of students in Wave 2 were identified as having PTSS 6 months later. These data suggest that the COVID-19 related PTSS among China's college students is generally high.

Differences of PTSS at Two Time Points

We performed related-samples McNemar tests to compare PTSS levels at two time points. The results show that the change was borderline significant. Participants showed lower PTSS levels at Wave 2 then at Wave 1 ($x^2 = 3.35$, $p = 0.06$) (**Table 2**).

Correlates and *T*-Test Results of PTSS in College Students

In the bivariate correlation analysis, the following variables were correlated with PTSS in Wave 1: age, ACEs, resilience and self-compassion ($ps < 0.05$). Independent t-tests showed significant differences in PTSS between rural and urban areas ($t = 2.11$, $p < 0.05$). There was marginal significance between intact and non-intact families ($t = -1.89$, $p = 0.059$). In Wave 2, gender, SES,

TABLE 3 | Correlations or *t*-test results of independent variables with PTSS in Waves 1 and 2 (February 2020 and August 2020).

	Age	Gender	Siblings	Family intactness	SES	Residence	ACEs	Resilience	Self-compassion
PTSD-Wave 1	0.09**	−1.75	1.26	−1.89†	0.01	2.11*	0.12***	−0.31***	−0.32***
PTSD-Wave 2	0.00	−2.05*	1.10	−0.98	−0.06*	0.07	0.19***	−0.31***	−0.31***

†*p = 0.059.*
**p < 0.05; **p < 0.01; ***p < 0.001.*

TABLE 4 | Multiple linear regression of predictors of PTSS in Waves 1 and 2 (February 2020 and August 2020).

Dependent variable: PTSS-Wave 1						Dependent variable: PTSS-Wave 2					
Independent variables	**B**	**SE**	***β***	***t***	**Δ*R*²**	**Independent variables**	**B**	**SE**	***β***	***t***	**Δ*R*²**
						Step 1					0.22***
						PTSD-Wave 1	0.50	0.03	0.47	16.69***	
Step 1					0.01***	**Step 2**					0.00
Demographic factors						Demographic factors					
Age	0.20	0.07	0.09	2.85**		Age	−0.08	0.07	−0.04	−1.25	
Gender	0.52	0.27	0.06	1.94		Gender	0.33	0.25	0.04	1.30	
Step 2					0.01	**Step 3**					0.01*
Familial factors						Familial factors					
Family intactness	0.75	0.46	0.05	1.63		Family intactness	0.06	0.43	0.00	0.14	
Subjective SES	−0.01	0.10	0.00	−0.06		Subjective SES	−0.21	0.09	−0.07	−2.32*	
Residence	−0.61	0.27	−0.08	−2.31*		Residence	0.25	0.25	0.03	1.01	
Step 3					0.12***	**Step 4**					0.04***
Psychological factors						Psychological factors					
ACEs	0.1	0.08	0.05	1.45		ACEs	0.30	0.08	0.12	3.86***	
Resilience	−0.11	0.02	−0.17	−4.52***		Resilience	−0.08	0.02	−0.12	−3.38**	
Self-compassion	−1.92	0.32	−0.22	−5.92***		Self-compassion	−0.75	0.32	−0.08	−2.32*	

**p < 0.05; **p < 0.01; ***p < 0.001.*

ACEs, resilience and self-compassion were correlated with PTSS ($ps < 0.05$) (**Table 3**).

Predictors of PTSS in College Students

The results of hierarchical regression analyses were shown in **Table 4**. In Wave 1, age positively predicted PTSS as older participants manifested more severe PTSS. Gender could not predict PTSS in both waves ($\beta = 0.06$, $\beta = 0.04$, $p > 0.05$). Residence also positively predicted PTSS as participants in urban areas reported higher PTSS. Resilience and self-compassion significantly predicted PTSD concurrently and longitudinally at 6 months as low amounts of both psychological variables were associated with higher levels of PTSS concurrently ($\beta = -0.17$, $p < 0.001$; $\beta = -0.22$, $p < 0.001$) and longitudinally ($\beta = -0.12$, $p < 0.001$; $\beta = -0.08$, $p = 0.021$). Subjective SES did not predict PTSS under COVID-19 in Wave 1. However, it significantly predicted participants' PTSS in Wave 2 ($\beta = -0.07$, $p = 0.021$). Likewise, ACEs did not correlate with PTSS in Wave 1 but they significantly predicted PTSS in Wave 2 ($\beta = 0.12$, $p < 0.001$).

DISCUSSION

This study showed the prevalence of PTSS under COVID-19 among Chinese college students with an interval of 6 months. In addition, the concurrent and longitudinal predictive effects of demographic, familial, and psychological factors on PTSS were examined. 30.8% of Chinese college students reported having PTSS in February but this number went down to 27.4% in August, 2020. The prevalence of PTSS among college students in China under the COVID-19 pandemic was lower than that after the Wenchuan earthquake among trauma-affected people (45.5%) (56). However, the prevalence of PTSS was almost as high as that of the SARS outbreak (31.18%) among the public in epidemic-affected areas (11). This may be because COVID-19 occurred over a longer time period in contrast to the Wenchuan earthquake which was sudden. Individuals are aware that their risk of being infected by COVID-19 can be reduced if the correct precautions are taken, which may lead to a less sense of losing control, resulting in a less severe posttraumatic stress reaction (57). Of note, despite the absence of a large-scale outbreak of COVID-19 in provinces other than Hubei provinces (worst-hit area), people in other regions may also be severely affected by the outbreak of COVID-19. The results are in consonance with some existed research on major stress events (58, 59). Potential reasons for this include the "amplification" effect of risk events (58, 59). Specifically, residents of light and non-affected areas primarily resort to the media to obtain COVID-19-related information. This dissemination through the media or other

informal pathways may affect an individual's risk perception and thus influences PTSS symptoms.

The prevalence rates of COVID-19-related PTSS in the present study were similar to two studies on the general Italian population (age range: 18–64, and 18–89, respectively), with a prevalence rate of 27.7–35.6% (60, 61). These were close to the prevalence rate of 31.8% in the third study with American young adults (aged from 18 to 30) during COVID-19 (62). Nevertheless, other research studies on similar samples depict a lower incidence of PTSS. For instance, Karatzias et al. found that 17.7% of adults (age: 18 to more than 65) in Ireland, and 16.79% in the United Kingdom reported COVID-19-related PTSS (3). One possible explanation of the disparity may be different screening tools adopted in the investigations, with some tools having higher cut-off points. In addition, the severity and development stage of the pandemic locally may also affect PTSS. Future studies can advance the research of PTSS during COVID-19 with representative samples, longitudinal studies, or meta-analysis.

Wave 1 of the study found that age and residence significantly predicted PTSS during COVID-19 in college students. Higher PTSS was reported with increasing age. A possible reason for this may be that older students may be experiencing more stress due to the difficulty of finding employment during the uncertainty of COVID-19 (63). Moreover, the results from the hierarchical regression showed that gender did not predict PTSS in this study, which is inconsistent with previous research (64). This may be due to the fact that, unlike certain traumas, infectious diseases such as COVID-19 are threatening regardless of gender. In addition, type of residence was associated with PTSS in Wave 1 which indicated that college students in urban areas experienced more PTSS compared to their rural counterparts. This may be due to the fact that the outbreak of COVID-19 during February, 2020 in China spread more rapidly in major cities with greater population densities. However, age and residence did not predict PTSS in Wave 2. This could be because Wave 2 data was gathered in late August, 2020 when COVID-19 was better controlled in China, compared to the situation in February, 2020. Consequently, older students could have more positive outlooks on their employment opportunities and urban residents may no longer fear the rapid spread of the virus in their cities.

Surprisingly, we found that individuals with fewer ACEs and higher SES reported lower levels of PTSS in Wave 2 while the differences were not significant in Wave 1. One possible explanation for this is that at the beginning of the pandemic, all individuals, regardless of their ACEs and SES, may be affected concurrently by the acute stress of the public health emergency. However, as the pandemic progressed and the economy deteriorated, those with higher family affluence have more resources to buffer stress from the economic downturn compared to individuals with low SES (65). Individuals with more ACEs may also have less effective strategies for emotion regulation, making them more vulnerable to negative adjustment longitudinally (66). As a result, despite COVID-19 infection numbers decreasing drastically by Wave 2 in August, 2020, the economic and psychological effects from the virus are long-lasting and likely still deeply impact individuals with higher ACEs and low SES.

We further found that self-compassion was significantly associated with PTSS concurrently and longitudinally as lower levels of self-compassion predicted higher levels of PTSS. These findings are similar to several studies conducted in America (67, 68). Self-compassion emphasizes kindness toward one's self and mindful awareness of distressing experiences which activates the mammalian caring system (69). This neurocognitive mechanism may lead to fewer posttraumatic stress symptoms. In addition, individuals with high self-compassion may be better at self-regulating their stress levels and adapting coping strategies such as constructively reframing or accepting difficulties (70), resulting in less severe PTSS. These findings suggest that individuals with low self-compassion are more psychologically vulnerable and have more risk factors, putting them at greater risk for being psychologically affected by the COVID-19 pandemic.

We also found that greater resiliency negatively predicted PTSS which is in line with previous study (71). One possible reason is that individuals with high resiliency are more adaptive when facing difficulties, enabling them to recover from negative events (72). High levels of resilience can help individuals suffering from trauma recover more quickly (73). As previous research has found, resilience can lead to positive emotions (74) as it can enhance happiness and promote psychological health which buffers negative psychological effects caused by major stressful events. Our results suggest that elevating levels of resiliency can diminish PTSS.

Several limitations should be noted in this study. First, our participants were mainly from Guangdong, Anhui, Hebei, and Jiangsu provinces in China. Survey data from the strongly-affected province (Hubei) accounted for a very small proportion (1.57%); thus, the findings may not be generalizable across the Hubei province. Furthermore, the present study assessed COVID-related PTSS. Therefore, generalizing the results to PTSS to other major stressors demands caution. Given this study mainly focused on the concurrent and longitudinal association between several demographic, social, and psychological variables on PTSS under the COVID-19 pandemic, the interactions between variables on PTSS were not examined. Future studies can explore their relationships and the underlying mechanism. Moreover, although the Abbreviated PCL checklist showed good psychometric properties in previous studies, the pandemic caused widespread suffering, and the reports from mass media exacerbated vicarious trauma. Given that we did not assess the fear and threat severity of COVID-19 among participants, the results may not preclude the possibility of false positives. It is preferable to assess the stress intensity of COVID-19 for each individual in future studies to improve data accuracy. Lastly, the general methodological limitations of self-reported surveys should be considered, which may affect the interpretations of the measured constructs as well as the generalizability of the study's findings. Further studies should be conducted using different methods of data collection to collect objective data (e.g., clinician-rated or bioindicators), minimize methodological biases, and explore

potential psycho-pathological mechanisms that may complement such advanced investigations.

Despite these limitations, this study has several results in aiding our understanding of PTSS among college students during the COVID-19 pandemic. The study can likely be generalized to most Chinese college students as it is based on a relatively large sample size. The incidence of PTSS among college students in China is relatively high, suggesting that policy-makers, educators, and clinical professionals need to take timely and effective measures to reduce the PTSS of college students thus promoting their healthy development. We found that individuals with low SES and ACEs longitudinally were more prone to develop PTSS under COVID-19, which suggests an immediate need for mental health interventions for this vulnerable population. Additionally, factors such as resilience and self-compassion may be protective factors against the negative effects of stressful events on mental health of college students at a single time point and over time. Recently, there have been calls for synchronous and asynchronous remote delivery of resiliency interventions to address COVID-19 stress (75). Our findings suggest that such programs can be particularly helpful if targeted to college students with histories of trauma or low SES backgrounds. Therefore, prospective measures for improving resiliency and self-compassion in college students may be a way to mitigate the impact of the COVID-19 pandemic on mental health and a strategy to improve general well-being in the future.

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 project obtained ethical clearance from the Human Research Ethics Committee of the Shenzhen University (No: 2020005). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

XC, LH, and TG took a principal role in designing the study, writing the protocol, developing methodologies, and drafting the manuscript. LH performed the statistical analysis. DH, RL, KL, and MH edited the manuscript. All authors have read and approved the final manuscript.

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Relationship Between Myopia and Other Risk Factors With Anxiety and Depression Among Chinese University Freshmen During the COVID-19 Pandemic

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Purpose: To investigate the association of myopia and other risk factors with anxiety and depression among Chinese university freshmen during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: This cross-sectional study was conducted at the Tianjin Medical University from October 2020 to December 2020. Ophthalmic examination of the eyes was performed by an experienced ophthalmologist. Detailed information on depression, anxiety, and other risk factors was collected *via* the Self-rating Anxiety Scale and Self-rating Depression Scale.

Results: The overall prevalence of anxiety and depression in our study was 10.34 and 25.13%, respectively. The prevalence of myopia and high myopia as 92.02 and 26.7%, respectively. There were significant associations between anxiety and spectacle power [odds ratios (OR) = 0.89; 95% CI: 0.81–0.98, $P = 0.019$], sphere equivalent (OR = 0.89; 95% CI: 0.81– 0.98, $P = 0.025$), sleep time (OR = 0.53; 95% CI: 0.35–0.79, $P = 0.002$), and body mass index (OR = 0.93; 95% CI: 0.86–0.99, $P = 0.047$). In the multivariable linear regression models, spectacle power ($\beta = -0.43$; 95% CI: −0.68 to −0.19, $P = 0.001$) and sphere equivalent ($\beta = -0.36$; 95% CI: −0.60 to −0.11, $P = 0.005$) were negatively associated with anxiety scores, whereas axial length ($\beta = 0.54$; 95% CI: 0.02–1.07, $P = 0.044$) was positively correlated with anxiety scores. Every 1 h decrease in sleep time was associated with a 0.12-point increase in depression score.

Conclusion: Myopia was associated with anxiety and anxiety scores. The greater the degree of myopia, the higher the anxiety score. However, myopia was not found to be associated with depression. The results highlight the importance of providing psychological support to students with myopia during the COVID-19 pandemic.

Keywords: depression, anxiety, psychological health, myopia, epidemiology

INTRODUCTION

Myopia has become a major health problem worldwide owing to its increasing prevalence in the past few decades (1). It is predicted that by 2050, 49.8% of the world population will have myopia and 9.8% will be highly myopic (2). China is one of the countries with a high prevalence of myopia (3). Based on data from a myopia study in Fenghua City, the prevalence of high myopia in China has nearly doubled from 7.9 to 16.6% from 2001 to 2015 (4). In Taiwan, the prevalence of myopia and high myopia in a sample of ∼4,000 university freshmen was 91.3 and 23.5% in 1988 and 95.9 and 38.9% in 2005 (5).

The coronavirus disease 2019 (COVID-19) outbreak occurred at the beginning of 2020. The Chinese government took many measures to curb COVID-19, such as the closure of schools with the education of students using online platforms. The increased digital screen time and the overall time spent on near work, together with the decreasing outdoor time, increased the risk of myopia progression in students (6). Accelerated myopic progression has been reported during the COVID-19 pandemic (7–9).

Myopia is not just a refractive error but a leading blinding disorder because of myopic retinopathy and myopia-associated glaucoma, especially in high myopia (2). Vision is an extremely valued sense that affects daily life activities; hence, myopia may face practical difficulties and limitations imposed on sports and career opportunities (10, 11).

University freshmen are special populations that endure a period of great challenges in college entrance examinations, entering new environments, facing risks, and social developmental transition. Previous studies have reported high rates of mental disorders among medical students compared to their peers of the same age (12–14). Depression and anxiety are among the most common mental disorders. Screening for depression or anxiety using questionnaires and self-rating scales has been helpful in primary care settings. The Self-rating Depression Scale (SDS) and Self-rating Anxiety Scale (SAS) questionnaires have been used to evaluate depression among keratoconus patients for research purposes (15–18).

With the rapid increase in the prevalence of myopia and psychological illness, studies have begun to examine their relationship. Yokoi et al. (19) reported that about 25% of highly myopic patients had possible depression or anxiety disorders, and the presence of these psychiatric disorders was a major factor associated with low vision-related quality of life in highly myopic patients (20, 21). A study in the United Kingdom, which surveyed 112 myopic patients aged 18–65 years, reported that psychological, cosmetic, practical, and financial factors affected their quality of life (10). Li et al. (16) suggested a correlation between myopia and mental health in adolescent students, especially in terms of anxiety. Although several studies have assessed the relationship between myopia and other risk factors of depression and anxiety (16, 19, 20, 22), to the best of our knowledge, no study has tested whethervision-related risk factors are associated with the psychological well-being of university freshmen.

Therefore, this study aimed to assess the prevalence of anxiety and depression among university freshmen and to investigate the relationship between vision-related risk factors and anxiety and depression.

METHODS

Study Design and Participants

This cross-sectional study was conducted from October 2020 to December 2020. All freshmen at the Tianjin Medical University were eligible for participation. The inclusion criteria were as follows: no eye surgery or disease, no eye trauma, and no other systematic disease. Participants who were receiving treatment from a mental health professional for either depression or anxiety disorder were excluded from the analysis. Overall, 764 of 946 students (275 men and 489 women) with a mean age of 18.2 ± 0.7 years (age range, 15–23 years) were included. This study was conducted with the approval of the authorities and the Ethics Committee of the Tianjin Medical University Eye Hospital and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from the subjects after an explanation of the nature and possible consequences of the study. The study protocol was approved by the university.

Eye Examination

All participants completed a detailed questionnaire concerning age, sex, height, weight, screen time, sleep time, eye disease history, and family disease history. Ophthalmic examinations of the eye were performed by an experienced ophthalmologist, namely, best corrected visual acuity (BCVA), slit-lamp examination (model YZ5X1; 66 Vision Tech Co., Ltd, Suzhou, China), non-cycloplegic autorefraction (model KR 8900; Topcon, Tokyo, Japan), lensmeter (model CL-300; Topcon, Tokyo, Japan), and ocular biometric measurements with Lenstar (LS-900; Haag-Streit AG, Köniz, Switzerland). All machine results were conducted three times to avoid bias.

Refractive errors were classified according to the spherical equivalent (SE = sphere + 0.5*cylinder) of non-cycloplegic autorefraction. Myopia was defined as an SE of −0.5 diopter (D) or less, and emmetropia was an SE between −0.50 and 0.50 D. Further classifications included mild, moderate, and high myopia as an SE of −0.5 to −3.0 D, −3.0 to −6.0 D, and <-6.0 D, respectively.

Body mass index (BMI) was calculated as weight divided by the square of height (23). We classified individuals into three BMI categories according to standard of China: lower weight (≤18.4 kg/m^2), normal weight (18.5 kg/m^2 ≤ BMI ≤ 23.9 kg/m^2), and overweight (≥24.00 kg/m^2) (24, 25).

Questionnaires

The SAS and SDS have been widely used as simple diagnostic tools in both clinical and research settings, and their reliability and validity have been examined in the Chinese population (15–17). The higher the score on the SAS or SDS, the higher the level of mental disorder. According to the Chinese norm for the SAS and SDS, a total standard score of 53 or 50 was set as the cut-off point for depression or anxiety, respectively (15, 16).

Measurement of Anxiety

The SAS is a 20-item, self-reported assessment, which uses a four-point Likert scale to rate the presence and anxiety of affective symptoms and somatic components of anxiety during the previous week. Each item is scored from 1 to 4 (1, rarely; 2, occasionally; 3, frequently; and 4, always). Fifteen questions are scaled; the higher the number, the more severe the symptoms. For the remaining five questions, the lower the score, the lower the symptom severity. The level of severity of anxiety can be measured by conversion to an index score by dividing the sum of the raw score by 80 and multiplying by 100. In the Chinese public, the index score has the following two categories: no anxiety (<50) and anxiety (≥50) (16).

Measurement of Depression

The SDS includes 20 questions (10 positive and 10 negative). Each question is scored from 1 to 4 (1, none or a little of the time; 2, some of the time; 3, a good part of the time; and 4, most or all the time). The level of severity of depression was measured by an index equal to the SDS sum score divided by 80 and multiplying by 100. In the Chinese general population, the index had the following two categories: no depression (<53) and depression (≥53) (15).

Statistical Analysis

All statistical analyses were performed using the SPSS statistical package for Windows (version 23.0; IBM, Armonk, NY, USA). Missing data were imputed by mean indicators. Descriptive statistics (frequencies) were calculated to assess the prevalence of anxiety and depression among the study participants. The differences between those with and without anxiety and depression were compared using Student's *t*-test for continuous variables and the chi-squared test for categorical variables. Associations between potential risk factors and the status of anxiety and depression were assessed using multivariable logistic regression, and odds ratios (ORs) and 95% CIs were calculated. General linear models were used to calculate the β coefficients and 95% CIs for the association between potential risk factors and anxiety/depression scores. Statistical significance was defined as a two-sided *P*-value of < 0.05.

RESULTS

Participant Characteristics

Of 946 freshmen, 859 (response rate: 90.80%) provided informed consent to participate in the study. Of these, 95 individuals were excluded from the analysis owing to an incorrect information ($n = 81$), history of surgery ($n = 13$), and eye disease ($n = 1$). None of the students had eye trauma, systematic diseases, or were treated by doctors for mental disease. Eventually, analyses were performed on data from 764 individuals, including 489 women (64%) and 275 men (36%). The mean age for the entire sample was 18.2 ± 0.7 years (age range, 15–23 years).

The prevalence of anxiety and depression in this study was 10.34 (79/764) and 25.13% (192/764), respectively. A total of 97.9% (748/764) of participants reported a sleep time of more than 6 h/day and 70.54% (539/764) had more than 4 h/day of screen time. A total of 59.42% (454/764) of students had a BMI within the normal range according to Chinese standards. A total of 71.60% (547/764) of students had an axial length (AL) longer than 26 mm, which was considered the threshold for higher risk of myopia. A total of 26.70% (204/764) of students had myopia higher than 6.00 D. However, only 19.50% (149/764) of students wore glasses more than 6.00 D; that is, the glasses they wore were undercorrected. The mean BCVA of 0.87 ± 0.26 reflected the same result.

Sleep time was different between participants with and without anxiety and ($P < 0.05$). In those with >7 h/day of sleep, the percentage of students with anxiety was much lower than that of those without anxiety (59.49 vs. 68.47%), while the percentage of students with anxiety was higher than those who did not suffer from anxiety in those with <6 h/day of sleep (2.54 vs. 2.04%). There were no significant differences in the distributions of age, sex, screen time, BMI, AL, SE, spectacle power, or BCVA between the two groups. The same results were found in the depression group (**Table 1**).

Associations of Demographic, Lifestyle, and Vision Characteristics With Anxiety and Depression

All risk factors were entered into multivariable logistic regression models. **Table 2** shows the results of multivariable logistic regression analyses of the risk factors associated with the prevalence of anxiety and depression symptoms. We found that spectacle power (OR = 0.89; 95% CI: 0.81–0.98; $P = 0.019$), SE (OR = 0.89; 95% CI: 0.81–0.98; $P = 0.025$), sleep time (OR = 0.53; 95% CI: 0.35–0.79; $P = 0.002$), and BMI (OR = 0.93; 95% CI: 0.86–0.99; $P = 0.047$) were significantly associated with anxiety status. No significant association was observed between any of the variables and depression. SE [variance inflation factor (VIF) = 3.874], AL (VIF = 1.694), and spectacle power were not included in the model together to avoid collinearity.

In Model 1, spectacle power was negatively correlated with anxiety scores ($\beta = -0.13$, $P = 0.001$). In Model 2, the anxiety score decreased by 0.11 per unit increase of SE ($P < 0.006$). In Model 3, AL was positively associated with anxiety scores ($\beta = 0.08$, $P < 0.047$). Other risk factors were not associated with anxiety scores ($P > 0.05$). As for depression, there was only a significant association between sleep time and depression scores ($\beta = 0.12$, $P = 0.002$), while other risk factors were not related to depression scores (**Table 3**).

DISCUSSION

The results of the current study indicate that the overall prevalence of anxiety and depression was 10.34 and 25.13%, respectively, among Chinese freshmen during the COVID-19 pandemic. There were significant associations between anxiety status and spectacle power, SE, sleep time, and BMI in logistic regression. In three multivariable linear regression models, spectacle power and SE were negatively associated with anxiety scores, whereas AL was positively related to anxiety scores. For every 1 h decrease in sleep time, the depression score is increased

TABLE 1 | Characteristics of the participants with and without anxiety, depression in Tianjin Medical University in 2020.

		Anxiety			Depression		
		No, 685	Yes, 79		No, 572	Yes, 192	
		N	*N*	*p*	*N*	*N*	*p*
Age	<18 y	521 (76)	62 (78.48)	0.632	435 (76.05)	148 (77.08)	0.771
	≥18 y	164 (23.94)	17 (21.52)		137 (23.95)	44 (22.92)	
Gender	Female	431 (62.9)	58 (73.42)	0.066	368 (64.33)	121 (63.02)	0.743
	Male	254 (37.08)	21 (26.58)		204 (35.66)	71 (36.98)	
BMI (kg/m^2)	≤18.4	141 (20.58)	21 (26.58)	0.272	120 (20.98)	42 (21.88)	0.751
	18.5–23.9	406 (59.27)	48 (60.76)		339 (59.27)	115 (59.90)	
	≥24	128 (18.69)	10 (12.66)		107 (18.71)	31 (16.15)	
Sleep time (h/d)	>7	469 (68.47)	47 (59.49)	**0.05***	373 (65.21)	143 (74.48)	0.07
	6–7	202 (29.49)	30 (37.97)		187 (32.69)	45 (23.44)	
	<6	14 (2.04)	2 (2.54)		12 (2.10)	4 (2.18)	
Screen time (h/d)	2–4	205 (29.93)	20 (25.32)	0.071	168 (29.37)	57 (29.69)	0.837
	4–6	398 (58.10)	55 (69.62)		342 (59.79)	111 (57.81)	
	6–8	59 (8.61)	1 (1.27)		42 (7.34)	18 (9.38)	
	>8	7 (1.02)	1 (1.27)		6 (1.05)	2 (1.04)	
BCVA		0.86 (0.26)	0.90 (0.23)	0.303	0.88 (0.26)	0.84 (0.25)	0.119
AL (mm)	<26	493 (71.97)	54 (68.35)	0.462	408 (71.33)	139 (72.40)	0.854
	>26	189 (27.59)	25 (31.65)		161 (28.15)	53 (27.60)	
SE (D)	> +0.50	11 (1.61)	1 (1.27)	0.233	9 (1.57)	3 (1.56)	0.268
	−0.50 to +0.50	48 (7.01)	1 (1.27)		35 (6.12)	14 (7.29)	
	−0.50 to −3.00	164 (23.94)	16 (20.25)		145 (25.35)	35 (18.23)	
	−3.00 to −6.00	281 (41.02)	38 (48.10)		238 (41.61)	81 (42.19)	
	<-6.00	181 (26.42)	23 (29.11)		145 (25.35)	59 (30.73)	
Spectacle power (D)	>-3.00	283 (41.31)	25 (31.65)	0.219	236 (41.26)	72 (37.5)	0.721
	−3.00 to −6.00	260 (37.96)	34 (43.04)		218 (38.11)	76 (39.58)	
	<-6.00	130 (18.98)	19 (24.05)		110 (19.23)	39 (20.31)	

*$p < 0.05$.
N, number; BMI, Body Mass Index; BCVA, Best Corrected Visual Acuity; AL, axial length; SE, Spherical Equivalent; D, diopters.

TABLE 2 | Associations of demographic, lifestyle and vision characteristics with anxiety, and depression status ($n = 764$).

	Anxiety		Depression	
	OR (95%CI)	*p*	OR (95%CI)	*p*
Spectacle power (D)	**0.89 (0.81, 0.98)**	**0.019***	1.00 (0.93, 1.07)	0.942
SE (D)†	**0.89 (0.81, 0.98)**	**0.025***	0.98 (0.91, 1.04)	0.473
AL (mm)‡	1.20 (0.98, 1.48)	0.08	1.03 (0.89, 1.19)	0.675
Age, yrs	0.84 (0.56, 1.26)	0.399	1.05 (0.81, 1.36)	0.704
Gender	0.60 (0.34, 1.06)	0.076	1.06 (0.74, 1.54)	0.744
BMI (kg/m^2)	**0.93 (0.86, 0.99)**	**0.047***	0.99 (0.94, 1.03)	0.542
Sleep time (h/d)	**0.53 (0.35, 0.79)**	**0.002***	1.26 (0.95, 1.69)	0.112
Screen time (h/d)	0.91 (0.72, 1.14)	0.411	1.03 (0.89, 1.20)	0.653
BCVA	2.25 (0.84, 6.03)	0.108	0.58 (0.30, 1.13)	0.108

*$p < 0.05$.
OR, odds ratio; CI, confidence interval; SE, Spherical Equivalent; D, diopters; AL, axial length; BMI, Body Mass Index; BCVA, Best Corrected Visual Acuity.
Model 1 adjusted for age, gender, BMI, sleep time, screen time, BCVA, and glass diopters.
†*Model 2 adjusted for age, gender, BMI, sleep time, screen time, BCVA, and SE.*
‡*Model 3 adjusted for age, gender, BMI, sleep time, screen time, BCVA, and AL.*

TABLE 3 | Associations of demographic, lifestyle and vision characteristics with anxiety, and depression score ($n = 764$).

	Anxiety		Depression	
	β (95%CI)	*p*	β (95%CI)	*p*
Spectacle power (D)	**−0.13 (−0.67, −0.18)**	**0.001***	0.19 (−0.11, 0.18)	0.619
SE (D)†	**−0.11 (−0.60, −0.10)**	**0.006***	−0.04 (−0.23, 0.06)	0.259
AL (mm)‡	**0.08 (0.01, 1.07)**	**0.047***	−0.01 (−0.35, 0.27)	0.786
Age, yrs	−0.01 (−1.11, 0.77)	0.725	−0.01 (−0.59, 0.51)	0.884
Gender	−0.04 (−2.07, 0.58)	0.272	0.00 (−0.77, 0.79)	0.986
BMI (kg/m^2)	−0.05 (−0.30, 0.05)	0.153	−0.03 (−0.14, 0.06)	0.460
Sleep time (h/d)	−0.07 (−1.99, 0.07)	0.068	**0.12 (0.37, 1.58)**	**0.002***
Screen time (h/d)	0.01 (−0.44, 0.62)	0.734	−0.00 (−0.33, 0.29)	0.908
BCVA	0.02 (−1.71, 3.09)	0.573	−0.04 (−2.12, 0.69)	0.319

*$p < 0.05$.
SE, Spherical Equivalent; D, diopters; AL, axial length; BMI, Body Mass Index; BCVA, Best Corrected Visual Acuity.
Model 1 adjusted for age, gender, BMI, sleep time, screen time, BCVA, and glass diopters.
†*Model 2 adjusted for age, gender, BMI, sleep time, screen time, BCVA, and SE.*
‡*Model 3 adjusted for age, gender, BMI, sleep time, screen time, BCVA, and AL.*

by 0.12. Findings from this study indicate that myopia was associated with both anxiety status and anxiety score, regardless of the index used. SE, AL, and spectacle power are all markers that reflect the severity of myopia, where SE is the real refractive error, AL is the length of the eyeball, and spectacle power is the degree of correction with glasses. The lower the SE or spectacle power, the higher the myopia. The longer the AL, the higher the myopia (2, 4, 16, 26). In the current study, the likelihood of anxiety increased per unit of spectacle power, and SE decreased. Spectacle power and SE were negatively associated with anxiety scores, while AL was positively associated with the score.

Previous studies have focused on the relationship between high myopia and mental health (19, 20); however, we assessed emmetropia, mild myopia, moderate myopia, and high myopia in our study. Most studies investigated the relationship in adolescents (12, 19–22, 27), and few studies are available on university students. Previous studies have shown that adolescents with myopia are more likely to suffer from psychological problems than their peers (12, 16, 20), while we assessed whether this situation still exists when they mature. Moreover, most studies have focused on social risk factors, such as sex and family income, and few have investigated the vision-related risk factors of anxiety or depression (10, 19, 27). We investigated the prevalence and vision-related risk factors of anxiety and depression among university freshmen.

In a high school student population, Li et al. (16) found that spectacle power was associated more closely with anxiety than depression in 1st-year high school students. When the spectacle power increased by 0.0848 D, the SAS scores increased by 1 point. Our results are consistent with those of Li et al.

Why do myopic students seem more anxious? Seitler (28) suggested that myopia is a refractive error caused by muscle tension outside the eye, causing a break in the separation-individuation process in which myopic patients experience separation anxiety resulting in a sense of an inability to cope with the world.

Furthermore, myopic students who wore glasses were bullied at school and felt victimized. Suffering in victims of bullying occurs due to stressful situations and dismissal to the margin of the group and a low social status among their peers (29). Copeland et al. (30) found that victims of bullying are at risk for psychiatric problems, and this risk extends into early adulthood. Meanwhile, myopia, especially high myopia, can decrease the quality of life (10). The quality of life of patients with high myopia is significantly lower than that of patients without myopia (10). A decreased quality of life affects the psychological status of patients.

In our study, most university students wore glasses to correct their myopia, which may also partly explain their anxiety. Prior research (31) has indicated that the myopic children wearing contact lenses evaluate their physical appearance, athletic skills, and social interactions more favorably than those with glasses, as glasses reduce the size of the eye and affect appearance. High myopia, defined as AL $\geq$ 26 mm, may drastically increase the risk of severe complications later in life, namely, myopic maculopathy, retinal detachment, and glaucoma, which can cause blindness (32). As a result, individuals with high myopia and a longer AL live in fear of possible blindness in the future, which may induce anxiety.

In the current study, we found that the prevalence of anxiety and depression was 10.34 and 25.13%, respectively. The rates were slightly lower than that of Mao (13), who reported that the mean prevalence of anxiety was 27.22% among medical students in China, while the mean prevalence of depression was 32.74%. The discrepancy across studies may be due to the following reasons. First, different assessment tools and criteria have been used in different articles. For example, Mao used the Beck Anxiety Inventory and Hamilton Anxiety Scale (33) to define anxiety and the Beck Depression Inventory (34) and the Center for Epidemiologic Studies Depression Scale (33) to define depression. Second, our participants were university freshmen aged 18–21 years, while Mao focused on both undergraduate and graduate students. The 5th-year undergraduate students and 3rd-year graduate students were facing employment pressure and feared future uncertainty.

Complaints of poor sleep were reported in up to 90% of people diagnosed with depression (35) and up to 70% of people with anxiety (36). Our results are in line with those of previous reports. We found that students with anxiety slept less than their peers did. Sleep time was also associated with depression score: the lower the sleep time, the higher the depression score.

Screen time was not significantly correlated with anxiety or depression. In contrast, Maras et al. (37) examined 2,482 grade 7–12 students and concluded that screen time was associated with the severity of depression and anxiety. It is plausible that the age difference could explain this inconsistency. Adolescents have limited self-control and feel frustrated once they decrease screen time, whereas university freshmen are adults with presumably more self-control. The percentage of students who had >6 h/day of screen time was only 8.9% during the COVID-19 pandemic.

Nevertheless, the percentage of students with screen time of more than 6 h/day was higher than that in a previous study conducted before COVID-19 (38). Therefore, we inferred that the increased screen time was caused by the COVID-19 pandemic. The increased near work at home and limited outdoor activities were all found to be associated with the progression of myopia, and myopia severity could be aggravated during and beyond the COVID-19 pandemic period. The pandemic may last for a relatively short time, but the negative impact of myopia on mental health may last for a long time. Schools, parents, doctors, and students themselves should create a joint response to these challenges.

This study has some limitations. First, because of the cross-sectional design of this study, causality cannot be clarified. Second, sleep time and screen time were self-reported; therefore, recall and reporting bias cannot be excluded. Third, the subjects recruited from a large Chinese university were generally healthy and well-educated, and one should be cautious in generalizing our findings to Chinese young adults. Finally, although we have adjusted some predictors such as screen time and sleep time, other factors (such as the changes that occur during the transition from school life to university life, changes in campus life during the lockdown, and technical stress resulting from online education) not surveyed in this study may also

confound the association between myopia and anxiety and depression symptoms.

CONCLUSIONS

Myopia was associated with anxiety and anxiety scores. The higher the myopia, the higher the anxiety score. Myopia was not found to be associated with depression. The results highlight the importance of providing psychological support to students with myopia during the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Tianjin Medical University Eye Hospital. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RW and HY conceived and supervised the experiment. HZ, HG, WD, and YiZ performed the study and collected the data. YuZ analyzed the data. HZ and YuZ wrote the manuscript. All authors read and approved the final manuscript.

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The Effect of Nursing Students' Self-Efficacy on Patient-Centered Communication During the COVID-19 Pandemic: The Mediating Effect of Learning Burnout

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Background: The 2019 coronavirus disease (COVID-19) outbreak has put the global health system under the spotlight. As part of the medical workforce, nurses play an important role in interacting with and caring for patients; hence, patient-centered communication (PCC) has been emphasized in nursing education. Thus, it is worth investigating how future nurses perceive PCC and PCC-related factors under the special circumstances of COVID-19. For this purpose, the present study analyzed the mechanisms underlying the association between self-efficacy and nurse–patient communication tendency through learning burnout among nursing students during the COVID-19 pandemic.

Methods: The general self-efficacy questionnaire, college students' learning burnout scale, and doctor–patient communication tendency scale were used to survey 2,231 nursing students in higher vocational medical colleges at the onset of the COVID-19 pandemic.

Results: General self-efficacy can directly negatively correlate with the degree of nursing students' overall nurse–patient communication, including caring, sharing, and health promotion. Dejection from learning burnout partially mediated the relationships between self-efficacy and caring and between self-efficacy and sharing; it fully mediated the relationship between self-efficacy and health promotion. Reduced personal accomplishment partially mediated between self-efficacy and caring, while it fully mediated between self-efficacy and health promotion; however, it did not play a role in the sharing model.

Conclusion: Self-efficacy influences nurse–patient communication through learning burnout. Specifically, dejection and reduced personal accomplishment—two aspects of learning burnout—may compromise nursing students' willingness to engage in PCC. Thus, the importance of PCC, especially during critical health situations such as pandemics, should be emphasized further in future nursing education.

Keywords: COVID-19, nursing students, general self-efficacy, learning burnout, patient-centered communication

INTRODUCTION

On March 11, 2020, the World Health Organization declared the outbreak of the 2019 coronavirus disease (COVID-19) a pandemic (1). This highly infectious disease remains a global health risk to date. To fight such a disease, biological, psychological, and social factors must be integrated into the patient recovery process. However, under these stressful circumstances, nursing staff must manage heavy workloads, long hospital hours, and fears of contagion as well as overcome the difficulties of communicating through layers of personal protection equipment. These difficulties may impair communication with patients, causing health workers to focus less on the patients' psychosocial well-being (2). Studies have reported that the quality of perceived nurse–patient communication has decreased since the onset of the COVID-19 pandemic, specifically when discussing treatment and medical procedures (3). To ensure future nurses' readiness to adopt a humanistic approach in medical settings, we must pay attention to how well nursing students perceive nurse–patient communication in a public health crisis such as COVID-19 and identify the factors influencing it.

In the past decades, nurse–patient communication in China was described as patriarchal and characterized by health-worker-centered communication (2). Patients expected health workers to be the experts and tell them what to do (4). Nevertheless, in recent years, most healthcare-related education has emphasized the importance of patient-centered communication (PCC), as it ensures balance and mutual understanding between nurses and patients (5). At the same time, it enhances patient compliance and improves patient satisfaction and health status (6–9).

PCC is a type of nurse–patient communication proposed by Balint in the 1960s. It contrasts with the "illness-oriented medicine" approach, which supports the biological method in patient care (10). The nursing objective of PCC is to strive for individualized care for patients to meet their physiological and psychological needs (11, 12). Epstein et al. (13) described the following PCC features: understanding patients' needs from their perspective and unique psychosocial backgrounds, being respectful and consistent with the patient's values, and sharing an expert understanding of the problem and treatment with them. However, some empirical studies have indicated the gaps between actual and idealized nurse–patient communication, suggesting that the actual nursing condition was often instrumental and focused on procedure rather than personalized patient-centered assessment (10). Therefore, the present study aims to clarify the factors influencing nurse–patient communication tendency in nursing education, specifically, self-efficacy and learning burnout.

Self-efficacy is an individual's confidence in their ability to accomplish certain goals (14). A recent study found that college nursing students' general self-efficacy was positively correlated with their communication ability (15). Similar conclusions were verified for practicing nurses, confirming that the higher their self-efficacy level, the better their clinical communication ability (16, 17). Another study showed that intern nurses who underwent self-efficacy training had greater nurse–patient communication ability than those who did not (18). Thus, in this study, we considered that self-efficacy may play a significant role in patient-centered communication in nursing education.

Learning burnout is a concept derived from job burnout. It refers to students' negative attitude and behavior toward learning caused by learning pressure or lack of interest (19). Learning burnout induces students' feelings of dejection—a sense of frustration or exhaustion due to lack of accomplishment and competence in dealing with academic tasks—which leads to improper behavior, such as skipping classes (19). Learning burnout negatively influences students' academic performance, interpersonal communication, and mental health (20). College students' learning burnout is influenced by both individual and environmental factors, self-efficacy being one of the major individual factors (21, 22). Many empirical findings have shown a negative correlation between self-efficacy and learning burnout among various student groups (23, 24). Nursing students' learning burnout mainly manifests in feelings of depression and improper use of learning strategies (20) and can negatively predict academic burnout (25). Furthermore, the COVID-19 situation could be considered an environmental factor of learning burnout. Indeed, COVID-19 negatively affects medical students' mental health and study performance in general, resulting in increased anxiety and stress (26, 27). Moreover, home quarantine, postponed return to college, and online learning mean that nursing students might be more vulnerable to learning burnout.

Meanwhile, learning burnout may impact nursing students' attitudes toward nurse–patient communication. One study by Williams et al. (28) established a doctor–patient cycle model and recorded how ineffectively managing stress and burnout could lead to a vicious cycle in the medical workplace. Leaving job burnout unaddressed could negatively impact the quality of medical contact with patients, for example, by exhibiting dehumanized behaviors. In this case, health workers might treat patients as operation objects rather than real people (29). Passalacqua and Segrin (12) found that the higher resident physicians' perceived burnout, the worst their patient-centered communication, and the higher their job burnout, the weaker their communication ability (30). Although nursing students have not yet experienced job burnout because they are yet to join the workforce, they are no strangers to learning burnout (31). Therefore, it is worthwhile to explore whether learning burnout could have the same negative relationship to their attitude toward nurse–patient communication, possibly in an indirect and mediating way.

This study aimed to explore the mechanisms of the relationship between self-efficacy and nurse–patient communication tendency among nursing students during the COVID-19 pandemic and further uncover the mediating role of learning burnout therein (see **Figure 1**). By constructing a theoretical model to explain nurse–patient communication tendencies, we sought to provide more insight into the formation of good PCC in future nurses. Given the evidence from previous studies, we hypothesized as follows:

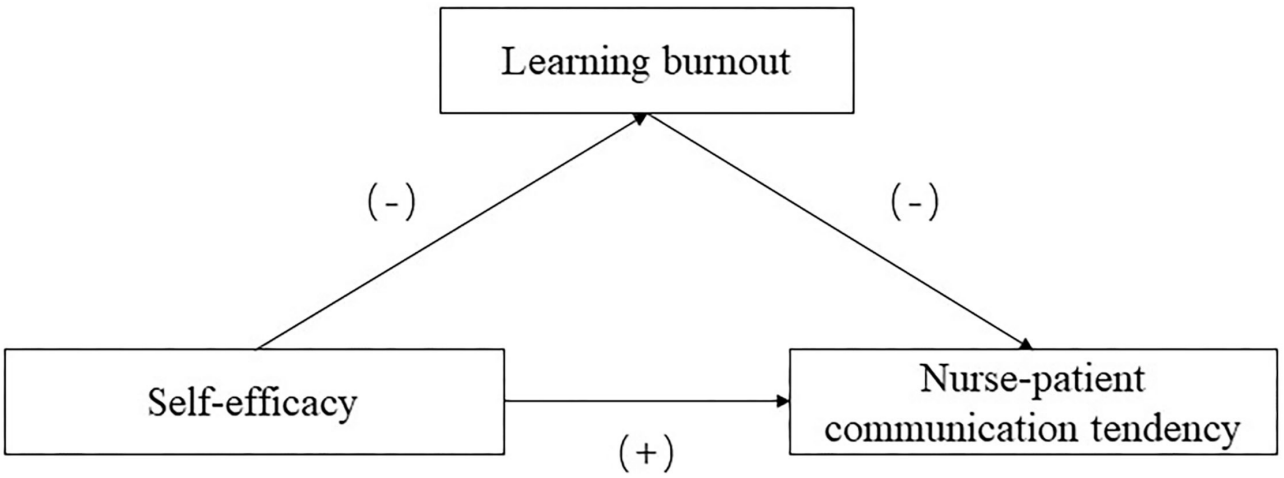

FIGURE 1 | Conceptual model.

H1: Self-efficacy positively predicts nurse–patient communication tendency; that is, the higher the self-efficacy is, the stronger the PCC tendency will be, and vice versa.
H2: Self-efficacy negatively predicts learning burnout; that is, the higher the self-efficacy is, the lower the learning burnout will be, and vice versa.
H3: Learning burnout mediates the relationship between self-efficacy and nurse–patient communication tendency.

MATERIALS AND METHODS

Participants

For this study, 2,272 nursing students from a higher vocational medical college in Fujian Province were recruited. Forty-one participants were excluded due to incomplete questionnaires. The remaining 2,231 questionnaires, 119 of which were from male participants and 2,112 from female participants, were valid for data analysis. This sample consisted of 705 freshmen, 755 sophomores, and 771 juniors with a mean age of 20.49 years (*SD* = 1.51).

Procedure

The survey was distributed to the nursing students in February 2020, when the COVID-19 pandemic began to unfold in China. In compliance with the quarantine requirements, we conducted the survey online via a Chinese survey website (www.wjx.cn). All participants completed the survey voluntarily and anonymously.

Measures

General Self-Efficacy Scale

The General Self-Efficacy Scale was developed by Schwarzer and colleagues in 1981 (32) and has been proven to have good reliability and validity when applied to the Chinese college population (33). The scale measures an individual's state of self-efficacy, showing that the higher their score, the better their perceived sense of self-efficacy. Here, participants are asked to rate 10 questionnaire items based on a seven-point Likert scale ranging from 1 (strongly agree) to 7 (strongly disagree). Sample items include "I am confident that I can deal with any unexpected circumstance effectively." The present sample had good internal consistency (Cronbach's $\alpha = 0.90$, KMO = 0.93).

College Students' Learning Burnout Scale

The College Students' Learning Burnout Scale was revised by Lian et al. (19) according to Maslach's Job Burnout Scale. It is a 20-item scale, measuring three dimensions of learning burnout: dejection, improper behavior, and reduced personal accomplishment. Dejection reveals college students' signs of depressive emotion, lack of interest, and difficulties in managing learning problems. Improper behavior reveals students' inappropriate behaviors associated with learning burnout, such as skipping class, being late to class, and failing to hand in assignments. Reduced personal accomplishment refers to students' low sense of achievement in the learning process due to an inability to complete tasks. Each item is rated on a five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree), whereby the higher the score, the higher the students' negative attitude toward learning. The present sample had good internal consistency (Cronbach's $\alpha = 0.88$, KMO = 0.92).

Doctor–Patient Communication Tendency Scale (DPCTS)

The Doctor–Patient Communication Tendency Scale is a modified version of the classic Patient–Practitioner Orientation Scale by Krupat et al. (34) that assesses communication tendency in the context of the Chinese medical environment (35). In Chinese, doctor–patient communication refers to the communication between patients and medical practitioners in general, including doctors, nurses, and other related health workers (36). This definition was also emphasized at the beginning of the survey. The Doctor–Patient Communication Tendency Scale is a 15-item scale consisting of three dimensions: caring, sharing, and health promotion. The caring dimension is used to measure the extent to which respondents value

warmth and support in the doctor–patient relationship and the extent to which medical staff pay attention to psychosocial problems. Sharing measures the extent to which respondents believe that patients are entitled to the same status and power as medical workers and the extent to which they share information with patients. Health promotion measures the respondent's recognition of personalized diagnosis and treatment methods and whether the patient's health should be maintained from a holistic perspective. Health promotion was rated from 1 (totally disagree) to 6 (totally agree). The higher the score, the likelier it is that respondents pay attention to health promotion. Higher scores for caring and sharing indicate patient-centered communication, whereas lower scores represent illness-centered communication. The present sample had good internal consistency (Cronbach's $\alpha = 0.76$, KMO = 0.89).

Statistical Analysis

Data was collected using a questionnaire survey. Thus, common method biases were examined first. SPSS 24.0 was used to calculate descriptive statistics and correlations of the study variables. The structural equation model was established using Mplus 8.3 software.

RESULTS

Harman's single-factor analysis showed that the first factor in our data explained only 19.94% of the variance—less than the critical value (40%)—suggesting that common method bias was unlikely to confound the interpretations of our results (37).

The average score for general self-efficacy was 2.74, slightly above the median level (Median = 2.5), while the results of learning burnout showed that the averages of improper behavior, dejection, and reduced personal accomplishment were below the median level (Median = 3). The results of nurse–patient communication tendency showed that the health promotion and care scores were above the median level, while those of sharing were below it (Median = 3.5). An overview of the correlation coefficients between all variables is presented in **Table 1**.

Testing for the Mediation Model

To understand how self-efficacy and learning burnout influence nurse–patient communication tendency, mediation analysis was performed for three separate dimensions (sharing, caring, and health promotion) after controlling the sociodemographic variables such as gender and grades. For each mediation analysis, 5,000 bootstrap samples were created to establish a 95% bias-corrected confidence interval for the expected indirect associations.

Mediation Effect of Learning Burnout Between Self-Efficacy and Caring

The results showed that self-efficacy had a significant direct predictive effect on dejection ($\beta = -0.38$, $t = -12.75$, $P < 0.001$), improper behavior ($\beta = -0.41$, $t = -12.73$, $P < 0.001$), reduced personal accomplishment ($\beta = -0.66$, $t = -33.13$, $P < 0.001$), and caring ($\beta = -0.26$, $t = -5.57$, $P < 0.001$; see **Figure 2**). Dejection ($\beta = -0.29$, $t = -7.81$, $P < 0.001$) and reduced personal accomplishment ($\beta = -0.12$, $t = -2.54$, $p < 0.05$) had a direct predictive effect on caring. Self-efficacy indirectly predicted caring through the mediating effect of dejection ($\beta = 0.11$, $t = 6.66$, $P < 0.001$, 95% CI [0.08, 0.14]) and reduced personal accomplishment ($\beta = 0.08$, $t = 2.53$, $P < 0.05$, 95% CI [0.02, 0.15]). Self-efficacy had a significant direct effect on caring ($\beta = -0.26$, $t = -5.57$, $P < 0.001$, 95% CI [−0.34, −0.17]). However, the total effect of this model was not significant ($\beta = -0.05$, $t = -1.55$, $P > 0.05$, 95% CI [−0.10, 0.01]).

Mediation Effect of Learning Burnout Between Self-Efficacy and Sharing

Self-efficacy had a significant direct effect on dejection ($\beta = -0.38$, $t = -12.75$, $P < 0.001$), improper behavior ($\beta = -0.41$, $t = -12.73$, $P < 0.001$), reduced personal accomplishment ($\beta = -0.66$, $t = -33.13$, $P < 0.001$), and sharing ($\beta = -0.13$, $t = -2.68$, $P < 0.01$; see **Figure 3**). Dejection had a significant direct effect on sharing ($\beta = -0.14$, $t = -3.42$, $P < 0.01$). Self-efficacy showed a significant direct effect on sharing ($\beta = -0.13$, $t = -2.68$, $P < 0.01$, 95% CI [−0.23, −0.03]) and a significant indirect effect on sharing through the mediation of dejection ($\beta = 0.05$, $t = 3.40$, $P < 0.01$, 95% CI [0.02, 0.08]). The total effect of this mediation model was significant ($\beta = -0.13$, $t = -3.80$, $P < 0.001$, 95% CI [−0.19, −0.06]).

Mediation Effect of Learning Burnout Between Self-Efficacy and Health Promotion

Self-efficacy had a significant direct effect on dejection ($\beta = -0.38$, $t = -12.75$, $P < 0.001$), improper behavior ($\beta = -0.41$, $t = -12.73$, $P < 0.001$), and reduced personal accomplishment ($\beta = -0.66$, $t = -33.13$, $P < 0.001$) but no effect on health promotion (see **Figure 4**). Dejection ($\beta = -0.11$, $t = -2.95$, $P < 0.01$) and reduced personal accomplishment ($\beta = -0.16$, $t = -3.44$, $P < 0.01$) had a direct effect on health promotion. Self-efficacy showed a significant indirect effect on health promotion through the mediation of dejection ($\beta = 0.04$, $t = 2.76$, $P < 0.01$, 95% CI [0.01, 0.08]) and reduced personal accomplishment ($\beta = 0.10$, $t = 3.39$, $P < 0.01$, 95% CI [0.05, 0.16]). The total effect of this mediation model was significant ($\beta = 0.20$, $t = 7.87$, $P < 0.001$, 95% CI [0.15, 0.25]).

DISCUSSION

The present study analyzed the mechanisms underlying the association between self-efficacy and nurse–patient communication tendency through learning burnout among nursing students during the COVID-19 pandemic. Specifically, nurse–patient communication tendency was examined through three key dimensions: caring, sharing, and health promotion.

The overall descriptive results showed that nursing students were more likely to demonstrate PCC through caring and health promotion but not through sharing. These results are consistent with previous studies showing that sharing is often lost in communication with patients and families (35). One explanation for these results is that sharing complex and professional medical information with patients in a short period is difficult. When examining the nursing curriculum, the emphasis on nursing,

TABLE 1 | Descriptive statistics and inter-correlations between variables ($n = 2{,}231$).

Variable	1	2	3	4	5	6	7
1. General self-efficacy	1						
2. Dejection	−0.29**	1					
3. Improper behavior	−0.37**	0.67**	1				
4. Reduced personal accomplishment	−0.54**	0.47**	0.50**	1			
5. Caring	−0.05*	−0.25**	−0.15**	−0.11**	1		
6. Sharing	−0.10**	−0.06**	−0.02	0.06**	0.33**	1	
7. Health Promotion	0.19**	−0.18**	−0.14**	−0.21**	0.25**	−0.33**	1
M	2.74	2.67	2.82	2.65	4.67	3.44	4.82
SD	0.41	0.68	0.61	0.59	0.89	0.90	0.96

*$p < 0.05$ (two-tailed). **$p < 0.01$ (two-tailed).

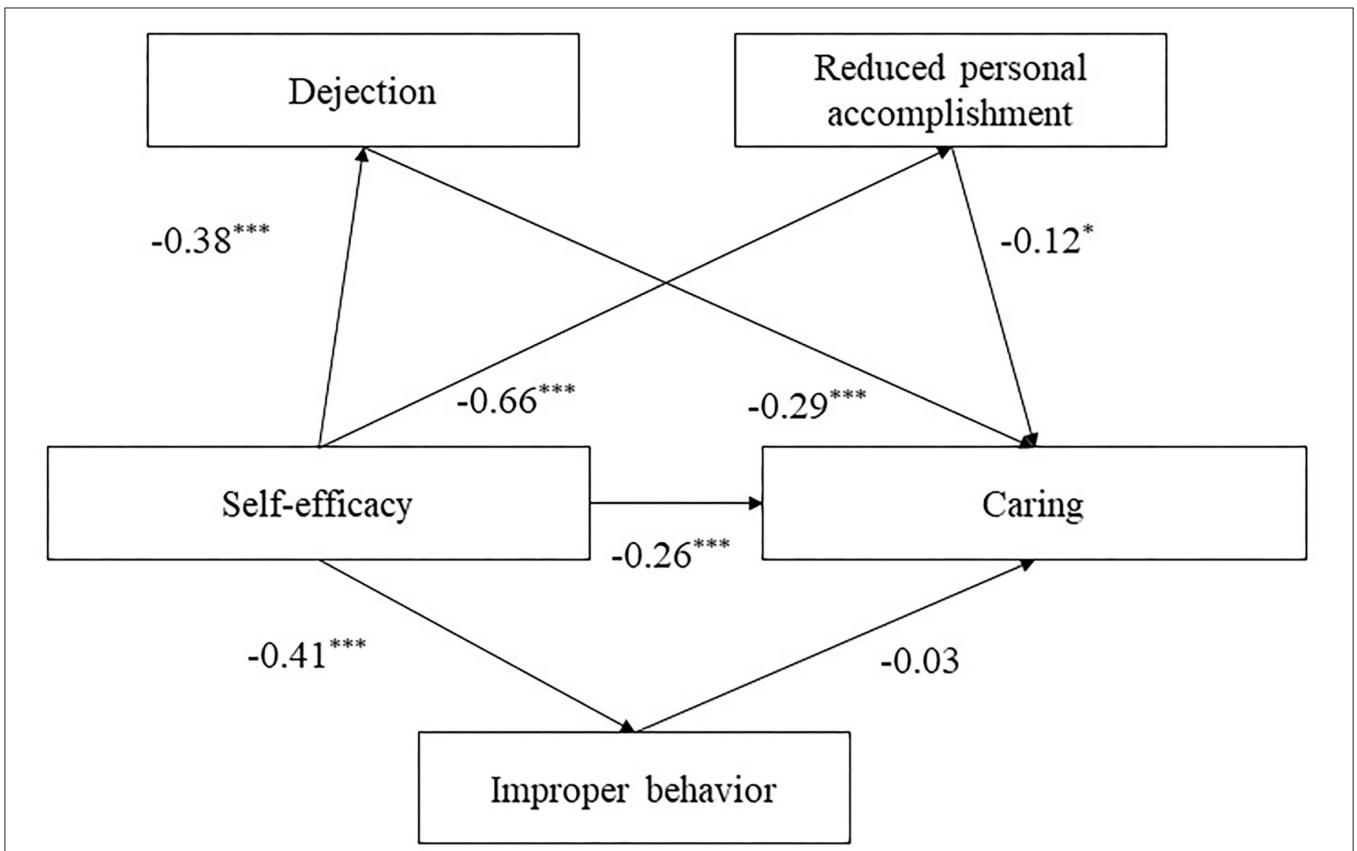

FIGURE 2 | The structural model of self-efficacy, dejection, reduced personal accomplishment and improper behavior on caring. Significant paths are presented by asterisks (*p <0.05, **p < 0.01, ***p < 0.001).

caring skills, and health promotion suggestions in various courses is noticeable. However, how nursing students should share their medical knowledge using simple language, let alone using it during public health emergencies such as the COVID-19 pandemic, is not emphasized. Another explanation is that our data collection was conducted in February 2020, when the COVID-19 pandemic had just started. At this time, the public had little knowledge about the virus and medical care supporting the recovery, and nursing students' perspective on sharing such knowledge in patient-centered communication tendency may have been compromised.

Our initial research objective was to investigate whether self-efficacy positively predicts nurse–patient communication tendencies among nursing students. Our results demonstrated that self-efficacy is negatively associated with students' recognition of the need for caring and sharing medical information with patients in nursing, thus contradicting our hypothesis and some previous literature. The higher their

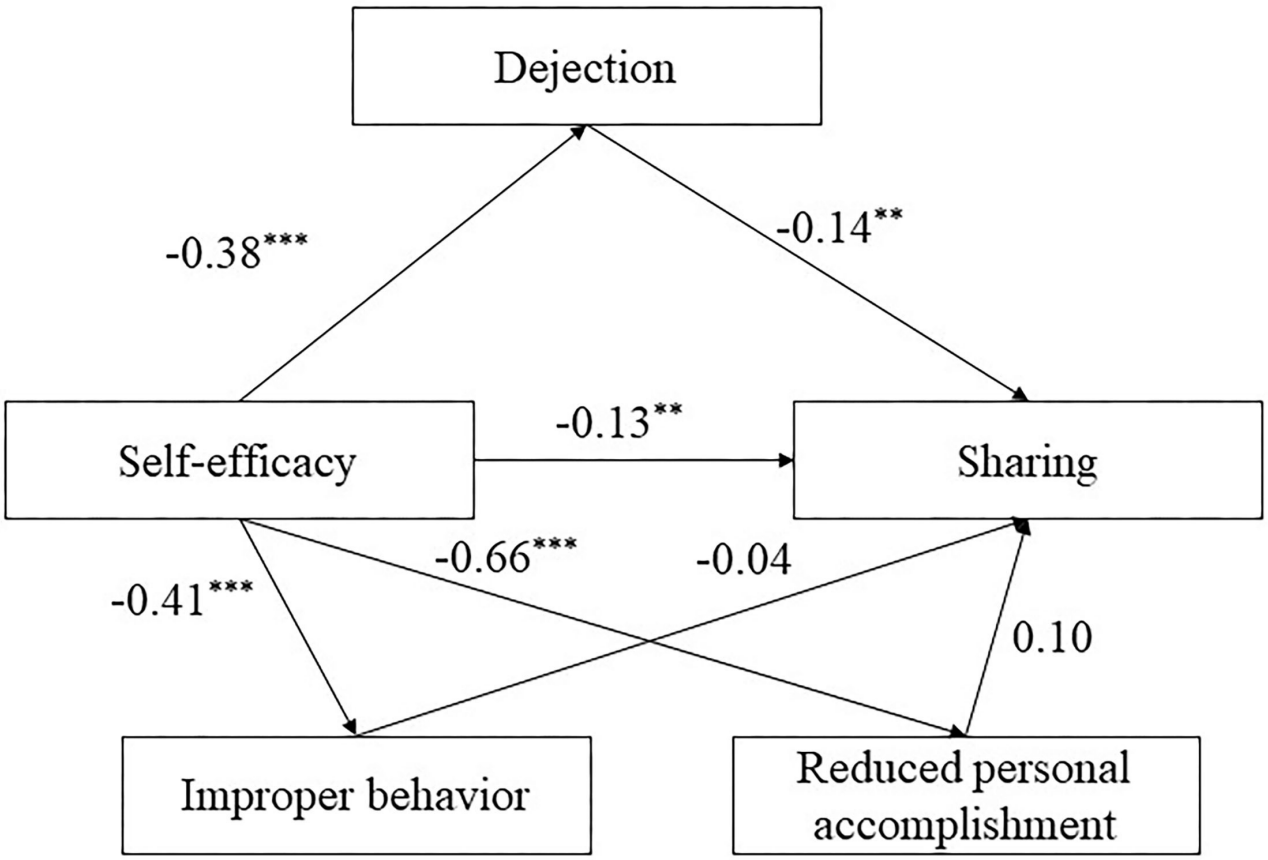

FIGURE 3 | The structural model of self-efficacy, dejection, reduced personal accomplishment and improper behavior on sharing. Significant paths are presented by asterisks (**$p < 0.01$, ***$p < 0.001$).

levels of self-efficacy, the less likely they are to endorse warmth and support, share medical information, or validate patients' rights in the nurse–patient relationship. Nonetheless, previous studies have suggested that the self-efficacy of intern nurses is positively correlated with their clinical communication skills (38). When they received adequate self-efficacy training, intern nurses scored higher on service satisfaction (18). These unexpected results may be due to the unspecified content of self-efficacy. In our study, we measured nursing students' general self-efficacy, whereas another study [i.e., (18)] targeted a specific situation. In Shang et al. (18), their self-efficacy training was based on a nurse–patient role reversal to allow nursing students to understand patients' pain during medical processes better and improve their communication and health promotion. In this case, high self-efficacy represents higher sensitivity and involvement in communication. In our study, when asked to rate their general self-efficacy level, the nursing students may have thought only about their study abilities and biomedical knowledge concerning diagnosis and treatment, ignoring the psychosocial factors of communication. Additionally, the COVID-19 outbreak inserts all medical workers in high-risk work environments, and they shoulder the responsibility to fight the disease (39). Under these special circumstances, nursing students with higher self-efficacy might be more inspired to favor the patriarchal and protective approach in nurse–patient communication.

In support of our second hypothesis, all three aspects of learning burnout were negatively associated with self-efficacy, caring, sharing, and health promotion in PCC. The analysis of its mediation effect partially supported the third hypothesis, with only dejection and reduced personal accomplishment partially or fully mediating the three separate areas of nurse–patient communication tendency. Dejection and Reduced Self-Accomplishment Were Key in Establishing PCC.

Dejection from learning burnout partially mediated the relationships between self-efficacy and caring and between self-efficacy and sharing but fully mediated the relationship between self-efficacy and health promotion. In other words, nursing students with higher self-efficacy may have fewer negative feelings toward learning burnout and, in turn, be more inclined to provide warm and supportive PCC. This is possibly because dejection can worsen emotional well-being, leaving students less capable of caring for others. Previous

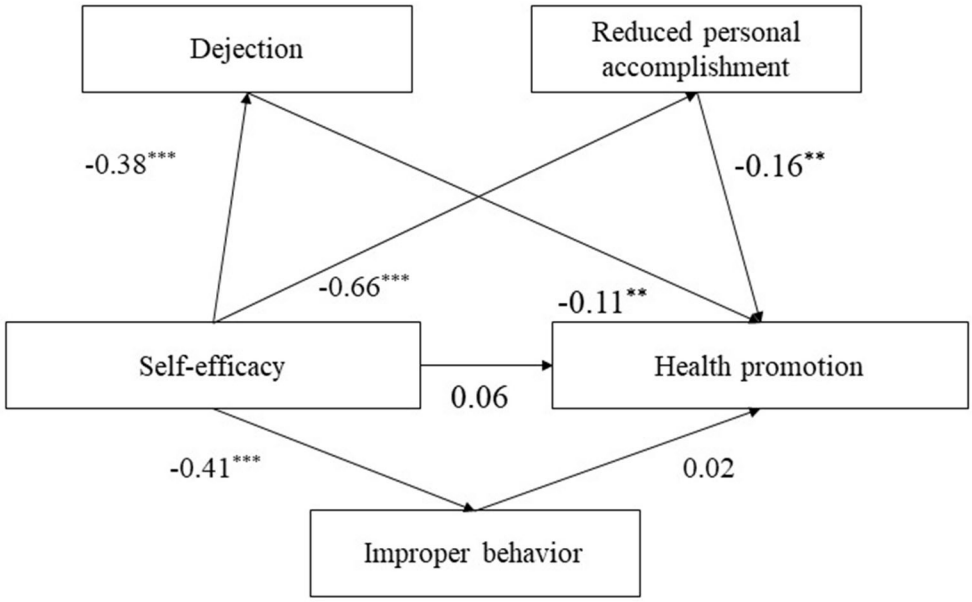

FIGURE 4 | The structural model of self-efficacy, dejection, and reduced personal accomplishment on health promotion. Significant paths are presented by asterisks (**$p < 0.01$, ***$p < 0.001$).

studies have found that nurses' emotional states can affect their communication. In one study, an enthusiastic and optimistic mood not only improved nurses' work efficiency but also resulted in positive feedback from patients (40). The more the nurses are frustrated and lacking in interest when learning, the less willing they become to communicate with patients regarding mental and physical health, and the more they struggle to engage in PCC.

Reduced personal accomplishment partially mediated between self-efficacy and caring, while it fully mediated between self-efficacy and health promotion. Surprisingly, it did not play a role in the sharing model. A possible explanation for this result is that a low sense of self-achievement lowers self-esteem and empathy levels (41). Being confident and empathetic is crucial for establishing nurse–patient participation, wherein patients can discuss their concerns, participate in their recovery process, and obtain more health information (42). In such PCC, medical workers are more likely to alleviate patient pressure in a warm and professional manner. However, reduced personal accomplishment did not mediate between self-efficacy and sharing. One reason is that, for this sample, sharing was not as favorable as caring and health promotion in the COVID-19 situation, as discussed earlier. Another possible reason is that nursing students did not perceive the relationship between self-accomplishment and patients' status and power.

Dejection and reduced personal accomplishment played a critical mediating role between self-efficacy and nurse–patient communication tendency among the nursing students. In contrast, improper behavior did not impact any of the three models. This is probably because improper behavior may be a learning burnout outcome and manifests in different ways. In the Chinese cultural context, students often conceal certain actual behaviors of learning dissatisfaction to avoid negative consequences, such as losing attendance marks.

Limitations and Future Direction

The present study had a few limitations that need to be addressed. First, although our investigation was conducted during the COVID-19 pandemic to see its impact on nursing students' PCC levels, we did not directly measure how the pandemic influenced students. Future studies should examine nursing students' COVID-19 perceptions and their related influences on the nursing profession. Second, the present study used a cross-sectional design; therefore, causality could not be confirmed. Future research could incorporate a longitudinal or experimental design to uncover the factors influencing PCC among nursing students further. Third, we used a Chinese modified version of the Patient–Practitioner Orientation Scale, in which the term was worded as doctor-patient communication but meant all health practitioners in general in the Chinese context. This needs to be re-worded when replicating this study in other cultural contexts. Future studies should also compare the response between nurses and doctors using the same scale. Fourth, most nursing students in our sample were women, which is representative of the women-to-men ratio in the nursing industry in China. However, we still need to be cautious while drawing conclusions about the relationship between self-efficacy, learning burnout, and PCC level in relation to gender. Finally, participants were recruited through convenience sampling by targeting nursing students in one vocational college in Fujian. During the data collection, all students stayed off-campus and

were distributed across southeast China due to the pandemic control policy. Therefore, the generalizability of these results was limited. Compared to other countries, nursing students from mainland China tend to have more course hours on medical science theory and less emphasis on humanities (43). The learning burnout in the present model might be weakened in nursing students with less study workload. Future studies could consider the cross-cultural comparison in PCC learning and its related factors.

CONCLUSION

The present study was the first to explore the mechanism by which self-efficacy and learning burnout influence nursing students' PCC tendency during the early stage of a public health crisis such as the COVID-19 pandemic. Self-efficacy influences nurse–patient communication through learning burnout. Specifically, dejection and reduced personal accomplishment—two aspects of learning burnout—may compromise nursing students' willingness to engage in PCC. Thus, the importance and meaningfulness of PCC, especially during critical health situations such as pandemics, should be emphasized further in future nursing education. Future nurses need to be equipped with a humanistic care mindset, respecting patients' involvement in medical treatment recovery. At the same time, medical education institutions need to note students' self-efficacy and reduce their learning burnout level (25). Students who discover their self-worth and emotional balance during their Nursing studies could become warm-hearted professionals.

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 Fujian Health College. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LW designed the theoretical framework. JW analyzed the data. WS and LW collected the data. All authors wrote the manuscript.

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The Influence of College Students' Empathy on Prosocial Behavior in the COVID-19 Pandemic: The Mediating Role of Social Responsibility

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Prosocial behavior has played an irreplaceable role during the COVID-19 pandemic, not only in infection prevention and control, but also in improving individual mental health. The current study was conducted after COVID-19 control was under the stage of Ongoing Prevention and Control in China. Using the Interpersonal Response Scale, Prosocial Tendencies Measure and Big Five Personality Questionnaire. In total, 898 college students participated in the current study (*M*age = 19.50, *SD*age = 1.05, Age range = 16–24). The result showed that against the background of the COVID-19 pandemic, college students' social responsibility partially mediated the relationship between empathy and prosocial behavior. This study provides new insights and inspiration for improving college students' mental health in the context of the pandemic.

Keywords: prosocial behavior, empathy, social responsibility, COVID-19, mental health

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INTRODUCTION

The global outbreak of COVID-19 began in December 2019 (1). The World Health Organization has classified the COVID-19 outbreak as a Public Health Emergency of International Concern (2). COVID-19 triggered a psychological crisis on an unprecedented global scale, especially for college students who faced many challenges (3, 4). Due to the negative impact of the pandemic and the subsequent lockdowns, college students have experienced a transition from physical classes to online remote classes, the loss of daily social activities, and the greater pressure of employment, which have significantly affected their mental health, normal interpersonal activities and social life (3–5). Thus, against the background of the COVID-19 pandemic, it is important to investigate the factors that improve college students' mental health.

When individuals are threatened by natural disasters or health crises, prosocial behavior can be a positive factor in improving individual mental health. Prosocial behavior can promote individual life satisfaction, happiness, mental health, and other psychological states (6). Meanwhile, prosocial behavior interventions can promote individual mental health (7), and reduce individual depression and anxiety levels (6). Furthermore, high level of prosocial behavior has positive effects on both helpers and recipients (8), not only providing benefits to the recipient, but also boosting the givers happiness and health, thus helping to cope with the deadly coronavirus (9). Therefore, against the background of the COVID-19 pandemic, promoting college students prosocial behaviors is a viable way to maintain mental health, which is of great significance. However, little is known about the prosocial behavior of college students in the context of COVID-19 (8). Therefore, exploring

prosocial behavior and its influencing factors among college students in the context of COVID-19 plays a significant role in promoting college students' mental health and disease prevention and control.

Quantitative studies have shown that empathy is closely related to prosocial behavior. Empathy ability can positively predict individual' s prosocial behavior (10). Highly empathetic individuals exhibited more prosocial behaviors (11–13). They are more attentive to the feelings and needs of others (14). In order to avoid feelings of guilt over unhelpful thoughts and actions, individuals may exhibit more prosocial behaviors. Furthermore, empathy is the common motivational basis of prosocial behavior (15). For example, during the COVID-19 pandemic, empathy romotes the motivation of individuals' prosocial behavior of wearing a face mask and maintaining physical distance (16, 17).

Empathy may promote prosocial behavior through a specific pathway. It is found that level of empathy positively predicts the degree of social responsibility (18, 19). There was is a moderate positive correlation between empathy and responsibility. That is, individuals with higher level of empathy have higher level responsibility (20). Furthermore, Chapman et al. (21) showed that the perception of another' s pain and the responsibility to the person in need might trigger prosocial behavior. Social responsibility acts as an important influence on individual helping behaviors (22), it is activated by situational and individual factors, and the level of activation determines the level of prosocial behavior (23). In addition, responsibility is an effective predictor of a series of positive psychology and behaviors such as altruism (24, 25). Individuals with higher social responsibility have higher level of prosocial behavior (23). We hypothesized that social responsibility may explain the relationship between empathy and prosocial behavior.

Based on the literature review, we proposed the following hypotheses:

Hypothesis 1. In the context of the COVID-19 pandemic, there is a significant positive correlation between empathy, social responsibility, and prosocial behavior among college students.

Hypothesis 2. In the context of the COVID-19 pandemic, social responsibility plays a mediating role in the effect of empathy on prosocial behavior.

MATERIALS AND METHODS

Participants

Fighting COVID-19 China in Action indicates that since April 29, 2020, COVID-19 control has been conducted on the ongoing prevention and control in China (26). The current study was conducted after the pandemic was basically controlled and normal daily life was restored in China. We Investigated the empathy, social responsibility and prosocial behavior of college students from September 2020 to March 2021. Data were collected by Questionnaire Star platform and offline paper questionnaire. In total, 898 ($M_{\text{age}} = 19.50$, $SD = 1.05$, Range = 16–24 years, 66.4% female) college students from Northwest Normal University completed the test anonymously. All participants in the current study were informed consent.

Measures

Empathy

Empathy was measured by the Interpersonal Reactivity Index-C (IRI-C), designed by Davis (27) and revised by Zhang Fengfeng et al. (28). The scale has 22 items. In total, rated on a five-point Likert scale ranging from one (complete disagreement) to five (complete agreement). A higher score indicates a higher level of empathy. This questionnaire includes four dimensions: viewpoint selection, empathic fantasy, empathic concern, and personal pain. Cognitive empathy is measured by viewpoint selection and empathic fantasy, and emotional empathy is measured by empathic concern and personal pain. This scale has been proven to have good reliability and validity in previous studies (28). The Cronbach α coefficients of this questionnaire in the current study was 0.76, the Cronbach α coefficients of cognitive empathy was 0.7, and the Cronbach α coefficients of emotional empathy was 0.61. Confirmatory factor analysis (CFA) suggested that the corrected model fit the data well: $\chi^2 = 382.917$, $\chi^2/df = 3.868$, CFI = 0.952, NFI = 0.937, RFI = 0.854, IFI = 0.953, RMSEA = 0.057.

Prosocial Behavior

Prosocial behavior was measured using the Prosocial Tendencies Measure (PTM) designed by Carlo (29) and revised by Cong Wenjun (30). The questionnaire has 23 items, rated on a five-point Likert scale ranging from one (complete disagreement) to five (complete agreement). The questionnaire had six dimensions: anonymity, altruism, openness, compliance, urgency, and emotional prosocial behavior. A higher score indicates a higher frequency of prosocial behavior. The scale has been proven to have good reliability and validity in practice (30). The Cronbach α coefficient of this questionnaire in the current study was 0.84. Confirmatory factor analysis (CFA) suggested that the corrected model fit the data well: $\chi^2 = 845.262$, $\chi^2/df = 4.449$, CFI = 0.883, NFI = 0.855, RFI = 0.808, IFI = 0.884, RMSEA = 0.062.

Social Responsibility

Social responsibility was measured by the "conscientiousness" subscale of John's Big Five Inventory (BFI). The scale consists of 12 items, rated on a five-point Likert scale ranging from one (complete disagreement) to five (complete agreement), with higher scores indicating higher levels of social responsibility. The scale has good reliability and validity (31, 32), The Cronbach α coefficient of the subscale in the current study was 0.69. Confirmatory factor analysis (CFA) suggested that the corrected model fit the data well: $\chi^2 = 155.053$, $\chi^2/df = 3.524$, CFI = 0.970, NFI = 0.959, RFI = 0.938, IFI = 0.970, RMSEA = 0.053.

Data Analysis

Data were analyzed using SPSS 24.0. Since empathy, social responsibility, and prosocial behavior were all measured by self-reported scales, there was a possibility that this may lead to common method bias effects (33). Therefore, the current study used anonymous measurements and reverse-scoring to control from program. After data collection, the Harman univariate test was used to test the size of the common

method deviation. Unrotated exploratory factor analysis results extracted a total of 12 factors having eigenvalue roots greater than one, and the maximum factor variance explanation rate was 16.76%, lower than the critical standard of 40%, indicating that there was no obvious common method bias in the current study. Next, descriptive statistics and correlation analyses were performed for the data in the current study. On this basis, the macro program Process 3.4 was used to test the mediating effect of social responsibility on empathy and prosocial behavior.

RESULTS

Preliminary Analysis

Independent samples *t*-test was used to test for gender differences. The results showed that there were significant gender differences in empathy, cognitive empathy, and emotional empathy. Female students' scores on empathy ($t = -4.60$, $p < 0.001$), cognitive empathy ($t = -3.18$, $p < 0.05$) and emotional empathy ($t = -4.75$, $p < 0.001$) were significantly higher than those of males. But there were no significant gender differences in social responsibility ($t = -0.91$, $p = 0.363$) and prosocial behavior ($t = 1.62$, $p = 0.105$).

One-sample *t*-test was used to investigate the differences of the empathy, prosocial behavior and social responsibility between our study and the previous studies. The mean score of empathy of college students in this study (3.28 ± 0.47) was lower than that of Huang S et al. (18) (3.35 ± 0.37), which was statistically significant ($t = -4.57$, $p < 0.001$). The mean score of prosocial behavior (3.14 ± 0.51) was lower than that of Li L et al. (34) (3.14 ± 0.51), which was statistically significant ($t = 0.02$, $p < 0.001$). However, the mean score of social responsibility (3.43 ± 0.47) was higher than the national norm of responsibility (3.35 ± 0.56) (32), which was statistically significance ($t = 5.02$, $p < 0.001$).

Correlation Analysis of Empathy, Prosocial Behavior and Social Responsibility

Table 1 shows the means, standard deviations, and Pearson correlation coefficients for all variables in the current study. Correlation analysis showed that, in the COVID-19 pandemic, there was a significant positive correlation between empathy and prosocial behavior, empathy and social responsibility, and social responsibility and prosocial behavior of college students, which confirmed Hypothesis 1.

TABLE 1 | Descriptive statistics and Pearson correlations for all measures.

Measure	*M*	*SD*	1	2	3
1 Empathy	3.28	0.47	1		
2 Prosocial behavior	3.14	0.51	0.389**	1	
3 Social responsibility	3.43	0.47	0.168**	0.320**	1

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

The Mediating Effect of Social Responsibility

The results of the correlation analysis showed that there were significant correlations among empathy, social responsibility, and prosocial behavior of college students in the current study, which met the conditions of the mediation effect analysis. Next, Model 4 in SPSS macro prepared by Hayes was used to conduct a mediation analysis with gender and grade as covariates, social responsibility as a mediating variable, empathy as an independent variable, and prosocial behavior as a dependent variable. The results are shown in **Table 2**. Empathy positively predicts social responsibility and prosocial behavior, while social responsibility positively predicts prosocial behavior.

The bootstrap method was used to test the mediating effects of the data collected in this study. The sample size was 5,000. Under the 95% confidence interval, the total effect of empathy on prosocial behavior was 0.4406. The direct effect result did not contain 0 (LLCI = 0.3227, ULCI = 0.4582), indicating that the direct effect was significant, and the direct effect size was 0.3914. The results of the mediating effect did not contain 0 (LLCI = 0.0281, ULCI = 0.0731), indicating that the mediating effect of social responsibility was significant. The size of the mediating effect was 0.0492, accounting for 11.2% of the total effect of empathy on prosocial behavior, as shown in **Table 3**. Social responsibility plays a partially mediating role in the relationship between empathy and prosocial behavior, and Hypothesis 2 of this study was confirmed. As shown in **Figure 1**, empathy can directly predict prosocial behavior, and social responsibility enhances the predictive effect of empathy on prosocial behavior.

DISCUSSION

The current study aimed to examine the relationship between empathy and prosocial behavior and the mediating role of social responsibility among college students in the context of COVID-19. The results showed that college students' social responsibility partially mediated the relationship between empathy and prosocial behavior. The result is helpful to popularize the cultivation of prosocial behavior among college students in the context of COVID-19 and its positive significance for mental health and pandemic prevention and control.

The study found that female students scored significantly higher in empathy, cognitive empathy and emotional empathy than male students, which is consistent with previous studies (35, 36). Gender differences in empathy may be related to the defects of self-reported scale. Male participants answer items with feminine characteristics on the IRI-C (softheartedness, worry, and fear) less honestly because they are unwilling to admit that they have "feminine" thoughts, feelings, or behaviors (36). At the same time, the study showed that in the context of the COVID-19 pandemic, college students' empathy is lower than it was before its outbreak (18), which may be linked to the excessive internet use caused by the policy of long-term at-home quarantine during the pandemic. Because excessive internet use had negative effects on empathy (37). In addition, the long-term home quarantine policy also blocks normal interpersonal communication among

TABLE 2 | The results of regression analysis of variables in this study.

Predictors	Model 1 (SR)		Model 2 (PB)		Model 3 (PB)	
	β (95%CI)	*t*	*β* (95%CI)	*t*	*β* (95%CI)	*t*
Gender	−0.039(−0.106,0.028)	−1.147	−0.103(−0.168,0.037)	−3.091*	−0.113(−0.181,−0.046)	−3.291*
Grade	0.027(0,0.041)	1.957	0.010(−0.017,0.036)	0.727	0.017(−0.010,0.045)	1.237
EP	0.178(0.113,0.243)	5.389***	0.391(0.327,0.456)	11.973***	0.441(0.375,0.506)	13.182***
SR			0.276(0.212,0.340)	8.493***		
R^2	0.036		0.228		0.166	
F	11.041***		65.973***		59.208***	

*N, 449; SR, social responsibility; PB, prosocial behavior; EP, empathy; Gender was dummy coded such that 0, female; 1, male; Grade was dummy coded such that 0, first year; 1, second year; 2, third year; 3, fourth year; 4, last year; 5, postgraduate. *p < 0.05, **p < 0.01, ***p < 0.001.*

TABLE 3 | Testing the mediating role of social responsibility.

Effect type	Effect size	*Boot SE*	Bootstrap 95% CI		Proportion of effect size
			Boot LLCI	*Boot ULCI*	
Total effect	0.4406	0.0375	0.3684	0.5142	
Direct effect	0.3914	0.0344	0.3227	0.4582	88.83%
Indirect effect	0.0492	0.116	0.0281	0.0731	11.17%

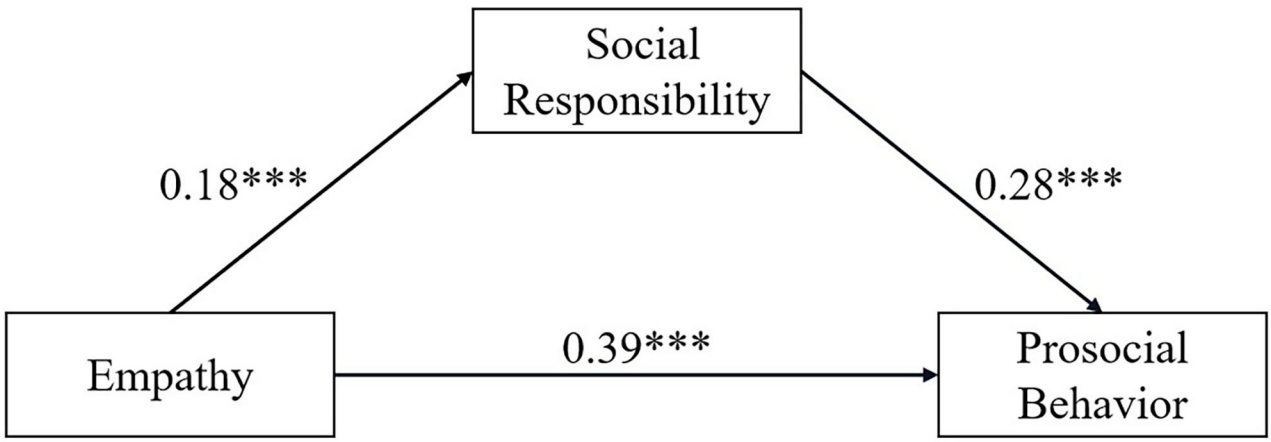

FIGURE 1 | Mediation effect model of social responsibility between empathy and prosocial behavior.

college students, and the loss of face-to-face contact for a long time may lead to the decline of individual social sensitivity and thus impair individual empathy (38).

Social responsibility of college students in the current study is higher than the norm level. This is consistent with previous studies in the context of COVID-19 pandemic (39, 40), college students have a high level of social responsibility in the context of pandemic, which may be related to the government' s education on social responsibility when there are major public health emergencies.

In this study, the prosocial behavior of college students in the context of pandemic is lower than that of college students before the pandemic (34). This may be related to the maladaptation of college students in the context of the pandemic. Students with better school adaptability had more prosocial behaviors (41), while maladaptation will reduce the probability of the occurrence of prosocial behaviors. In the context of the pandemic, Chinese college students have experienced the transition from online classes to physics classes. This results in maladjustment of college students and negative influence on prosocial behavior. In addition, the novel coronavirus human-to-human transmission characteristics (42) require colleges students to maintain a set mandatory physical distance from each other, which may lead to a decrease in the frequency of prosocial behavior.

The study results showed that empathy levels of college students in the context of pandemic can significantly positively predict prosocial behavior, and the higher the level of empathy, the more prosocial behavior, which is consistent with previous research results on college students' prosocial behavior (43, 44). According to the Empathy-Altruism hypothesis, when an

individual empathizes with others, they will experience events and emotions by stepping into people's shoes, thus arousing the pure altruistic motivation of the individual and encouraging the individual to help others regardless of the cost (45). This suggests that empathy is an important motivational basis for prosocial behavior (15, 16). Meanwhile, some researchers believe that individuals engage in prosocial behaviors to alleviate intrapsychic pain caused by empathy (13). However, no matter what kind of the motivation is, empathy has a positive impact on prosocial behavior, which then promotes individual mental health (6, 46). Therefore, in the context of COVID-19, cultivation of student empathy levels effectively promotes students' prosocial behaviors.

The results showed that social responsibility plays a partial mediating role in the effect of empathy on prosocial behavior. Under the background of pandemic, college students' empathy ability can enhance the expression effect of social responsibility, thus increasing the frequency of prosocial behavior. The anterior radius of the mediation model showed that empathy can positively predict social responsibility, which is consistent with the results of previous studies (18, 47). In the context of the pandemic, college students directly or indirectly feeled the disaster and pain brought by novel Coronavirus to others, and their empathy for the victims inspires their high sense of social responsibility. The posterior radius of the mediation model showed that social responsibility can positively predict prosocial behavior, which is consistent with previous study (23). This may be because individuals who feel the pain of the victim and have the responsibility to the person in need engage in more prosocial behaviors (22). College students are in a period when their values are forming and becoming stable. Role models, social conditions and cultural background have an important influence on the formation of their faiths (48). In the context of the pandemic, scientific research workers, paramedics, firefighters, and other groups with a high degree of social responsibility could be appropriate examples of social responsibility for college students. Follow such workers could produce more prosocial behaviors in college students, which would in turn contribute to the prevention and control of the pandemic and support for college students' mental health.

The results showed that social responsibility plays a partial mediating role in the influence of empathy on prosocial behavior, while there is still a significant direct effect. An increasing number of researchers agree that most research results are partial mediations when mediating variables are correctly manipulated and tested, because partial mediations do not mean that data results are not perfect; it may mean that there is not only one mediation path for independent variables to influence dependent variables. Other mediating variables are worth exploring in the future (49, 50). This suggests that in addition to social responsibility as a partial mediator, other mediating variables, such as solidarity, emotion, gratitude, and social support may exist in the influence path of empathy on prosocial behavior, which requires further consideration.

Limitations and Future Directions

First, this study examined only the correlation between empathy and prosocial behavior, so we cannot infer a causal link. Future studies can investigate whether a causal relationship exists between empathy and prosocial behavior during a pandemic through a more rigorous experimental design. Second, a longitudinal study design would be more effective to obtain the developmental trend of the relationship between empathy and prosocial behavior in the context of a pandemic. Third, the participants of the study resided in low-risk areas of the pandemic, so the applicability of results to higher-risk areas is limited.

In addition, the results of this study have a positive reference for the psychological construction of college students in the context of the pandemic. The country, society and schools can cultivate college students' empathy and social responsibility in various ways, so as to promote more prosocial behaviors of college students and improve their mental health. To be specific, college mental health education can carry out mental health courses with the theme of cultivating empathy, and college moral education courses can cultivate college students' social responsibility through social responsibility education courses and different kinds of social practice activities.

Future researches can investigate the manifestations of new prosocial behaviors, such as wearing masks and maintaining physical distance, and develop measurement tools suitable for prosocial behaviors in the context of pandemic, so as to better study the influencing mechanism of prosocial behaviors and its relationship with mental health in the context of pandemic.

CONCLUSION

This study found that in the context of COVID-19, college students' empathy can positively predict prosocial behavior and social responsibility, and social responsibility can positively predict prosocial behavior, and social responsibility plays a partial mediating role in the impact of empathy on prosocial behavior.

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 Northwest Normal University, Development of Psychology. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

YJ and SW designed the study. YJ supervised the project. YJ and XZ helped revise the manuscript. YY analyzed the data and drafted the manuscript. SW collected the data. All authors have read and approved the final manuscript.

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Associated Effects of Meaning in Life and Social Adjustment Among Chinese Undergraduate Students With Left-Behind Experiences in the Post-epidemic Period

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Background: The outbreak of COVID-19 has brought about radical changes in social life. The study focuses on a special group, Chinese undergraduate students with left-behind experiences. Specifically, the study addresses how such students feel and grasp the meaning in life and how they adapt to the current social environment after experiencing the impermanence of life. The correlation between the meaning in life and social adjustment in the post-epidemic period is evaluated.

Methods: The Meaning in Life Scale and the Social Adjustment Scale were used to test 988 undergraduate students. Multi-factor analysis, correlation, regression, and dominance analysis were performed on the test results.

Results: (1) During the epidemic, Chinese undergraduate students generally had low meaning in life scores, including below-average values for life goals, and middle-range scores for social adjustment. (2) Having or not having left-behind experiences had an important influence on the meaning in life and social adjustment of undergraduates: undergraduates with left-behind experiences performed better than those without left-behind experiences in terms of meaning in life, while their social adjustment was weaker than those without left-behind experiences. (3) The zest for life and freedom of life of undergraduates in both groups negatively predicted social adjustment, and zest for life preferentially influenced social adjustment. Zest for life also had a significant effect on life value in the group without left-behind experiences. Zest for life was a priority factor influencing social adjustment.

Conclusion: The epidemic and left-behind experiences are important factors influencing the relationship between meaning in life and social adjustment among Chinese undergraduate students.

Keywords: post-epidemic period, Chinese undergraduate students with left-behind experiences, meaning in life, social adjustment, dominance analysis

INTRODUCTION

In late 2019 and early 2020, a "storm" of COVID-19 swept the whole world. Most Chinese were stuck at home, using their devices and screens to communicate and maintain social contact. Screens were now used to convey good news that relatives and friends were safe and bad news about illnesses and death, causing an inordinate amount of tension and stress. Currently, China has entered the phase of regular epidemic prevention and control. Its college undergraduates, with a large portion receiving cross-regional education, rely more on the Internet for distance learning. These students often have to wear masks, show health codes, get vaccinated and undergo nucleic acid tests. Changes in their learning/living environments tended to increase anxiety, depression, confusion, and helplessness (1, 2). In such a context, how should Chinese undergraduate students with left-behind experiences feel and grasp meaning in life? What are the special manifestations and patterns of social adjustment? How is meaning in life related to social adjustment? These questions have important implications for psychological well-being, and they inspire the current research.

Left-behind experience is a concept that is used to describe what a Chinese undergraduate student experiences when they are currently enrolled at a college or University and have lived apart from their out-working parent(s) for more than half a year in the juvenile period (3). Left-behind children represent a particular phenomenon in China's economic development. They account for about 14-26% of the population at institutions of higher education, and as high as 78.24% at vocational colleges (4, 5). Left-behind experiences can generate loneliness during a critical time in a person's development. As a result, Chinese undergraduates with left-behind experiences have underperformed both socially and mentally during the COVID epidemic (6).

Life meaning is a concept proposed by the famous psychologist Viktor Frankl. It includes a person's awareness and pursuit of purposes and goals in life (7). Undergraduate students are in the early stage of youth, a crucial period for personality development and ego identity, and they have the will to actively pursue meaning in life (8, 9). People who have found their meaning in life are psychologically healthier and adapt better socially (10–12). In comparison, those who lack such meaning tend to experience loneliness (13, 14), anxiety, and depression (15). Furthermore, Chinese undergraduate students with left-behind experiences have less momentum in their search for meaning, and the momentum decreases with time (16).

Social adaptation is a process of positive interaction between the individual and the external environment – an environment from which the individual continuously obtains information and makes adjustments (17). Late puberty is a complex time in a person's life. It is a time of physical and mental changes, along with social transitions (18). One study found that parental roles are usually absent in left-behind adolescents' socialization, resulting in lower adaptability (19). However, this may also be a positive factor because it encourages young people with left-behind experiences to deal with problems and enhance their own social adaptability (3).

TABLE 1 | Distribution of participants.

Variables	Levels	Number	Proportion
Gender	Male	463	46.86%
	Female	525	53.14%
Grade	Freshman	343	34.72%
	Sophomore	399	40.38%
	Junior	182	18.42%
	Senior	64	6.48%
Left-behind Experience	Having	421	42.61%
	Not Having	567	57.39%
Only-Child	Yes	436	44.13%
	No	552	55.87%
Origin	Urban	467	47.27%
	Rural	521	52.73%

At present, there are some studies with undergraduates that suggest meaning in life is significantly and positively correlated with social adjustment and serves as an effective predictor of social adjustment (20–22). However, concerning the relationship between meaning in life and social adjustment, there are no direct studies that involve undergraduate students with left-behind experiences. In sum, we believe it is important to address the issues and difficulties that Chinese undergraduate students with left-behind experiences face during this challenging time. Hopefully, interventions can be found and applied.

To this end, the hypothesis of this study is that life meaning and social adjustment of Chinese undergraduates with left-behind experiences have unique characteristics in the post-epidemic period. Meaning of life is correlated with social adjustment, and there are dominant factors. The epidemic and left-behind experiences are important factors influencing the relationship between meaning in life and social adjustment among Chinese undergraduate students.

METHODS

Participants

The selection criteria for undergraduate students with left-behind experiences include: (1) being currently enrolled at a college or University and once lived apart from their out-working parent(s) for more than half a year in the juvenile period; (2) having an age between 18 and 22, considering gender, grade, residence and number of children; (3) not having a severe physical illness or mental illness. The inclusion criteria for ordinary college students are the same as above (except Item 1). Each participant voluntarily answered all questions and signed an informed consent.

Through convenience sampling method, 1,050 questionnaires were distributed online, and 988 valid ones were recovered, with an effective recovery rate of 94.09%. The distribution of participants is shown in **Table 1**.

Research Tools

Meaning of Life Scale (MLS)

The Meaning of Life Scale in this study was revised by Dong (23) with reference to Song (24). It consists of 18 questions in 4 dimensions of life enthusiasm, life goal, life value, and life freedom. Answers were given on a 7-point Likert scale – the higher the score, the greater the sense of meaning in life. The coefficient alpha (α) of the full scale in this study is 0.886.

Social Adaptation Scale (SAS)

The Chinese College Student Adjustment Scale (25) consists of 60 questions in 7 dimensions of satisfaction, emotional adaptation, study adaptation, occupational adaptation, self-adaptation, interpersonal adaptation, and campus adaptation. Answers were given on a 5-point Likert scale – the higher the score, the better the social adaptability. The coefficient alpha (α) of the full scale in this study is 0.933.

Testing Method and Process

We used a MANOVA, a correlation, and a multiple regression analysis to explore the predictive roles of the various variables. A dominance analysis was also used to further investigate the relative importance of each influencing factor. By calculating the mean of the direct, overall, and partial effects of each independent variable, a dominance analysis can decompose the contribution of each independent variable to the total variance of the dependent variables into a percentage in the predicted variance. This way, the analysis makes itself model-independent and free from the impact of different variable combinations, thus showing the relative importance of each independent variable more accurately (26).

We adopted the testing method of one-to-one online inquiry. Initially, a researcher briefs the purpose and significance of the survey to a participant and obtains informed consent. Participants are asked to answer all questions on the questionnaire, independently, and item by item. If a question arises, the researcher responds efficiently via the network. The testing time is 5–10 min. After all questionnaires are completed and collected, some are selected randomly for online one-on-one interviews. Our research was approved by the Ethics Review Committee at the University where the lead researchers work. We used SPSS 22.0 for all statistical analyses.

RESEARCH RESULTS

Characteristics of Life Meaning and Social Adaptation

Overall, participants scored low on meaning in life, below-average on life goal, and at the medium level on social adjustment (**Table 2**).

A multi-factor ANOVA of two variables suggested that there were main and interaction effects for each dimension of meaning in life and social adjustment (**Table 3**).

Characteristics of Life Meaning

Concerning the MLS dimensions on life enthusiasm, the main effect of having a left-behind experience or not was significant ($p < 0.001$), with having a left-behind experience greater than not having a left-behind experience. The interaction effect between gender and origin was also significant ($p < 0.05$); according to simple effect tests, females scored lower than males among urban participants ($p < 0.05$), and urban scored lower than rural among female participants ($p < 0.001$). On life goal, the main effect of having a left-behind experience or not was significant ($p < 0.01$), with having a left-behind experience greater than not having a left-behind experience. On life value, the interaction effect between having a left-behind experience or not and being an only child or not was significant ($p < 0.01$); according to simple effect tests, having a left-behind experience was greater than not having a left-behind experience among only-child participants ($p < 0.001$), and only-child participants was greater than non-only-child participants, among participants with a left-behind experience ($p < 0.01$). On life freedom, the interaction effect between having a left-behind experience or not and origin was significant ($p < 0.05$); according to simple effect tests, not having a left-behind experience was less than having a left-behind experience among urban participants ($p < 0.001$), and urban was less than rural among participants without a left-behind experiences ($p < 0.01$). On the total score on meaning in life, the interaction effect between having a left-behind experience or not and being an only child or not was significant ($p < 0.05$); according to simple effect tests, having a left-behind experience was greater than not having a left-behind experience among only-child participants ($p < 0.001$), and only-child participants were greater than non-only-child participants, among participants with a left-behind experience ($p < 0.01$).

Characteristics of Social Adaptation

Concerning the SAS dimensions on satisfaction, the main effect of having a left-behind experience or not was significant ($p < 0.01$), with not having a left-behind experience greater than having a left-behind experience. On emotional adaptation, the interaction effect among gender, being an only child or not, and origin was significant ($p < 0.01$); according to a simple effect test, urban was greater than rural among female participants ($p < 0.05$). On study adaptation, the interaction effect among gender, having a left-behind experience or not, being an only child or not, and origin was significant ($p < 0.05$). According to simple effect tests, not having a left-behind experience was greater than having a left-behind experience among male and female participants under the interaction effect between gender and having a left-behind experience or not ($p < 0.05$); urban was greater than rural among females under the interaction effect between gender and origin ($p < 0.05$); not having a left-behind experience was greater than having a left-behind experience among urban participants under the interaction effect between origin and having a left-behind experience or not ($p < 0.05$); urban was greater than rural among non-only-child participants under the interaction effect between origin and being an only child or not ($p < 0.05$); and not having a left-behind experience was greater than having a left-behind experience among only-child participants under the interaction effect between being an only child or not and having a left-behind experience or not ($p < 0.05$). On occupational adaptation, the interaction

TABLE 2 | Descriptive statistics of MLS and SAS scores among undergraduates.

Variables	Gender		Left-behind experience		Only child		Origin	
	Male (n = 463)	Female (n = 525)	Have (n = 421)	Have not (n = 567)	Yes (n = 436)	No (n = 552)	Urban (n = 467)	Rural (n = 521)
Life enthusiasm	3.47 ± 1.08	3.44 ± 0.98	3.66 ± 0.95	3.30 ± 1.06	3.43 ± 1.08	3.48 ± 1.26	3.36 ± 1.09	3.54 ± 0.96
Life goal	2.99 ± 1.42	2.96 ± 1.21	3.14 ± 1.32	2.85 ± 1.31	3.00 ± 1.38	2.96 ± 1.26	2.87 ± 1.36	3.07 ± 1.27
Life value	3.19 ± 1.29	3.21 ± 1.10	3.33 ± 1.21	3.10 ± 1.17	3.20 ± 1.23	3.20 ± 1.26	3.15 ± 1.22	3.24 ± 1.17
Life freedom	3.21 ± 1.15	3.13 ± 1.08	3.31 ± 1.04	3.06 ± 1.15	3.18 ± 1.14	3.16 ± 1.26	3.06 ± 1.18	3.26 ± 1.05
Total score onLife meaning	3.22 ± 0.96	3.18 ± 0.90	3.36 ± 0.89	3.08 ± 0.94	3.20 ± 0.97	3.20 ± 0.26	3.11 ± 0.98	3.28 ± 0.88
Satisfaction	3.27 ± 0.88	3.26 ± 0.73	3.14 ± 0.78	3.35 ± 0.81	3.30 ± 0.83	3.24 ± 0.26	3.34 ± 0.80	3.20 ± 0.80
Emotional adaptation	3.24 ± 0.47	3.23 ± 0.45	3.20 ± 0.46	3.26 ± 0.46	3.25 ± 0.45	3.23 ± 0.26	3.26 ± 0.47	3.21 ± 0.45
Study adaptation	3.22 ± 0.65	3.22 ± 0.60	3.15 ± 0.60	3.28 ± 0.63	3.23 ± 0.63	3.22 ± 0.26	3.27 ± 0.63	3.18 ± 0.61
Occupational adaptation	3.29 ± 0.53	3.33 ± 0.48	3.28 ± 0.49	3.33 ± 0.52	3.30 ± 0.54	3.32 ± 0.26	3.35 ± 0.51	3.27 ± 0.50
Self-adaptation	3.34 ± 0.67	3.36 ± 0.62	3.28 ± 0.63	3.40 ± 0.65	3.36 ± 0.66	3.34 ± 0.26	3.40 ± 0.63	3.30 ± 0.65
Interpersonal adaptation	3.31 ± 0.66	3.33 ± 0.64	3.24 ± 0.62	3.38 ± 0.66	3.35 ± 0.66	3.30 ± 0.26	3.38 ± 0.64	3.26 ± 0.65
Campus adaptation	3.32 ± 0.63	3.40 ± 0.59	3.31 ± 0.59	3.40 ± 0.62	3.36 ± 0.63	3.36 ± 0.26	3.40 ± 0.64	3.33 ± 0.58
Total score on social adaptation	3.28 ± 0.53	3.31 ± 0.47	3.23 ± 0.47	3.35 ± 0.52	3.31 ± 0.52	3.29 ± 0.26	3.34 ± 0.50	3.25 ± 0.50

TABLE 3 | Multi-factor ANOVA of MLS and SAS scores (n = 988).

Dependent variables	Independent variables	F	df	p	η_p^2
Life enthusiasm	Having left-behind experience or not	26.266	1	0.000	0.026
	Gender * Origin	5.534	1	0.019	0.006
Life goal	Having left-behind experience or not	8.380	1	0.004	0.009
Life value	Having left-behind experience or not	10.144	1	0.001	0.010
	Having left-behind experience or not * Being an only child or not	8.092	1	0.005	0.008
Life freedom	Having left-behind experience or not	12.651	1	0.000	0.013
	Having left-behind experience or not * Origin	5.538	1	0.019	0.006
Total score on life meaning	Having left-behind experience or not	20.552	1	0.000	0.021
	Having left-behind experience or not * Being an only child or not	5.776	1	0.016	0.006
Satisfaction	Having left-behind experience or not	10.048	1	0.002	0.010
Emotional adaptation	Gender * Being an only child or not * Origin	9.600	1	0.002	0.010
Study adaptation	Having left-behind experience or not	6.689	1	0.010	0.007
	Gender * Being an only child or not	4.862	1	0.028	0.005
	Gender * Being an only child or not * Origin	4.236	1	0.040	0.004
	Gender * Having left-behind experience or not * Being an only child or not * Origin	4.168	1	0.041	0.004
Occupational Adaptation	Gender * Being an only child or not * Origin	5.474	1	0.020	0.006
Self-adaptation	Having left-behind experience or not	6.609	1	0.010	0.007
	Gender * Being an only child or not * Origin	5.033	1	0.025	0.005
Interpersonal Adaptation	Having left-behind experience or not	4.325	1	0.038	0.004
Campus Adaptation	Having left-behind experience or not	4.779	1	0.029	0.005
	Gender * Origin	4.614	1	0.032	0.005
Total Score on Social Adaptation	Having left-behind experience or not	8.041	1	0.005	0.008
	Gender * Being an only child or not * Origin	4.342	1	0.037	0.004

effect among gender, being an only child or not, and origin was significant ($p < 0.05$), with urban greater than rural among females ($p < 0.05$) and urban greater than rural among non-only child participants ($p < 0.05$). On self-adaptation, the main effect of having a left-behind experience or not was significant ($p < 0.05$), with not having a left-behind experience greater than

TABLE 4 | Correlation analysis of life meaning and social adaptation.

	Variables	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
With left-behind experience(n = 421)	F2	0.46**											
	F3	0.62**	0.63**										
	F4	0.57**	0.44**	0.49**									
	F5	0.74**	0.87**	0.81**	0.71**								
	F6	−0.49**	−0.09	−0.28**	−0.38**	−0.28**							
	F7	−0.57**	−0.52**	−0.56**	−0.60**	−0.61**	0.46**						
	F8	−0.51**	−0.30**	−0.35**	−0.43**	−0.42**	0.60**	0.59**					
	F9	−0.46**	−0.46**	−0.39**	−0.46**	−0.41**	0.36**	0.66**	0.67**				
	F10	−0.54**	−0.35**	−0.44**	−0.51**	−0.51**	0.61**	0.72**	0.66**	0.63**			
	F11	−0.43**	−0.33**	−0.38**	−0.44**	−0.44**	0.50**	0.67**	0.55**	0.63**	0.71**		
	F12	−0.47**	−0.35**	−0.36**	−0.36**	−0.44**	0.50**	0.65**	0.65**	0.57**	0.62**	0.53**	
	F13	−0.60**	−0.39**	−0.25**	−0.54**	−0.55**	0.74**	0.66**	0.84**	0.79**	0.88**	0.81**	0.80**
Without left–behind experience(n = 567)	F2	0.59**											
	F3	0.63**	0.67**										
	F4	0.67**	0.47**	0.54**									
	F5	0.82**	0.87**	0.77**	0.75**								
	F6	−0.54**	−0.14**	−0.34**	−0.47**	−0.34**							
	F7	−0.70**	−0.47**	−0.57**	−0.63**	−0.62**	0.58**						
	F8	−0.57**	−0.34**	−0.37**	−0.51**	−0.46**	0.66**	0.66**					
	F9	−0.53**	−0.43**	−0.41**	−0.56**	−0.44**	0.45**	0.69**	0.70**				
	F10	−0.59**	−0.37**	−0.49**	−0.60**	−0.54**	0.73**	0.77**	0.74**	0.66**			
	F11	−0.58**	−0.34**	−0.43**	−0.57**	−0.51**	0.62**	0.76**	0.63**	0.62**	0.79**		
	F12	−0.58**	−0.38**	−0.47**	−0.55**	−0.54**	0.60**	0.74**	0.66**	0.63**	0.71**	0.70**	
	F13	−0.68**	−0.39**	−0.19**	−0.65**	−0.58**	0.80**	0.74**	0.85**	0.78**	0.91**	0.87**	0.85**

*Note: * means $p < 0.05$, ** means $p < 0.01$. F1=life enthusiasm, F2 = life goal, F3 = life value, F4 = life freedom, F5 = life meaning, F6 = satisfaction, F7 = emotional adaptation, F8 = study adaptation, F9 = occupational adaptation, F10=self-adaptation, F11 = interpersonal adaptation, F12 = campus adaptation, and F13=social adjustment.*

having a left-behind experience. The interaction effect among gender, being an only child or not, and origin was significant ($p < 0.05$), with urban greater than rural among females ($p < 0.01$). On interpersonal adaptation, the main effect of having a left-behind experience or not was significant ($p < 0.05$), with not having a left-behind experience greater than having a left-behind experience. On campus adaptation, the main effect of having a left-behind experience or not was significant ($p < 0.05$), with not having a left-behind experience greater than having a left-behind experience. The interaction effect between gender and origin was significant ($p < 0.05$), with females greater than males among urban participants ($p < 0.01$) and urban greater than rural among females ($p < 0.01$). On the total score on social adjustment, the main effect of having a left-behind experience or not was significant ($p < 0.01$), with not having a left-behind experience greater than having a left-behind experience. The interaction effect among gender, being an only child or not, and origin was significant ($p < 0.05$), with urban greater than rural among females ($p < 0.001$) and among non-only-child participants ($p < 0.05$).

Correlation and Regression Analysis of Life Meaning and Social Adaptation

Through the multi-factor ANOVA, it was found that having a left-behind experience or not was a key influencing factor on meaning in life and social adjustment. To explore the influence of a left-behind experience on these two aspects from each dimension, we divided the participants into two groups for a correlation and regression analysis.

As can be seen from **Table 4**, there was a significant negative correlation between participants with and without a left-behind experience on all dimensions of meaning in life and social adjustment ($r_{\text{with}} = -0.25 \sim -0.61$, mean $p < 0.01$; $r_{\text{without}} = -0.14 \sim -0.70$, mean $p < 0.05$).

Table 5 shows a significant negative predictive effect of life enthusiasm and life freedom on social adjustment among participants with a left-behind experience, and the same for life enthusiasm, life value, and life freedom on social adjustment among participants without a left-behind experience.

Dominance Analysis of Life Meaning to Social Adaptation

Life meaning was a significant predictor of social adjustment, but the traditional multiple regression method could not accurately determine the relative importance of each life meaning dimension in influencing social adjustment. Therefore, a further investigation was planned through a dominance analysis.

As shown in **Table 6**, the contribution of life enthusiasm was strongest among the participants with a left-behind experience for predicting social adjustment. Likewise, the contribution of life

TABLE 5 | Regression analysis of life meaning on social adaptation.

	Variables	Social adaptation (with left-behind experience, $n = 421$)		Social adaptation (without left-behind experience, $n = 567$)	
		Step one	Step two	Step one	Step two
Step One	Gender	0.033	0.039	0.008	−0.011
	Grade	−0.040	−0.055	−0.100*	0.000
	Being an Only Child or Not	−0.048	0.026	0.007	−0.007
	Origin	0.030	0.050	0.089	0.013
Step Two	F1		−0.363***		−0.436***
	F2		−0.089		0.060
	F3		−0.074		−0.106*
	F4		−0.283***		−0.328***
	ΔF	0.629	85.484***	2.467*	161.189***
	R^2	0.006	0.457	0.017	0.544
	ΔR^2	0.006	0.451	0.170	0.527

F1 = life enthusiasm, F2 = life goal, F3 = life value, and F4 = life freedom.
** means $p < 0.05$, *** means $p < 0.001$.*

TABLE 6 | Relative importance of each life meaning dimension for social adaptation.

Variables	With left-behind experience ($n = 421$)			Without left-behind experience ($n = 567$)			
	R^2	X1 life enthusiasm	X2 life freedom	R^2	X1 life enthusiasm	X2 life value	X3 life freedom
—	—	0.368	0.315	—	0.474	0.266	0.425
X1 Life enthusiasm	0.368	—	0.068	0.474	—	0.012	0.065
X2 Life value	0.315	0.121	—	0.266	0.220	—	0.197
X3 Life freedom				0.425	0.114	0.038	—
X1X2	0.436	—	—	0.486	—	—	0.056
X1X3				0.539	—	0.003	—
X2X3				0.463	0.079	—	—
X1X2X3				0.542	—	—	—
Decomposition of R^2		0.245	0.192		0.222	0.080	0.186
Percentage in predicted variance		56.19	44.04		40.96	14.76	34.32

enthusiasm was the strongest, and life value the weakest, among the participants without a left-behind experience for predicting social adjustment. Life enthusiasm was the dominant factor that influences social adjustment in both groups.

DISCUSSION

Characteristics of Life Meaning and Social Adaptation

On the whole, undergraduate students in this study scored slightly below average on meaning in life, and toward the middle on social adjustment during the post-epidemic period. There were significant differences between total scores on meaning in life and social adjustment, and also most dimensions (except emotional and occupational adaptation) related to having a left-behind experience or not. On meaning in life, having a left-behind experience was greater than not having a left-behind experience. The opposite occurred for social adjustment.

For meaning in life, studies have shown that undergraduate students with left-behind experiences underperform relative to other groups (16). There are contradictory results, however, suggesting that during a public health emergency, an epidemic, an individual's mental state will change with the external environment, revealing unique manifestations that last for a longer period (27). The interviews in this research uncovered a deeper view of meaning in life in the participants with a unique left-behind experience. Examples of statements during the epidemic's trial of life and death include: "Life is fragile, but tenacious" and "Find out how to live and don't ask why." Chinese culture refers to an obstacle faced by an individual as "a great test to mind before a great mission invested" to "strengthen a person's resilience and inadequacies" – optimistic explanations of the hardship in life (28). In this sense, if the lack of parental companionship represents an uncontrollable external challenge, then an undergraduate student's stronger sense of meaning in life is the result of an autonomous choice

in this environment. In comparison, undergraduates without a left-behind experience during the epidemic have mostly enjoyed parental companionship before college, which leads to less independence (29), a lack of deeper thinking on meaning in life, and lower scores on meaning in life.

Life enthusiasm is an individual's feeling for his or her current life. In this study, urban females scored lower than urban males and rural females. This is because gender and origin suggest different perspectives on life and generate different levels of psychological mindedness (30). Life freedom is the autonomy of an individual's life. In this study, urban undergraduate students without a left-behind experience scored lower than both urban and rural undergraduates with such an experience. Undergraduate students with a left-behind experience behave more independently and rely more on themselves to make decisions (29). Since most rural families have poorer conditions compared with urban ones, rural undergraduates act more maturely.

Life value is an individual's identification with his or her value, and the total score on meaning in life reflects an individual's general meaning in life. In this study, only-child undergraduates with a left-behind experience scored higher than non-only-child undergraduates with such an experience and only-child undergraduates without such an experience. This is because undergraduate students with left-behind experiences are more likely to respond negatively to things (31), which eventually fosters negative feelings. But sometimes, this enables a relatively objective evaluation of their own abilities and identification with their life value. Growing up with family love and more social support (32), only-child undergraduates can explore their life value and interpret meaning in a way that reflects the current situation.

On social adjustment, the existing literature suggests that a left-behind experience can encourage undergraduates to live more positively, leading to better social adjustment, compared to those without such an experience (3). But in this study, in terms of social adjustment, the undergraduate students with a left-behind experience scored lower than those without. On the one hand, this might be relevant to the absence of parental roles during childhood socialization for those with a left-behind experience (19). Then in turn, their social adaptability is lower during the epidemic. On the other hand, most undergraduates and parents are bound together at home during this difficult time. Thus, the major changes in family structures, parent-child patterns, and economic conditions, impact undergraduates with a left-behind experience far more than those who have spent more time with their parents. During this unique time, family relationships can directly influence left-behind children's social adjustment, and therefore, their behavior (33). When interviewed about social adjustment, undergraduate students with a left-behind experience often emphasized the impact of family changes: "I feel like the epidemic has caused more family conflicts." As this group of students devote more cognitive resources to adjusting to the dramatic changes in their families, there is a sharp decline in resources for social adjustment.

Campus adaptation is an individual's ability to enjoy a smooth college life. Previous studies indicated that urban undergraduate students had better campus adaptability than corresponding rural students (34), irrespective to any gender differences (18). But in this study, urban females outperformed urban males and rural females. This may be due to females' higher self-control than males (35, 36). Emotional adaptation is an individual's ability to control and maintain emotions, occupational adaptation is an individual's decision and preparation for a career goal, and self-adaptation is an individual's awareness and evaluation of his/her ego, as well as the maintenance of positive feelings. As for the total score on social adjustment, it is a holistic assessment of an individual's social adjustment. The current study showed a significant interaction effect among gender, being an only child or not, and origin for the above dimensions. In general, urban females performed better than urban males and rural females. Perhaps females have better emotional perceptions, mental expectations for career choice, and self-knowledge, compared to males (35–39). Also, perhaps urban undergraduates have better emotional control and expression, independence, and adaptation, compared to rural undergraduates (34, 40).

Study adaptation is the mental and behavioral process by which an individual achieves equilibrium with his/her learning environment. In this study, undergraduate students without a left-behind experience outperformed those with such an experience. Also, urban females scored higher than urban males and rural females. This is consistent with research that urban undergraduates adjust better to learning environments and undergraduates without a left-behind experience have higher academic achievements (34, 41). But it is inconsistent with the conclusion that males adjust better to learning environments (42, 43). It is likely that studying online requires more self-discipline, especially when teachers' supervision is minimal during an epidemic. When it comes to self-control and self-regulation, females usually win out (36, 44). Apparently, they also show better adaptability for difficult learning situations.

In short, the characteristics of meaning in life and social adjustment for undergraduates with a left-behind experience are not only a reflection of their past, but also an interpretation of meaning in life and a reflection of their social adjustment during a global crisis.

Correlation, Regression, and Dominance Analysis of Life Meaning, Social Adaptation, and Left-Behind Experience

In this study, there were significant negative correlations and negative predictive relationships, to varying degrees, for each dimension of meaning in life and social adjustment among undergraduate students with or without a left-behind experience. Based on a hierarchical regression analysis, the social adjustment of undergraduates with a left-behind experience was influenced by life enthusiasm and freedom – two factors of meaning in life. The social adjustment of undergraduates without a left-behind experience was influenced by life enthusiasm, freedom, and value – three factors of meaning in life. Unlike those with a left-behind experience, life value entered the regression equation in this group. Based on a dominance analysis, in

terms of the prediction of social adjustment, life enthusiasm contributed most of the explained variance (56.19%), among undergraduates with a left-behind experience. Likewise, life enthusiasm contributed the most (40.96%), and life value the least (14.76%), among those without a left-behind experience. Overall, concerning the influence of meaning in life on social adjustment, the two groups of undergraduate students showed certain commonalities in these two aspects, and demonstrated the uniqueness of the contributing variable "having a left-behind experience or not."

Previous studies concluded that undergraduates' meaning in life was an effective predictor of their social adjustment (20–22). This is in contrast to the current results. Life meaning is an individual's recognition and pursuit of his/her goals in life, while social adjustment is an individual's positive interaction with the environment. Before the COVID outbreak, undergraduate students lived freely on campus as relatively independent adults. They had much more time to imagine and assume what their life would be like and what meaning they might find. Thus, their sense of meaning in life was mostly positive and enabled them to face joys and sorrows of life with optimism. In turn, this enhances social adaptability.

But since the epidemic, life has been more fragile. Students stay at home, not knowing where life might lead them. Meaning in life has become a riddle, and its pursuit is suspended. A survey conducted during 2019–2020, suggests that 18.5% of Chinese undergraduate students are prone to depression, and 8.4% have a tendency toward anxiety (45). Fear, loneliness, anxiety, and depression have become more prevalent. Without thinking as much about the past or future, undergraduate students are more likely to live in the present and try to cherish every moment (45). In an interview, one student pointed out, "One must live to carry love. Life needs communication, help, and company; it wants sunshine, air, activities, and places for free activities; it asks for food and fun; and it demands feeling and thinking. Life is not a past tense, nor is it a present perfect tense. It is always in the present moment. So, cherish life and cherish the moment."

The idea of living in the moment and suspending the pursuit of meaning in life enables Chinese undergraduate students to detach themselves from the volatile experience, face the epidemic, and cherish the present with the satisfaction of being alive. The entire society changed rapidly with the onset of COVID-19. People were overwhelmed with the sudden anti-epidemic fight, lock-down, and for students this included the transition to online courses. To adapt to these changes and survive every moment of the present, undergraduate students devoted more cognitive resources to social adjustment, hoping to reach a new balance with the epidemic environment, as opposed to devoting those resources for pursuing meaning in life. This is why their meaning in life and social adjustment show a negative correlation and negative prediction, different from what used to be normal. It is likely that this way of coping will continue in the post-epidemic period of regular prevention and control.

The results of the hierarchical regression and dominance analysis suggested more subtle differences between the undergraduate students with and without a left-behind experience in predicting social adjustment on the dimensions of meaning in life. Overall, both life enthusiasm and freedom played an important role in predicting social adjustment for meaning in life, with enthusiasm proving a dominant influence. But to students without a left-behind experience, life value also matters. Life value refers to an individual's identification with his/her life value. Undergraduates without such experience identify their life value not only from their own perception and experience, but also from the people around them, including their parents. This way, they can feel higher social support (46), obtain a greater sense of safety (47, 48), and find it easier to recognize their meaning in life. The identification with life value will give these undergraduates more courage to face the complex epidemic environment and other challenges.

In sum, the differences in the predicted social adjustment of meaning in life between our two groups of Chinese undergraduate students actually reflect the important role of a left-behind experience in shaping an individual's mindset and perspective.

The current study is limited because it relied solely on explicit, consciously controlled self-reports. Life meaning and social adjustment include both explicit and implicit (less conscious) cognitive processes (49, 50). The results of existing research about explicit and implicit processes are ambiguous. Some studies have demonstrated that explicit and implicit processes are independent of each other, while others indicate explicit and implicit measures assess the same construct (51, 52). The present research will inspire us to conduct future studies on the implicit and explicit natures of both meaning in life and social adaptation of Chinese undergraduates with left-behind experiences.

CONCLUSION

Overall, Chinese undergraduate students scored low on meaning in life, below-average on life goal, and at a medium level on social adjustment during the epidemic. Undergraduates with a left-behind experience out-performed those without such an experience in terms of meaning in life, but underperformed in terms of social adjustment. Life enthusiasm and freedom of the students in both groups had a negative predictive effect on social adjustment, with life enthusiasm showing greater influence. Life value in the group without a left-behind experience also made an important impact. The epidemic environment and a left-behind experience were key factors influencing the relationship between meaning in life and social adjustment among Chinese undergraduate 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 Chongqing University of Arts and Sciences

Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YG: resources. YG, JL, and JW: writing – review & editing, supervision, and methodology. YG and M-QS: writing – original draft. JL: validation. M-QS and JL: data analysis. YG, M-QS, and C-YL: investigation. YG and JL: project administration. All authors contributed to the article and approved the submitted version.

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Mental Disorders and Emotional Competence Among Chinese Adolescents Before and During COVID-19 Pandemic: A Longitudinal Mediation Model

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Background: The outbreak of the COVID-19 pandemic has had a profound influence on the mental health and well-being of individuals across the globe. Emotional competence, defined as one's ability to recognize, understand, and manage their emotions, has been found linked with mental health problems (e.g., depression and anxiety) in previous studies. However, there is limited knowledge about the direction of the association between these factors among populations exposed to COVID-19. This study examined the possible mediation relationships between depression, anxiety, emotional competence, and COVID-19 exposure among Chinese adolescents.

Methods: Responses from 7,958 Chinese adolescents who had previously taken part in a two-wave study before (December 23, 2019–January 13, 2020) and during COVID-19 (June 16, 2020–July 8, 2020) were analyzed (51.67% males, mean age = 11.74, SD = 2.15). Structural equation modeling with three covariates (i.e., age, gender, and ethnicity) was used to test the longitudinal mediation relationships between COVID-19 exposure and depression, anxiety via emotional competence.

Results: Results indicated that the prevalence of depression (38.67 to 36.74%) and anxiety (13.02 to 12.77%) decreased from Time 1 to Time 2. The T2 emotional competence significantly mediated the relationship between T2 COVID-19 exposure and T2 anxiety (indirect effect [95% CI] = 0.011 [0.004–0.019], $p < 0.05$). T2 emotional competence also significantly mediated the relationship between T2 COVID-19 exposure and T2 depression (indirect effect [95% CI] = 0.013 [0.005–0.022], $p < 0.05$). The results indicated that T2 emotional competence had a significant and negative influence on T2 anxiety ($\beta = -0.266$, SE = 0.005, $p < 0.001$), and T2 depression ($\beta = -0.326$, SE = 0.029, $p < 0.001$).

Conclusions: This longitudinal research study demonstrated the crucial role of emotional competence in influencing the severity of long-term mental health problems, and suggested that emotional competence interventions can be conducted to improve mental well-being among Chinese adolescents exposed to COVID-19.

Keywords: anxiety, depression, emotional competence, longitudinal mediation model, COVID-19 exposure

INTRODUCTION

Adolescence is a vulnerable dangerous period during which mental disorders (e.g., depression and anxiety) can easily present themselves, increasing the risk of life-long mental illnesses (1). According to a report by the World Health Organization (2), 10 to 20% of adolescents suffer from mental problems worldwide, and most are underdiagnosed and undertreated (3). Being the fourth and sixth major causes of mental illness and disability among adolescents, depression and anxiety, respectively, are considered to be highly prevalent (2). For example, a meta-analysis of 17,894 subjects found that the prevalence of depression and anxiety was 17.96 and 13.99%, respectively, in Chinese adolescents (4). In the USA, anxiety is the most common mental disorder, with a prevalence of 31.9% among 10,123 adolescents aged 13–18 years (5). Additionally, an Australian research with a sample of 1,299 adolescents identified that the prevalence of depression and anxiety was 14.2 and 13.2%, respectively (6). Most previous research has applied a cross-sectional design to explore mental health and its correlates among adolescents, but this approach lacks the long-term tracking of mental health status among the target population (7, 8). Therefore, it is crucial to explore the potential mechanisms associated with long-term mental disorders and related factors among adolescents.

Many prior studies have shown that public emergencies have a profound effect on mental health (9–12). In the UK, a national longitudinal cohort study with a sample of 53,351 participants indicated that the prevalence of mental distress increased from 18.9% before COVID-19 to 27.3% during COVID-19 pandemic (13). In Switzerland, a study found that levels of anxiety and depressive symptoms significantly worsened among undergraduate students after COVID-19, compared with those before COVID-19 (14). However, research in the Netherlands showed that mental health variables remained approximately the same before and during COVID-19 among 141 adolescent students (15). Another longitudinal study among 203 Chinese students reported a significant decrease in anxiety and depression during COVID-19 lockdown (16). Furthermore, an American study, which included 322 young adolescents, found that for participants with a good mental health (i.e., fewer emotional problems before COVID-19), psychological symptoms significantly decreased during COVID-19 pandemic (17). Existing literature on mental health developing trend and related variables remained debatable before and during COVID-19 pandemic. Hence, it is necessary to further track long-term mental health status, and explore the influence of exposure to public emergencies on the mental health of Chinese adolescents, before and during COVID-19.

Emotional competence (EC) is broadly defined as an individual's ability to recognize, understand, and manage their emotions (18). In recent years, more research has underscored the vital role of EC in psychopathology, such as depression and anxiety (18–21). For example, previous meta-analyses have shown that individuals with higher EC are associated with lower levels of psychological distress, including depression and anxiety (20, 22–24). A previous study highlighted that a higher level of EC was associated with greater well-being and a lower risk of developing mental disorders (25). Moreover, an 18-h EC intervention experiment showed that improvement in EC promoted positive changes in psychological well-being (26). Most previous studies on EC applied a cross-sectional design and there has been a lack of studies examining the EC-mediated relationship between depression and anxiety based on longitudinal data. Thus, it is necessary to further explore the directional association between EC, depression, and anxiety, using a longitudinal mediation model.

Several previous theories and models have shown the potential influence mechanism of EC for mental disorders. First, according to the transdiagnostic emotion dysregulation model of mood and anxiety disorders, a triggering event could connect with the present diathesis and result in a negative or positive influence. The final psychological impact could depend on an individual's emotional style and recognition (27). Mood disorders result from emotional dysregulation of negative influences and are associated with an absence of positive affect (28). Second, the transdiagnostic models of psychopathology explain the mechanisms by which transdiagnostic risk factors result in multiple mental disorders (29). The model suggested that biological factors giving rise to potentially maladaptive emotional and cognitive trends could directly result in psychological symptoms, such as depression and anxiety (30). Finally, the ABC theory of emotion proposed by Ellis (31) holds that emotions can be directly determined by the individual evaluation and cognition processes of the triggering event. Emotional evaluation and recognition are greatly influenced by EC, which can lead to various emotional reactions and changes (20). Hence, based on the research gaps and theoretical foundation, this study aimed to explore the possible mediation relationships between depression, anxiety, emotional competence, and COVID-19 exposure, and understand the long-term developmental trend of mental health status among Chinese adolescents through a longitudinal design study, before and during COVID-19. This longitudinal analysis involved six major variables including T1 depression, T2 depression, T1 anxiety T2 anxiety, T2 emotional competence,

and T2 COVID-19 exposure. As previous research suggested that people with different mental disorders (e.g., depression and anxiety) before COVID-19 could display dissimilar developing trends in psychological status during COVID-19 (15). It is imperative to examine the mental health symptoms (i.e., T1 depression and T1 anxiety) before COVID-19 and accurately detect changes in mental health via a longitudinal study during the pandemic.

MATERIALS AND METHODS

Dataset

A face-to-face interview questionnaire was used to collect data from students in two middle schools and three high schools. Data were collected from two-wave studies named Chengdu Positive Child Development (CPCD) survey (8). Time 1 (T1) data were collected between December 23, 2019, and January 13, 2020, before the outbreak of COVID-19 in China. Time 2 (T2) data were collected between June 16, 2020, and July 8, 2020, when the epidemic was under control in China and schools were re-opened. All participants were informed of the research purpose, privacy measures, and data retained in the signed consent form. This study was approved by the Research Ethics Committee of the University. Questionnaires were distributed to 10,370 participants. A total of 8,749 valid questionnaires were returned in the T1 study (51.62% males, $M_{age} = 12.02$, SD = 2.30, response rate = 84.37%). A total of 7,958 participants completed the second-wave T2 (51.67% males, $M_{age} = 11.74$, SD = 2.15, response rate = 76.74%). A total of 791 participants were lost to follow-up at T2. This study only included a sample of 7,958 participants who completed the two-wave study.

Measures

Depression

The past-week symptoms of depression were measured using the Chinese version of the Center for Epidemiologic Studies Depression Scale (CES-D) in both wave studies (32). The depression scale consists of 20 items, each rated on a four-point scale from 0 (not at all) to 3 (a lot). An example item is, "I felt lonely, and I don't have a lot of friends." Higher scores indicated a higher severity of depressive symptoms and total scores over 15 can indicate significant levels of depressive symptoms. The Chinese version of the CES-D has good validity and reliability in Chinese samples (32, 33). In this study, the scale showed good internal consistency (Cronbach's alphas were > 0.87 in both wave data).

Anxiety

The last 3-month symptoms of anxiety were assessed using a subscale (Generalized Anxiety Disorder) of the Chinese Screen for Child Anxiety Related Emotional Disorders (SCARED) in each wave (34). The subscale contains nine items in total. Participants rated each item on a three-point scale from 0 (never) to 2 (often). A sample item is, "I worry about whether other people like me." Higher scores indicated a greater level of anxiety. Total scores over 9 can indicate significant levels of anxiety symptoms. The Chinese version of the SCARED has been shown to have good validity and reliability in previous studies (34, 35). In the current study, the internal consistency for this measure was good (Cronbach's alphas were >0.86 in both wave data).

Emotional Competence

Emotional competence was measured using a subscale of the Chinese Positive Youth Development Scale (CPYDS) in the second wave of the study (36). The CPYDS included 90 items, in which a six-item subscale was used to examine emotional competence. Each item is rated on a six-point scale ranging from 1 (strongly disagree) to 6 (strongly agree). An example item is "When I am unhappy, I can appropriately show my emotions." The reliability and validity of the subscale were established in previous studies (36, 37). In this study, the subscale showed good internal consistency (Cronbach's alpha was 0.86).

COVID-19 Exposure

Based on the context of the participant population and previous studies (38, 39), nine items were developed to test the COVID-19 exposure in the second wave of the study. Four items with a four-point scale (1 = not at all; 4 = extremely severe/dangerous/possible/ability) examined the perceived severity, danger, infection risk, and prevention ability for COVID-19. One dichotomous question tested whether the participant's family had been infected with COVID-19 (1 = no; 2 = yes). Additionally, four questions with a four-point scale (1 = not at all; 4 = extreme influence) assessed the effects of diet, study, social life, and recreational activities. The total score was the sum of all items, with a higher score indicating a higher level of COVID-19 exposure.

Statistical Analysis

There were four aspects in the data analysis using SPSS Version 24.0 (40) and AMOS Version 23.0 (41). First, descriptive analyses and correlations were conducted for all the variables. Second, the independent samples *t*-test was used to examine the differences between 7,958 participants who completed the two-wave study and 791 respondents who were lost to follow-up in the T2 study among all variables. Third, a paired-samples *t*-test was used to test the differences in levels of depression and anxiety between the first and second waves of the study. Finally, structural equation modeling was conducted to test the longitudinal mediation relationships between depression, anxiety, and emotional competence. Six potential mediation pathways were tested. Four variables—depression, anxiety, emotional competence, and COVID-19 exposure were modeled as latent variables in the current study. In addition, three covariates, including age, gender, and ethnicity, were added to examine the mediation model since they could be correlated with depression, anxiety, and emotional competence. To test the hypothesized mediation effect for statistical significance in AMOS, bootstrapping was used via 5,000 bootstrapped replications. Parameters were examined through a maximum likelihood estimation. According to prior research (42), χ^2 statistics are usually applied for testing model fit, but they could be largely influenced by the sample size. Thus, other model fit indices were recommended to further assess the goodness fit of

the model via several indexes (43), including χ^2/df, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), Tucker-Lewis Index (TLI), and comparative fit index (CFI). According to the recommendation of the acceptable model index, the ratio of χ^2 to the degree of freedom should be <5.0, TLI and CFI should be higher than 0.95, and SRMR and RMSEA should be smaller than 0.05 (42).

RESULTS

Descriptive Findings

The descriptive statistics, including the means, standard deviations, and intercorrelations among study variables, are displayed in **Tables 1**, **2**. There were significant correlations between depression, anxiety, emotional competence, and COVID-19 exposure across the study waves. All scale scores showed a significantly moderate or high intercorrelation, excluding the COVID-19 exposure at T2, which was marginally correlated with emotional competence at T2 ($r = -0.089$, $p < 0.001$) after adjusting for age, gender, and ethnicity. The prevalence of depression decreased from 38.68% ($n = 3{,}078$) in T1 to 36.74% ($n = 2{,}924$) in T2. Similarly, the prevalence of anxiety significantly decreased from 13.02% ($n = 1{,}036$) in T1 to 12.77% ($n = 1{,}016$) in T2 ($p < 0.001$). Additionally, no significant differences, except for age and anxiety, were found between the study population ($n = 7{,}958$) and the participants lost to follow-up, based on all variables ($p_s > 0.001$).

TABLE 1 | Demographics ($n = 7{,}958$).

Variable	(*N*, %)
Age (7–17)	M = 11.74, SD = 2.15
Gender	
Male	4,112 (51.67%)
Female	3,846 (48.33%)
Ethnicity	
Han Chinese	7,893 (99.2%)
Other Ethnicities	65 (0.8%)
T2 COVID-19 Exposure	M = 21.00, SD = 4.05
T2 Emotional Competence	M = 28.38, SD = 6.67
Depression	
T1	M = 14.40, SD = 10.16, N_{Yes} = 3,078 (38.68%)
T2	M = 14.36, SD = 10.62 N_{Yes} = 2,924 (36.74%)
Anxiety*	
T1	M = 3.71, SD = 3.96 N_{Yes} = 1,036 (13.02%)
T2	M = 3.33, SD = 4.07 N_{Yes} = 1,016 (12.77%)

*M, Mean; SD, Standard Deviation; N_{yes}, number of participants with anxiety or depression; * p < 001 (Paired-sample t-test); T1, Time 1; T2, Time 2.*

Longitudinal Mediation Model

The results showed the mediation model without three covariates (i.e., age, gender, and ethnicity) and had excellent model fit (χ^2/df = 4.029, CFI = 0.984, TLI = 0.982, SRMR= 0.037, RMSEA [90% CI] = 0.020 [0.019–0.020]). The model fit remained excellent after including covariates, age, gender, and ethnicity status (χ^2/df = 4.974, CFI = 0.976, TLI = 0.973, SRMR = 0.038, RMSEA [90% CI] = 0.022 [0.022–0.023]) (see **Figure 1**). Two relationships were significantly mediated by T2 emotional competence. First, T2 emotional competence significantly mediated the relationship between T2 COVID-19 exposure and T2 anxiety (indirect effect [95% CI] = 0.011 [0.004–0.019], $p < 0.05$). Second, T2 emotional competence significantly mediated the relationship between T2 COVID-19 exposure and T2 depression (indirect effect [95% CI] = 0.013 [0.005–0.022], $p < 0.05$).

The longitudinal mediation model estimated the association between COVID-19 exposure, emotional competence, anxiety, and depression across the two waves, in which age, gender, and ethnicity were covariates. The path coefficients of the model are displayed in **Figure 1**, which indicates several significant direct paths, including autoregressive paths from T1 anxiety to T2 anxiety ($\beta = 0.461$, SE = 0.016, $p < 0.001$) and T1 depression to T2 depression ($\beta = 0.442$, SE = 0.014, $p < 0.001$), and direct effects from T2 COVID-19 exposure to T2 anxiety ($\beta = 0.114$, SE = 0.006, $p < 0.001$), T2 COVID-19 exposure to T2 depression ($\beta = 0.107$, SE = 0.031, $p < 0.001$), T2 COVID-19 exposure to T2 emotional competence ($\beta = -0.041$, SE = 0.015, $p < 0.001$), T2 emotional competence to T2 anxiety ($\beta = -0.266$, SE = 0.005, $p < 0.001$), and T2 emotional competence to T2 depression ($\beta = -0.326$, SE = 0.029, $p < 0.001$).

Age was significantly associated with T2 anxiety ($\beta = -0.100$, SE = 0.002, $p < 0.001$), T2 emotional competence ($\beta = -0.061$, SE = 0.005, $p < 0.001$), and T2 depression ($\beta = 0.068$, SE = 0.011, $p < 0.001$). Gender was significantly associated with T2

TABLE 2 | Means, standard deviations, and correlations among study variables ($n = 7{,}958$).

#	Variables	M ± SD	1	2	3	4	5	6
1	T1 Depression	14.40 ± 10.15	–	0.613*	0.530*	0.412*	−0.350*	0.135*
2	T1 Anxiety	3.71 ± 3.96	0.607*	–	0.424*	0.504*	−0.298*	0.138*
3	T2 Depression	14.36 ± 10.62	0.528*	0.430*	–	0.634*	−0.448*	0.183*
4	T2 Anxiety	3.33 ± 4.07	0.405*	0.518*	0.635*	–	−0.361*	0.187*
5	T2 EC	28.38 ± 6.67	−0.348*	−0.303*	−0.451*	−0.366*	–	−0.089*
6	T2 COVID-19	21.00 ± 4.05	0.134*	0.132*	0.180*	0.177*	−0.088*	–

*Left/bottom triangle is the Pearson's correlations of all study variables, right/top triangle is the partial correlation of all the variables adjusted by age, gender, and ethnicity; M, Mean; SD, Standard Deviation; EC, Emotional Competence; COVID-19, COVID-19 Exposure; *p < 0.001.*

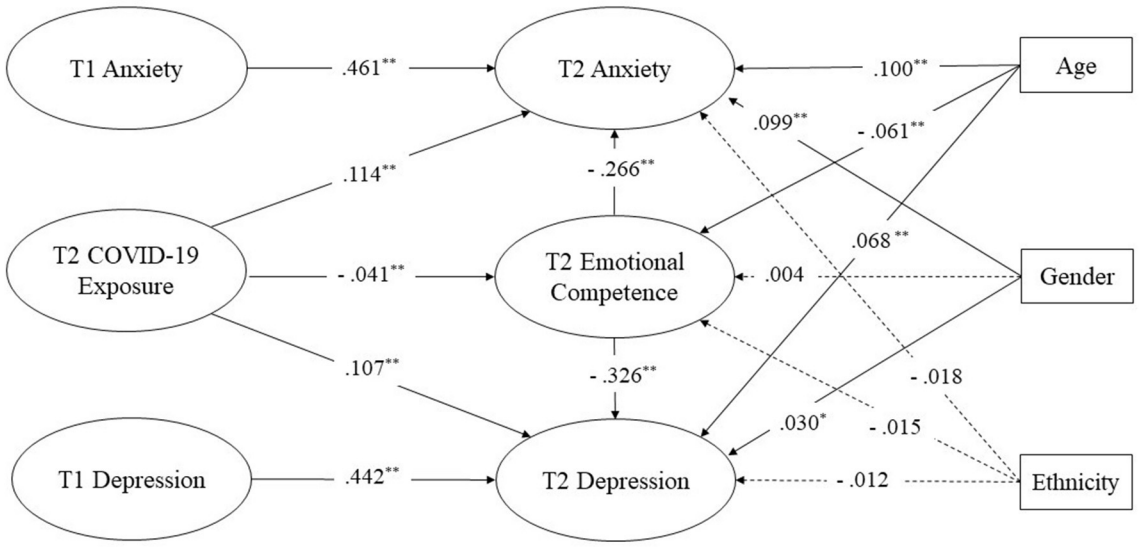

FIGURE 1 | Longitudinal mediation model with standardized path coefficients. *$p < 0.05$, **$p < 0.001$; For simplicity, factor loadings of all items are not displayed in this figure. Dotted lines displayed the non-significant paths; Solid lines displayed the significant paths.

anxiety (β = 0.099, SE = 0.009, $p < 0.001$) and T2 Depression (β = 0.030, SE = 0.047, $p < 0.05$). However, four non-significant paths were found in this study. Ethnicity did not significantly associate with T2 anxiety (β = −0.018, SE = 0.047, p = 0.080), T2 emotional competence (β = −0.015, SE = 0.125, p = 0.169), and T2 depression (β = −0.012, SE = 0.263, p = 0.218), respectively. Gender was not a significant predictor of T2 emotional competence (β = 0.004, SE = 0.023, p = 0.700).

DISCUSSION

This longitudinal study explored the associations between depression, anxiety, emotional competence, and COVID-19 exposure among Chinese adolescents before and during COVID-19. To our knowledge, this is the first longitudinal study to highlight the vital mediating role of emotional competence as a possible mechanism underlying the association between COVID-19 exposure and long-term mental disorders of depression and anxiety. Additionally, the results further evidenced the negative influence of COVID-19 exposure on long-term mental health among Chinese adolescents. The results may provide a better understanding of psychological disorder development trends related to public health emergencies, highlighting the role of emotional competence as a mediator. This could benefit the development of more emotional competence interventions to improve future mental well-being among adolescents exposed to public health emergencies.

Based on the hypothesized mediation model, one of the major findings was that 6-month follow-up levels of emotional competence played a vital mediating role in the association between 6-month follow-up depression and COVID-19 exposure after controlling for gender, age, and ethnicity. Most prior studies on mental health in the COVID-19 preferred to explore its correlation between outcome variables without including potential mediators of psychological disorders (44, 45). The results from the current study suggested that emotional ability related variables, particularly the ones examining the levels of emotional skills or capabilities, could be included when exploring long-term psychological disorders in the context of the COVID-19 pandemic. It is imperative for researchers to consider variables related to emotional ability in studies on adolescents. This is because when young people are better able to manage their emotions, they are more likely to seek mental support from professionals and are more likely to recover from mental disorders (46). Other vital elements of emotional ability include the knowledge to identify mental health problems, the capacity to seek help, and the capability to recognize mental health issues (26). These aspects could be included in future studies to examine their effect on relieving long-term mental disorders among adolescents exposed to public emergencies. Moreover, this current study displayed a significantly negative association between depression and emotional competence at the 6-month follow-up, which suggested that adolescents with a higher emotional competence are likely to have lower levels of depression. This is consistent with previous research which showed that people with a better ability to recognize mental disorders are less likely to suffer from mental disorders when exposed to the COVID-19 pandemic (47). The results further emphasized the importance of improving emotional competence, such as improving Chinese adolescents' ability to recognize and modify their negative emotions.

This study found at the 6-month follow-up, that levels of emotional competence significantly mediated the association between anxiety and COVID-19 exposure. These results are consistent with the study hypotheses and supported

by the transdiagnostic emotion dysregulation model which states that increasing emotional competence influences the association between early indication of psychological distress (e.g., depression and anxiety) and relieving psychological distress later (27, 48–50). This pattern also matches the transdiagnostic models of psychopathology, which claim that better emotional trends and abilities help diminish mental disorders (29, 30). For individuals with early mental health problems, future well-being can be safeguarded by improving their emotional competence (22). Additionally, there was a significant negative association at the 6-month follow-up between emotional competence and COVID-19 exposure. A meta-analysis with 31 cross-sectional studies reported a slightly higher overall prevalence of anxiety (24%) than depression (22%) among adolescents exposed to COVID-19 pandemic (12). These results suggested that promoting emotional competence could be an effective way to help adolescents with anxiety symptoms when suffering from public emergencies.

Unexpectedly, this study found that the prevalence of depression and anxiety decreased among Chinese adolescents after exposure to the COVID-19 pandemic. This result is different from the findings of most previous studies that reported the increasing of psychological disorders during COVID-19 pandemic (13, 14). One possible explanation is that adolescents with severe mental health problems were able to seek more emotional support from families or friends, increasing their emotional ability, which resulted in a decrease in the occurrence or severity of future mental health problems (51). Moreover, previous research suggested that people could receive more emotional support from society under triggering events, such as COVID-19 pandemic, than during routine times (52). When COVID-19 pandemic occurred, Chinese society provided considerable mental health support for exposed individuals, which could promote emotional competence and relieve mental disorders (53). This study also demonstrated an increase in emotional competence among Chinese adolescents after exposure to COVID-19 pandemic, which possibly resulted from the improvement in social and mental health support resources during COVID-19 pandemic in China (53). Prior research has shown that long-term mental health problems can be decreased when more emotional recognition is received (23).

This result indicating decreased mental disorders aligned with the results of smaller research among Chinese and American populations (16, 17). There are some possible explanations for this result. For example, the level of depression and anxiety decreased in Chinese adolescents because of decreased academic pressure (54). A major reason for depression and anxiety among Chinese adolescents is their interpersonal relationships (55). Many Chinese adolescents had to study at home because of COVID-19 pandemic, and they could avoid academic stress and difficult interpersonal relationships at school. Therefore, the prevalence of mental disorders could be reduced during the COVID-19 period compared with the pre-COVID-19 period (16). Moreover, a previous study suggested that COVID-19 stay-at-home regulations could provide a protective effect and context for the mental health of youth (17). Thus, there was a decreasing trend of depression and anxiety among Chinese adolescents because they could have gained more mental health support from their families during COVID-19 than pre-COVID-19 pandemic, because they were likely to have had more time with their family members at home (56).

The results suggested that ethnicity was not a significant predictor of depression, anxiety, and emotional competence in the 6-month follow-up, which was inconsistent with previous research which suggested that being an ethnicity could influence mental health and emotional competence (57, 58). One possible explanation for these results was that the differences between the other minorities and the Hans (viz., The ethic Han Chinese accounts for more than 90% of the total population in China) are narrowing because of the educational improvement, economic development, and acculturation within the Chinese population (59), which suggests that ethnic differences did not influence the mental status and emotional competence education. Furthermore, the percentage of ethnic minority participants was low in this study, compared with the Han participants, which possibly resulted in underestimating the influence of minorities on outcome variables in the structural equation model (60). Further research is suggested to balance the percentage of the minorities and the Han participants when exploring related research topics.

Based on a large sample of Chinese adolescents, the current study applied well-validated measures to explore the associations between emotional competence, depression, anxiety, and COVID-19 exposure via a complete longitudinal mediation design. The results underscored the vital role of emotional competence in influencing long-term mental disorders, such as depression and anxiety, among Chinese adolescents exposed to COVID-19 pandemic. Despite these merits, this study has several limitations that warrant discussion. First, this study utilized face-to-face interview questionnaires to collect data, which could result in response bias because of the different qualities of the interviewer (61). Future studies should apply multiple approaches to collect data, such as mixed-method research. Second, this study was based on a two-wave study to explore the mediating effect of emotional competence on the association between COVID-19 exposure and mental disorders. There are other possible factors influencing long-term mental disorders among Chinese adolescents exposed to COVID-19 pandemic, such as social support (10), psychological help-seeking (62), social media usage (63), and resilience (64). Future research is suggested to explore more possible factors relieving long-term mental disorders among adolescents exposed to COVID-19 pandemic. Finally, the mediation model could not prove the causal relationships between the variables without using the experimental method. A future study is recommended to explore the related intervention of emotional competence and its effect on long-term mental disorders among adolescents based on an experimental design (65).

CONCLUSIONS

This study emphasized emotional competence as an effective alleviative variable against long-term depression and anxiety

among Chinese adolescents exposed to COVID-19 pandemic, the negative association between psychological distress (i.e., depression and anxiety) and emotional competence, and the long-term influence of improving emotional competence on mental health when exposed to COVID-19 pandemic. Additionally, the study found a decreased trend of mental disorders, including depression and anxiety among Chinese adolescents before and during the COVID-19 pandemic, which suggests that more variables, such as family support (51), receiving social information (63), and quarantine policies (10), need to be explored for releasing the mental burden among the population exposed to COVID-19 pandemic. Concerning psychological practice, this study suggested that more government- or school-based online lectures, training, or guidebooks about improving emotional competence should be provided for adolescents exposed to the COVID-19 pandemic, which could protect exposed individuals from exacerbating mental disorders. Moreover, intervention programs targeted at reinforcing emotional competence during or after COVID-19 pandemic are necessary, which could be beneficial for strengthening emotional recognition and resilience and assisting in mental health and adaptability in future public health emergency events. For example, Kumschick and his colleagues (66) designed a literature-based intervention, named *READING AND FEELING*, to increase emotional competence. The results demonstrated the effectiveness of the *READING AND FEELING program* in improving emotional ability, based on emotional words, specific emotional literacy, and recognition of disguised moods among the youth. Furthermore, another intervention, *Health Promoting Schools Up*, was developed to effectively boost mental health by improving social and emotional competence among schoolchildren (67). Many researchers have recommended that various health support materials be provided for individuals exposed to COVID-19 pandemic to potentially relieve their long-term mental health disorders that develop due to this pandemic. These include online peer-support interventions (68), cyber-counseling (69), and digital mental health services (70), which could help to detect early psychological problems and avoid mental symptom deterioration (71–74).

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 Research Ethics Committee of the University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

PJ and LZ did study design and data collection. WS and GY analyzed data, drafted, and submitted this manuscript together. PJ, LZ, BH, YS, and XL revised the manuscript. All authors contributed to manuscript checking and approval the final manuscript.

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Relationships Between Cross-Cultural Adaption, Perceived Stress and Psychological Health Among International Undergraduate Students From a Medical University During the COVID-19 Pandemic: A Moderated Mediation Model

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International university students may be at greater risk for developing psychological problems due to the unique stressors in them, particularly during the COVID-19 pandemic. The purpose of present study is to propose and test a moderated mediation model that would illuminate the underlying relationships of cross-cultural adaption, perceived stress and psychological health as well as the moderating effect of optimism and resilience among international medical undergraduates in China during the COVID-19 pandemic. The study was conducted via a web-based survey in November 2020. Electronic informed consents were obtained from all participants. A total of 453 students including 233 males and 220 females aged 18 to 28 years with an average age of 22.09 ($SD = 2.73$) completed the questionnaires. Symptom Checklist 90, the measurement of cross-cultural adaption, the Perceived Stress Scale, the Life Orientation Test-Revised and the Resilience Scale were used for the survey. Results for the moderated mediation model testing revealed that cross-cultural adaption significantly and negatively associated with the Global Severity Index (GSI) of the Symptom Checklist 90 ($\beta = -0.24$, $P < 0.01$), and perceived stress partially mediated the relationship. Optimism ($\beta = -0.29$, $P < 0.01$) and confidence in COVID-19 control ($\beta = -0.19$, $P < 0.01$) had direct negative effects on perceived stress. Furthermore, optimism and resilience negatively moderated the indirect effect of cross-cultural adaption on psychological health through perceived stress. Findings of this study suggest that university educators ought to promote or make use of programs that cope with stress and boost optimism and resilience in order to support students not only adapt well to a new culture, but also keep good psychological health during the period of COVID-19 pandemic.

Keywords: cross-cultural adaption, perceived stress, optimism, resilience, psychological health, international undergraduates, COVID-19

INTRODUCTION

Along with the trend of globalization, more and more students choose to receive their higher education abroad. Proportion of international student within the campus has been recognized as one of the important indicators in various world university rankings, and the international students have already been an essential part of the higher education worldwide. With the rapid development of economy and the expanded international influence, China has attracted more and more international students since the twenty first century. In 2015, nearly 400,000 international students from 202 countries and regions were studying in China, an increase of 50% over in 2010 (1). Among them, the number of students specialized in medicine, engineering and science increased most remarkably (1). In 2018, this figure increased to 492,200, and China has become the largest destination for overseas study in Asia (1). However, for the international students, studying and growing up in another culture can be very challenging, and at the time of public crisis such as the COVID-19 pandemic, the challenge they are facing could be overwhelming.

During the COVID-19 pandemic, control and prevention measures such as lockdown, reduction of social contact and changes of teaching mode interrupted the students' daily life, hampered their studies and negatively impacted their psychological health (2). Moreover, previous studies revealed that the international students were more prone to psychological problems because, compared with their domestic peers, they lacked resources to counteract stress and had to cope with more challenges unique to them, such as the language barrier and culture shock (3, 4). However, most of the previous studies were done in western countries, and the research in Asia has been limited, especially during the COVID-19 pandemic. According to the results of a recent survey to the international students, 73.4, 76.6, and 58.5% of the participants had depression, anxiety and stress symptoms, respectively, during the pandemic, and male students presented more symptoms of depression and anxiety than females due to their more risk-taking behaviors (2). As international medical students will be incorporated into the future work force safeguarding the health of mankind, their well-being especially their mental health during the pandemic should arouse our attention. Therefore, the purpose of this study is to investigate the psychological health and the related factors of this student population in order to provide proper help to them during the period of COVID-19 pandemic.

Cross-cultural adaption is one of the challenges that international students have to cope with. Many researchers have examined the cross-cultural adaption or other related concepts in the realm of acculturation and cultural shock. The term cross-cultural adaption has been used to indicate a wide range of definitions which include a host language ability, a feeling of acceptance, the nature and extent of interaction with host nationals, or the acquisition of culturally acceptable behaviors (5). Cross-cultural adaption is often described as a stressful process for international students (6). Previous studies showed that the international undergraduates had more psychological problems, and failure in cross-cultural adaption might be an important stressor (7–9). According to Berry's acculturative stress theory, high levels of acculturation stress exceeding the individual's coping capacity is considered detrimental and thought to be the main mechanism for psychological distress among the immigrant population (10). Thus, stress perception might be an essential contributor to the relationship between cross-cultural adaption and psychological health.

With the emergence of the scientific field of positive psychology (11), the interest in understanding individuals from a positive psychological perspective has become a current development in higher education practice (12). Although there is still limited research on positive psychological health among undergraduates in universities (13), strong evidence exists supporting the relationship between positive psychology and psychological health of employees in organizational settings (14).

As one of the important positive psychological resources, optimism is defined as positive expectation of future success that creates renewed efforts to attain goals despite of any adversity that may be anticipated or created by stressful experiences (15). Optimism has been linked to better psychological health (16) and physical health (17), and many studies have documented optimism's protective effects against stress, which suggests that optimism may moderate the development of psychological problems in response to stress (18). Furthermore, optimism has also been found to be useful in dealing with psychological stressors (19). A meta-analysis examining experimental studies found that optimism was a significant moderator of the effects of stressors on psychological health, such that individuals with lower optimism typically showed the greatest benefit from the intervention (20). Therefore, optimism may moderate the impact of both stressors and stress on psychological health.

On the other hand, as another important positive psychological resource, resilience has been characterized by the ability to bounce back from negative emotional experiences and by flexible adaption to the changing demands of stressful experience (21). Individuals who have the ability to adapt and bounce back in adverse situations tend to exhibit strength in making realistic plans and taking necessary actions. It is recognized that resilience was an important protective factor against the development of psychiatric disorders in the face of continued adversity (22). Previous studies revealed that resilience might help undergraduates coping effectively with the stress in university life (23). Thus, resilience may be a moderator in the relationship between stress and psychological health.

However, little research has been done to study the mechanisms of the relationship between cross-cultural adaption and psychological health including the mediating or moderating variables (24). Therefore, the present study aims to test a moderated mediation model that proposes the underlying relationships of cross-cultural adaption, perceived stress and psychological health among international medical undergraduates from a Chinese university during the COVID-19 pandemic. In addition, the moderating effect of optimism and resilience will also be explored. For that purpose and based on the literature review, we formulate the following hypotheses: (H1) Perceived stress mediated the relationship between cross-cultural adaption and psychological health; (H2) Optimism moderated

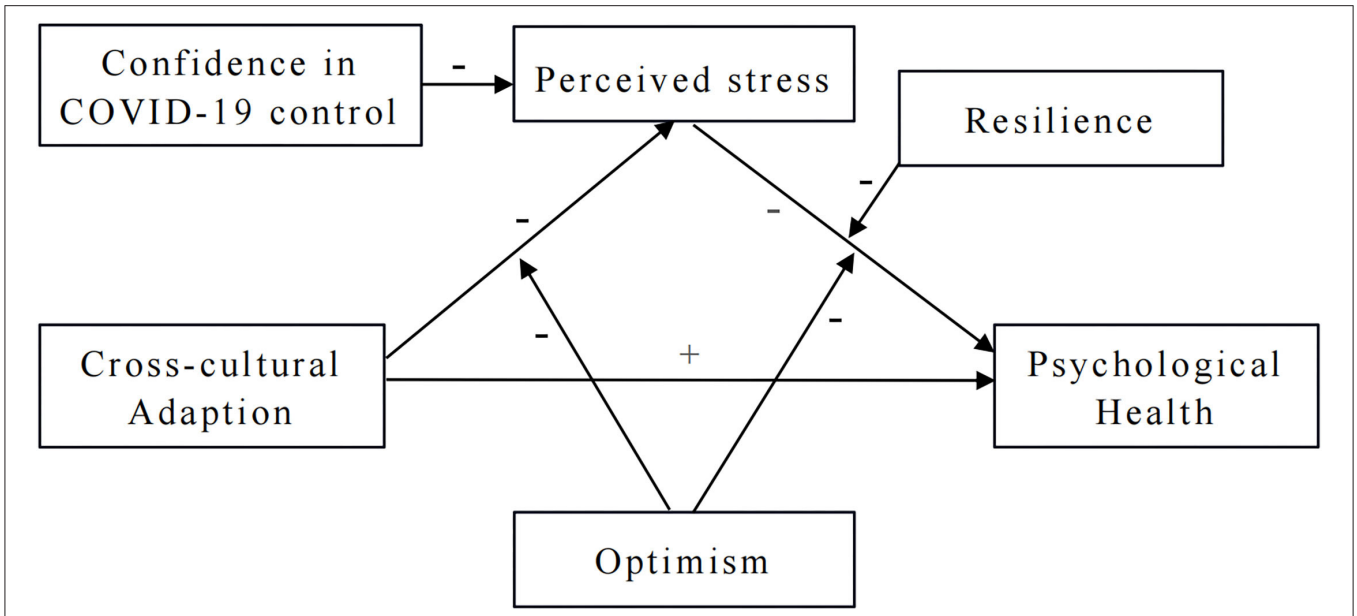

FIGURE 1 | The conceptual diagram of moderated mediation model.

the relationship between cross-cultural adaption and perceived stress; (H3) Optimism moderated the relationship between perceived stress and psychological health; (H4) Resilience moderated the relationship between perceived stress and psychological health. The proposed moderated mediation model is depicted in the conceptual diagram in **Figure 1**.

MATERIALS AND METHODS

Study Design and Subjects

The study was conducted via a web-based survey in November 2020. A cluster sampling was used and the international undergraduates enrolled at one Chinese university (China Medical University) were the target population for the study. The inclusion criteria required that each participant was under the period of study and could access to the internet. Ethics approval from the Research Ethics Committee at China Medical University (2020-25) was obtained on March 16th, 2020. There were a total of 945 international undergraduates who met the criteria, and the emails were sent to them for invitation to the survey. The email briefly detailed the purpose of the study and invited the students to participate with a link to the online survey. The first page of the online survey included a brief description of the study and an informed consent letter, in which the participants were informed about their rights to decline participation and measures to protect their confidentiality. If the students agreed to the informed consent, they could then begin the questionnaires. In the end, a total of 453 international medical undergraduates out of 500 responses completed the questionnaires, with a response rate of 47.94%. The sample consisted of 233 (51.43%) males and 220 (48.57%) females. Their ages ranged from 18 to 28 years, with an average age of 22.09 years (standard deviation = 2.73). The students were originally from 49 countries, of which 84.98% were from Asia, 7.95% from Africa, 3.09% from Europe, 2.21% from North America, and 1.77% from Oceania.

Measurements

Measurement of Psychological Health

The Symptom Checklist 90 (SCL-90) has been widely used to assess the psychological functioning not only in psychiatric patients but also in non-clinical population (25). Therefore, it was used to evaluate the psychological health of international undergraduates in this study. The SCL-90 is a multidimensional symptom self-report clinical rating scale, and contains 90 items in which respondents are to rate their degree of distress on each item according to a five-point Likert scale ranging from not at all to extremely. Eighty-three items reflect nine symptoms dimensions, which are Somatization (12 items), Obsessive-Compulsive (10 items), Interpersonal Sensitivity (9 items), Depression (13 items), Anxiety (10 items), Hostility (6 items), Phobic Anxiety (7 items), Paranoid Ideation (6 items), and Psychoticism (10 items) (26). The Global Severity Index (GSI) of the SCL-90 is regarded as the best single indicator to reflect overall symptom severity, because it combines information on both numbers of symptoms and intensity of distress (26). The GSI and the dimension scores can be calculated by summing up all the distress scores or the ones belong to a specific dimension, and then divided by 90 or the number of items to the specific dimension. A number of studies have been conducted demonstrating the reliability and the validity of this instrument (27, 28), and a Cronbach's alpha of 0.98 was found in this study.

Measurement of Cross-Cultural Adaption

Cross-cultural adaption of the international undergraduates was measured by 6 questions regarding the language barrier and its

negative influence on their life and study, the negative impact of the cultural differences, and whether they were already adapted to the study and life at the university. Response options are presented along a four-point Likert-type scale ranging from not at all to very much, and a higher summative score (negative items are reverse-scored) represents a higher level of cross-cultural adaption. The Cronbach's alpha for this sample was 0.75.

Measurement of Confidence in COVID-19 Control

Confidence in COVID-19 control was measured by 5 questions regarding if the participant is taking personal protective measures and the confidence in the personal protective measures, the confidence in the knowledge and the ability to protect oneself from being infected, and if the participant is confident that the outbreak will eventually be contained. Participants answered 1 (not at all) to 4 (very much) to the questions, and a higher total score represented a higher level of confidence in the COVID-19 control. The Cronbach's alpha was 0.72 in this study sample.

Measurement of Perceived Stress

The Perceived Stress Scale (PSS) was used to obtain an indication of the extent to which the international undergraduates perceived situations in their life to be stressful. It is the most widely used psychological measurement for the perception of stress, and requires respondents to indicate how frequently in the past month they had perceived their life to be overwhelming (29). The scale consists of 10 items, and a five-point Likert scale ranging from 0 (never) to 4 (very often) is used for answering statements. The PSS is scored by reversing positively stated items and then summing up all items with a total score ranging from 0 to 40. The score indicates the degree of perceived stress; the higher the score, the more stressful the individual perceives his or her life is. Adequate reliability and validity was reported for the PSS (30), and the Cronbach's alpha for PSS in the present study was 0.85.

Measurement of Optimism

Optimism was assessed with the Life Orientation Test-Revised (LOT-R). The LOT-R is a self-report, 6-item questionnaire that measures generalized positive outcome expectancy or optimism (31), and has been the most commonly used instrument to measure optimism in psychological research (32). To complete the scale, respondents were asked to indicate on a 5-point scale (0 = strongly disagree and 4 = strongly agree) the extent to which they agree or disagree with each of the six items. The scale consists of three positive and three negative items, and an overall optimism score was computed by adding ratings of the positive and reversed-scored negative items, with higher scores indicating greater optimism. The LOT-R has previously shown acceptable validity and good reliability when used as a measure for optimism (33). When used in this study, it has shown moderate internal consistency with a Cronbach's alpha of 0.71.

Measurement of Resilience

The Resilience Scale measures the ability to cope with stress and adversity (34). In this study, we used the 14-item Resilience Scale (RS-14) to assess the resilience level of the international undergraduates. Respondents were asked to select a response on a seven-point Likert-type scale with anchoring statements from 1 (strongly disagree) to 7 (strongly agree) to indicate how well one is able to accept themselves and life in terms of adaptability, flexibility, a balanced perspective on life, determination, mastery, perseverance and so on (34). The sum of the responses on the 14 items was used to calculate the resilience scores of the participants, with higher scores indicating stronger resilience. This scale yielded a good overall reliability for different samples (34), with a Cronbach's alpha of 0.96 in the current study.

Statistical Analysis

Analyses were conducted using SPSS statistics 23. The instruments in the study were all validated for the sample through confirmatory factor analysis and showed good fits to the data. The data was analyzed using descriptive statistics which included the means and standard deviations along with correlation coefficients. Pearson Correlation test was used to measure the correlation between the variables. An independent samples *t*-test was conducted to determine if a significant difference exists between genders.

Mediation and moderated mediation model analyses were tested using ordinary least squares path analysis and bootstrapping methods (35). Bootstrapping drew a large number of samples from the dataset and calculated the direct and the indirect effect (via perceived stress) of the independent variable (cross-cultural adaption) on the dependent variable (psychological health), which were tested against the null hypothesis that the effect was zero. The 95% confidence interval produced by the bootstrapping procedure was examined and if zero was not included within the confidence interval, the effect was considered significant (36, 37). When both the direct effect and the indirect effect were significant, partial mediating effect was proved, while full mediating effect was proved when only the indirect effect was significant (36, 37).

In addition to testing the indirect effect of cross-cultural adaption on psychological health, mediated by perceived stress, path analysis was conducted to assess whether these relationships were conditional on values of the moderators (optimism and resilience). In these analyses, cross-cultural adaption, confidence in COVID-19 control, optimism, and the cross-cultural adaption × optimism interaction term were entered as predictors of perceived stress, and cross-cultural adaption, perceived stress, optimism, resilience, the perceived stress × optimism interaction term, and the perceived stress × resilience interaction term were included as predictors of psychological health. A statistically significant interaction implied a moderating effect which was then plotted, and the significance of the slopes was examined.

In the case of a significant interaction, further analyses were conducted to probe the indirect effect by estimating conditional indirect effects at different values of the moderators (optimism and resilience). The indirect effect of cross-cultural adaption on psychological health through perceived stress was calculated at values of the moderator one standard deviation below the mean, at the mean, and above the mean (35). If the 95% bootstrapping confidence interval did not contain zero, the

TABLE 1 | Correlations of variables in the analysis.

Variable	Mean	*SD*	1	2	3	4	5	6
1. Age	22.09	2.73						
2. Cross-cultural adaption	19.60	3.27	0.03					
3. Confidence in COVID-19 control	16.35	2.29	0.06	0.29**				
4. Perceived stress	16.65	6.09	−0.09	−0.31**	−0.29**			
5. Optimism	14.26	4.02	0.09	0.15**	0.15**	−0.35**		
6. Resilience	78.59	16.38	0.05	0.29**	0.20**	−0.29**	0.33**	
7. GSI	1.51	0.60	−0.03	−0.39**	−0.26**	0.58**	−0.26**	−0.22**
8. Somatization	1.31	0.50	0.02	−0.35**	−0.22**	0.46**	−0.21**	−0.22**
9. Obsessive-Compulsive	1.71	0.78	−0.03	−0.37**	−0.26**	0.56**	−0.22**	−0.19**
10. Interpersonal Sensitivity	1.60	0.74	−0.05	−0.32**	−0.24**	0.51**	−0.23**	−0.17**
11. Depression	1.66	0.77	−0.03	−0.40**	−0.26**	0.60**	−0.25**	−0.23**
12. Anxiety	1.38	0.59	0.01	−0.34**	−0.26**	0.53**	−0.23**	−0.23**
13. Hostility	1.47	0.65	−0.03	−0.31**	−0.20**	0.54**	−0.25**	−0.17**
14. Phobic Anxiety	1.42	0.62	−0.04	−0.33**	−0.23**	0.43**	−0.19**	−0.21**
15. Paranoid Ideation	1.58	0.72	−0.05	−0.31**	−0.23**	0.49**	−0.24**	−0.16**
16. Psychoticism	1.41	0.63	−0.02	−0.39**	−0.23**	0.52**	−0.28**	−0.21**

SD, Standard deviation; $^{**}P < 0.01$.

conditional indirect effect at that value of the moderator was considered significant (35).

All mediation and moderated mediation analyses were conducted using Hayes' PROCESS macro for SPSS, a statistical tool for path analysis-based mediation, moderation, and conditional indirect effects analyses (35). For the mediation analysis, Model 4 of PROCESS was employed to test whether perceived stress mediated the effect of cross-cultural adaption on psychological health after controlling for the confidence in COVID-19 control. For the moderated mediation analysis, Model 64 of PROCESS was used in this study. In addition, bias-corrected bootstrapping procedures with 5,000 resamples were utilized to calculate 95% confidence intervals of the effects. To avoid the problem of multicollinearity, variables were mean-centered before performing the regression. A significance level of 0.05 was used for all analyses.

RESULTS

Descriptive Statistics

Means, standard deviations and correlations of the variables used in the analysis are presented in **Table 1**. The average GSI of the SCL-90 was 1.51, and the dimension scores based on severity of symptoms in descending order were Obsessive-Compulsive, Depression, Interpersonal Sensitivity, Paranoid Ideation, Hostility, Phobic Anxiety, Psychoticism, Anxiety, and Somatization. Cross-cultural adaption, confidence in COVID-19 control, optimism and resilience were significantly negatively correlated with GSI and all the dimension scores of the SCL-90, while perceived stress was significantly positively correlated with GSI and all the dimension scores of the SCL-90. Age was not significantly correlated with any variable.

TABLE 2 | Differences of psychological health between genders.

Psychological health	Gender	Mean	*SD*	*t*	*P*
GSI	Male	1.50	0.59	−0.53	0.59
	Female	1.53	0.62		
Somatization	Male	1.27	0.47	−1.57	0.12
	Female	1.35	0.54		
Obsessive-Compulsive	Male	1.70	0.76	−0.42	0.67
	Female	1.73	0.80		
Interpersonal Sensitivity	Male	1.60	0.74	−0.12	0.91
	Female	1.61	0.74		
Depression	Male	1.63	0.74	−0.89	0.38
	Female	1.70	0.79		
Anxiety	Male	1.37	0.56	−0.63	0.53
	Female	1.40	0.62		
Hostility	Male	1.45	0.66	−0.41	0.68
	Female	1.48	0.64		
Phobic Anxiety	Male	1.38	0.56	−1.21	0.23
	Female	1.45	0.67		
Paranoid Ideation	Male	1.58	0.71	−0.23	0.82
	Female	1.59	0.73		
Psychoticism	Male	1.43	0.65	0.80	0.43
	Female	1.38	0.60		

SD, Standard deviation.

Differences of Psychological Health Between Genders

The tests found no significant differences on the GSI and all the dimensions of the SCL-90 between males and females. A summary of the results is shown in **Table 2**.

TABLE 3 | Results of the mediation model testing.

Path	β	*SE*	*t*	*F*	R^2
Direct effect					
Cross-cultural adaption→ GSI	−0.23	0.01	−5.97**	140.34**	0.38
Perceived stress→ GSI	0.51	0.01	13.07**		
Cross-cultural adaption→ Perceived stress	−0.24	0.08	−5.32**	36.27**	0.14
Confidence in COVID-19 control→ Perceived stress	−0.22	0.12	−4.85**		
Indirect effect	Effect	*SE*	*LLCI*	*ULCI*	
Cross-cultural adaption→ Perceived stress→ GSI	−0.02	0.01	−0.03	−0.01	

*β, standardized coefficient; SE, standard error; LLCI, lower level of the confidence interval; ULCI, upper level of the confidence interval; **P < 0.01.*

TABLE 4 | Results of the moderated mediation model testing.

Variable	β	*SE*	*t*	*F*	R^2
Independent variable: Perceived stress				31.30**	0.22
Cross-cultural adaption	−0.21	0.08	−4.76**		
Confidence in COVID-19 control	−0.19	0.12	−4.30**		
Optimism	−0.29	0.06	−6.75**		
Cross-cultural adaption × Optimism	−0.01	0.02	−0.01		
Independent variable: GSI				57.04**	0.43
Cross-cultural adaption	−0.24	0.02	−6.16**		
Perceived stress	0.51	0.01	12.66**		
Optimism	−0.06	0.02	−1.56		
Resilience	0.03	0.01	0.86		
Perceived stress × Optimism	−0.09	0.01	−2.16*		
Perceived stress × Resilience	−0.16	0.01	−4.00**		

*β, standardized coefficient; SE, standard error; *P < 0.05, **P < 0.01.*

Mediation Model Testing Results

Since age was not significantly correlated to the GSI of the SCL-90 and gender didn't yield a significant effect on the GSI of the SCL-90 in the univariate analyses, they were not controlled in the models. After controlling for the confidence in COVID-19 control, the results for the mediation model testing are presented in **Table 3**, from which the analysis indicated that cross-cultural adaption significantly and negatively associated with the GSI ($\beta = -0.23$, $P < 0.01$) and perceived stress ($\beta = -0.24$, $P < 0.01$), and perceived stress significantly and positively associated with the GSI ($\beta = 0.51$, $P < 0.01$). There was also a significantly negative association between confidence in COVID-19 control and perceived stress ($\beta = -0.22$, $P < 0.01$). The output showed that the direct effect of cross-cultural adaption on the GSI was significant, and the indirect effect through perceived stress on the GSI was also significant (Effect = −0.02, 95% confidence interval [−0.03, −0.01]), supporting the hypothesis (H1) that the perceived stress mediated the relationship between cross-cultural adaption and the psychological health of international medical undergraduates partially. These findings indicated that the stress perceived by the international medical undergraduates decreased when the cross-cultural adaption improved, and then the GSI decreased accordingly, which represented an improvement of the psychological health.

Moderated Mediation Model Testing Results

The results for the moderated mediation model testing are shown in **Table 4**, and the final model with statistic values is shown in **Figure 2**. Unfortunately, optimism did not moderate the relationship between cross-cultural adaption and perceived stress, as the cross-cultural adaption × optimism interaction term was not significant. However, it had a significant and negative effect ($\beta = -0.29$, $P < 0.01$) on perceived stress directly, whose strength was even stronger than the direct effect of cross-cultural adaption ($\beta = -0.21$, $P < 0.01$) and confidence in COVID-19 control ($\beta = -0.19$, $P < 0.01$) on perceived stress. Combination of the cross-cultural adaption, confidence in COVID-19 control and optimism explained 22% of the variance ($R^2 = 0.22$, $F = 31.30$, $P < 0.01$) in perceived stress.

In the moderated mediation model, the strength of the relationship between perceived stress and the GSI ($\beta = 0.51$) was stronger than the relationship between cross-cultural adaption and the GSI ($\beta = -0.24$). Although optimism and resilience did not significantly associate with the GSI, both interactions with perceived stress were significant. The combination of the variables above explained 43% of the variance in psychological health of international medical undergraduates.

The interaction between perceived stress and optimism ($\beta = -0.09$, $P < 0.05$), as well as the interaction between perceived stress and resilience ($\beta = -0.16$, $P < 0.01$), were all negative on the GSI, indicating that optimism and resilience negatively moderated the relationship between perceived stress and the GSI, supporting H3 and H4. In order to interpret the interaction term, the simple slopes of optimism and resilience predicting the GSI are presented in **Figures 3**, **4**. For those who were low in optimism, higher perceived stress was associated with higher GSI (simple slope = 0.06, $t = 11.48$, $P < 0.01$). However, for those who were high in optimism, the association was weakened (simple slope = 0.04, $t = 7.93$, $P < 0.01$), which means optimism dampens the positive relationship between perceived stress and the GSI. Thus, when there is a high level of perceived stress with a high level of optimism, it is less likely to have a serious negative impact on psychological health. Similarly, the slope of the regression line of perceived stress predicting the GSI at low (simple slope = 0.07, $t = 10.79$, $P < 0.01$) and high (simple slope = 0.03, $t = 6.02$, $P < 0.01$) level of resilience were all significant, but the slope was smaller when the level of resilience was high. Therefore, resilience mitigated the positive relationship between perceived stress and the GSI, too.

Moderation of the indirect effect of cross-cultural adaption on the GSI was tested for low, medium and high levels of optimism, and at the corresponding levels of resilience as well. As shown in **Table 5**, the indirect effects were significant for all the levels of optimism and resilience but differentiated at

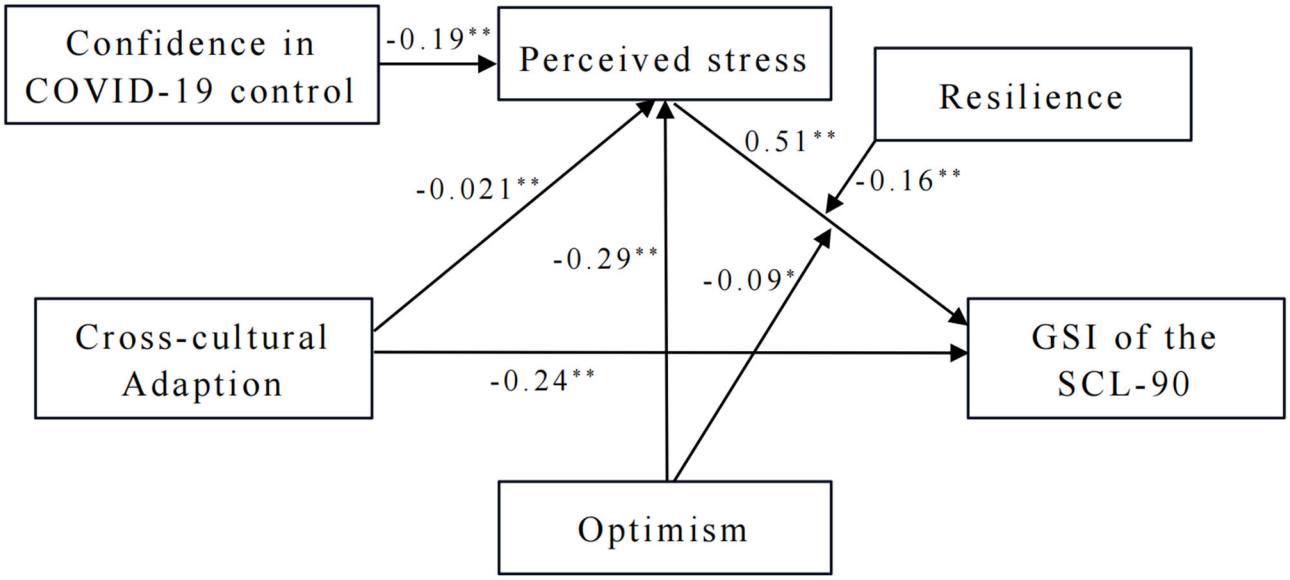

FIGURE 2 | The final model with statistic values. *$P < 0.05$, **$P < 0.01$.

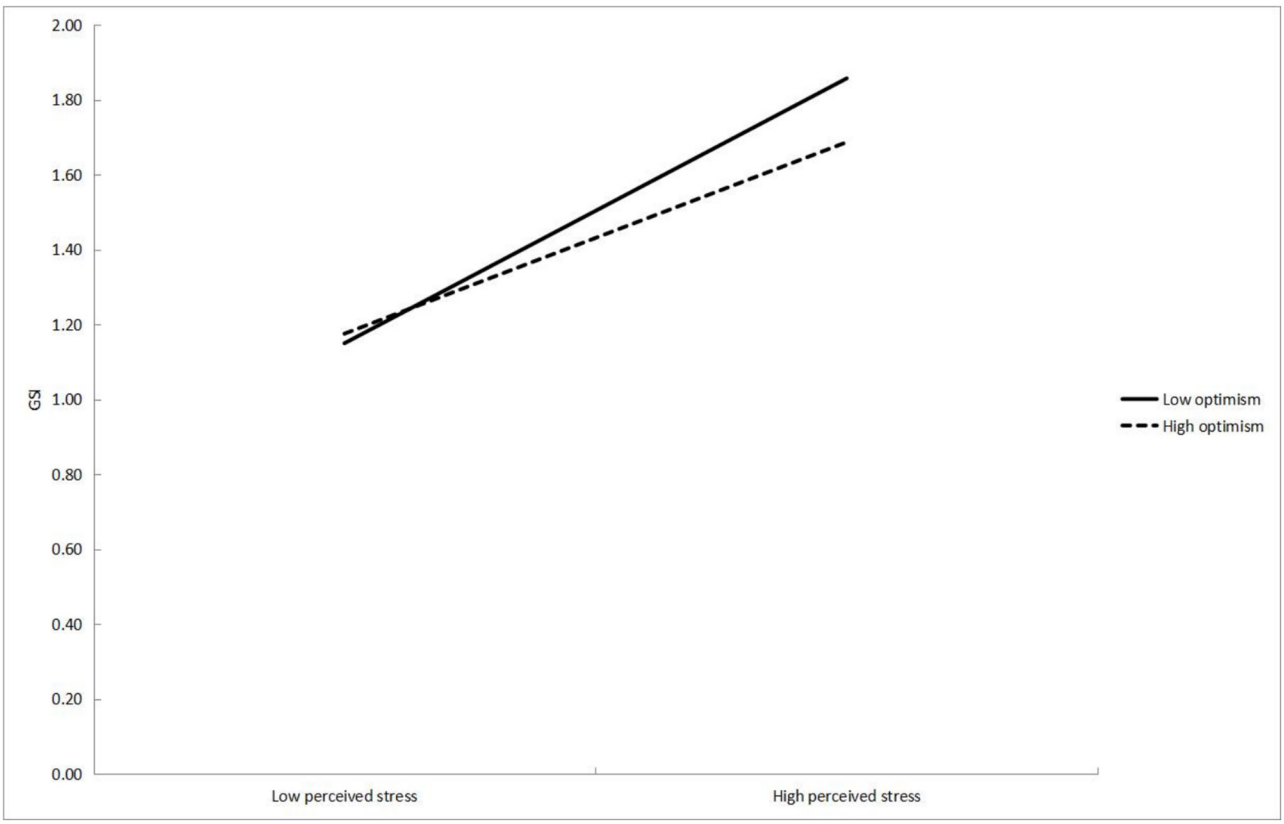

FIGURE 3 | The moderation of optimism on the relationship between perceived stress and GSI of the SCL-90.

different levels. When optimism or resilience moved to higher levels, the indirect effect was seen to be smaller, which means that the indirect effect of cross-cultural adaption on the GSI via perceived stress becomes weaker as optimism or resilience improves. The high optimism and resilience subgroup was affected the least compared with other subgroups by the indirect

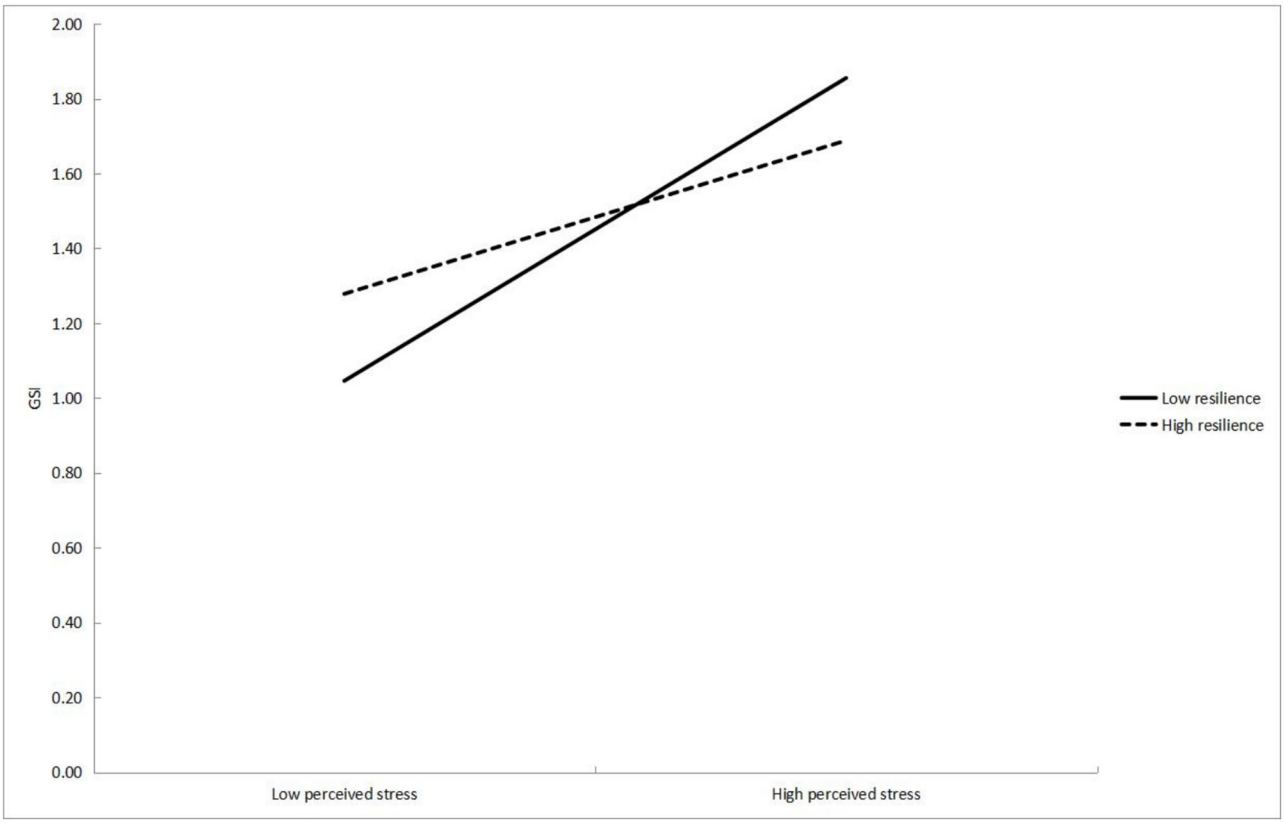

FIGURE 4 | The moderation of resilience on the relationship between perceived stress and GSI of the SCL-90.

effect of cross-cultural adaption associated with the GSI of the SCL-90.

DISCUSSION

The COVID-19 pandemic adversely impacts on the psychological health of university students worldwide. However, it's still possible that individuals can adjust to the pandemic through remaining positive (38). In our study, the average GSI of the SCL-90 among international medical undergraduates was mild (1.51), which is similar to that of previous studies in China (39, 40). The possible reason may be related with a more stable psychological reaction that the medical undergraduates had, due to the knowledge and training from campus.

Our study proposed a mediation model first to identify the relationship between cross-cultural adaption and psychological health among international medical undergraduates during the COVID-19 pandemic, and to see whether the relationship was mediated by perceived stress. We found that cross-cultural adaption significantly and negatively associated with the GSI of SCL-90 ($\beta = -0.23$, $P < 0.01$) and perceived stress ($\beta = -0.24$, $P < 0.01$) with moderate effects; and perceived stress significantly and positively associated with the GSI of SCL-90 ($\beta = 0.51$, $P < 0.01$) with a strong effect. Consistent with previous studies, our findings support the positive relationship between cross-cultural adaption and psychological health among international medical undergraduates, which implies the students with better cross-cultural adaption adjust better to the new environment and are optimally functioning in social arenas (41–43). Furthermore, our findings revealed that in addition

TABLE 5 | Conditional indirect effects of cross-cultural adaption on psychological health at different levels of optimism and resilience.

Level of optimism	Level of resilience	Indirect effect	*SE*	*LLCI*	*ULCI*
−1*SD*	−1*SD*	−0.029	0.01	−0.05	−0.01
−1*SD*	Mean	−0.022	0.01	−0.04	−0.01
−1*SD*	+1*SD*	−0.016	0.01	−0.03	−0.01
Mean	−1*SD*	−0.026	0.01	−0.04	−0.01
Mean	Mean	−0.020	0.01	−0.03	−0.01
Mean	+1*SD*	−0.013	0.01	−0.02	−0.01
+1*SD*	−1*SD*	−0.024	0.01	−0.04	−0.01
+1*SD*	Mean	−0.017	0.01	−0.03	−0.01
+1*SD*	+1*SD*	−0.010	0.01	−0.02	−0.01

SE, standard error; LLCI, lower level of the confidence interval; ULCI, upper level of the confidence interval.

to the significant direct effect on the GSI of SCL-90, cross-cultural adaption also had a significant indirect effect on the GSI of SCL-90 by influencing the stress perceived by international medical undergraduates. This means that perceived stress partially mediated the relationship between cross-cultural adaption and psychological health among international medical undergraduates, which was in line with the previous research findings among immigrant and other populations (44, 45). Consequently, international medical undergraduates with poor cross-cultural adaption were likely to perceive more stress, which was associated with increase of GSI in the current sample. Since perceived stress had a strong effect on psychological health, how to manage the stress effectively would be crucial for international medical undergraduates.

In the final moderated mediation model, our results revealed that although no moderating effect of optimism was found on the relationship between cross-cultural adaption and stress perceived by international medical undergraduates, optimism had a negative direct effect on perceived stress ($\beta = -0.29$, $P < 0.01$), which should also be considered as a useful resource to combat stress. Previous studies have proven that optimism could influence stress-perception (46, 47), and the individuals who had higher level of optimism, as a consequence of the optimistic style of appraisal, were more likely to report active ways of coping with stressful situations, which in turn led to perceive less stress than those with lower level of optimism (48). Therefore, optimism is a protective factor of perceived stress for international medical undergraduates. Importantly, similar to one previous research finding (49), our study also revealed that the confidence in COVID-19 control was negatively correlated with perceived stress of international medical undergraduates ($\beta = -0.19$, $P < 0.01$). During the COVID-19 pandemic period, although the pandemic was a stressor for international medical undergraduates, the achievements in combating COVID-19 across different countries might encourage them to cooperate and abide by the various control measures, and their confidence in COVID-19 control might increase accordingly, which could alleviate the perception of stress (50). This finding suggests that during the pandemic of COVID-19, building confidence in COVID-19 control in the students may be a good strategy to make international medical undergraduates feel less stress and improve their psychological health. Therefore, the improvement of optimism and confidence in COVID-19 control could help international medical undergraduates to perceive less stress.

Moreover, in our moderated mediation model, optimism and resilience negatively moderated the relationship between perceived stress and the GSI of SCL-90, and the effects were differentiated for subgroups, which implied that the indirect effect of cross-cultural adaption on psychological health via perceived stress was dependent on the levels of optimism and resilience. Our findings showed that the indirect effect of cross-cultural adaption on psychological health via perceived stress was weaker for international medical undergraduates with high level of optimism and resilience compared with those with low or medium level of optimism and resilience. These findings are also in agreement with previous studies which revealed that higher level of optimism and resilience, as internal resources, would be valuable strategies to improve coping mechanisms for stress on psychological health (21, 51–53). This indicates that an intervention of protection might be useful for international medical undergraduates, in particular for those with low level of optimism and resilience. Various positive psychology exercises have demonstrated that optimism and resilience could be taught, learned and developed over time (21, 54, 55). Findings of our study provide evidence for developing training programs that support fostering high levels of optimism and resilience. In this sense, we suggest this knowledge could be used by university educators and managers to build positive characteristics and improve strengths for international undergraduates under the circumstances of COVID-19 pandemic.

This study has several limitations. First of all, since our study population only included the international undergraduates at one medical university of China, caution should be noted in generalizing the findings from this study to other international undergraduates. This warrants a replication of this study inquiry across a number of universities in China before more robust conclusions can be drawn. Second, the data was obtained by self-report measurements and could have included both participant bias and dishonesty, so it is possible that data could be inaccurate. Third, due to the cross-sectional study design, causal inferences cannot be made regarding the relationships between variables in this study. A possible future research opportunity is to investigate through longitudinal approach study. Fourth, as only two integral components of psychological capital i.e., optimism and resilience are studied, other aspects of the psychological capital should be taken into account in future studies.

Despite the limitations, our study offers some positive findings and opportunities for further research in the area of psychological health of international medical undergraduates and enriches the literature of cross-cultural adaption and positive psychology in higher education research. Our findings are also potentially useful for psychological health intervention programs for international medical undergraduates to cope with stressful situations such as COVID-19 pandemic more effectively. Although the results and recommendations from this study cannot eliminate the stressors, they may help lessen the degree to which the international medical undergraduates are affected by the poor cross-cultural adaption. Since previous studies have developed a series of brief micro-training interventions that focused on improving individuals' optimism and resilience (56–58), it is worth implementing among the international medical undergraduates to counteract stress induced by cross-cultural adaption, and maintain their psychological health during the COVID-19 pandemic. University educators ought to promote and make use of programs such as the ones that cope with stress and boost optimism and resilience in order to support students not only adapt well to a new culture, but also keep good psychological health.

CONCLUSION

In the present study, we found a positive association between cross-cultural adaption and psychological health among international medical undergraduates, which was mediated by perceived stress. Optimism and confidence in COVID-19 control were negatively correlated with perceived stress. In

addition, optimism and resilience negatively moderated the indirect effect of cross-cultural adaption on psychological health through perceived stress. Therefore, collaborations from multiple departments on campus are required to implement the training programs that cope with stress and foster high levels of optimism and resilience, in order to maintain psychological health among international medical undergraduates in China during the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

XiW drafted the manuscript. LL helped analyzing the statistics. XuW and MQ collected the data. LY and YG helped with the study design and data analysis. BP provided the guidance of the study design and reviewed the manuscript. All authors contributed to the article and approved the submitted version.

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Psychosocial Factors Associated With Increased Adolescent Non-suicidal Self-Injury During the COVID-19 Pandemic

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Non-suicidal self-injury (NSSI) in adolescents hospitalized with psychiatric disorders continues to increase after the outbreak of COVID-19. This study aimed to explore the relationship between the pandemic and NSSI among adolescents and whether the composition of psychosocial factors related to NSSI has changed during the pandemic. Through the retrospective analysis of medical records retrieved from the electronic system of the psychiatric hospital located in Chengdu from January 2016 to March 2021, 609 medical records of adolescents were obtained. The main potential psychosocial factors were determined by deductive content analysis. Among the 609 adolescents, 420 subjects had engaged in NSSI, while 189 did not. We found that the percentage of adolescents who had engaged in NSSI in 2016 was only 29.2%, reaching 34.5% in 2017, 45.7% in 2018, 61.3% in 2019, 92.5% in 2020, and 95.9% in 2021. In the binary logistic regression model, female sex (OR = 0.073, 95% CI: 0.028–0.186), older age (OR = 1.234, 95% CI: 1.030–1.478), having a single parent (OR = 7.865, 95% CI: 3.997–15.476), having experienced trauma (OR = 2.192, 95% CI: 1.032–4.654), having experienced social isolation from peers (OR = 8.139, 95% CI: 4.037–16.408), having experienced body-focused bullying (OR = 3.078, 95% CI: 1.295–7.318), overuse of a mobile phone in the parents' opinions (OR = 4.354, 95% CI: 1.380–13.738), having attempted suicide (OR = 9.120, 95% CI: 4.492–18.512), and during the pandemic (time point is January 30, 2020) (OR = 5.399, 95% CI: 1.679–17.357) were the factors that were significantly associated with NSSI. When comparing the differences in psychosocial factors between the pre-pandemic and the during-pandemic groups, the results showed that the family constitution, parent–child relationships, mobile phone overuse, and stressful learning were important factors. Tailored interventions geared towards changed psychosocial factors should be formulated.

Keywords: adolescent, COVID-19, NSSI, psychosocial factors, during-pandemic

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INTRODUCTION

NSSI (non-suicidal self-injury) refers to the behaviour of directly damaging one's body tissue, such as self-harming, skin scratching, and self-burning (1). According to the definition, the purpose of implementing this behaviour is not to cause death, but many related studies have found that the suicide risk of patients who engage in NSSI is hundreds of times higher than that of the general

population (2, 3). NSSI brings a severe burden to the society and families. Some scholars have found through epidemiological investigation that the incidence rate of NSSI is 14–39% in the general adolescent population, while it is as high as 40–61% in adolescent inpatients (4). Due to its high detection rate, high risk, and high repeatability, this behaviour has become one of the most important public health problems in the world.

In recent years, there have been many studies aimed at exploring the causes of NSSI among adolescents. According to Chapman's Experiential Avoidance Model, individuals engage in NSSI to escape from unwanted emotions, which is primarily maintained by negative reinforcement (5). Casey and colleagues revealed that adolescents are vulnerable to NSSI because of their elevated levels of impulsivity and emotional reactivity (6). Beyond emotional reasons, demographic factors such as female sex (7) were found to be related to NSSI. Other risk factors for NSSI might focus on psychosocial factors, including dysfunctional relationships (8), being bullied by peers (9), and being mistreated by parents (10). Among all these risk factors, it was found that accumulated stressors play an important role in the onset of NSSI (11). Adolescents living in modern society experience many stressors (12), and it was estimated that by 2020, there would be 15–30 million teenagers who engage in NSSI (13). In addition to the increased stressors mentioned above, a sudden COVID-19 pandemic hit us in early 2020, which greatly changed our life, and the changed lifestyle might make people anxious (14). Compared to adults, the particular group of children and adolescents, who constitute ∼ 28% of the world's population (15), have more vulnerability factors, which increases the impact of the pandemic on their lives (16). The latest studies have reported that the pandemic has caused adolescents to be unable to meet friends, unable to participate in outdoor activities, and unable to engage in school activities, which may have continuous negative effects on their mental health (17, 18). Undoubtedly, the COVID-19 pandemic is a strong stressor for adolescents, which might further increase their NSSI prevalence, like the experience reported by Hasking et al., (19). It can be demonstrated by the findings in the research by Ougrin et al., that the pandemic-related emergency psychiatric presentations of NSSI for children and adolescents increased from 50% in 2019 to 57% during the COVID-19 lockdown in 2020 (20).

Although the psychosocial factors for NSSI have been studied in depth, there is little literature that points out the composition and structural changes of these factors brought about by the COVID-19 pandemic, and it remains to be determined what reasons have caused the increase in NSSI among hospitalized adolescents in psychiatric hospitals. To answer these questions, we performed a retrospective analysis of the medical record data of adolescent patients treated in the Clinical Psychology Department of the Fourth People's Hospital of Chengdu from 2016 to present. The purpose of our study was 1) to determine if the pandemic is associated with an increase in NSSI among adolescents; 2) to explore whether the composition of related psychosocial factors related to NSSI has changed during the pandemic; and 3) to provide tailored measures for the prevention of NSSI in the future.

MATERIALS AND METHODS

Participants

Our study was a retrospective analysis of medical record data retrieved from the electronic medical record system of the Fourth People's Hospital of Chengdu. This hospital is responsible for the treatment of all types of common psychiatric disorders, and the patients were mainly from major cities in Sichuan Province, sometimes from cities outside the province. It could be said that the population coverage rate of this hospital is still relatively large. The key limitations for retrieval were the patients' age $\leq$ 18 years, who were admitted to the Clinical Psychology Department of the Fourth People's Hospital of Chengdu during the period from January 2016 to March 2021. It is important to note that from February 2020 to March 2020, this ward was shut down due to the pandemic, so the number of cases in these 2 months was 0. (This ward was mainly responsible for treating patients with anxiety, depression, and other mood disorders.) Irrelevant data were filtered out, including the data of adults over 18 years old and data from repeat hospitalizations; for the latter, we only chose the latest medical record for analysis. In the initial records search, the number of patients hospitalized repeatedly was 23. A total of 609 medical records were obtained, all of which were approved for use by the patients' parents at the time of admission.

Measures

Four members in this study read through the medical records of each case, and according to their contents of the records, they included the information of the patients' biological sex, age, duration of disorder, the frequency of treatment episodes (it referred to the times of treatment for their psychiatric disorders before being admitted to our hospital, including the medication and psychotherapy), psychiatric diagnoses (The diagnoses were made according to the International Classification of Diseases, ICD, the 10th version, by the diagnosis and treatment team in the ward through the professional rounds. The team consisted of three psychiatrists who had worked in this field for at least 10 years.), the date of hospitalization, the marital status of their parents, whether they were only children, and their lifetime history of NSSI behaviours and suicide attempts. All these data were recorded into the Excel spreadsheet created on the computer. NSSI was defined as any act of self-injury associated with no intent to die, including the intentional self-cutting, self-burning, self-biting, self-scratching, and self-punching. NSSI was assessed during admission *via* a psychiatric interview conducted by attending physicians. The psychiatric interview was implemented in a standardized process, which could gain the information of the patients' upbringing history, including their relationship with peers and parents. In this evaluation, all patients were asked whether they had ever engaged in NSSI. If they said yes, physicians needed to record the way, the frequency, and the time of the latest self-injury behaviour into the medical records. Simultaneously, physicians were responsible for checking the scars or damaged body tissue caused by NSSI during the physical examination session. To determine whether the pandemic was associated with NSSI, we also added an item named "Before/During the pandemic" to classify the data.

TABLE 1 | The demographic characteristics and psychosocial factors related to NSSI among adolescents admitted to our hospital.

Variable and assignments	NSSI group (Total $n = 420$) (N %)	Without NSSI group (Total $n = 189$) (N %)	*OR* (95% CI)	*p*-value
Gender			0.075 (0.029, 0.190)	<0.001
Female (1)	402 (95.7%)	130 (68.8%)		
Male (2)	18 (4.3%)	59 (31.2%)		
Average age (years ± SD)	15.33 ± 1.74	15.37 ± 1.75	1.215 (1.022, 1.444)	0.023
Average duration of disease (months ± SD)	15.42 ± 8.24	14.83 ± 7.08	1.021 (0.978, 1.065)	0.364
Frequency of treatment episodes (times ± SD)	0.34 ± 0.67	0.39 ± 0.75	0.882 (0.587, 1.326)	0.547
Single parent			7.751 (3.951, 15.205)	<0.001
Yes (1)	226 (53.8%)	33 (17.5%)		
No (0)	194 (46.2%)	156 (82.5%)		
Only child			0.713 (0.396, 1.287)	0.278
Yes (1)	124 (29.5%)	77 (40.7%)		
No (0)	296 (70.5%)	112 (59.3%)		
Experienced trauma			2.214 (1.043, 4.700)	0.041
Yes (1)	75 (17.9%)	27 (14.3%)		
No (0)	345 (82.1%)	162 (85.7%)		
Social isolation from peers			8.313 (4.134, 16.716)	<0.001
Yes (1)	239 (56.5%)	24 (12.7%)		
No (0)	181 (43.1%)	165 (87.3%)		
Hurt by information on social media			1.082 (0.434, 2.696)	0.870
Yes (1)	115 (27.4%)	13 (6.9%)		
No (0)	305 (72.6%)	176 (93.1%)		
Body-focused bullying			3.116 (1.311, 7.405)	0.011
Yes (1)	109 (26.0%)	12 (6.3%)		
No (0)	311 (74.0%)	177 (93.7%)		
Parents' misunderstanding*			0.812 (0.438, 1.504)	0.489
Yes (1)	252 (60.0%)	76 (40.2%)		
No (0)	168 (40.0%)	113 (59.8%)		
Online class			1.494 (0.304, 7.333)	0.601
Yes (1)	181 (43.1%)	6 (3.2%)		
No (0)	239 (56.9%)	183 (96.8%)		
Learning stress			1.702 (0.793, 3.656)	0.191
Yes (1)	228 (54.3%)	26 (13.8%)		
No (0)	192 (45.7%)	163 (86.2%)		
Mobile phone overused			4.199 (1.343, 13.122)	0.012
Yes (1)	201 (47.9%)	9 (4.8%)		
No (0)	219 (52.1%)	180 (95.2%)		
Attempted suicide			9.276 (4.580, 18.783)	<0.001
Yes (1)	289 (68.8%)	23 (12.2%)		
No (0)	131 (31.2%)	166 (87.8%)		
Before/during pandemic			5.421 (1.693, 17.352)	0.005
During (1)	266 (63.3%)	14 (7.4%)		
Before (0)	154 (36.7%)	175 (92.6%)		
Constant	–	–	0.063	0.062

**The item of "Parents' mis-understanding" stands for the psychosocial factor "Parent–child relationships".*

According to the statement by the World Health Organization, which declared January 30, 2020, as the start date of the outbreak of COVID-19 (21), we defined this date as the time point; namely, the patients admitted before this time were considered as "before the pandemic." The spreadsheet also includes items related to psychosocial factors of NSSI behaviours, which were selected by

the members in this study by deductive and inductive content analysis. (The specific process was described in section Statistical analysis) The research received institutional review board (IRB) approval from the Fourth People's Hospital of Chengdu.

Statistical Analysis

The study combined qualitative and quantitative analyses. For the qualitative part, deductive content analysis was utilized to identify the main related psychosocial factors of NSSI. On the basis of a literature review, we developed an unconstrained classification matrix, which focused on the relevant factors of NSSI. The identified categories, including "Experienced trauma," "Body-focused bullying," "Social isolation from peers," "Hurt by information on social media," and "Parent–child relationships," were all retrieved from previously published studies (22–28). Then, four members in this study read all 609 medical records and coded the data for correspondence with the five identified categories. Under the item "Parent–child relationships," we found that most of the records had a similar phrase: "parents didn't understand my feelings, and they often misunderstood me." Therefore, we changed the title to "Parents' misunderstanding" and used it in **Table 1**. During our work, we found some factors that did not fit the categorization frame, and then we followed the principles of inductive content analysis to create the new categories (after discussing collectively, until consensus was reached, the lists of headings were grouped under higher-order subthemes. As a result, the subthemes of "Learning Stress," "Online class," and "Overuse of mobile phone" were formulated. See **Table 2** for the classification matrix). For quantitative data, the analysis involved descriptive statistics, with data expressed as the mean ± SD or frequency. Age and duration of disorder data were used for comparisons between the groups using the *T*-test, and Cohen's d was used to describe the effect size of the differences. The chi-square test was used to determine the differences in psychosocial factors related to NSSI between the pre-pandemic group and the during-pandemic group. Binary logistic regression models were performed using the forward stepwise method to explore the psychosocial factors associated with NSSI among discharged adolescents, and odds ratio (OR) and 95% confidence intervals (CIs) were obtained to show the associations between these factors and the outcomes. The sample of discharged adolescents that did not engage in NSSI after the outbreak of the pandemic was small, and the number of factors was relatively large, resulting in the restriction of using logistic regression models, so Spearman's correlation was used to examine the association between NSSI behaviours and psychosocial factors in the different groups. A $p < 0.05$ was considered statistically significant. The statistical software used for all analyses was SPSS, version 20.0 (IBM-SPSS Inc., Armonk, NY, USA).

TABLE 2 | The unconstrained categorization matrix of psychosocial factors of NSSI.

What are the psychological factors related to NSSI?	
Experienced trauma	Earthquake Traffic accident Sexual assault ……
Body-focused bullying	Be slapped in the face Be besieged Be pulled clothes down ……
Social isolation from peers	Neglected by peers No one to play with Being kept distance ……
Hurt by information on social media	Be attacked by words on the internet ……
Parent–child relationships	Misunderstood by parents
New categories to be formulated by inductive content analysis	……

RESULTS

The Demographic and Clinical Characteristics of All Included Adolescents

Among the 609 adolescents, 43.7% (266/609) came from Chengdu, 44.5% (271/609) came from other cities of Sichuan Province, and the rest came from other provinces. The top four pre-valences of psychiatric disorders among them were "behavioural and emotional disorders that usually occur in childhood and adolescence" (33.5%), "depressive disorders" (24.6%), "anxiety disorders" (13.1%), and "bipolar disorder" (10.0%). The remaining diagnoses included "post-traumatic stress disorder" (4.8%), "personality disorders" (4.3%), "obsessive-compulsive disorder" (3.1%), "conversion disorder" (2.6%), and "adjustment disorder" (0.5%). When grouped according to their behaviours, 420 subjects had engaged in NSSI behaviours, while 189 had not; we classified the former into the "NSSI group," and the latter into the "without NSSI group." In the "NSSI group," the top three disorders were "behavioural and emotional disorders that usually occur in childhood and adolescence" (48.6%), "depressive disorders" (22.1%), and "bipolar disorder" (8.8%), while the top three disorders in the "without NSSI group" were "anxiety disorders" (33.3%), "depressive disorders" (30.2%), and "bipolar disorder" (12.7%). The demographic details of these two groups are shown in **Table 1**. In the NSSI group, the disorder duration ranged from 5 to 72 months, and the age ranged from 10 to 18 years, while the corresponding ranges in the other group were 6–36 months and 12 to 18 years. In the NSSI group, the proportion of patients who got their first treatment for their psychiatric disorders in our ward was 76.2% (320/420), while the proportion in the "without NSSI group" was 73.5% (139/189).

The Distribution of Adolescents That Engaged in NSSI for Each Year

The percentage of adolescents who engaged in NSSI in 2016 was only 29.2% (7/24), reaching 34.5% (29/55) in 2017, 45.7% (42/92) in 2018, 61.3% (76/124) in 2019, 92.5% (196/212) in 2020, and 95.9% (70/73) in 2021 (each adolescent was only included in one of these years). We found that since 2020, the proportion of adolescents who engaged in NSSI has increased

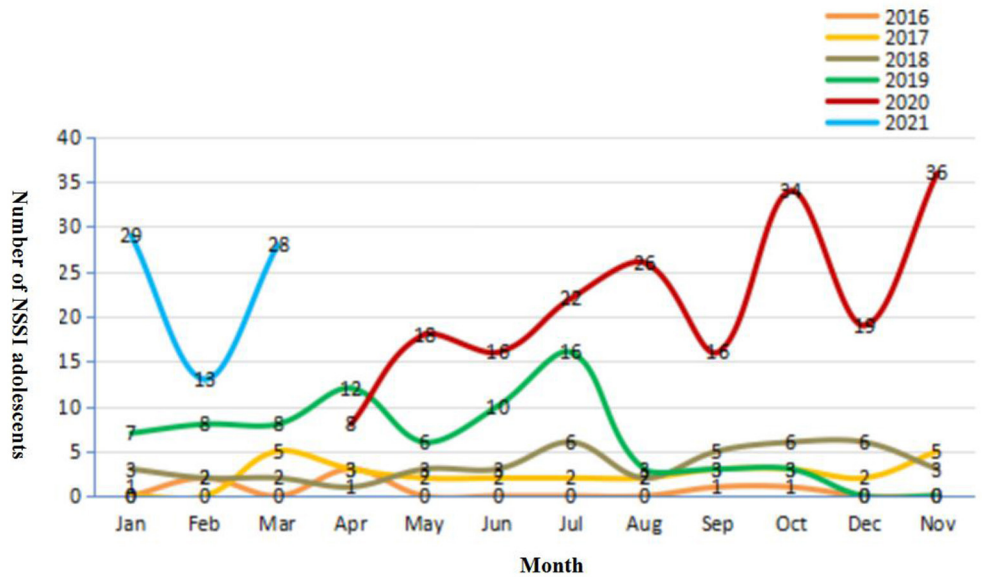

FIGURE 1 | The number of NSSI adolescents in each month from 2016 to 2021. From February 2020 to March 2020, our ward was shut down due to the pandemic, so the line for these 2 months was broken.

dramatically. **Figure 1** displays the number of adolescents who engage in NSSI in each month from 2016 to 2021. We can see that after the central provinces and cities gradually resumed work (due to the outbreak of COVID-19, many cities in China stopped production), that is, since May 2020, the number of hospitalized adolescents who engage in NSSI has increased further. We can see that the number in February 2021 was relatively small. Because it was the traditional Spring Festival, most Chinese adolescents would not want to be hospitalized during this period.

The Related Psychosocial Factors of NSSI in All Discharged Adolescents

We took NSSI behaviours as the dependent variable; 0 indicates no NSSI behaviours, and one indicates having NSSI behaviours. All demographic characteristics, the frequency of treatment episodes, the main eight psychosocial factors abstracted from their medical records, whether the adolescents had attempted suicide previously, and the item "Before/During the pandemic" were considered independent variables, and their assignments are shown in **Table 1**. The association of the psychosocial factors with NSSI is presented in **Table 1**. In the binary logistic regression model, female sex (OR = 0.073, 95% CI: 0.028–0.186), older age (OR = 1.234, 95% CI: 1.030–1.478), having a single parent (OR = 7.865, 95% CI: 3.997–15.476), having experienced trauma (OR = 2.192, 95% CI: 1.032–4.654), having experienced social isolation from peers (OR = 8.139, 95% CI: 4.037–16.408), having experienced body-focused bullying (OR = 3.078, 95% CI: 1.295–7.318), overusing a mobile phone (OR = 4.354, 95% CI: 1.380–13.738), having attempted suicide (OR = 9.120, 95% CI: 4.492–18.512), and during the pandemic (OR = 5.399, 95% CI: 1.679–17.357) were the factors that were significantly associated with NSSI in discharged adolescents. The Omnibus tests of model coefficients showed that the model was significant ($\chi^2 = 448.012$, df = 16, $p < 0.001$), and the Nagelkerke R square was 0.733, which meant that 73.3% of the variance could be explained by this model.

The Differences in the Demographic Characteristics and Incidence Rate of Psychosocial Factors Between the Different Groups

Through the results of the logistic regression model, we demonstrated that adolescents admitted to our hospital during the pandemic were more likely to engage in NSSI. To explore the reasons, we divided all subjects into two groups. One group consisted of subjects admitted to our hospital before the pandemic ($n = 329$), and another consisted of those admitted during the pandemic ($n = 280$). The average age of all the adolescents in the pre-pandemic group (15.58 ± 1.68 years) was significantly higher than that in the during-pandemic group (15.06 ± 1.78 years), and their disorder duration (14.59 ± 7.32 months) was significantly shorter than that in the during-pandemic group (16.00 ± 8.47 months) ($t = 3.674, -2.215$; $p < 0.001$, $p = 0.027$; the Cohen's d was 0.300 and 0.178, respectively). We also found that the average age of adolescents with NSSI behaviours in the pre-pandemic group (15.83 ± 1.60 years) was significantly higher than that in the during-pandemic group (15.06 ± 1.80 years), and their disorder duration (14.25 ± 7.42 months) was significantly shorter than that in the during-pandemic group (16.10 ± 8.61 months) ($t = 4.409, -2.227$; $p < 0.001$, $p = 0.026$, the Cohen's d was 0.452 and 0.230, respectively).

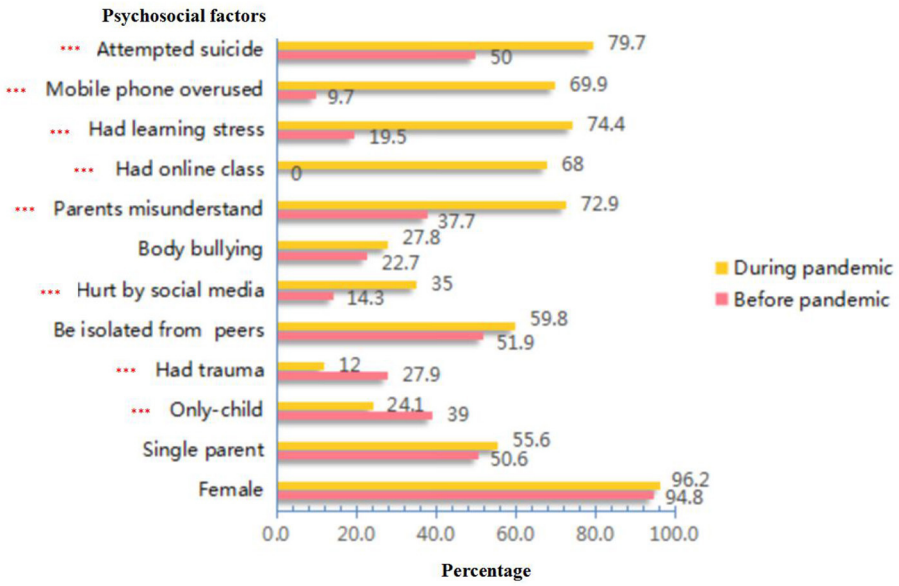

FIGURE 2 | The comparison of incidence rates of related psychosocial factors among NSSI adolescents in different periods. ***stands for $P < 0.001$.

We used the chi-square test to compare the incidence rate of all the psychosocial factors between the adolescents who engaged in NSSI in the pre-pandemic group and those in the during-pandemic group and discovered that after the outbreak of the pandemic, fewer adolescents who engaged in NSSI were only children ($\chi^2 = 10.408$, df $= 1$, $p = 0.001$), fewer adolescents had experienced trauma ($\chi^2 = 16.793$, df $= 1$, $p < 0.001$), more adolescents were hurt by the information on social media ($\chi^2 = 20.971$, df $= 1$, $p < 0.001$), more adolescents thought their parents did not understand them ($\chi^2 = 50.554$, df $= 1$, $p < 0.001$), more adolescents took online classes ($\chi^2 = 184.149$, df $= 1$, $p < 0.001$), more adolescents thought their learning was stressful ($\chi^2 = 118.697$, df $= 1$, $p < 0.001$), more adolescents' parents thought their children overused mobile phones ($\chi^2 = 141.573$, df $= 1$, $p < 0.001$), and more adolescents had previously attempted suicide ($\chi^2 = 40.084$, df $= 1$, $p < 0.001$) (see **Figure 2** for details).

The Correlation Between NSSI Behaviours and Related Psychosocial Factors in the Different Groups

We used Spearman's correlation to analyse the relationship between NSSI behaviours and all psychosocial factors in the pre-pandemic group and during-pandemic group. The results are shown in **Table 3**. The influencing factors in the two groups were different (see the bold font in **Table 3**), which illustrated that the pandemic had changed the potential psychosocial factors for NSSI behaviours.

TABLE 3 | The correlation between NSSI and psychosocial factors in different groups.

Factors	NSSI status	
	Pre-pandemic (n = 329)	During-pandemic (n = 280)
Age	0.140*	−0.044
Gender	−0.317**	−0.422**
Duration of disorder	−0.043	0.050
Frequency of treatment episodes	−0.026	−0.009
Single parent	0.349**	0.181**
Only child	−0.005	−0.165**
Experienced trauma	0.160**	0.033
Social isolation from peers	0.418**	0.232**
Hurt by information on social media	0.122*	0.128*
Body-focused bullying	0.237**	0.102
Parents' misunderstanding	0.005	0.299**
Online class	–	0.117
Learning stress	0.069	0.323**
Mobile phone overused	0.088	0.323**
Attempted suicide	0.422**	0.301**

*$p < 0.05$; **$p < 0.01$. The coding rules for the binary variables: for the NSSI status, 0 stands for without NSSI, and 1 for engaged in NSSI. For other binary variables, such as gender and being a single parent, the specific assignments were the same as listed in **Table 1**.*

DISCUSSION

This is an important study to understand the changing trend of NSSI behaviours and the related psychosocial factors among adolescents in psychiatric hospitals during the pandemic. We found that after the outbreak of COVID-19, the number of adolescents with NSSI behaviours admitted to the hospital increased, and their average age was younger, while their duration

of disorder was longer, which means that the seriousness and difficulty of the problem increased.

In **Figure 1**, we can tell that the incidence of patients with NSSI behaviours in 2019 appeared to show a similar trajectory to 2020 until the month of August (except for the period of the Spring Festival and the shutdown of our ward in 2020), which shows an obvious increase compared to previous years. It could be implied that, prior to the current pandemic, the prevalence of NSSI behaviours among adolescents has increased, just as the findings of Gillies et al. identified a significant increase in the estimated lifetime prevalence of self-harm over time from 1990 to 2015 (29). The reason might be the growing pressure from social networks and the propagation effect of the media (11, 30). However, we also found that after the outbreak of the pandemic, the number of adolescents with NSSI behaviours continued to rise, which might indicate the persistent negative impact of the pandemic.

When analysing the influencing factors of NSSI in all adolescents admitted to our hospital, we found that females were more prone to engage in NSSI behaviours, which is consistent with findings from previous studies on NSSI behaviours in adolescents (31, 32). We also found that parents' divorce, having experienced trauma, having experienced social isolation from peers, and having experienced body-focused bullying were all associated with adolescents' NSSI behaviours. These psychosocial factors screened out in our study have been reported by many similar studies (33–35). Another important influencing factor in our study was the item of attempted suicide, which is further supported by the study by Wolff et al. that stated that more than 70% of hospitalized adolescents with NSSI behaviours had ever attempted suicide or committed suicide (36). This finding is also similar to the report of Fox of a significant association between NSSI behaviours and prior suicidal thoughts/behaviours (37). In contrast to other studies, we found that the overuse of mobile phones deemed by parents was significantly associated with adolescents' NSSI behaviours, and the outbreak of the pandemic did become another influencing factor of NSSI behaviours. The reasons are discussed in the next paragraph.

When analysing the results, we cannot help but to ask why the pandemic aggravated the appearance of NSSI behaviours. Studies have found that the pandemic does have a particular impact on mental health, leading people to be more prone to be anxious and depressed (38). However, apart from the psychological pressure brought by the pandemic, what factors lead these adolescents to hurting themselves repeatedly and being sent to the hospital? We might determine the answer by comparing the incidence of psychosocial factors between different groups. After the outbreak of the pandemic, great changes have taken place in the structure of adolescents' lives. First, due to the delay of returning to work because of the COVID-19 pandemic, parents and adolescents are with each other day and night, so parents may have a greater awareness of their children's self-injury behaviours, similar to the results that Hasking et al. mentioned in their study (19). This could impel parents to change their decision to seek professional medical help. When NSSI occurs, parents might try hard to control their children's behaviours. In turn, adolescents might think this control is an intrusion, which might then lead to an increased risk for NSSI (25). Second, the time spent together inevitably increased communication. As parents and adolescents always insist their own opinions are correct instead of putting themselves in each other's shoes, the conflicts brought by misunderstanding might intensify. When conflicts rose to a certain level that adolescents could not endure, they started to hurt themselves habitually to alleviate the pain caused by the contradiction (39). Therefore, 72.9% of adolescents with NSSI behaviours in the during-pandemic group thought their parents did not understand them, and this misunderstanding was also proven to be significantly correlated with the appearance of NSSI behaviours. The latest study discovered that the COVID-19 pandemic is associated with impaired distress tolerance of family members and may reduce satisfaction among parents and their children (19). Third, due to the pandemic, most schools had to postpone their opening dates. To avoid cancelling the courses, the schools carried out distant learning as a new teaching mode, which might bring long-term consequences to students (40), which is similar to the report by Sindiani et al. that found that online classes could not provide a calm environment for students and might bring lower academic achievement (41). The limited class interaction and inefficient timetable might reduce students' satisfaction (42). Many adolescents thought the teaching mode for online courses made it difficult to understand the class materials, which may further increase their anxiety about learning. This could be proven by the high rate of 74.4% for learning stress in the during-pandemic group, and this factor was also found to be correlated with NSSI behaviours during the pandemic. Finally, the increased time of using electronics during the pandemic may also increase parents' anxiety transmitted to their children, which could be echoed by the opinions of these parents. We found that 69.9% of the parents of adolescents with NSSI behaviours in the during-pandemic group complained that their children spent too long playing on mobile phones, which successfully included this factor into the sequence of NSSI influencing factors. Chaturvedi et al. discovered a significant increase in the use of social media as a medium for stress relief in adolescents after the outbreak of the pandemic (42). For adolescents with emotional problems, the virtual world might be safer and could help them calm down, which could be verified by the finding that mobile phone use was positively correlated with anxiety (43). Furthermore, mobile phone use was found to be negatively correlated with a good parent–child relationship (43). Adolescents who use mobile phones excessively might have a bad relationship with their parents, and a tense parent relationship has been proven to be a risk factor for NSSI (23). In addition to the risk factors mentioned above, we also found that adolescents from multiple child families were more likely to engage in NSSI during the pandemic. The possible reason might be the competitive interaction between siblings. With the liberalization of the second child policy, an increasing number of Chinese families have at least two children. The proportion of only child adolescents with NSSI behaviours in the during-pandemic group was only 24.1%, which was significantly lower than that in the pre-pandemic group. Most of them had to suffer the role of taking care of their younger siblings, and according to

a related study, it was found that these adolescents might consider caring for young siblings to be stressful, and had the feeling of deprived love from their parents (44, 45), which might further lead to NSSI behaviours.

Regarding the composition change of related psychosocial factors of NSSI behaviours, we found that after the outbreak of the pandemic, experiencing trauma and suffering body-focused bullying played decreased roles in the appearance of NSSI behaviours, while the family constitution, parents' misunderstanding, mobile phone overuse, and stressful learning have become important factors. It is imperative to plan tailored strategies to prevent NSSI behaviours from the factors listed above. First, schools can provide relevant education for adolescents on how to cope with stress, from passive coping with NSSI behaviours to active mental health education and guidance, thus providing a suitable environment for their healthy growth. As recommended by Singh et al., teachers can conduct academic and non-academic sessions in their classes and play a role in the promotion of mental health among the students (16). Second, it is also vital for parents to learn how to understand and contain their children's emotions beyond paying attention to academic achievements, because parents' rejection and neglect in family rearing patterns are related to teenagers' self-injury behaviours (46). If parents can master a reasonable way to manage emotions and guide their children in times when their children have difficulties, they will avoid intensifying conflicts. As Paul once pointed out, providing health education and skills training for the families of adolescents who engage in NSSI would be very beneficial (47). Regarding the problem of mobile phone overuse, if the parents stop their children's use in a simple and disrespectful way, it might further deteriorate their dysfunctional emotions. Parents are recommended to learn how to negotiate with adolescents to limit their time in an understanding and respectful manner. In addition, if schools can contact psychotherapists or psychiatrists regularly to assist in developing emotional processing skills such as dialectical behaviour therapy (DBT) for teachers and parents, it would greatly benefit children with emotional problems (48). The research conducted by Singh et al. also suggested that it is vital to ameliorate adolescents' access to mental health support services and to establish collaborative networks with psychiatrists and psychologists (16).

LIMITATIONS

Our study should be interpreted in light of the following limitations. First, all data came from the medical records in the electronic system, and it was impossible to acquire the objective risk factors in terms of scale scores. Second, the subjects in our study came from the same ward, and their representativeness would lead to the limitation of extending the conclusions to a wider population. There is a pressing need to plan a strong and evidenced-based follow-up study to understand the changing trend of NSSI behaviours among adolescents. Third, if we can conduct an in-depth analysis of the patterns and times of adolescents' self-injury behaviours, our results will be richer.

CONCLUSIONS

In this study, we not only discovered a dramatic increase in adolescents with NSSI behaviours during the pandemic but also examined the structural changes in NSSI risk factors over time. The results showed that family constitution, relationship with their parents, mobile phone overuse, and stressful learning had significant association with NSSI behaviours during the pandemic, which were distinguished from those before the pandemic (49).

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 Fourth People's Hospital of Chengdu. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

ND: conception and design and drafting of the manuscript. ND, YO, and YX: conduction and statistical analysis. YL: administrative, technical, or material support. YO and YX: critical revision of the manuscript for important intellectual content. All authors read and approved the final paper.

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COVID-19 Related Experiences Among College Students With and Without Disabilities: Psychosocial Impacts, Supports, and Virtual Learning Environments

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This cross-sectional analysis estimated differences, based on disability status, in college students' ($n = 777$) experiences during the COVID-19 pandemic. Data were modeled using *t*-tests and logistic regression. Most participants were white (86.2%), and women (66.4%). The mode age was 23. A third (35.6%) had at least one disability. Students reported high rates of psychosocial distress, like fear of contracting (59.7%) and spreading (74.3%) COVID-19, worry about friends and family (83.7%), and increased anxiety (72.5%), depression (59.9%), and substance use (24.7%). Forty-two percent (42.2%) were scared they would miss out on their education through virtual classes. About a third feared forgetting assignments (34.1%) and making mistakes (33.9%). Fewer students expressed apprehension about (27.9%) and intimidation by (26.3%) virtual learning. Only 17.2% would continue taking virtual classes after the pandemic. Students with disabilities ($M = 12.4$, $SD = 4.1$) experienced more psychosocial stressors compared to students without disabilities ($M = 9.9$, $SD = 4.2$), [$t_{(775)} = 7.86$, $p < 0.001$]. In adjusted models, disabled students were more than twice as likely to experience worry about medical bills (OR = 2.29), loneliness (OR = 2.09), and increased anxiety (OR = 2.31). They were also more than three times as likely to report increased depression (OR = 3.51) and changes in sexual activity (OR = 3.12). However, students with disabilities ($M = 1.5$, $SD = 1.1$) also reported receiving more support compared to their non-disabled classmates ($M = 1.1$, $SD = 1.1$), [$t_{(775)} = 6.06$, $p < 0.001$]. Disabled students were more likely to feel a sense of contributing to society by following precautions (OR = 1.80) and receive support from family and others (emotional support: OR = 2.01, financial support: OR = 2.04). Interestingly, no significant differences were found in students' feelings associated with online or virtual learning [$t_{(526.08)} = 0.42$, $p = 0.68$]. Students with disabilities, though, trended toward reporting negative experiences with virtual learning. In conclusion, students with disabilities were disproportionately affected by COVID-19 stressors, but also expressed more support and a sense of contributing to the common good.

Keywords: COVID-19, students, disability, mental health, higher education

INTRODUCTION

As community spread of COVID-19 became an increasing concern, college campuses in the United States implemented drastic changes to their day-to-day operations. Students returning to college from spring break were forced to relocate away from campus and engage in alternate learning formats to limit community spread. By the end of March 2020, more than 1,400 colleges and universities had transitioned away from existing course formats relying mostly on face-to-face instruction to virtual learning formats exclusively (1). Almost all supporting institutional infrastructure was modified to decrease in-person contact and slow community spread of the virus. Dormitories and cafeterias shuttered, access to computing laboratories and other educational resources were restricted, and most university staff began working remotely.

Even prior to the challenges brought about by COVID-19, college students in the United States experienced significant levels of psychosocial distress (2). Between 2007 and 2017, the rates of mental health related diagnoses and treatment of mental health conditions among college students in the United States increased by almost 80 and 60%, respectively (3). Changes brought about by the pandemic intensified these psychosocial concerns as students lost social activity, which was one of their main coping strategies (4) and faced upheaval and uncertainty (5, 6). Studies addressing distress among U.S. college students reported, for example, increased or worse depression (7), grief, loneliness, and generalized anxiety (8), stress, and worry (9). While the stressors of the pandemic affected all students, they also intensified long-standing issues for students from historically excluded groups.

Disabled people[1] are historically excluded from higher education. As Timothy Dolmage asserts in Academic Ableism "disability has always been constructed as the inverse or opposite of higher education" (11). As a symptom of this history of exclusion, people with disabilities account for a quarter (25.7%) of the community population in the United States (12) but only 19% of the undergraduate college student population (13), and are less likely to have completed at least a bachelor's degree compared to people without disabilities (14). Among people aged 25 and older, 40% of those with no disability have at least a bachelor's degree. By that same age, only 20% of their disabled peers completed at least a bachelor's degree (14). Two thirds (67%) of high school students with disabilities graduate on time, a rate lower than the total population (84%) and lower than other historically excluded students. For example, when aggregated by ethnicity, race, and economic status, the graduation rate of Hispanic high school students is 80%, Black high school students is 77%, and economically disadvantaged high school students is 78%—all much higher than disabled students (15). Even when emerging adults with disabilities "make it" to college, their graduation rates drop dramatically at the college level compared to high school, with <35% of disabled college students obtaining a 4-year degree within 8 years of graduating high school (16). There are several factors that directly influence the lower graduation rates among disabled college students. While attending a 4-year college, disabled students report discrimination and barriers to learning. In a large-scale study of 13,844 undergraduates in the United States, Aquino et al. found that 22% of students with disabilities experienced offensive verbal comments (17). Disabled students surveyed in a study of undergraduate students attending Indiana University system colleges also reported lower levels of sense of belonging and higher levels of physical assault, verbal assault, and academic challenges (18). Students with disabilities often cite negative faculty attitudes, like questioning the validity of the student's disability and capability and refusing to adapt classroom techniques, as barriers to success in higher education (19).

Disablism and ableism in the United States further place disabled people in precarious positions with intersecting struggles (20), particularly during emergencies and disasters (21). Disabled people face barriers in accessing appropriate health care (12, 22), discriminatory employment environments (23), impoverishment (24), and stigma (25, 26). COVID-19 precautions lead to disruptions in, for example, much needed community based care and clinical services (27). Health care policies during the pandemic discriminated against disabled people by prioritizing health education, access to medications, services, and life-saving equipment for the abled (28, 29). While disability status is not the same as health status, some disabled people, like those with health conditions associated with poor COVID-19 outcomes or those residing in congregate living settings, were at an increased risk for severe complications and death (30–32).

Even as many factors converged to further hinder the academic progress of disabled college students, little work has been done to explore their experiences in the United States during the pandemic. The current literature focuses primarily on the experiences of personnel and higher education professionals who work with students with disabilities (33, 34), barriers faced by educators who teach students with disabilities (33, 35), and policy analyses (36, 37). The few studies that focused on the experiences of students with disabilities found evidence of hardship and distress during the pandemic. For example, in her narrative reflection, disabled student and advocate, Syreeta Nolan, described the stress of sudden isolation, loss of accommodations and services, and intersectional discrimination due to COVID-19 and long-standing discriminatory practices (38). In a report of undergraduate students at nine universities in the United States, Soria et al., explored well-being among disabled students during COVID-19 looking at, among other factors, financial impact, health during the pandemic, belonging, and engagement (39). According to this report, more disabled students (n = 1,788 and representing around 6% of respondents) experienced financial hardships, food insecurity, housing insecurity, lack of safety, and lack a sense of belonging and support on campus than students without disabilities. A greater percentage of students with

[1]We alternate between identity-first language and person-first language to fit with the language preferences of the disability community (10).

disabilities also reported major depression and anxiety compared to students without disabilities. However, it is unclear whether these circumstances existed prior to the pandemic or developed because of the pandemic. In another study of COVID-19 experiences, Zhang et al. described the impact of COVID-19 on 28 students with disabilities at the University of Washington, and found that disabled students were more concerned about the switch to virtual learning and experienced more COVID-19 related adversity than students without disabilities (40). Unlike Soria et al., they report that students with and without disabilities experienced similar levels of perceived stress, depression, and anxiety. Similar to Zhang et al., Gin et al. observed that disabled students in STEM ($n = 66$) faced challenges with the move to a virtual learning environment, compound by the loss of accommodations (41).

Following the Spring 2020 semester, many universities utilized the Summer 2020 semester to create campus safety plans for the upcoming Fall 2020 semester to protect the health of students, faculty, and staff and slow the spread of COVID-19. Some universities continued to provide instruction fully online, whereas others provided mostly online instruction with some face-to-face courses having drastically reduced course enrollments to allow for social distancing within classrooms. In addition to adopting state-wide mask mandates, many universities in states without such mandates created their own campus-wide mask mandates while providing both single use and reusable masks to students, faculty, and staff. Some universities reopened a limited number of residence halls and campus dining hubs with special protocols in place for students who needed to quarantine due to diagnosis or exposure to COVID-19. Some institutions even provided support to local, county, and state-level health agencies to aid in contract-tracing and COVID-19 testing efforts.

The current study adds to this very important, but currently limited, literature on the experiences of disabled students in higher education during the COVID-19 pandemic by including measures specifically created to ascertain COVID-19 related-experiences and support and asking students specifically about feelings toward virtual environments. We surveyed students with and without disabilities attending Oklahoma State University in the United States to answer the following research questions:

1. How did students with disabilities experience pandemic-related stress compared to students without disabilities? Based on previous research regarding the experiences of disabled college students during the COVID-19 pandemic (38–40), we hypothesize that students with disabilities will report significantly higher pandemic-related stressors compared to non-disabled students.
2. Were students with disabilities more likely to receive support during the pandemic compared to students without disabilities? We hypothesize that students with disabilities will report lower feelings of support during the pandemic compared to abled students. This hypothesis stems from the larger body of research regarding the multitude of barriers disabled students face in higher education (16–19).
3. How did students with disabilities perceive online education compared to students without disabilities? Similar to the findings of Gin et al. (41) and Zhang et al. (40), we hypothesize that disabled students in our sample will report more struggles with virtual learning than students without disabilities.

MATERIALS AND METHODS

Study Design

This cross-sectional survey analysis involved estimating differences, based on disability status, in psychosocial impacts, supports, and reactions to virtual learning environments among college students during the COVID-19 pandemic. Full models were adjusted based on social and economic characteristics associated with differences in psychosocial distress. These characteristics included race, ethnicity, gender, income, and rurality (42–44). Report of our study processes and results followed the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) (45).

Setting

The study took place at Oklahoma State University, a land-grant university with a total enrollment of 24,580 undergraduate and graduate students and located in a rural county in Oklahoma. Oklahoma ranked 12th out of 50 states, Washington DC, and US protectorates for the highest rate of COVID-19 cases per 100,000 people (46). Just prior to the study period, Oklahoma State University made the news when students returning for the fall 2020 semester were filmed partying in packed bars adjacent to the university (47). This study was conducted from August 2020 to December 2020 and was approved by the Oklahoma State University Institutional Review Board (IRB-20-427).

Positionality

At the time of the study, all the authors taught higher education courses in Oklahoma. Two of the authors are disabled scholars, two of the authors are caretakers for a student with disabilities, and one author grew up with a sibling who was disabled. Their interest in this research and subsequent development of the research questions stems from their experiences in higher education and experiences in the disabled community during the COVID-19 pandemic. COVID-19 disproportionately affected people with disabilities, and they questioned if students with disabilities were also disproportionately affected.

Participants, Recruitment, and Privacy Protections

All registered students at Oklahoma State University were eligible to participate. Participants were required to be at least 18 years old at the time of the survey. No additional inclusion or exclusion criteria were utilized. Using a targeted and snowball sampling design, a recruitment email linking to the survey was sent to a random sample of 5,000 students to generate a sample of convenience (as is the nature of open surveys). Instructors were also asked to send out the recruitment email to students in their

courses. Students who received this email were asked to share the survey link with Oklahoma State University students in their acquaintance circle who had not received the email and were potentially willing to participate. The email included information about the study, the informed consent document, and a link to the electronic survey. The informed consent process consisted of explaining to the student-participants, in plain language, who the principal investigator was, the purpose of the study, the estimated amount of time the survey would take, and the data storage processes. To protect against unauthorized access, all data were collected and stored via a password protected and encrypted professional Qualtrics account. Only investigators with IRB approval had access to the data. The data will be stored for 3 years.

At the end of the survey, student-participants could opt-in to a drawing for a chance to win an Amazon gift card. Gift card prizes were one $100 gift card, two $50 gift cards, and forty $20 gift cards. If participants opted into the drawing, they were redirected to a separate survey and asked to provide an email address for the drawing. This separate survey ensured that survey responses could not be connected to the email provided.

Data Sources and Measurement

Data were collected as part of a larger study. Of the random sample of 5,000 students who were recruited to participate in the study, 783 students began the survey with 715 of those students completing the survey in its entirety (91% completion rate). An additional 134 students, who were recruited via classrooms and word-of-mouth, completed the study using an anonymous link, which increased our total sample to 849 affirmative responses. However, 72 observations were removed from our sample for missing response for all items, straight line response, speed responses, and for obviously fake or manipulated responses (for example, writing in "Pterodactyl" for gender), resulting in an analytic sample of 777 observations. Most student-participants took between 10 and 25 min to complete the online survey.

The survey was developed by the project research team through an iterative process of item selection and adaptation. Team members first selected existing surveys that measured domains of interest. Scales and items from those surveys were chosen through team discussion and adapted as necessary to fit the population of focus. The final items included a mix of closed items with open options and Likert-type items. The survey domains for this analysis included: (1) demographic data on the student-participant adapted from the National College Health Assessment IIc survey (48) and items created by the research team, (2) COVID related experiences and psychosocial stressors adapted from the Pandemic Stress Index (49), and (3) reactions to virtual learning environments adapted from items in the User Acceptance of Information Technology Scale (50). In the following section we describe the items used in the analysis.

Demographic Data

Demographic data items used in this analysis were items adapted from the National College Health Assessment IIc (48) and asked students to report their ethnicity, race, and disability status. Additional items created by the research team asked students to report their gender, zip code of permanent residence, and family income. From the National College Health Assessment, students were first asked "Are you Hispanic, Latinx, or of Spanish origin" and then asked to disclose their racial identification by checking all that applied: White, Black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Pacific Islander. Students were also asked to identify their disability status ("Have you ever been diagnosed with any of the following?") by selecting all applicable options: sensory impairment, mobility impairment, learning disability, mental health disorder, or a disability/impairment not listed. To compare disabled students to students without disabilities, we created a variable indicating the presence or absence of a disability [disability: yes (1)/no [0]] based on an affirmative response to one or more of the conditions listed in the disability item.

Gender, zip code of permanent residence and family income were items created by the research team. The gender item asked students "How would you describe your gender" and included three options: male (including transgender men), female (including transgender women), and prefer to self-describe as (non-binary, gender-fluid, agender, etc.) with an open answer response. Rurality was identified using the self-reported zip code of the student's permanent address and categorized based on Rural-Urban Commuter Area (RUCA) codes (USDA ERS, 2020). RUCA codes classify U.S. census tracts on a continuum of rural to urban categories using patterns of daily commuting, population density, and measures of urbanization. RUCA classifications can be applied from census tracts to ZIP codes. Whether a student originated from a rural community was determined based on permanent residence in a ZIP code associated with large rural, small rural, or isolated RUCA codes.

Psychosocial Stressors

Items indicating psychosocial stressors were adapted from the Pandemic Stress Index, which was created at the University of Miami in Florida to measure behavior changes and stress associated with the COVID-19 pandemic (49). More information about the Pandemic Stress Index can be found at the University of Miami School of Nursing and Health Studies Center of Excellence for Health Disparities Research (51). The Pandemic Stress Index included three sets of questions: (1) what behaviors participants have done in the past or are currently doing in "check all that apply" format, (2) how much the COVID-19 pandemic has impacted participants' daily life in Likert-scale format, and (3) what experiences participants have had or are currently having in "check all that apply" format. For our study, we were interested in the last question set and incorporated minor adaptations to include circumstances specific to the college student population (e.g., worry about missing my classes if I get sick with coronavirus), which were not included in the original Pandemic Stress Index. As such, we asked student-participants to report "which of the following are you experiencing (or did you experience) during COVID-19 (coronavirus)?" with a checklist of 24 items measuring experiences of emotional distress, substance use, sexual behavior, financial stress, stigma, support, and "other difficulties or challenges" with an opportunity for participants to provide a descriptive open-ended response. The

PSI items were split to measure two different domains for this study: (1) psychosocial stressors and (2) support. Twenty items were grouped together to measure the domain of psychosocial stressors. A few of these items included "more depression," "fear about the economy," "stigma or discrimination from other people," and "increased alcohol or other substance use." Depending upon whether the participant checked or did not check the box for an item, items were scored dichotomously to represent presence [yes (1)] or absence [no [0]] of the experience. Taken together, a participant's score on psychosocial stressors could range from 0 to 20 based upon the number of boxes they checked indicating the COVID-19 related experiences they had in the past or are currently having.

Support During COVID-19

Three items from the Pandemic Stress Index were used to measure the "support" domain. These items asked participants to endorse whether they were "getting emotional or social support from family, friends, partner, counselor, or someone else," "getting financial support from family, friends, partner, counselor, or someone else," and "feeling that I was contributing to the greater good by preventing myself and others from getting coronavirus" during the pandemic. The support items were scored similarly to the psychosocial stressors items with participant's scores ranging from 0 to 3.

Reaction to Virtual Learning Environments

The remaining outcome measure, reactions to virtual learning environments, consisted of six items adapted from the User Acceptance of Technology Scale to measure reactions to virtual learning (50). These items asked student-participants how much they agree on a scale of 1(strongly disagree) to 7 (strongly agree), with statements related to apprehension, fearing missing out on their education by taking virtual classes, fear of forgetting assignments, afraid of making mistakes they cannot correct, and intimidation around virtual learning environments. The scale includes a reverse-coded item that asked students if they intended to take virtual classes once COVID-19 concerns had passed. Participant scores on this scale could range from 6 to 42. For some of the analyses we conducted (see below), scale items were dichotomized [presence of reaction: yes (1) no [0]]. Responses "agree" and "strongly agree" were re-coded to indicate 'yes' whereas responses "strongly disagree," "disagree," "somewhat disagree," "neither agree nor disagree," and "somewhat agree" were re-coded to indicate 'no' [strongly disagree to somewhat agree = no [0], agree and strongly agree = yes (1)].

Statistical Analysis

Data were inspected for missing response, straight line responses, speed responses, and fake or manipulated responses. Data were modeled using *t*-tests and logistic regression, which adjusted for the sociodemographic characteristics of race, ethnicity, gender, rurality, and income.

T-Tests

Scale scores were used to identify group differences in psychosocial stressors during COVID-19, support during COVID-19, and feelings regarding the virtual learning environment between students with and without disabilities.

TABLE 1 | Sample characteristics ($N = 777$).

Demographics	*n* (%) unless otherwise specified
Age (Mode, IQR)	21 (19, 23)
Gender (Female)	516 (66.4)
Race/ethnicity*	
White	670 (86.2)
American Indian or Native American	111 (14.3)
Hispanic/Latino	62 (8.0)
Black	53 (6.8)
Asian	38 (4.9)
Native Hawaiian or Pacific Islander	9 (1.2)
Multiple selected	102 (13.2)
Disability (reported at least one disability)	277 (35.6)
Household income	
<$20,000	105 (13.5)
$20,000–$34,999	80 (10.3)
$35,000–$49,999	103 (13.3)
$50,000–$74,999	157 (20.2)
$75,000–$99,999	112 (14.4)
Over $100,000	210 (27.0)
Location of permanent address (rural)	277 (35.6)

Percentages based on non-missing responses.
**Respondents could select more than one option. Percentages will not sum to 100%.*

Logistic Regression Models

We fit logistic regression models for categorical responses (STATA *logit*) to the data for each COVID-19 psychosocial stress, support, and virtual learning environment item. The models included disability status and controlled for socio-economic and demographic characteristics (race, ethnicity, gender, income, and rurality). Logistic regression analyses were conducted using Stata 15 (52). Odds ratios (ORs) and 95% confidence intervals (CIs) are presented.

RESULTS

Description of the Student Participants

Table 1 shows the demographic characteristics of the students who participated in the study ($n = 777$). Most of the student-participants were white (86.2%), women (66.4%), and between 18 and 24 years old (79.5%). Just over a third (35.6%) of the students were from rural communities. Among the students who participated in the survey, just over a third (35.6%) reported a disability. About a third (28%) of the students with disabilities reported multiple disabilities.

Overall Experiences of the Student Participants

Table 2 presents COVID-19 related psychosocial stressors, support, and feelings about virtual learning environments across the entire sample of students who participated in

TABLE 2 | All students' experiences during the COVID-19 pandemic ($N = 777$).

Factors	*n* (%)
Psychosocial Stressors Fear of getting COVID-19	464 (59.7)
Fear of giving COVID-19 to someone else	578 (74.3)
Confusion about what COVID-19 is, how to prevent it, or why social distancing/isolation/quarantines are needed	257 (33.1)
Fear about the economy	458 (58.9)
Worry about friends, family, partners, neighbors, etc.	651 (83.7)
Worry about medical bills if I get sick from COVID-19	307 (39.5)
Worry about missing classes if I get sick from COVID-19	488 (62.8)
Worry about missing work if I get sick from COVID-19	422 (54.3)
Worry about infection rates of COVID-19 in my community	413 (53.1)
Increased depression	466 (59.9)
Increased anxiety	564 (72.5)
Loneliness	475 (61.3)
Frustration	583 (75.0)
Boredom	602 (77.4)
Increased alcohol or other substance use	192 (24.7)
Changes in sexual activity	145 (18.6)
Changes to normal sleep pattern	501 (64.4)
Stigma or discrimination from other people	240 (30.8)
Personal financial loss	380 (48.9)
Not having enough basic supplies	182 (23.4)
Support Receiving increased emotional or social support	327 (42.0)
Receiving increase financial support	235 (30.2)
Feeling that I was contributing to the greater good by preventing myself or others from getting COVID-19	389 (50.0)
Virtual learning Feeling apprehensive about virtual learning	217 (27.9)
Feeling intimidated by virtual learning	205 (26.3)
Scared to miss out on education by taking virtual classes	328 (42.2)
Fear of forgetting assignments for virtual classes	265 (34.1)
Afraid of making uncorrectable mistakes in virtual classes	264 (33.9)
Continue to take virtual classes after COVID-19 pandemic	134 (17.2)

Items measuring psychosocial stressors and support were adapted from Pandemic Stress Index and items measuring virtual learning were adapted from User Acceptance of Information Technology Scale.

the survey. We found high rates of psychosocial distress among the sample of students. When looking at psychosocial impact, three quarters of the students endorsed concern about transmitting COVID-19 to others (74.3%), and over half (59.7%) feared contracting COVID themselves. The students were worried about friends, families, partners, neighbors, and others (83.7%), missing class should they contract COVID-19 (62.8%) and the economy (58.9%) but were less worried about rates in their community (53.1%), missing work (54.3%) or medical bills (39.5%). A substantial number of the sample of students reported boredom (77.4%), frustration (75%), increased anxiety (72.5%), sleep changes (64.4%), loneliness (61.3%), and increased depression (59.9%) during the COVID-19 outbreak. A quarter (24.7%) of the students said their alcohol or substance use increased because of the pandemic. About twenty percent (18.6%) reported changes in sexual activity.

Some students experienced additional adversities during the COVID-19 pandemic. Almost a third (30.8%) of the students who participated in the study reported people treating them differently because of their identity, having symptoms, or other factors related to COVID-19. Almost half (48.9%) reported personal financial loss, and almost a quarter (23.4%) did not have enough basic supplies like food, water, medications, and a place to stay.

Regarding reactions to virtual learning environments, students expressed negative feelings toward taking virtual classes. Across the entire sample of students, forty-two percent (42.2%) said they agreed or strongly agreed that they were scared they would miss out on their education if their classes were virtual. Rates of fear of forgetting assignments and making mistakes were 34.1% and 33.9%, respectively. About a quarter reported "agreed" or "strongly agreed" that they felt apprehensive about virtual learning (27.9%), and that virtual learning is intimidating to them (26.3%). Only 17.2% agreed or strongly agreed that they would continue taking classes virtually once the pandemic ended.

Not all experiences were negative. As far as positive aspects of experiences during the COVID-19 pandemic, half (50%) reported feeling like they were contributing to "the greater good" by following CDC guidelines to prevent the spread of COVID-19. A little less than half reported receiving emotional and social support (42%) and about a third (30.2%) reported receiving financial support from friends, family, and others.

Comparisons of Experiences of Disabled and Non-disabled Students

Comparisons between students with disabilities and those without disabilities on COVID-19 related psychosocial stressors, supports, and feelings about virtual learning environments are depicted in **Tables 3**, **4**. Overall, disabled students experienced more psychosocial stressors, were significantly more likely to have experienced key stressors, but were also more likely to receive support. There were minimal differences between students with and without disabilities in feelings about virtual learning environments.

Table 3 shows that a higher percentage of disabled students endorsed feelings of psychosocial distress compared to students without disabilities. In group comparisons we observed that students with disabilities ($M = 12.4$, $SD = 4.1$) reported experiencing more stressors compared to students without disabilities ($M = 9.9$, $SD = 4.2$), [$t_{(775)} = 7.86$, $p < 0.001$]. These differences are significant.

Table 4 presents the adjusted odds of students with disabilities endorsing psychosocial stressors, supports, and feelings about virtual learning environments. After controlling for sociodemographic characteristics, disabled students were 66% more likely to report fear of getting [OR = 1.58, 95% CI (1.15–2.17)] and 81% more likely to report fear of transmitting COVID-19 [OR = 1.81, 95% CI (1.25–2.62)] compared to students without disabilities. They also had 1.41 times the odds of being fearful about the economy [95% CI (1.04–1.92)]. Disabled students were almost three times more likely to worry about friends and family [OR = 2.80, 95% CI (1.72–4.54)], over twice as likely to worry about cost of medical bills [OR = 2.29, 95% CI (1.67–3.14)] and missing class (OR = 2.26, 95% CI (1.62–3.13)], and over 1.5 times more likely to worry about missing work should they contract COVID-19 [OR = 1.61, 95% CI [1.18–2.19)]. They had significantly higher odds of being worried about infection rates of COVID-19 in their community [OR = 1.77, 95% CI (1.30–2.40)] compared to non-disabled students. Students with disabilities were also 1.48 times more likely to report frustration [95% CI [1.03–2.12)], 2.09 times more likely to report loneliness [95% CI [1.52–2.89)], 2.31 times more likely to report increased anxiety [95% CI [1.63–3.27)], and 3.58 times more likely to report increased depression [95% CI (1.59–3.36)]. They were 73% more likely to say they did not have enough basic supplies like food, water, medications, and a place to stay [OR = 1.73, 95% CI (1.21–2.47)] and to report financial loss [OR = 1.73, 95% CI (1.27–2.35)]. Disabled students were 82% more likely to say their alcohol and substance use increased [OR = 1.82, 95% CI (1.30–2.56)] and over 200% more likely to say their sexual activity changed [OR = 3.12, 95% CI (2.14–4.56)] during the pandemic. Although more disabled students endorsed feelings of stigma [72 vs. 29%), after controlling for other social and economic indicators this difference was not significant [OR = 1.19, 95% CI (0.86–1.65)].

Regarding the reception of support during the pandemic, disabled students ($M = 1.5$, $SD = 1.1$) reported having more supportive experiences compared to non-disabled students ($M = 1.1$, $SD = 1.1$), $t_{(775)} = 6.06$, $p < 0.001$. More specifically, students with disabilities were twice as likely to receive emotional [OR = 2.01, 95% CI (1.48–2.74)] and financial support [OR = 2.04, 95% CI (1.48–2.82)] from friends, family, and others. Additionally, they were 80% more likely to feel like they contributed to the greater good by following COVID-19 protocols [OR = 1.80, 95% CI (1.33–2.44)] than students without disabilities.

In comparing disabled students' ($M = 4.4$, $SD = 1.7$) feelings about online learning to students without disabilities ($M = 4.3$, $SD = 1.6$), no significant differences emerged based upon disability status, $t_{(526.08)} = 0.42$, $p = 0.68$. Using the responses "agree" and "strongly agree" to indicate an affirmative response, we did find that students with disabilities were slightly more likely to express apprehension of [OR = 1.26, 95% CI (0.91–1.75)], fear of forgetting assignments [OR = 1.29, 95% CI (0.94–1.76)], fear of making a mistake that cannot be corrected [OR = 1.15, 95% CI (0.84–1.57)] and feel intimidated by [OR = 1.16, 95% CI (0.83–1.63)] the online learning environments the university implemented during the pandemic. They were essentially equally as likely to fear missing out on their education [OR = 1.06, 95% CI (0.78–1.43)] due to online learning, and slightly more likely to continue taking virtual classes after the pandemic [OR = 1.41, 95% CI (0.96–2.08)]. These results, however, were not significant.

DISCUSSION

College is a time of transitions, life changes, and increased responsibility for emerging adults. In the United States these stressors, along with adverse events and psychosocial issues that existed prior to enrollment, result in high levels of mental distress among college students. Swift and extreme changes to daily life brought about to mitigate community spread of COVID-19 served to exacerbate mental health concerns among all college students and compound distress among students from historically excluded groups. In our study, we explored COVID-19 related experiences among college students with and without disabilities enrolled at Oklahoma State University during the Fall 2020 semester. Our results suggest that experiences of psychosocial stressors were high among the students surveyed, with disabled students having much higher likelihoods of reporting distress than students without disabilities. We found that, regardless of gender, race, ethnicity, income, or rurality, students with disabilities were over three times more likely to report increased depression and over twice as likely to report loneliness and increased anxiety compared to students without disabilities. This distress extended over into financial hardships and worries, with disabled students about 1.5 to 2 times more likely to report worry about the economy, missing work, and medical bills due to COVID-19 and report experiencing personal financial loss.

However, students with disabilities were also more likely to be supported and have positive feelings about following precautions to prevent the spread of COVID-19. Specifically, students with disabilities had two times greater odds of receiving emotional and financial support from friends, family, partners, counselors, or someone else. They were also 80% more likely to feel like they contributed to the "greater good" by following COVID-19 precautions than non-disabled students.

One factor affecting distress may be the change from in-person classes to a virtual learning environment. Students in our study did express fear, intimation, and apprehension around online learning, with little difference between disabled and abled students. However, with only about a quarter of the students reporting negative reactions to online learning, the switch to virtual formats was likely not the main driver of mental distress in our sample.

Psychosocial Stressors

Findings across the entire sample suggest all students, regardless of their disability status, experienced increased mental health distress at the time of this study. Much of the research regarding the COVID-19 pandemic and college student mental health have had similar findings regarding this topic (Conrad

TABLE 3 | Disability status comparisons using Independent Samples *T*-tests.

	Students with disabilities		Students w/o disabilities		
Factors	**M**	**SD**	**M**	**SD**	***t*-test**
Psychosocial stressors	12.36	4.13	9.89	4.24	7.86*
Support	1.53	1.08	1.05	1.05	6.06*
Virtual learning	4.38	1.74	4.33	1.59	0.42

*$p < 0.001$.

TABLE 4 | Adjusted likelihood of experiences during COVID-19 pandemic between students with (w/) disabilities ($n = 277$) and students without (w/o) disabilities ($n = 500$).

Factors	**Students w/disabilities *n* (%)**	**Students w/o disabilities *n* (%)**	**Adjusted odd ratio (CI)**
Psychosocial stressors			
Fear of getting COVID-19	185 (66.7)	279 (55.8)	1.58 (1.15–2.17)**
Fear of giving COVID-19 to someone else	225 (81.2)	353 (70.6)	1.81 (1.25–2.62)**
Confusion about what COVID-19 is, how to prevent it, or why social distancing/isolation/quarantines are needed	82 (29.6)	175 (35.0)	0.77 (0.56–1.07)
Fear about the economy	178 (64.2)	280 (56.0)	1.41 (1.04–1.92)*
Worry about friends, family, partners, neighbors etc.	253 (91.3)	398 (79.6)	2.80 (1.72–4.54)**
Worry about medical bills if I get sick from COVID-19	145 (52.3)	162 (32.4)	2.29 (1.67–3.14)**
Worry about missing classes if I get sick from COVID-19	207 (74.7)	281 (56.2)	2.26 (1.62–3.13)**
Worry about missing work if I get sick from COVID-19	173 (62.4)	249 (49.8)	1.61 (1.18–2.19)**
Worry about infection rates of COVID-19 in my community	173 (62.4)	240 (48.0)	1.77 (1.30–2.40)**
Increased depression	216 (77.9)	250 (50.0)	3.51 (2.49–4.94)**
Increased anxiety	229 (82.6)	335 (67.0)	2.31 (1.59–3.36)**
Loneliness	200 (72.2)	275 (55.0)	2.09 (1.52–2.89)**
Frustration	221 (79.7)	362 (72.4)	1.48 (1.03–2.12)*
Boredom	221 (79.7)	381 (76.2)	1.25 (0.87–1.80)
Increased alcohol or other substance use	89 (32.1)	103 (20.6)	1.82 (1.30–2.56)**
Changes in sexual activity	83 (29.9)	62 (12.4)	3.12 (2.14–4.56)**
Changes to normal sleep pattern	204 (73.6)	297 (59.4)	1.84 (1.33–2.54)**
Stigma or discrimination from other people	93 (72.5)	147 (29.4)	1.19 (0.86–1.65)
Personal financial loss	161 (58.1)	219 (43.8)	1.73 (1.27–2.35)**
Not having enough basic supplies	86 (31.0)	96 (19.2)	1.73 (1.21–2.47)**
Support			
Receiving emotional or social support	148 (53.4)	179 (35.8)	2.01 (1.48–2.74)**
Receiving financial support	112 (40.4)	123 (24.6)	2.04 (1.48–2.82)**
Feeling that I was contributing to the greater good by preventing myself or others from getting COVID-19	165 (59.5)	224 (44.8)	1.80 (1.33–2.44)**
Virtual learning			
Feeling apprehensive about virtual learning	86 (31.0)	131 (26.2)	1.26 (0.91–1.75)
Feeling intimidated by virtual learning	79 (28.5)	126 (25.2)	1.16 (0.83–1.63)
Scared to miss out on education by taking virtual classes	119 (42.9)	209 (41.8)	1.06 (0.78–1.43)
Fear of forgetting assignments for virtual classes	105 (37.9)	160 (32.0)	1.29 (0.94–1.76)
Afraid of making uncorrectable mistakes in virtual classes	100 (36.1)	164 (32.8)	1.15 (0.84–1.57)
Continue to take virtual classes after COVID-19 pandemic	58 (20.9)	76 (15.2)	1.41 (0.96-2.08)

*Adjusted for race, ethnicity, gender, income, and rurality. Items measuring psychosocial stressors and support were adapted from Pandemic Stress Index and items measuring virtual learning were adapted from User Acceptance of Information Technology Scale. *$p < 0.05$; **$p < 0.01$.*

et al., Charles et al., Hagedorn et al., Hoyt et al., to name a few). More specifically, students are reporting experiencing heightened depression, anxiety, worry, and isolation as a result of "stay-at-home" orders, relocation from campus residence (8), switch to online/virtual learning (40), and financial losses (6, 53). Students who have minoritized or marginalized identities, such as race (38, 54), gender (53), sexual orientation (53), and disability status (38–40), are reporting even higher rates of mental health stressors compared to their classmates. In our study, students who reported having a disability experienced more mental health distress compared to their non-disabled classmates. Our findings specifically about depression and anxiety align with Soria et al.'s findings (39). Though our study differed from how Soria et al. grouped students with disabilities (grouped as a whole vs. grouped according to type of disability), both samples of disabled students reported having, at least, more than double the likelihood of experiencing COVID-19 related depression and anxiety compared to students without disabilities. This aligns with reports of mental distress among disabled adults outside of the academic setting. In April and May 2020, Okoro et al. found that adults with any disability type were three times more likely to report depressive symptoms compared to non-disabled participants (55).

Other psychosocial stressors that students with disabilities experienced at significantly higher rates compared to non-disabled students were related to financial hardships. More specifically, disabled students in our sample were 40% more likely to report being afraid for the economy, 60% more likely to be worried about missing work if they contracted COVID-19, almost twice as likely to experience personal financial losses, and over two times more likely to worry about having to pay medical bills. Other researchers reported similar findings as it relates to financial distress and hardships among disabled college students. For example, disabled participants in Soria et al.' study were twice as likely to report losing wages from their off-campus employment (39). Additionally, Zhang et al. found personal financial loss to be significantly higher among students with disabilities (40). Interestingly, among the general population of adults, Okoro et al. found non-disabled persons were significantly more likely to report experiencing job or income loss compared to adults with disabilities (55). These findings may contrast with our study due to the differences in how these data were collected and reported. Okoro et al.'s window of data collection was smaller (April–May 2020) compared to the current study because students could report on past and current experiences of financial hardships going back to March 2020 through the administration of the survey (August–December 2020).

In addition to experiencing more financial hardships, students with disabilities reported not having adequate access to the resources they needed during the pandemic. In our sample, disabled students were almost 75% more likely to not have basic supplies such as food, water, medications, and a safe place to live. Though we did not have separate items measuring lack of or worry about food and housing, our findings are still similar to previous research that measured these topics specifically. Soria et al. found similar results, with disabled students in their study being three times more likely to experience food insecurity compared to non-disabled students, and depending on disability type between 1.5 and 3.5 times more likely to experience unexpected spending for technology (39). Similarly, adults with disabilities were 50% more likely to worry about not getting enough food as compared to adults without disabilities (55). Regarding housing security, disabled students were twice as likely (39) and disabled adults were 70% more likely (55) to experience housing insecurity or instability as compared to non-disabled individuals. In March 2020, many universities closed residence halls and required students to find housing elsewhere with relatives or friends. Conrad et al. reported students experiencing more grief, loneliness, and anxiety over having been mandated to relocate (8). Taken together, an intermingling of psychosocial stressors, such as health concerns regarding COVID-19, employment instability, financial hardships, and food and housing insecurity, created experiences of psychosocial distress among both disabled and non-disabled students.

Support

An unexpected, though positive, finding from our study indicated that students with disabilities were more likely to be recipients of support from family, friends, and others compared to students without disabilities. More specifically, we found that students with disabilities were twice as likely to receive financial, emotional, and social support compared to non-disabled students. These findings are particularly interesting as they appear contrary to previous research on such topics. In their survey of students in California, Soria et al. reported that students with disabilities were more likely to have family members who experienced a reduction or loss of income during the pandemic compared to students without disabilities (39). Additionally, disabled students in Zhang et al.'s study also reported higher family financial loss (40). Such financial losses may exacerbate stress levels within households and increase rates of violence and abuse taking place in homes. For example, disabled students from Soria et al.s' study were significantly more likely to be in living situations where they experienced physical or emotional abuse compared to students without disabilities (39). Furthermore, students with disabilities were two to three times more likely to indicate it was "never true" or "sometimes true" that they resided in an abuse-free living situation. Disabled adults, outside of a collegiate environment, have also reported being two and half times more likely to experience physical or emotional abuse (55).

Disabled students in our study were more likely to report psychosocial distress, financial loss, *and* support from people in their community—results that may appear at odds. However, our findings suggest that such experiences are not mutually exclusive. In other words, students with disabilities who are struggling with psychosocial stressors were able to rely upon their social support systems to help alleviate some of the challenges they were facing during the pandemic. Interestingly, even given the increased psychosocial distress experienced by disabled students

in our study, they still reported feeling as if they were contributing to the collective "greater good" by following CDC guidelines (e.g., limiting contact with others, not participating in large gatherings or events), more so compared to non-disabled students. This mindset aligns with the body of research that found greater prosocial behavior occurs among people experiencing stressful, marginalizing, and resource-poor environments [see the work of Paul K Piff, starting with Piff et al. (56)].

Virtual Learning

Interestingly, there were no statistically significant differences in feelings regarding online learning between students with and without disabilities. Most students in our study reported having neutral feelings (selected "neither agree nor disagree") regarding online classes when asked about their apprehension, intimidation, making mistakes, forgetting assignments, and missing out on educational opportunities. This finding does not align with previous research regarding this topic from previous researchers. When Zhang et al. described the impact of COVID-19 on students with disabilities at the University of Washington, they found that disabled students were more concerned about the switch to virtual learning and experienced more COVID-19 related adversity in learning than students without disabilities (40). Within the interviews conducted by Gin et al., disabled students also voiced concerns regarding online learning as many students were unable to access previously established accommodations or instructors were autonomous in the decision-making of what accommodations were deemed appropriate (41). As such, it is not surprising that students with disabilities reported distress regarding the transition to online learning, course grades, and impact on matriculation and graduation (40, 41). Both disabled and non-disabled students in our sample may not have had heightened concerns regarding online learning because data collection occurred during the Fall 2020 semester. In other words, instructors at this institution had previously dealt with the swift transition to online learning in mid-March 2020 and received institutional support regarding technology and pedagogy over Summer 2020 to increase the quality of online instruction for the Fall 2020 semester.

Limitations

Findings from our study are not without limitations. Timing is an important variable to consider due to the cross-sectional nature of the survey. Participants completed the survey in the Fall 2020 semester at a time when state-level and campus-wide restrictions were becoming less restrictive. Some counties in the state no longer required masks, and, though campus and local city policies required mask wearing, some academic courses returned to face-to-face instruction, students returned to living in residence halls, and campus activities, such as sporting events, began to take place again. The recommencement of typical college activities and experiences could have led to students reporting less intense distress due to their increase in interactions with friends, classmates, and faculty/staff compared to the Spring 2020 semester when instruction was abruptly shifted online, and campus housing emptied. Furthermore, the wording of the question adapted from the PSI used to assess psychosocial impacts of COVID-19 allowed participants to report both past and current COVID-19 experiences without timing differentiation. In other words, it is unknown if a participant was currently experiencing more depression at the time of survey completion or if they had previously experienced more depression a few months prior to survey completion. Additionally, the demographics of students who participated in the survey were largely homogeneous, and, as such, our findings may not accurately reflect the feelings and experiences of all college students. Furthermore, our rate of disabled students is higher than other national estimates (35 vs. 19%), presumably due to students with disabilities selecting into the study at a higher rate than other students. We also focused on an aggregate measure of disability, rather than differences between different types of disability. While an aggregate measure provided a more robust sample, we must acknowledge the diversity in lived experiences between people with different disabilities, particularly during the COVID-19 pandemic. Within the disability community there are opposing and conflicting experiences of the same pandemic-related factors, and these differences often fall along the lines of type of disability.

Implications

The most significant findings of our study were associated with factors outside of academic performance, which suggests that disabled students, particularly, experienced compounded stressors during the COVID-19 pandemic that affected their overall well-being. Campuses should take a holistic approach to supporting students with disabilities that strengthens accommodations but is not limited to reducing academic stressors. A holistic approach must be proactively implemented and not simply a reaction to extreme circumstances like natural disasters or a pandemic. Copeland et al. point out that institutional mitigation strategies that promote emotional and behavioral wellness and foster a sense of community were modestly but persistently beneficial for first-year college students during the pandemic, who are perhaps the most vulnerable to the stressors associated with academic life and the rapid changes due to COVID-19 (57). Reaching further, in discussing priorities for mitigating the pandemic's effect on college students' mental health, Liu et al. propose using the COVID-19 crisis as a leverage point to implement innovative models of support that highlight assets and strengths associated with students' identities and factors that promote resilience (58). These strategies could and should be considered regardless of whether college students are facing a global crisis.

However, neither article—one of which speaks directly to higher education administrators—mentions students with disabilities, which serves to highlight the lack of visibility of disabled students in higher education which, in turn, compounds stressors and creates obstacles. For example, while Liu et al.'s suggestions are forward thinking and could serve to reduce barriers to mental health services among college students,

disability is missing in this discussion of at-risk students. They recommend helping students "name and claim pre-covid identity factors to promote resilience" but do not mention disability as an identity factor (12, 58). This aligns with Meleo-Erwin et al.'s findings that accessibility information was mostly missing from student services websites during the pandemic, Gin et al.'s findings regarding inaccessibility of established accommodations, and Soria et al.'s findings regarding disabled students' feeling significantly unsupported by their university (36, 39, 41). Together, these findings suggest that disabled students were less than an afterthought during the pandemic.

When considering our findings through a student-identity lens, our results reiterate the importance of disability as an identity factor because after holding other identity factors like race, gender, ethnicity, rurality, and economic status constant, disabled students were still more likely to report psychosocial distress and negative experiences associated with the pandemic. And, perhaps, due to the inadequacy of institutional support for students with disabilities, they were also more likely to seek out and receive emotional and financial support from persons outside of their university. Thus, any changes to current systems to mitigate mental distress among college students, whether during a crisis like the COVID-19 pandemic or otherwise, must take into consideration both the academic and non-academic needs of disabled students and disabled identity as crucial components of support and services in highereducation.

DATA AVAILABILITY STATEMENT

De-identified data may be made available upon reasonable request.

ETHICS STATEMENT

This study involving human participants was reviewed and approved by the Oklahoma State University Institutional Review Board. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DM contributed to conception of the study. CD managed human subjects' protocols. KR organized the database. DM and KR performed the statistical analysis and wrote the first draft of the manuscript. XC and HH reviewed the analytic code and output. All authors contributed to manuscript revision, read, approved the submitted version, and contributed to the design of the study.

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Post-secondary Student Mental Health During COVID-19: A Meta-Analysis

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The COVID-19 pandemic has posed notable challenges to post-secondary students, causing concern for their psychological well-being. In the face of school closures, academic disruptions, and constraints on social gatherings, it is crucial to understand the extent to which mental health among post-secondary students has been impacted in order to inform support implementation for this population. The present meta-analysis examines the global prevalence of clinically significant depression and anxiety among post-secondary students during the COVID-19 pandemic. Several moderator analyses were also performed to examine sources of variability in depression and anxiety prevalence rates. A systematic search was conducted across six databases on May 3, 2021, yielding a total of 176 studies (1,732,456 participants) which met inclusion criteria. Random-effects meta-analyses of 126 studies assessing depression symptoms and 144 studies assessing anxiety symptoms were conducted. The pooled prevalence estimates of clinically elevated depressive and anxiety symptoms for post-secondary students during the COVID-19 pandemic was 30.6% (95% CI: 0.274, 0.340) and 28.2% (CI: 0.246, 0.321), respectively. The month of data collection and geographical region were determined to be significant moderators. However, student age, sex, type (i.e., healthcare student vs. non-healthcare student), and level of training (i.e., undergraduate, university or college generally; graduate, medical, post-doctorate, fellow, trainee), were not sources of variability in pooled rates of depression and anxiety symptoms during the pandemic. The current study indicates a call for continued access to mental health services to ensure post-secondary students receive adequate support during and after the COVID-19 pandemic.

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INTRODUCTION

The coronavirus (COVID-19) pandemic has disrupted the lives of individuals around the world. Physical-distancing measures and quarantine orders implemented were intended to prepare for, and mitigate the risk of, an overburdened healthcare system. However, an unintended consequence of these protective measures is an increased risk for mental illness. Indeed, one of the largest and most sustained effects of the COVID-19 pandemic is estimated to be its negative effects on

the mental health and well-being of citizens (1–4). Several emerging meta-analyses of general population samples show that rates of mental illness have increased during the COVID-19 pandemic (1, 5). Further, large population-based samples with longitudinal pre-pandemic data have shown that the mental health of certain subgroups of the population have deteriorated more rapidly, including individuals aged 18–24 (3), many of whom are post-secondary students.

Post-secondary students may be uniquely at increased risk for mental illness during the pandemic due to university/college closures, academic disruptions, and social restrictions. Extensive research has been conducted on the mental health of post-secondary students during the COVID-19 pandemic, and prevalence rates have varied widely, from 1.3–100% for clinically elevated depression and 1.1–100% for clinically elevated anxiety (6, 7). Ascertaining more precise estimates of clinically significant depression and anxiety symptoms among post-secondary students globally during the COVID-19 pandemic will be important for informing how supports can be allocated to young adults. To this end, we conducted a systematic review and meta-analysis of research amassed to date. We also conducted demographic and methodological study quality moderator analyses in order to identify under what circumstances and for whom prevalence rates of depression and anxiety may be higher or lower. These moderator analyses may inform practice and health policy initiatives more reliably and be used to guide future research.

Depression and Anxiety Symptoms in Post-secondary Students

Depression and anxiety are two of the most common mental illnesses in the general population and represent leading causes of disease burden worldwide (8). Depression is characterized by overwhelming feelings of sadness, hopelessness, as well as lack of interest, pleasure, and/or motivation. Depression often has associated physical symptoms, such as sleep, appetite, and concentration difficulties. Anxiety includes symptoms such as excessive worry, physiological hyperarousal, and/or debilitating fear. Existing meta-analyses have demonstrated that, prior to COVID-19, 23.8% of Chinese university students and 24.4% of university students living in low- and middle-income countries experienced symptoms of depression (9, 10). Further, 33.8% of university students globally experienced at least mild symptoms of anxiety (11) and a meta-analysis of Iranian university students found 33% of students experienced mild to severe anxiety (12). A study of over 43,000 Canadian college students found 14.7 and 18.4% of students were diagnosed or treated for depression and anxiety, respectively, in the past 12 months (13).

There are several reasons to expect that depression and anxiety will rise due to the COVID-19 pandemic. Being quarantined is associated with negative psychological symptoms, such as stress, loneliness, confusion, and anger (14, 15). Fear of contamination, or fear of death to self or loved ones, can lead to efforts to increase self-isolation (16). The unpredictable and uncontrollable nature of COVID-19 can also increase mental distress. When social capital, such as social support, community integration, social norms, as well as family rituals, norms, and values are limited or inhibited, disruptions to emotional and behavioral regulation are likely to occur (16–18). Unique to post-secondary students, stressors include a fear of class cancellation and missed milestones (e.g., graduation), which could lead to increased psychological distress (19). Moreover, peer relationships represent a crucial and prominent source of social support among emerging adults (20). Given academic closures and isolation measures, students were distanced from a crucial support network during the COVID-19 pandemic.

To date, several meta-analyses have attempted to synthesize pooled prevalence estimates of depression and anxiety among post-secondary students during the COVID-19 pandemic. Research examining depression symptoms have found pooled prevalence rates that range from 26 to 34% (21–24) and anxiety symptoms that range from 28 to 31% (21, 24, 25). However, there are several limitations of the previous meta-analyses. First, their inclusion criteria often did not specify the need for moderate-to-severe symptoms, which are considered to indicate "clinically elevated" mental distress. Second, several of the meta-analyses examined specific student populations (e.g., nursing or medical students) who may experience higher rates of mental illness during the COVID-19 pandemic due to stress from frontline clinical work (26) and may, in turn, inflate prevalence estimates. Third, several of the existing meta-analyses did not explore sources of between-study variability (i.e., moderators) in prevalence estimates. A central goal of a meta-analysis is to conduct moderator analyses to determine if between-study variability can be attributed to methodological or demographic factors. Finally, existing meta-analyses have only synthesized data from a portion of time over the course of the pandemic. The current meta-analysis addresses the above-mentioned issues by synthesizing data on clinically elevated symptoms of depression and anxiety (i.e., moderate to severe) which is more consistent with large-scale research reporting on the prevalence of mood and anxiety disorders [e.g., (27)] and studies evaluating the global burden of diseases, which are typically based on the proportion of individuals who meet the threshold for DSM/ICD criteria (28). The present meta-analysis also addresses gaps in existing literature by conducting moderator analyses and includes studies on all populations of post-secondary students well over a year into the COVID-19 pandemic.

Potential Moderators of Prevalence Rates

Within the context of a meta-analysis, moderator analyses can ascertain whether certain populations of post-secondary students are at higher risk for mental health symptoms during the COVID-19 pandemic, as well as whether certain study-level characteristics, such as methodological characteristics, explain variability in prevalence estimates. As mentioned, compared to studies investigating post-secondary students broadly, the mental health of students enrolled in healthcare fields involved in clinical work may have been disproportionately affected by COVID-19 due to engaging in frontline clinical training in addition to the pandemic-related changes affecting all students, such as academic closures and online learning. Further, mental illness rates have been found to differ based on level of training. A previous

meta-analysis found higher rates of mental illness among undergraduate students relative to graduate students during the COVID-19 pandemic (29). Differing rates of mental illness across levels of training could be the result of the distinct stressors at each level, which could be exacerbated by the pandemic. For example, undergraduate students are often adjusting to increased independence during an age that coincides with the onset of many mental illnesses (30). Graduate students, however, may be focused on academic work and have longer work hours which may limit the amount of time dedicated to protective factors such as social activities and hobbies (31). Another source of between-study variability could include methodological factors. For example, it is likely that the desire for rapid information about mental health during COVID-19 has led to less rigorous methodologies [e.g., convenience sampling; (32)], which may explain between-study heterogeneity. Geographical region may also increase or decrease the prevalence of mental illness during the pandemic. A meta-analysis of child and adolescent mental illness during the COVID-19 pandemic found higher rates of anxiety symptoms in European countries compared to East Asian countries (4). Rates may vary across geographical region as certain countries or regions have more accepting attitudes toward mental illness (33). In addition, countries have varied in terms of COVID-19 infection rates, strictness of quarantine and self-isolation orders, and governmental responses to the pandemic, all of which could impact reports of mental distress. Rates may also vary over the course of the pandemic, such that continued social isolation and school disruptions may have more negative effects on mental health over time. Indeed, existing research has found that rates of mental illness were higher later in the pandemic compared to the beginning of the pandemic (4, 34). More generally, it is also well-established that symptoms of depression and anxiety are more common among females than males (33) and the age of onset for both depression and anxiety disorders begins in young adulthood (35), thus sex and age will also be examined as moderators.

The Current Study

The aim of the current meta-analysis was to provide estimates of the global prevalence of clinically elevated depression and anxiety symptoms during the COVID-19 pandemic among post-secondary student samples. It was hypothesized that depression and anxiety have increased on account of the COVID-19 pandemic, compared to prior global estimates. Methodological study quality, type of student (i.e., healthcare vs. non-healthcare), level of training (i.e., undergraduate, university or college generally; graduate, medical, post-doctorate, fellow, trainee), as well as participant sex, age, month data collection was completed, and geographical region were explored as potential moderating factors that may amplify or attenuate prevalence estimates.

METHODS

Search Strategy and Selection Criteria

This review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (36) and the PRISMA-S extension (37). The protocol for this review was developed by the authors and registered with the PROSPERO International Prospective Register of Systematic Reviews (CRD42021253547). Searches were conducted in MEDLINE (Ovid), EMBASE (Ovid), APA PsycINFO (Ovid), Cochrane Central Register of Controlled Trials (Ovid), ERIC (EBSCOhost), and Education Research Complete (EBSCOhost) by a health sciences librarian on May 3, 2021. Search strategies combined search terms falling under three themes: (1) mental health and illness (including, anxiety and depression); (2) COVID-19; and (3) students (see **Supplementary Tables 1–5** for full search strategies in each database). The search included students broadly with the understanding that results could be more deliberately limited to the post-secondary audience during the screening phase. Terms were searched both as keywords and as database subject headings as appropriate. Both adjacency operators and truncation were used to capture phrasing variations in keyword searching. No language or date restrictions were applied. References of relevant studies were reviewed manually for additional pertinent articles. Using Covidence software, three authors reviewed all titles, abstracts, and full text articles emerging from the search strategy to determine eligibility for inclusion. All abstracts were reviewed by at least two independent coders. Disagreements were resolved to consensus *via* expert review by the first author. All studies identified in the abstract review as meeting inclusion criteria, underwent full text review by five coders to ensure that all inclusion criteria were met. Thirty percent of full texts were reviewed by two independent coders and random agreement probabilities ranged from 0.72 to 0.90.

Data Extraction

Studies meeting inclusion criteria during full text review underwent data extraction. In this phase, prevalence data on clinically elevated anxiety and depression symptoms were recorded. We also extracted data on the following moderators: (1) study quality (see below); (2) participant age (continuously as a mean); (3) sex (% male in a sample); (4) type of student (healthcare; non-healthcare); (5) level of training (undergraduate, university or college generally; graduate, medical, post-doctorate, fellow, trainee), (6) time of data collection (i.e., month in 2020) and (7) geographical region (e.g., East Asia, Europe, North America). Twenty percent of included studies underwent data extraction by a second coder to verify judgements for correctness and accuracy (random agreement probabilities ranged from 0.84 to 1.00). Discrepancies were resolved *via* discussion and attainment of consensus coding.

Study Quality

A 5-item study quality measure was used, based on modified versions of the National Institute of Health Quality Assessment Tool for Observation Cohort and Cross-Sectional Studies and the Newcastle-Ottawa Quality Assessment Scale (38) for cross-sectional studies (scores ranged from 0 to 5). The following criteria were applied: (1) outcome was assessed with a validated measure of depression and/or anxiety; (2) study was peer-reviewed vs. unpublished; (3) study had a response rate of at

least 50%; (4) depression or anxiety was assessed objectively (i.e., diagnostic interview); (5) the study had sufficient exposure time to COVID-19 (i.e., at least 1 week since the onset of COVID-19 in the specific country where the study was conducted). Studies were given a score of 0 (no) or 1 (yes) for each criterion and a summed score out of 5. When information was not provided by the study authors, it was marked as 0 (no). The coding protocol for the quality scoring can be found in **Supplementary Table 6**.

Data Analysis

Extracted data were entered into Comprehensive Meta-Analysis [CMA version 3.0; (39)]. Pooled prevalence rates were computed with associated 95% confidence intervals (CIs) around the estimate. CMA transforms the prevalence into a logit event rate (i.e., represented as 0.XX but interpreted as prevalence = XX%) with a computed standard error. Subsequently, event rates are weighted by the inverse of their variance, giving greater weight to studies with larger sample sizes. Finally, logits are retransformed into proportions to facilitate ease of interpretation.

Random-effects models, which assume that variations observed across studies exist because of differences in samples and study designs, were used. To assess for between-study heterogeneity, the Q and I^2 statistics were computed. A significant Q statistic suggests that study variability is greater than sampling error and that moderator analyses should be explored (40). The I^2 statistic, which ranges from 0 to 100%, examines the rate of variability across studies (41). Typically, when I^2 values are $> 75\%$, moderator analyses should be explored (41). As recommended by Borenstein et al. (39), categorical moderators were conducted when $k \geq 10$ with a cell size of $k > 3$ for each categorical comparison. Random-effect meta-regression analyses were conducted with restricted maximum likelihood estimation for all continuous moderators. Egger's test and visual examination of funnel plots was utilized to

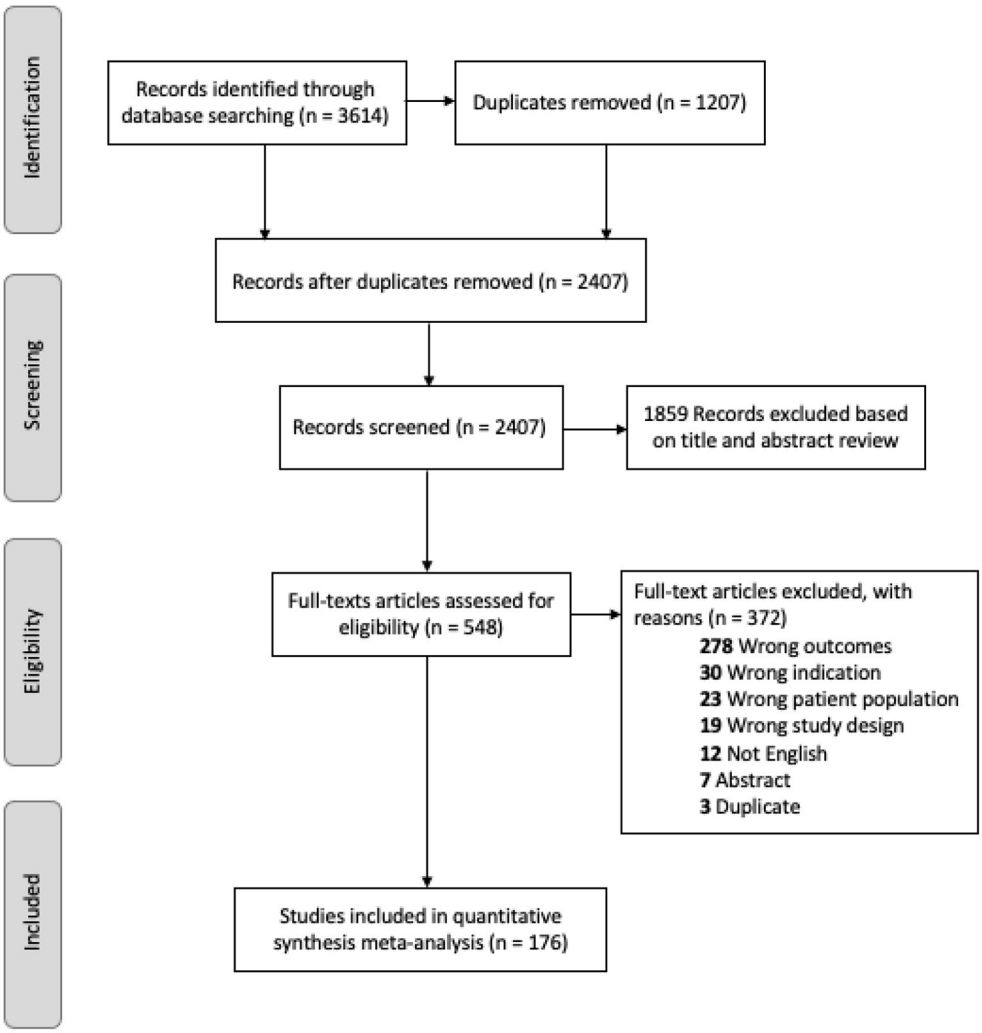

FIGURE 1 | PRISMA diagram of review search strategy.

identify publication bias (42). The set threshold for significance of moderators was $p < 0.05$.

RESULTS

As illustrated in the PRISMA flow diagram (see **Figure 1**), the electronic search yielded 3,614 records. After removing 1,207 duplicates, 548 full-text articles were retrieved for evaluation against inclusion criteria and 176 non-overlapping studies met full inclusion criteria.

Study Characteristics

The present meta-analysis included 176 studies, 126 of which reported clinically significant depression symptoms and 144 reported on clinically significant anxiety symptoms. As detailed in **Table 1**, across all 176 studies, 1,732,456 participants were included, with 35.6% being male and a mean age of 21.8 years (age range, 18.5–31.5). Forty-eight studies (27.3%) were from East Asia, 40 (22.7%) from Europe, 35 (19.9%) from South Asia, 18 (10.2%) from Middle East, 17 (9.7%) from North America, eight (4.5%) from Southeast Asia, four (2.3%) from Africa, three (1.7%) from Central America, one (0.6%) from Oceania, and two were from multiple geographical regions. The mean study quality score was 3.5 out of 5 (range: 2–4; see **Supplementary Table 7**). Specifically, 176 (100%) studies used validated measures; 176 (100%) were peer-reviewed, 102 (58.0%) had a response rate $\geq$ 50%, no studies (0%) used diagnostic interviews to assess clinically elevated anxiety or depression, and 165 (93.8%) of studies had sufficient exposure time to COVID-19.

Pooled Prevalence of Clinically Elevated Depressive Symptoms During COVID-19

A random-effects meta-analysis of 126 studies revealed a pooled event rate of 0.306 (95% CI: 0.274, 0.340; see **Figure 2**). That is, the prevalence of clinically significant depression across studies was 30.6%. The funnel plot was symmetrical (see **Supplementary Figure 1**); however, Egger's test was significant ($p = 0.028$), indicating possible publication bias. There was significant between-study heterogeneity ($Q = 128{,}577.686$, $p < 0.001$, $I^2 = 99.90$); thus, potential moderators were explored based on all included studies (see **Table 2**).

Two moderators emerged as significant: geographical region and month of data collection. Specifically, prevalence of clinically significant depression was lower in studies conducted in East Asia ($k = 39$; rate = 0.168, 95% CI: 0.143, 0.197; $p < 0.001$) compared to studies from all other regions. The second significant moderator was month of data collection, such that for every 1-month increase, a 0.16% increase in depression prevalence was observed ($k = 119$; rate = 0.157, 95% CI: 0.084, 0.230; $p < 0.001$. None of age, sex, type of student, level of training, or study quality emerged as significant moderators for the prevalence of depression symptoms among students during the COVID-19 pandemic.

Pooled Prevalence of Clinically Elevated Anxiety Symptoms During COVID-19

A random-effects meta-analysis of 144 studies revealed a pooled event rate of 0.282 (95% CI: 0.246, 0.321; **Figure 3**). That is, the prevalence of clinically significant anxiety across studies was 28.2%. The funnel plot was symmetrical (see **Supplementary Figure 2**); however, Egger's test was significant ($p = 0.037$), indicating possible publication bias. There was significant between-study heterogeneity with ($Q = 160{,}472.80$, $p < 0.001$, $I^2 = 99.91$); thus, potential moderators were explored based on all included studies (see **Table 3**).

Two moderators emerged as significant: geographical region and month of data collection. Specifically, the prevalence of clinically significant anxiety symptoms was lower among studies conducted in East Asia compared to all other geographical regions ($k = 36$; rate = 0.131, 95% CI: 0.101, 0.168; $p < 0.001$). Additionally, for every 1-month increase, a 0.18% increase in anxiety prevalence was observed ($k = 133$; rate = 0.178, 95% CI: 0.113, 0.243; $p < 0.001$). None of age, sex, type of student, level of training, or study quality emerged as significant moderators for the prevalence of clinically significant anxiety symptoms among students during the COVID-19 pandemic.

DISCUSSION

In the current meta-analysis, the pooled estimates of post-secondary students who reported clinically elevated depression ($N = 126$ studies) or anxiety ($N = 144$ studies) symptoms were 30.6 and 28.2%, respectively. Although findings of the present research indicate estimates are generally consistent with estimates prior to the COVID-19 pandemic, which ranged from 23.8 to 33% (9, 10, 12), anxiety and depression among post-secondary students remains a cause for significant concern. First, the rates of clinically significant anxiety and depression observed among post-secondary students during the COVID-19 pandemic were notably higher among students compared to the general population (216, 217) and continue to be higher relative to other populations during the COVID-19 pandemic [e.g., (4, 148)]. Second, in addition to the COVID-19 related stressors faced uniquely by student populations [e.g., academic disruptions and uncertainty; (19)], they also experienced many of the risk factors that have been attributed to worsened mental health among the general population, including financial insecurity, unemployment, and loss of loved ones (2). Indeed, post-secondary student populations lie at a unique intersection of elevated risk for mental health difficulties during the COVID-19 pandemic. Overall, results herein highlight the importance of continued investigation into who is struggling as well as which factors can be targeted through mental health intervention. For example, it will be important for future research to follow participants longitudinally to determine if current levels of anxiety and depression decrease, increase, and/or are sustained over time.

Although it may appear as though global estimates of mental health concerns in this population appear to have remained largely unchanged compared to pre-pandemic estimates, it is of

TABLE 1 | Characteristics of studies included.

References	*N*[a]	Mean age (years)	% male	Country	Mental health measured	Name of mental health measures	Month of data collection[b]	Published	Health-care student	Level of training[c]	Study design
Abas et al. (43)	478	21.55	72.00	Sudan	Anx	BAI	May	Yes		Undergrad	Cross.
Ahmed et al. (44)	1,445	-	29.40	Pakistan	Anx, Dep	GAD-7, PHQ-9	May—July	Yes	Yes	Postgrad	Cross.
Akinkugbe et al. (45)	426	-	37.70	USA	Anx	GAD-7	April—May	Yes	Yes	Postgrad	Cross.
Alkhamees and Aljohani (46)	336	-	-	Saudi Arabia	Anx, Dep	DASS-21	April	Yes	-	Undergrad	Cross.
Alqudah et al. (47)	736	20.97	24.90	Jordan	Anx	HAM-A	April—May	Yes	-	Undergrad	Cross.
Alsairafi et al. (48)	298	-	10.40	Kuwait	Anx, Dep	GAD-7, PHQ-9	May—July	Yes	-	Undergrad	Cross.
Amatori et al. (49)	159	23.00	50.94	Italy	Dep	PHQ-9	April	Yes	-	Undergrad	Cross.
Amendola et al. (50)	676	25.00	24.00	Switzerland	Anx	GAD-7	April	Yes	-	Undergrad	Long.
Amerio et al. (51)	8,177	22.02	50.10	Italy	Dep	PHQ-9	April—May	Yes	-	Undergrad	Cross.
Aslan et al. (52)	358	23.00	42.46	Turkey	Anx, Dep	GAD-7, PHQ-8	May—June	Yes	-	Undergrad	Cross.
Aylie et al. (53)	314	-	63.40	Ethiopia	Anx, Dep	DASS-21	May—June	Yes	-	Undergrad	Cross.
Balhara et al. (54)	128	19.60	40.00	India	Anx, Dep	GAD-7, PHQ-9	-	Yes	-	Undergrad	Cross.
Baloch et al. (55)	494	-	39.00	Pakistan	Anx	SAS	May—June	Yes	-	Undergrad	Cross.
Bashir et al. (56)	523	24.61	20.10	Pakistan	Anx, Dep	GAD-7, PHQ-9	August—September	Yes	-	Undergrad	Cross.
Batais et al. (57)	322	21.92	46.90	Saudi Arabia	Anx	GAD-7	March	Yes	Yes	Postgrad	Cross.
Biber et al. (58)	1,640	-	38.60	USA	Anx	GAD-7	April	Yes	-	Undergrad	Cross.
Bilgi et al. (59)	178	21.00	28.65	Turkey	Anx, Dep	GAD-7, PHQ-9	June	Yes	Yes	Postgrad	Cross.
Biswas and Biswas (60)	209	20.33	12.44	India	Anx	GAD-7	-	Yes	-	Undergrad	Cross.
Blake et al. (61)	99	20.36	13.10	UK	Anx	GAD-7	July—October	Yes	-	Undergrad	Cross.
Bolatov et al. (62)	798	20.31	24.30	Kazakhstan	Anx, Dep	GAD-7, PHQ-9	April	Yes	Yes	Postgrad	Cross.
Bourion-Bedes et al. (63)	3,936	21.70	29.40	France	Anx	GAD-7	May	Yes	-	Undergrad	Cross.
Brett et al. (64)	151	-	24.80	Australia	Anx	GAD-7	March—May	Yes	-	Undergrad	Cross.
Cam et al. (65)	1,095	21.72	25.50	Turkey	Anx, Dep	DASS-21	May 2020	Yes	-	Undergrad	Cross.
Campos et al. (66)	66	21.70	24.2	Brazil	Anx, Dep	DASS-12	May—June	Yes	Yes	Undergrad	Cross.
Chakraborty et al. (67)	168	24.00	19.00	India	Dep	PHQ-9	May 2020	Yes	Yes	Postgrad	Cross.
Chen et al. (68)	361,969	-	40.30	China	Dep	PHQ-9	February	Yes	-	Undergrad	Cross.
Chi et al. (69)	2,038	20.56	37.00	China	Anx, Dep	SAS, PHQ-9	February	Yes	-	Undergrad	Cross.
Cici and Yilmazel (70)	322	20.80	23.60	Turkey	Anx	BAI	March—April	Yes	Yes	-	Cross.
Cuschieri and Calleja Agius (71)	172	-	33.70	Malta	Anx	GAD-7	April—May	Yes	Yes	Postgrad	Cross.
Dangal and Bajracharya (72)	96	20.95	20.9	Nepal	Anx	GAD-7	-	Yes	-	-	Cross.
Das et al. (73)	208	-	56.70	Bangladesh	Anx, Dep	GAD-7, PHQ-9	April—May	Yes	-	-	Cross.
Deng et al. (6)	1,607	-	64.80	China	Anx, Dep	DASS-21	May 2020	Yes	-	Undergrad	Cross.
Dhar et al. (74)	15 543	-	66.70	Bangladesh	Anx	GAD-7	-	Yes	-	Undergrad	Cross.
Diaz-Jimenez et al. (75)	365	23.22	9.90	Spain	Anx	DASS-21	May 2020	Yes	-	Undergrad	Cross.
Dratva et al. (76)	2,223	26.4	30.00	Switzerland	Anx	GAD-7	April 2020	Yes	-	Undergrad	Cross.
Du et al. (77)	2,254	22.50	30.80	China, Ireland, Malaysia, South Korea, Taiwan, Netherlands, USA	Anx	GAD-7	April—May	Yes	-	-	Cross.

(Continued)

TABLE 1 | Continued

References	*N*[a]	Mean age (years)	% male	Country	Mental health measured	Name of mental health measures	Month of data collection[b]	Published	Health-care student	Level of training[c]	Study design
Dun et al. (78)	12,889	20.00	20.00	China	Dep	BDI-II	May	Yes	-	Undergrad	Cross.
Elhadi et al. (79)	2,430	23.30	21.00	Libya	Anx, Dep	GAD-7, PHQ-9	April—May	Yes	Yes	Postgrad	Cross.
El-Monshed et al. (80)	612	20.00	38.20	Egypt	Anx, Dep	DASS-21	May – June	Yes	-	Undergrad	Cross.
Essadek and Rabeyron (81)	8,004	21.70	32.60	France	Anx, Dep	GAD-7, PHQ-9	April	Yes	-	Undergrad	Cross.
Evans et al. (82)	254	19.76	12.60	UK	Dep	HADS	April—May	Yes	-	Undergrad	Long.
Faisal et al. (83)	874	22.83	63.80	Bangladesh	Anx, Dep	GAD-7, CES-D	April	Yes	-	Undergrad	Cross.
Far Abid Hossain et al. (84)	474	-	61.80	Bangladesh	Anx	SAS	May—June	Yes	-	-	Cross.
Fawaz and Samaha (85)	520	21.03	38.70	Lebanon	Anx, Dep	DASS-21	April	Yes	-	Undergrad	Cross.
Feng et al. (86)	1,346	19.76	27.00	China	Anx, Dep	GAD-7, PHQ-9	Febuary	Yes	-	Undergrad	Cross.
Feng et al. (87)	219	23.17	25.10	China	Anx	GAD-7	March—April	Yes	-	-	Cross.
Fruehwirth et al. (88)	419	18.90	-	USA	Anx, Dep	GAD-7, PHQ-8	June—July	Yes	-	Undergrad	Long.
Fu et al. (89)	89 588	-	43.75	China	Anx	GAD-7	May—June	Yes	-	Undergrad	Cross.
Garvey et al. (90)	198	-	32.80	Spain	Anx	GAD-7	April	Yes	-	Undergrad	Cross.
Gas et al. (91)	699	21.31	35.30	Turkey	Anx, Dep	DASS-21	May—July	Yes	Yes	Postgrad	Cross.
Ge et al. (92)	2,009	-	49.03	China	Anx	GAD-7	Febuary	Yes	-	Undergrad	Long.
Gecaite-Stonciene et al. (93)	619	22.00	7.10	Lithuania	Anx, Dep	GAD-7, PH-9	May—November	Yes	-	Undergrad	Cross.
Generali et al. (94)	399	23.45	43.10	Italy	Anx	GAD-7	April—May	Yes	Yes	Postgrad	Cross.
Ghazawy et al. (95)	1,335	-	38.20	Egypt	Anx, Dep	DASS-21	June 2020	Yes	-	Undergrad	Cross.
Giusti et al. (96)	103	22.50	18.40	Italy	Anx, Dep	SAS, BDI-II	March—May	Yes	-	Undergrad	Cross.
Graupensperger et al. (97)	135	19.84	37.00	USA	Dep	PROMIS	February—April	Yes	-	Undergrad	Long.
Guo et al. (98)	852	-	-	USA	Anx	GAD-7	June—August	Yes	Yes	Postgrad	Cross.
Hakami et al. (99)	697	21.76	45.30	Saudi Arabia	Anx, Dep	DASS-21	April	Yes	Yes	Postgrad	Cross.
Halperin et al. (100)	1,428	22.30	32.40	USA	Anx, Dep	GAD-7, PHQ-9	April	Yes	Yes	Postgrad	Cross.
Hamza et al. (101)	733	18.52	25.00	Canada	Anx, Dep	GAD-7, CES-D	April	Yes	-	Undergrad	Long.
Imran et al. (102)	10,178	31.50	43.30	Pakistan	Anx, Dep	GAD-7, PHQ-9	April—May	Yes	Yes	Postgrad	Cross.
Islam et al. (103)	3,122	21.40	59.50	Bangladesh	Anx, Dep	DASS-21	April	Yes	-	Undergrad	Cross.
Islam et al. (104)	476	-	67.20	Bangladesh	Anx, Dep	GAD-7, PHQ-9	May	Yes	-	Undergrad	Cross.
Jia et al. (105)	740	-	38.11	China	Anx	SAS	February	Yes	-	Undergrad	Cross.
Jin et al. (106)	847	20.09	22.40	China	Anx, Dep	DASS-21	March	Yes	-	Undergrad	Cross.
Jindal et al. (107)	664	-	47.60	India	Anx	GAD-7	May	Yes	Yes	Undergrad	Cross.
Jones et al. (108)	2,282	-	42.10	USA	Anx, Dep	PHQ-4	April	Yes	Yes	Undergrad	Cross.
Joshi et al. (109)	2,088	-	23.00	India	Anx	GAD-7	-	Yes	-	-	Cross.
Juchnowicz et al. (110)	2,172	22.10	27.01	Poland	Anx, Dep	DASS-21	April	Yes	-	Undergrad	Cross.
Kadam et al. (111)	60	-	12.00	India	Anx	HAM-A	-	Yes	-	Undergrad	Cross.
Kalkan Ugurlu et al. (112)	411	20.60	20.70	Turkey	Anx, Dep	DASS-42	July	Yes	Yes	-	Cross.
Kalok et al. (113)	772	-	28.40	Malaysia	Anx, Dep	DASS-21	April	Yes	Yes	Postgrad	Cross.
Kamaludin et al. (114)	983	-	33.60	Malaysia	Anx	SAS	April—May	Yes	-	Undergrad	Cross.

(Continued)

TABLE 1 | Continued

References	*N*[a]	Mean age (years)	% male	Country	Mental health measured	Name of mental health measures	Month of data collection[b]	Published	Health-care student	Level of training[c]	Study design
Kannampallil et al. (115)	393	-	45.00	USA	Anx, Dep	DASS-21	April	Yes	Yes	Postgrad	Cross.
Kaparounaki et al. (116)	1,000	22.07	30.99	Greece	Dep	CES-D	April	Yes	-	Undergrad	Cross.
Kassir et al. (117)	73	-	27.40	Lebanon	Anx, Dep	GHQ-28	June—September	Yes	-	Undergrad	Cross.
Khoshaim et al. (118)	400	-	24.80	Saudi Arabia	Anx	SAS	April—June	Yes	-	Undergrad	Cross.
Kibbey et al. (119)	641	20.10	27.30	USA	Anx, Dep	DASS-21	April—May	Yes	-	Undergrad	Cross.
Kohls et al. (120)	3,382	23.98	28.6	Germany	Dep	PHQ-9	July—August	Yes	-	Undergrad	Cross.
Kuman Tuncel et al. (121)	3,105	22.37	43.30	Turkey	Anx	BAI	April—May	Yes	Yes	Postgrad	Cross.
Lai et al. (122)	124	-	36.30	UK, USA	Anx, Dep	PHQ-4, PH-4	April—May	Yes	-	Undergrad	Cross.
Lan et al. (123)	304	-	71.40	Vietnam	Anx, Dep	DASS-18	March	Yes	-	Undergrad	Cross.
Le Vigouroux et al. (124)	1,297	21.27	20.66	France	Anx, Dep	HADS	March—May	Yes	-	Undergrad	Cross.
Lee et al. (125)	1,410	-	26.00	USA	Anx, Dep	GAD-7, PROMIS-D	March—May	Yes	-	-	Cross.
Li et al. (126)	68,685	-	36.80	China	Anx, Dep	GAD-7, PHQ-9	February	Yes	-	Undergrad	Long.
Li et al. (127)	7,747	20.74	50.95	China	Anx, Dep	GAD-7, PHQ-9	February—March	Yes	-	Undergrad	Cross.
Li et al. (128)	1,168	-	65.07	China	Anx	GAD-7	April—June	Yes	-	Undergrad	Cross.
Li et al. (129)	6,348	-	9.63	China	Anx, Dep	GAD-7, PHQ-9	March	Yes	Yes	Undergrad	Cross.
Liang et al. (130)	4,164	-	52.00	China	Dep	PHQ-9	February	Yes	-	Undergrad	Cross.
Lin et al. (131)	628	20.17	35.20	China	Dep	CES-D	March	Yes	-	Undergrad	Cross.
Lin et al. (132)	2,086	-	-	China	Anx	STAI-6	April	Yes	Yes	Postgrad	Cross.
Lischer et al. (133)	557	27.00	36.20	Switzerland	Anx	PHQ-4	April—May	Yes	-	Undergrad	Cross.
Liu et al. (134)	217	21.70	41.50	China	Anx, Dep	GAD-7, PHQ-9	February—April	Yes	Yes	Postgrad	Cross.
Lopez-Castro et al. (135)	909	-	30.80	USA	Anx, Dep	GAD-7, PHQ-9	May	Yes	-	Undergrad	Cross.
Ma et al. (136)	746,217	-	44.40	China	Anx, Dep	GAD-7, PHQ-9	February	Yes	-	Undergrad	Cross.
Majumdar et al. (137)	325	22.10	39.07	India	Dep	CES-D	April—May	Yes	-	-	Cross.
Manjareeka and Pathak (138)	101	19.70	63.37	India	Anx	STAI-S	February—May	Yes	Yes	Postgrad	Long.
Mechili et al. (139)	892	-	11.4	Albania	Dep	PHQ-9	March—April	Yes	-	Undergrad	Cross.
Medeiros et al. (140)	113	21.46	23.00	Brazil	Anx, Dep	HADS	May	Yes	Yes	Postgrad	Cross.
Mekonen et al. (141)	338	24.70	56.20	Ethiopia	Anx, Dep	DASS-21	November	Yes	-	Undergrad	Cross.
Meng et al. (142)	3,304	21.18	39.39	China	Anx, Dep	GAD-7, PHQ-9	February	Yes	-	Undergrad	Cross.
Miskulin et al. (143)	347	-	-	Brazil	Dep	HADS	March—June	Yes	Yes	Postgrad	Cross.
Moayed et al. (144)	207	-	69.08	Iran	Anx, Dep	DASS-21	February—March	Yes	Yes	Postgrad	Cross.
Mridul et al. (145)	159	-	-	India	Anx, Dep	DASS-21	July	Yes	-	Undergrad	Cross.
Mushquash and Grassia (146)	131	20.32	19.08	Canada	Dep	PHQ-9	May	Yes	-	Undergrad	Cross.
Nakhostin-Ansari et al. (147)	323	23.73	47.70	Iran	Anx, Dep	BAI, BDI	April	Yes	Yes	Postgrad	Cross.
Naser et al. (148)	1,165	-	46.20	Jordan	Anx, Dep	GAD-7, PHQ-9	March	Yes	-	Undergrad	Cross.
Nihmath Nisha et al. (149)	359	-	50.40	India	Anx, Dep	GAD-7, CES-D	April—June	Yes	Yes	Postgrad	Cross.

(Continued)

TABLE 1 | Continued

References	*N*[a]	Mean age (years)	% male	Country	Mental health measured	Name of mental health measures	Month of data collection[b]	Published	Health-care student	Level of training[c]	Study design
Nishimura et al. (150)	473	22.00	65.80	Japan	Anx, Dep	GAD-7, PHQ-9	June	Yes	Yes	Postgrad	Cross.
Nomura et al. (151)	2,449	20.50	53.80	Japan	Dep	PHQ-9	May—June	Yes	-	-	Cross.
Padron et al. (152)	932	-	23.80	Spain	Anx, Dep	GAD-7, PHQ-9	April—May	Yes	-	Undergrad	Cross.
Pandey et al. (153)	82	-	43.40	India	Anx, Dep	GAD-7, PHQ-9	April	Yes	Yes	Postgrad	Cross.
Patelarou et al. (154)	787	22.70	16.10	Greece, Spain, Albania	Dep	PHQ-9	April—May	Yes	Yes	Undergrad	Cross.
Patsali et al. (155)	1,535	22.00	28.08	Greece	Dep	CES-D	April—May	Yes	-	Undergrad	Cross.
Pavan et al. (156)	233	22.82	58.70	India	Anx	GAD-7	August	Yes	Yes	Postgrad	Cross.
Pelaccia et al. (157)	1,165	23.00	34.80	France	Anx	STAI-S	May	Yes	Yes	Postgrad	Cross.
Poon et al. (158)	374	-	-	China	Anx, Dep	GAD-7, PHQ-9	-	Yes	Yes	Postgrad	Cross.
Qanash et al. (159)	721	22.00	40.60	Saudi Arabia	Anx, Dep	PHQ-4, PH-4	April—June	Yes	-	Undergrad	Cross.
Rogowska et al. (160)	1,512	20.06	31.35	Ukraine	Anx, Dep	GAD-7, PHQ-9	May—June	Yes	-	Undergrad	Cross.
Rogowska et al. (161)	914	23.04	56.89	Poland	Anx	GAD-7	March—April	Yes	-	Undergrad	Cross.
Romeo et al. (162)	478	23.30	22.60	Italy	Anx, Dep	STAI-Y1, BDI-II	March—April	Yes	-	Undergrad	Cross.
Rosenthal et al. (163)	222	-	8.00	USA	Anx, Dep	DASS-21	June	Yes	Yes	Postgrad	Cross.
Rudenstine et al. (164)	1,821	26.17	27.10	USA	Anx, Dep	GAD-7, PHQ-9	April—May	Yes	-	Undergrad	Cross.
Saadeh et al. (165)	6,157	19.79	28.70	Jordan	Dep	CES-D	-	Yes	-	Undergrad	Cross.
Saddik et al. (166)	1,485	20.50	28.20	UAE	Anx	GAD-7	March	Yes	Mixed	-	Long.
Safa et al. (167)	425	22.00	37.65	Bangladesh	Anx, Dep	HADS	April—May	Yes	Yes	Postgrad	Cross.
Saguem et al. (168)	251	21.00	17.50	Tunisia	Anx, Dep	DASS-21	April—May	Yes	Yes	Postgrad	Cross.
Salman et al. (169)	1,134	21.70	29.50	Pakistan	Anx, Dep	GAD-7, PHQ-9	April—May	Yes	-	Undergrad	Cross.
Saraswathi et al. (170)	217	20.00	35.94	India	Anx, Dep	DASS-21	June	Yes	Yes	Postgrad	Long.
Sathe et al. (171)	433	20.00	27.94	India	Dep	PHQ-9	-	Yes	-	Undergrad	Cross.
Savitsky et al. (172)	216	26.00	12.04	Israel	Anx	GAD-7	March—April	Yes	Yes	Undergrad	Cross.
Sayeed et al. (173)	589	-	65.70	Bangladesh	Anx, Dep	DASS-21	April—May	Yes	-	Undergrad	Cross.
Shailaja et al. (174)	530	20.57	42.6	India	Anx, Dep	DASS-21	April	Yes	Yes	Postgrad	Cross.
Sogut et al. (175)	972	20.79	9.44	Turkey	Anx	BAI	March	Yes	Yes	Undergrad	Cross.
Song et al. (176)	1,128	-	44.00	China	Anx, Dep	SAS, SDS	February	Yes	Mixed	-	Cross.
Song et al. (177)	261	20.00	46.70	China	Anx, Dep	DASS-21	-	Yes	-	-	Cross.
Soria and Horgos (178)	69,054	20.00	72.80	France	Anx, Dep	STAI-Y2	April—May	Yes	-	Undergrad	Cross.
Srivastava et al. (179)	97	19.15	47.42	India	Anx	GAD-7	-	Yes	Yes	Postgrad	Cross.
Sultana et al. (180)	3,997	21.96	61.10	Bangladesh	Dep	PHQ-9	May—June	Yes	-	Undergrad	Cross.
Sun et al. (181)	1,912	20.28	30.23	China	Anx, Dep	GAD-7, PHQ-9	March—April	Yes	-	-	Cross.
Sundarasen et al. (182)	983	-	33.60	Malaysia	Anx	SAS	April—May	Yes	-	Undergrad	Cross.
Syam et al. (183)	1,044	21.12	17.40	Indonesia	Dep	KADS-6	April	Yes	-	Undergrad	Cross.
Tang et al. (184)	2,485	19.81	39.20	China	Dep	PHQ-9	February	Yes	-	Undergrad	Cross.
Tasnim et al. (185)	3,331	21.40	59.40	Bangladesh	Anx, Dep	DASS-21	April—May	Yes	-	Undergrad	Cross.
Vahedian-Azimi et al. (7)	207	27.23	69.10	Iran	Anx, Dep	DASS-21	February—March	Yes	Yes	Postgrad	Cross.
Vala et al. (186)	250	-	44.00	India	Anx, Dep	DASS-21	-	Yes	Yes	Postgrad	Cross.

(Continued)

TABLE 1 | Continued

References	*N*[a]	Mean age (years)	% male	Country	Mental health measured	Name of mental health measures	Month of data collection[b]	Published	Health-care student	Level of training[c]	Study design
Van Der Feltz-Cornelis et al. (187)	925	27.50	26.00	UK	Anx, Dep	GAD-7, PHQ-9	May—June	Yes	-	Undergrad	Cross.
Verma (188)	131	-	48.00	India	Anx, Dep	GAD-7, PHQ-9	-	Yes	-	Undergrad	Cross.
Villani et al. (189)	501	22.90	28.54	Italy	Anx, Dep	SAS, SDS	June—July	Yes	-	Undergrad	Cross.
Vitale et al. (190)	285	-	14.03	Italy	Dep	PHQ-9	March—April	Yes	Yes	-	Cross.
Volken et al. (191)	2,363	26.00	30.20	Switzerland	Dep	PHQ-9	April—October	Yes	-	Undergrad	Long.
Wan Mohd Yunus et al. (192)	1,005	-	24.50	Malaysia	Anx, Dep	DASS-21	April	Yes	-	Undergrad	Cross.
Wang et al. (193)	1,172	-	39.08	China	Anx	SAS	Febuary—March	Yes	-	Undergrad	Long.
Wang et al. (194)	44,447	21.00	45.50	China	Anx, Dep	SAS, CES-D	January—February	Yes	-	Undergrad	Cross.
Wang et al. (195)	2,014 (Anx) 1994 (Dep)	22.88	38.36	USA	Anx, Dep	GAD-7, PHQ-9	May	Yes	-	Undergrad	Cross.
Wang et al. (196)	3,092	-	33.60	China	Anx	GAD-7	February—March	Yes	-	Undergrad	Cross.
Wathelet et al. (197)	69,054	20.00	26.10	France	Anx, Dep	STAI-Y2, BDI	April—May	Yes	-	Undergrad	Cross.
Widiyanto et al. (198)	430	-	25.12	Indonesia	Anx, Dep	GAD-7, WHO-5	May	Yes	-	Undergrad	Cross.
Wong et al. (199)	340	-	-	Malaysia	Anx, Dep	DASS-21	May—September	Yes	-	Undergrad	Cross.
Wu et al. (200)	11,787	20.45	42.89	China	Anx, Dep	GAD-7, PHQ-9	February	Yes	-	Undergrad	Cross.
Xiang et al. (201)	1,396	20.68	63.10	China	Anx, Dep	SAS, SDS	February—March	Yes	-	Undergrad	Cross.
Xiao et al. (202)	933	-	29.90	China	Anx, Dep	GAD-7, PHQ-9	February	Yes	Yes	Postgrad	Cross.
Xie et al. (203)	1,026	-	36.40	China	Dep	SDS	February	Yes	Yes	Postgrad	Cross.
Xie et al. (204)	2,705	-	22.48	China	Anx, Dep	GAD-7, PHQ-9	February	Yes	Mixed	Undergrad	Cross.
Xin et al. (205)	24,378	19.90	32.30	China	Dep	PHQ-9	February	Yes	-	Undergrad	Cross.
Yadav et al. (206)	409	22.10	16.90	Nepal	Anx, Dep	GAD-7, PHQ-9	June	Yes	No	Postgrad	Cross.
Yang et al. (207)	521	-	22.50	China	Anx	SAS	April—May	Yes	-	Undergrad	Cross.
Yu et al. (208)	430	18.51	19.30	China	Anx, Dep	GAD-7, PHQ-9	October	Yes	-	Undergrad	Cross.
Yu et al. (209)	23,863	-	31.90	China	Dep	PHQ-9	February	Yes	-	Undergrad	Cross.
Yu et al. (210)	1,681	-	35.20	China	Dep	CES-D	March	Yes	-	Undergrad	Cross.
Zhang et al. (211)	66	20.70	37.88	China	Anx, Dep	DASS-21	February—March	Yes	-	Undergrad	Long.
Zhang et al. (36)	1,041	21.34	47.60	China	Anx, Dep	DASS-21	April	Yes	Yes	Postgrad	Cross.
Zhao et al. (212)	821	23.08	37.15	China, South Korea, Japan	Dep	PHQ-9	March—April	Yes	-	-	Cross.
Zhao et al. (213)	420	22.90	31.67	China	Dep	PHQ-9	March—April	Yes	-	Undergrad	Cross.
Zhou et al. (214)	4,099	-	25.00	China	Anx, Dep	GAD-7, PHQ-9	March	Yes	-	Undergrad	Cross.
Zhu et al. (215)	342	20.72	13.20	China	Anx, Dep	GAD-7, PH-9	March—April	Yes	Yes	Undergrad	Cross.

BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; BDI-II, Beck Depression Inventory-II; CES-D, Center for Epidemiologic Studies Depression Scale; DASS-18, Depression, Anxiety and Stress Scale 18-Item; DASS-21, Depression, Anxiety and Stress Scale 21-Item; DASS-42, Depression, Anxiety and Stress Scale 42-Item; GHQ-28, General Health Questionnaire-28; GAD-7, Generalized Anxiety Disorder 7-Item; HADS, Hospital Anxiety and Depression Scale; HAM-A, Hamilton Anxiety Rating Scale; KADS-6, Kutcher Adolescent Depression Scale 6-Item; PHQ-4, Patient Health Questionnaire 4-Item; PHQ-8, Patient Health Questionnaire 8-Item; PHQ-9, Patient Health Questionnaire 9-Item; PROMIS, Patient-Reported Outcomes Measurement Information System; PROMIS-D, PROMIS Depression Short Form; SAS, Zung Self-Rating Anxiety Scale; SDS, Zung Self-Rating Depression Scale; STAI-S, State-Trait Anxiety Inventory State Subscale; STAI-Y1, State-Trait Anxiety Inventory Form Y1; STAI-Y2, State-Trait Anxiety Inventory Form Y2; STAI-6, State-Trait Anxiety Inventory 6-Item; WHO-5, World Helath Organization Well-being Index; -, not reported.

[a]*Sample size entered into the meta-analysis.*

[b]*Data collection for all included studies occurred in 2020.*

[c]*Undergrad: includes university undergraduate students, university students generally, college students generally, midwifery students, and nursing students; Postgrad: includes graduate students, medical students, dental students, pharmacy students, fellows, trainees, and postdocs.*

Study	Event	N	Rate [95% CI]
Ahmed 2020	714	1445	0.49 [0.47, 0.52]
Alkhamees 2021	145	336	0.43 [0.38, 0.48]
Alsairafi 2021	277	298	0.93 [0.89, 0.95]
Amatori 2020	32	159	0.20 [0.15, 0.27]
Amerio 2020	1050	8177	0.13 [0.12, 0.14]
Aslan 2020	225	358	0.63 [0.58, 0.68]
Balhara 2020	34	128	0.27 [0.20, 0.35]
Bashir 2020	275	523	0.53 [0.48, 0.57]
Bilgi 2021	104	178	0.58 [0.51, 0.65]
Bolatov 2020	220	798	0.28 [0.25, 0.31]
Cam 2021	532	1120	0.47 [0.45, 0.50]
Campos 2021	46	66	0.70 [0.58, 0.80]
Chakraborty 2020	90	168	0.54 [0.46, 0.61]
Chen 2020	27872	361969	0.08 [0.08, 0.08]
Chi 2020	475	2038	0.23 [0.21, 0.25]
Das 2021	88	208	0.42 [0.36, 0.49]
Deng 2020	20	1607	0.01 [0.01, 0.02]
Dun 2021	1905	12889	0.15 [0.14, 0.15]
El-Monshed 2021	315	612	0.52 [0.47, 0.55]
Elhadi 2020	1041	2430	0.43 [0.41, 0.45]
Essadek 2020	3442	8004	0.43 [0.42, 0.44]
Evans 2021	87	254	0.34 [0.29, 0.40]
Faisal 2021	630	874	0.72 [0.69, 0.75]
Fawaz 2021	81	520	0.16 [0.13, 0.19]
Feng 2020	429	1346	0.32 [0.29, 0.34]
Fruehwirth 2021	133	419	0.32 [0.28, 0.36]
Gas 2021	78	699	0.11 [0.09, 0.14]
Gecaite-Stonciene 2021	270	619	0.44 [0.40, 0.48]
Ghazawy 2020	613	1335	0.46 [0.43, 0.49]
Giusti 2020	17	103	0.17 [0.10, 0.25]
Graupensperger 2020	37	135	0.27 [0.21, 0.35]
Hakami 2021	321	697	0.46 [0.42, 0.50]
Halperin 2021	347	1428	0.24 [0.22, 0.27]
Hamza 2021	242	733	0.33 [0.30, 0.36]
Imran 2020	2221	10178	0.22 [0.21, 0.23]
Islam 2020a	1963	3122	0.63 [0.61, 0.65]
Islam 2020b	256	476	0.54 [0.49, 0.58]
Jin 2021	144	847	0.17 [0.15, 0.20]
Jones 2021	963	2282	0.42 [0.40, 0.44]
Juchnowicz 2021	942	2172	0.43 [0.41, 0.46]
Kalkan Ugurlu 2020	188	411	0.46 [0.41, 0.51]
Kalok 2020	194	772	0.25 [0.22, 0.28]
Kannampallil 2020	107	393	0.27 [0.23, 0.32]
Kassir 2021	10	73	0.14 [0.07, 0.24]
Kibbey 2021	287	641	0.45 [0.41, 0.49]
Kohls 2021	1249	3382	0.37 [0.35, 0.39]
Lai 2020	15	124	0.12 [0.07, 0.19]
Lan 2020	152	304	0.50 [0.44, 0.56]
Le Vigouroux 2021	263	1297	0.20 [0.18, 0.23]
Lee 2021	511	1410	0.36 [0.34, 0.39]
Li 2020	14863	68685	0.22 [0.21, 0.22]
Li 2021b	354	7747	0.05 [0.04, 0.05]
Li 2021d	784	6348	0.12 [0.12, 0.13]
Liang 2020	554	4164	0.13 [0.12, 0.14]
Lin 2020	217	628	0.35 [0.31, 0.38]
Liu 2020	24	217	0.11 [0.07, 0.16]
Lopez-Castro 2021	817	909	0.90 [0.88, 0.92]
Ma 2020	157452	746217	0.21 [0.21, 0.21]
Mechili 2020	217	892	0.24 [0.22, 0.27]
Medeiros 2020	44	113	0.39 [0.30, 0.48]
Mekonen 2021	136	338	0.40 [0.35, 0.46]
Meng 2021	347	3304	0.10 [0.10, 0.12]
Miskulin 2020	125	347	0.36 [0.31, 0.41]
Total			0.306 [0.274, 0.340]

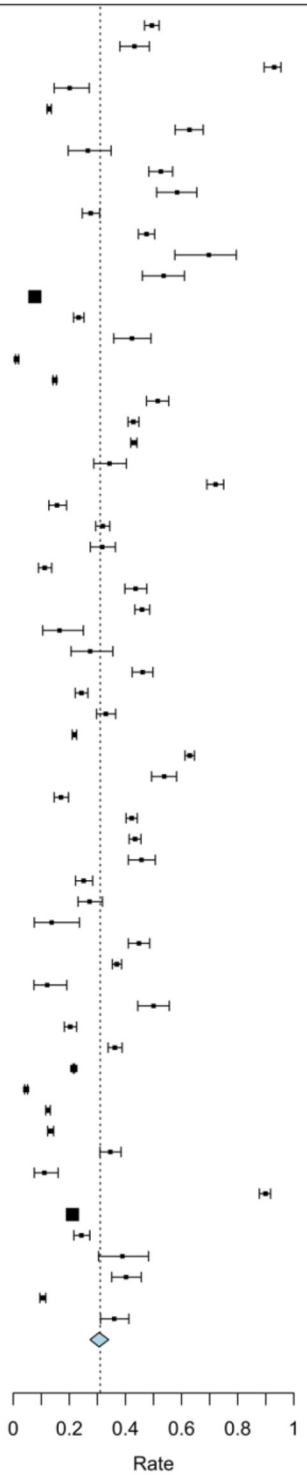

FIGURE 2 | Continued

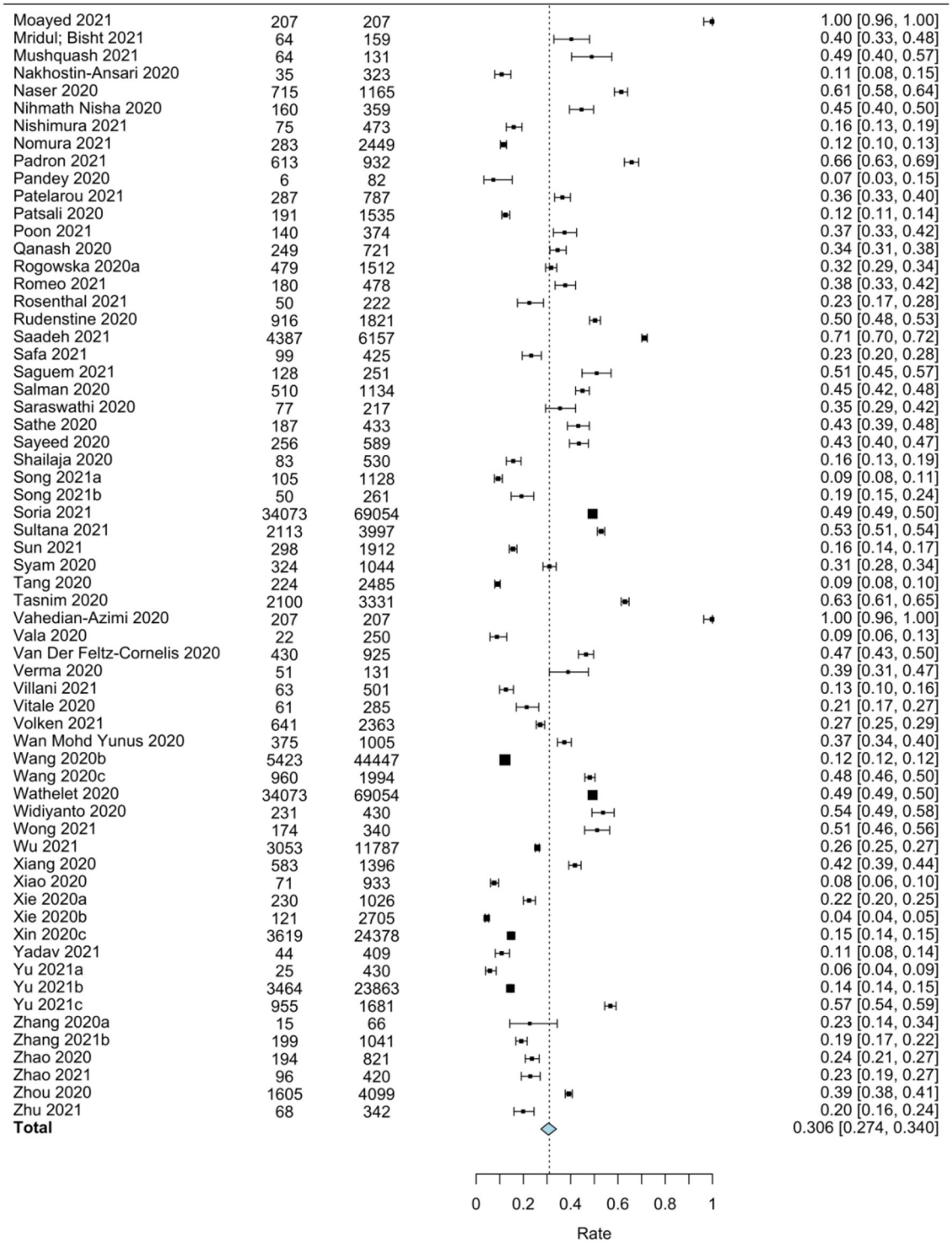

FIGURE 2 | Forest plot for the meta-analysis on prevalence rates of depression in students.

utmost importance to consider the heterogeneous trajectories of mental health during the COVID-19 pandemic. That is, while the mental health of some students may have remained stable prior to, and during the pandemic, the pandemic may have initiated and/or attenuated mental distress in other students. Previous research has shown disparities in who was more severely

TABLE 2 | Results of moderator analyses for the prevalence of depressive symptoms in post-secondary students during COVID-19.

Categorical moderators	*k*	Prevalence	95% CI	Heterogeneity *Q*	*p*
Study quality score[a]				1.948	0.163
2–3	53	0.334	0.284, 0.389		
4	73	0.287	0.247, 0.330		
Type of student				0.567	0.451
Non-healthcare	86	0.324	0.284, 0.366		
Healthcare	37	0.295	0.238, 0.360		
Student level of training				1.344	0.246
Undergraduate/College	86	0.325	0.285, 0.368		
Graduate/Professional/Fellow/Trainee	31	0.279	0.219, 0.348		
Geographical region				102.286	<0.001
North America	13	0.409*	0.331, 0.492		
East Asia	39	0.168***	0.143, 0.197		
Europe	25	0.328***	0.277, 0.383		
Continuous moderators	***k***	**Estimate**	**95% CI**	***Z***	***p***
Participant age	80	0.091	−0.003, 0.185	1.89	0.058
Participant sex	120	0.001	−0.010, 0.012	0.22	0.829
Month of data collection in 2020	119	0.157***	0.084, 0.230	4.20	<0.001

k, number of studies; CI, confidence interval.
**p < 0.05; ***p < 0.001.*
[a]*Four studies had a study quality of 2 and were combined with those with a study quality of 3.*

impacted during the COVID-19 pandemic from a mental health standpoint (218). Recent studies showed that students who faced greater COVID-19 related stressors (e.g., lack of social support, uncertainties about academic programs) were more vulnerable to declines in mental health (122). Thus, whereas some students may have experienced consistent or improved mental health, it is likely that those with greater stressors may be disproportionately negatively impacted by the COVID-19 pandemic. It will be important in future longitudinal research to examine the trajectories of mental distress from pre-pandemic to during the pandemic (and beyond) to ascertain a more complete picture of the patterns of stability and change in mental distress among post-secondary students.

We included a much larger sample of studies ($n = 176$, ∼2 million participants) and applied more strict inclusion criteria in the current study, compared to previous meta-analyses. More specifically, we only included studies that reported clinically elevated depression and anxiety symptoms (i.e., above clinical cut-offs in the moderate to severe range), whereas previous meta-analyses have also included mild (i.e., subthreshold) symptoms in their pooled prevalence estimates, which could lead to estimate inflation. Nonetheless, the current prevalence estimates are in line with previous meta-analyses examining post-secondary student depressive [26–34%; (21–24)] and anxiety [28–31%; (21, 24, 25)] symptoms during the COVID-19 pandemic. However, unique to this meta-analysis was an examination of moderator variables. Results revealed that geographical location and month of data collection were important for explaining between-study differences in prevalence estimates, with rates of both anxiety and depression being lower in East Asian countries and higher as the month of data collection increased. Further, while estimates of mental illness typically vary by sex and age, these demographic factors did not explain between-study variability in the current meta-analysis of pandemic related mental illness symptoms, emphasizing the importance of providing adequate mental health services to individuals regardless of age or sex. As well, study quality was not a significant moderator. This may be related to the fact that there was limited variability in study quality among included studies (2–4 out of 5 with a mean study quality of 3.5). Although previous studies have found differences in student mental illness depending on level of study before (219) and during the COVID-19 pandemic (29), and healthcare fields may be disproportionately affected by the pandemic, none of these emerged as significant moderators. This finding may be explained by the fact that students working in healthcare fields may not necessarily be in direct contact with COVID-19 patients. Further, there may be stressors that negatively impact all students, regardless of level of training and type of student, such as financial stress.

This meta-analysis suggests that rates of clinically significant anxiety and depression among post-secondary students may be similar to pre-pandemic estimates. It is possible that the COVID-19 pandemic may have led to a shift in university and college procedures that created favorable learning conditions for post-secondary students. Take, for example, the finding that a sample of medical students reported lower levels of burnout during online learning over the course of the pandemic compared to traditional in-person learning pre-pandemic (85).

As such, factors such as method of teaching delivery could have created an environment for students that decreases stress and increases flexibility and accessibility compared to in-person learning pre-pandemic.

Rates of anxiety and depression may also have remained relatively unchanged due to continued access to familial social support. Research during the pandemic has shown that college students who reported greater social support displayed better psychological health compared to those with lower levels of social support (122, 220). Many post-secondary students moved home and were in quarantine with family members. Returning home may have provided a source of support that helped to protect against the adverse mental health consequences of the pandemic, given that students who did not return to their home country or region reported more COVID-19 related stressors, including a lack of social support and worse mental health (122). For all students, access to social media may have been a particularly helpful tool to continue seeking and obtaining social support from peers, relatives, and colleagues (221).

Further, despite the disruption to mental health services during COVID-19 generally, many post-secondary students may have been able to continue to receive mental health services. Even prior to the pandemic, some colleges began implementing telehealth services to meet the increasing demands and these telemental health services may have been particularly helpful for students by allowing them to stay connected to care (222). Previous research has shown that many students, especially those with greater levels of depression and anxiety symptoms, are willing to use telemental health resources (223). Lastly, the COVID-19 pandemic has highlighted the importance of accessible mental health services and some institutions may be presently exploring strategies to promote better mental health among their students [e.g., (224, 225)].

Many included studies with the largest sample sizes were conducted in East Asian countries. The current results revealed that samples from East Asia possessed lower pooled prevalence rates of depression and anxiety compared to other geographical regions. Previous research has documented that East Asian populations may underreport or underestimate their psychological distress (32), either because they do not perceive their symptoms as indicative of mental health problems or due to the stigma associated with mental illness. Thus, the large representation of studies from East Asian countries should be considered in the interpretation of the minimal increase in results from pre- to during the COVID-19 pandemic. Furthermore, East Asian countries were also the first to report COVID-19 infections and had some of the strongest public health measures. The measures to "flatten the curve" may have reduced the risk of mental health responses where infection rates were diminished. These results are consistent with existing literature that similarly found rates of anxiety and depression among youth were lower in East Asian countries during COVID-19 (4). The current meta-analysis cannot explicate whether regional differences in the prevalence of anxiety and depression symptoms were related to true cultural differences in these symptoms, or to differing attitudes and reports of symptoms.

In addition to geographical region, the current study revealed month of data collection as a moderator of elevated depression and anxiety, such that rates of depression and anxiety increased later into the COVID-19 pandemic. This finding parallels a recent meta-analysis on children and adolescents (4), which also found that mental health deteriorated over the course of the pandemic. Among young adults, peer relationships can be an important element of social support (20). Although students may have experienced increased familial support throughout the COVID-19 pandemic, campus closures and social distancing measures removed students from a critical source of social support (i.e., peers). One possible explanation for the current finding is that social isolation, campus closures, and academic disruptions had a compounding effect on the mental health of post-secondary students as the COVID-19 pandemic progressed (14, 19). Alternatively, studies conducted earlier in the COVID-19 pandemic were more likely to have been conducted in East Asia as East Asian countries were the first to report COVID-19 infections (Racine et al., 2021). Previous studies have indicated that self-reported prevalence of psychological distress tends to be lower among East Asian populations (226).

Limitations

The results of this meta-analysis should be viewed within the context of several limitations. First, power was limited in some categorical moderator analyses due to small sample sizes at each level of the moderator variable. Several potentially interesting moderators could also not be explored as there were insufficient studies reporting on these factors. For example, factors that may have increased or decreased prevalence rates of anxiety and depression could include SES, history of pre-existing mental disorder, and living situation (e.g., subjected to stay-at-home vs. physical distancing orders). Indeed, pandemic-related mental health research has shown that mental illness tends to increase during periods of quarantine and self-isolation. A fuller exploration of these factors in future research will be essential for planning and targeting interventions to address mental distress. Relatedly, despite strict criteria for inclusion in the present meta-analysis (e.g., use of clinical cut off scores for depression and anxiety), there was still considerable heterogeneity among the included studies that was not accounted for by the tested moderators. This indicates there is notable heterogeneity in research conducted on this topic to date, suggesting there may be unexplored moderators that further account for the observed heterogeneity. Future research may wish to explore moderators including SES, vaccination rates, and mental health assessment measures to determine if greater heterogeneity among existing research can be accounted for. Second, while all included studies used validated measures of anxiety and depressive symptoms, no study to date has employed diagnostic measures. Therefore, our results are based on elevated self-reports of moderate to severe anxiety and depressive symptoms, but not diagnoses of these disorders. Fourth, all included studies are cross-sectional reports of mental illness symptoms. Cross-sectional studies can establish rates of mental illness during an acute period of distress, but it is critical to establish if the estimated prevalence rates are sustained over time.

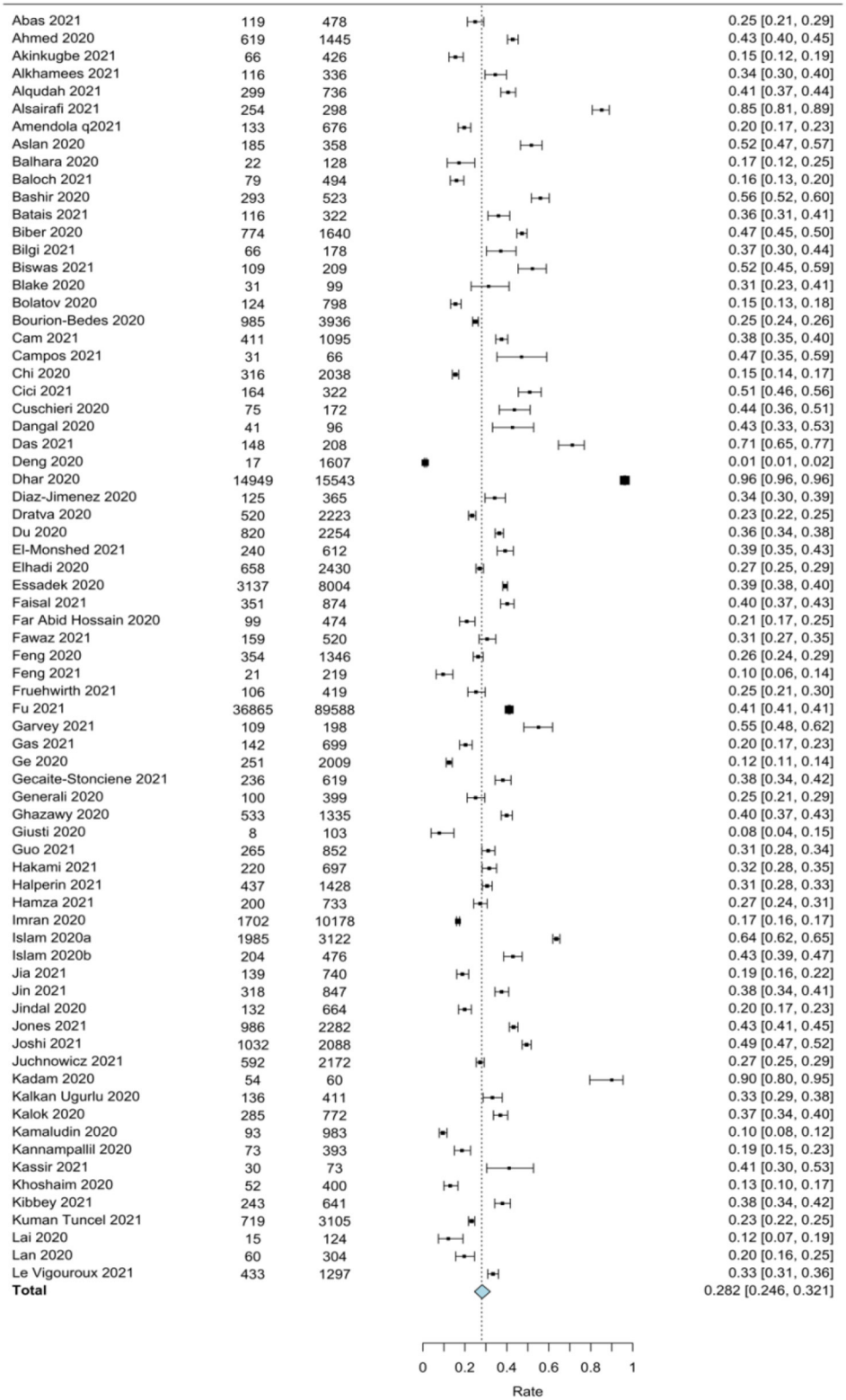

FIGURE 3 | Continued

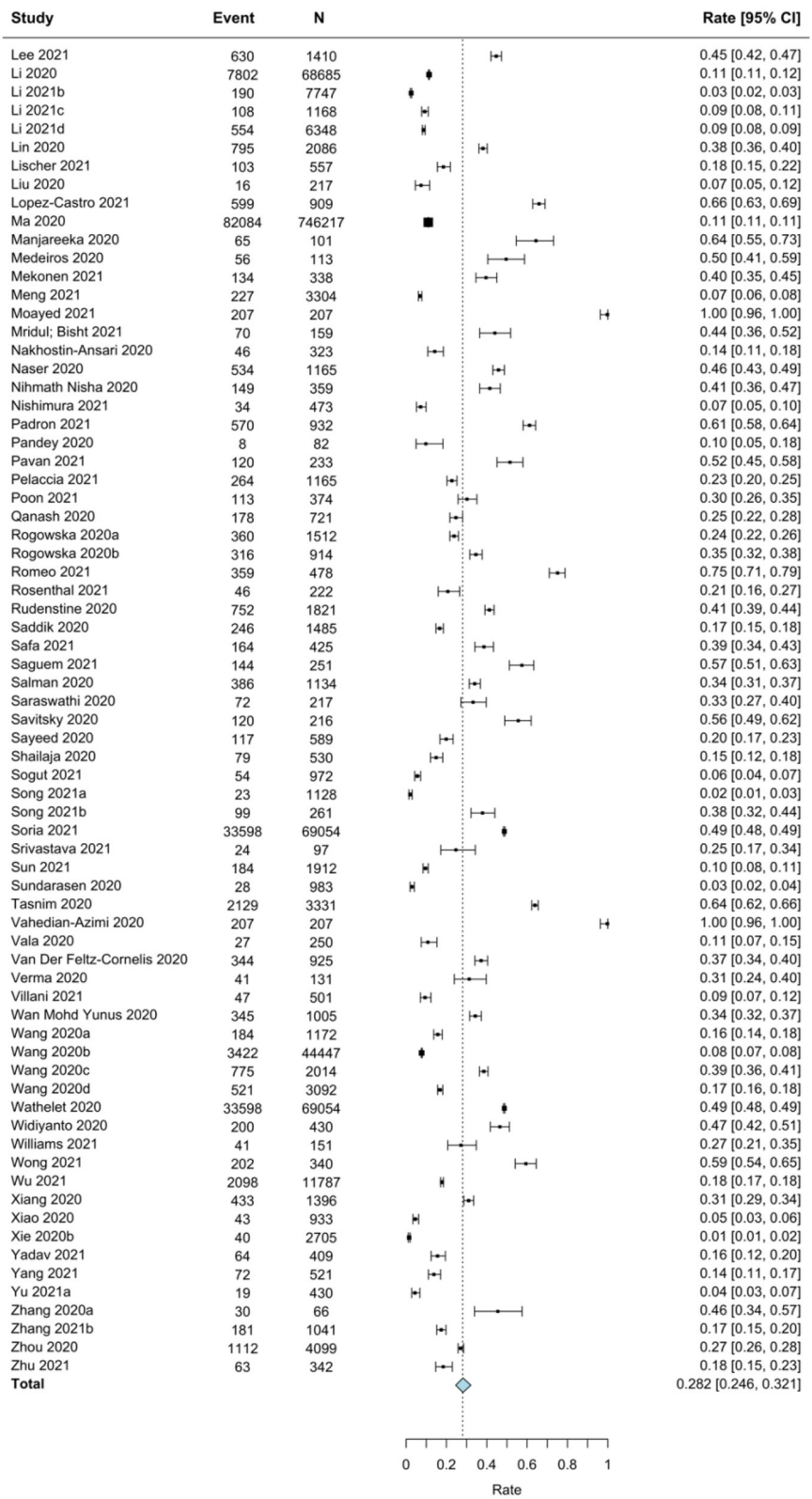

FIGURE 3 | Forest plot for the meta-analysis on prevalence rates of anxiety in students during COVID-19.

TABLE 3 | Results of moderator analyses for the prevalence of anxiety symptoms in post-secondary students during COVID-19.

Categorical moderators	*k*	Prevalence	95% CI	Heterogeneity *Q*	*p*
Study quality score				0.237	0.627
2–3	67	0.292	0.239, 0.353		
4	77	0.273	0.225, 0.328		
Type of student				0.157	0.692
Non-healthcare	93	0.299	0.253, 0.349		
Healthcare	47	0.282	0.220, 0.353		
Student level of training				0.003	0.953
Undergraduate/College	92	0.283	0.238, 0.333		
Graduate/Professional/Fellow/Trainee	39	0.281	0.213, 0.360		
Geographical region				62.525	<0.001
East Asia	36	0.131***	0.101, 0.168		
North America	14	0.338***	0.243, 0.448		
Europe	30	0.314***	0.250, 0.386		
Continuous moderators	***k***	**Estimate**	**95% CI**	***Z***	***p***
Participant age	83	0.057	−0.026, 0.141	1.35	0.177
Participant sex	137	0.003	−0.010, 0.016	0.41	0.679
Month of data collection in 2020	133	0.178***	0.113, 0.243	5.34	<0.001

*k, number of studies; CI, confidence interval. ***p < 0.001.*

Future Directions

This meta-analysis provided a synthesis of existing evidence on clinically elevated depressive and anxiety symptoms experienced by post-secondary students during the COVID-19 pandemic. Future research should attend to several methodological issues to inform this body of research more fully and to increase the applicability of findings for health policy and practice (32, 227). First, as aptly outlined by others (2, 32), more rigorous recruitment methods, such as random sampling methods, are critical in order to fully understand the burden of the COVID-19 pandemic and capture inequalities experienced by vulnerable groups. Second, it is important for future research to continue to longitudinally examine whether the prevalence of anxiety and depressive symptoms remain constant, decrease, or increase over the course of the pandemic, and beyond. For example, an innovative study by Ayers et al. (228) demonstrated that internet searches for acute anxiety spiked early in the pandemic compared to historical pre-pandemic levels, but following the peak of the pandemic, searches returned to historical pre-pandemic levels. To date, several longitudinal studies have been conducted to assess mental illness throughout the COVID-19 pandemic [e.g., (3, 229, 230)]. For example, emerging longitudinal research on student populations by Amendola et al. (50) shows that the prevalence of moderate-to-severe anxiety symptoms during the COVID-19 pandemic decreased between the first to second timepoint. As highlighted above, the present research underscores the need for additional longitudinal research on mental illness among post-secondary student populations over the course of, and in the aftermath of, the COVID-19 pandemic to determine if estimates are sustained over time and/or lead to an increase in treatment seeking. Cohort samples with baseline estimates pre-COVID-19 pandemic are particularly advantageous, as they can ascertain changes in prevalence rates on account of the COVID-19 pandemic. Future longitudinal studies can also be harnessed to examine mechanisms associated with mental health, so that targets of interventions can be mechanistically informed (2).

Future research should explore additional contextual factors that may impact the risk for mental illness. For example, student SES may have notable impacts on the ability to engage in online learning. Consider the fact that stable internet connection, electronic devices, and a workspace at home are all prerequisites to partaking in online learning. Indeed, high SES has been found to be a protective factor following natural disasters and low SES students tended to report higher rates of anxiety during the COVID-19 pandemic (231, 232). Examination of such factors may inform how best to support students and gain a better understanding regarding how to target prevention and intervention efforts. Further, targeted research with post-secondary students who have pre-existing mental illness and may be particularly impacted by COVID-related stressors [e.g., loss of social capital, suspension of mental health services; (233)] is critical to determine if these stressors have exacerbated mental illness or increased the potential for relapse (16). Initial research has found that female university students with pre-existing mental illness reported greater loneliness, avoidant, and negative emotional coping during the pandemic compared to those without pre-existing mental illness (234). Finally, to our knowledge, few studies have examined protective factors that may mitigate the risk for mental illness during the COVID-19 pandemic. Sun et al. (181) found that, among a sample of university students, perceived social support and mindfulness

was associated with lower anxiety and depression symptoms. It will be important to conduct additional research to examine whether the protective benefits of social support differ between physical and virtual social support, for example, and can buffer the effects of the COVID-19 pandemic on mental health, to further inform policy and resource planning.

Implications for Policy and Practice

The current results implicate a need for continued, and possibly increased, availability of mental health services to meet the needs of students who develop or continue to experience pre-existing mental health symptomatology during, and following, the COVID-19 pandemic. Previous research has shown that unaddressed mental health difficulties can lead to poor long-term health (235), as well as lost income and productivity (236). Distress and anxiety related to unemployment or fear of contracting illness may be best addressed *via* broader social or public health interventions, rather than psychiatric care. Thus, governments and policymakers must prioritize the funding and provision of mental health services alongside social and public health interventions that broadly improve quality of life.

Mental health supports for post-secondary students are of utmost importance given the high rates of clinically significant anxiety and depression both prior to and during the COVID-19 pandemic. For example, it may be necessary to provide students with psychoeducational materials regarding mental health and well-being (i.e., importance of sleep hygiene, routines, exercise) and create increased accessibility to in-person and/or telemental health services. Telemental health services in particular will be important to increase equitable accessibility and improve scalability for student populations (237). Further, academic accommodations, including flexible deadlines and the option of virtual lectures, for students suffering from severe mental distress should be implemented in post-secondary institutions. The mental health needs of some students may surpass what can be provided by on-campus mental health centers, and funding for students to access mental health services in the community may be necessary. Given that stress is a primary precipitant of mental illness (238), policies that reduce stress by offering students financial support (i.e., income supplements) and social support (e.g., peer support resources; helplines) may be necessary and represent important mental health prevention efforts (239). Overall, these suggestions are encouraged both during, and following, the COVID-19 pandemic. Finally, while the implementation of quarantine may be necessary at times, previous research suggests that quarantine is associated with psychological distress (14), and as such, the closure of post-secondary institutions should be considered a last resort.

CONCLUSIONS

The current meta-analysis of 176 studies and close to 2 million participants demonstrate consistent prevalence rates of clinically elevated depressive and anxiety symptoms prior to, and during, the COVID-19 pandemic among post-secondary students. The COVID-19 pandemic represents a global crisis, both with respect to its physical consequences, but also its dire implications for the mental health of individuals globally. As such, the results of the current study represent a clarion call for urgent and sustained funding and support for evidence-based mental health screening, case-finding, and treatment for depression and anxiety.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

NR, SM, and JZ: concept and design. JZ, NR, RE, KD, and SM: critical revision of the manuscript for important intellectual content. NR: statistical analysis. SM: administrative, technical, and material support. NR and SM: supervision. All authors: acquisition, analysis, interpretation of data, and drafting 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/fpsyt.2021.777251/full#supplementary-material

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*Indicates study was included in the meta-analysis.

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The Association Between Changes in the University Educational Setting and Peer Relationships: Effects in Students' Depressive Symptoms During the COVID-19 Pandemic

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Objective: Abrupt life changes imposed by the lockdown measures, with a direct impact on teaching methodology and social interactions, as well as sleeping patterns, harmed university students' mental health. This study aimed to analyze the relationship between satisfaction with online teaching, social interaction with depression, anxiety symptomatology, and to analyze the effects of the pandemic and the lockdown in mental care access.

Methods: The online survey collected demographic data, satisfaction with online teaching, and social interaction. We evaluated the depression and anxiety symptomatology using the 9-item Patient Health Questionnaire and the 7-item Generalized Anxiety Disorder, respectively. For the PHQ-9, we used the cut-off 15 for moderately severe depressive symptoms, whereas for GAD-7, we recurred to the cut-off 10 for moderately severe anxiety symptoms. This study used three data points: October 2019, June 2020, and March 2021.

Findings: The study included $n = 366$ participants from all university study fields, with a mean age of 21.71 (SD = 1.42) in the last survey, and 71.3% were women. Depressive symptoms increased significantly from October 2019 to June 2020, and the mean scores grew until March 2021. Anxiety symptoms also significantly increased from October 2019 to June 2020; however, from June 2020 to March 2021, there was a non-significant decrease in the proportion. Mean scores for satisfaction with online teaching were 38.23% in June 2020 and 34.25% in March 2021, a non-significant difference. Satisfaction with social interaction significantly decreased from 37.35% in 2020 to 24.41% in 2021. Participants with scores above the cut-off of moderately severe and severe depressive and anxiety symptoms showed significantly lower satisfaction with online teaching than students with lower depression and anxiety scores. Despite the significant increase in clinical symptomatology, help-seeking behaviors did not change accordingly, and more than 50% of the students with mild or severe depressive and anxiety symptomatology did not get treatment during the pandemic.

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Conclusion: The findings of this study suggest that most students are dissatisfied with online teaching and the type of social interaction they were forced to adopt because of the pandemic. The severity of depressive and anxiety symptomatology significantly increased between October 2019 and March 2021, but help-seeking behaviors did not increase accordingly.

Keywords: COVID-19, depression, anxiety, online teaching, help-seeking behaviors

INTRODUCTION

The COVID-19 pandemic had a massive impact on public life, and for the first time in recent history, a large set of restrictions changed life as we used to know. In Portugal, as in most countries, we experienced the interdiction of face-to-face interactions, the closing of all schools and universities, and a vast set of adjustments to our lifestyle. These changes affected everyone with no exception; however, university students became a critical risk group because of the already high reported rates of mental illness among university students (1).

It soon became clear that the quarantine strategies harmed students' mental health alongside a consensus on the literature about increased anxiety and depression symptomatology (2–4). Previous studies have described increments in fear (2, 3), worry (4), and stress (5). However, most of the research is still cross-sectional or without pre-pandemic information in the same sample (5–8), and the maintenance of the symptoms after the quarantine is also not straightforward in the literature (9).

University students have also reported sleep alterations during the pandemic, with an evident decrease in sleep quality (10), insomnia and other sleep alterations (11).

Research on the effects of the lockdown in Europe in university students is concordant regarding the harm on mental health, especially concerning depressive and anxiety symptomatology (9, 12–14).

The most recent study, published by Kohls et al. (14) concluded that university students are a vulnerable risk for the development of mental illness as a result of the lockdown, namely depression. Another important conclusion of this study is the evidence that only half of the students diagnosed with any mental disorder received treatment.

Before the pandemic, Paul et al. (15) were interested in comparing traditional and online teaching methods: focusing on student performance, they found no differences between online and face-to-face students' performance overall between gender or class rank.

Students' learning experiences and the effectiveness of online programs are some of the challenges of online teaching (16), and student satisfaction, along with outcomes, can be a good indicator of the quality of the programs (17). To the best of our knowledge, not many studies investigated student satisfaction with online teaching. Most of them included students from the health care areas (16, 18, 19), and results are far from consensual. The Rajabalee and Santally study (16) showed that students were generally satisfied with the online learning experience and performance levels. On the other hand, they reported low levels of satisfaction with tutor support and technical difficulties. Dutta et al. (18) concluded, in their study with medical and nursing students, that online teaching is not an effective alternative. Rota et al. (19), evaluating professors' perceptions about online teaching, depicted that most academics favored providing online teaching, but opinions were almost unanimous that distant education could not substitute face-to-face teaching.

Due to the expected consequences of the pandemic and its life-change implications, many countries started to promote the importance of mental health care, and virtual care has become a growing area of investment (20, 21). Previous studies on mental health care help-seeking behaviors have established that many university students with mental health problems do not seek help (22). The most frequently identified help-seeking barriers are stigma and embarrassment about help-seeking and poor mental health literacy (23–25).

Even though many institutions invested many resources in developing mental health care programs remotely accessible, there is a lack of information on how people adjusted in terms of help-seeking behaviors.

With our study, we aimed (a) to evaluate the impact of COVID-19 lockdown in university students' anxiety and depression symptoms and how it progressed during the pandemic; (b) to analyze self-reported changes in satisfaction with online teaching, social interaction, and sleeping changes; and (c) to evaluate the effects of the pandemic in mental care access.

MATERIALS AND METHODS

Participants

The current study used three surveys: October 2019 (before the pandemic), June 2020 and March 2021 (during the pandemic). We extracted participants' data from a cohort of students from the University of Porto. The data was collected throughout an online survey and included participants registered in the first year from all University courses in 2019. More detailed information about this cohort participants is available elsewhere (12, 26).

The context of the surveys in 2020 and 2021 was considerably different in terms of lockdown measures. In 2020, lockdown had started on the 18th of March, and in June, lockdown measures were softer: shopping centers, cinemas, theaters, and gyms were open, however with restrictions in their maximum capacity of people and closing time; outside gatherings were allowed for a maximum of 20 people. In 2021, a new lockdown started in January, and lockdown measures were still stringent in March, with minimal face-to-face interactions allowed: civic duty of

home collection, prohibition of events or gatherings with more than 10 people, most of the shops were closed, cinemas, theaters and gyms were also closed. Both in 2020 and 2021 surveys, universities were still closed, and teaching was exclusively online.

Procedures and Outcomes

We asked participants to answer a short socio-demographic questionnaire about sex, age, and previous mental health care. In the 2020 and 2021 surveys, we also asked if students knew anyone infected by COVID-19 and if they were infected.

Participants also answered the Portuguese versions of The Patient Health Questionnaire (PHQ-9) (27, 28) and the Portuguese version of the Generalized Anxiety Disorder (GAD-7) (28) in all three surveys. Cronbach's alpha of the PHQ-9 was 0.86 at baseline, and GAD-7's Cronbach alpha was 0.91, indicating good internal reliabilities.

We analyzed PHQ-9 and GAD-7 scores as continuous variables, indicating a central average score for the sample and a binary threshold score, indicating the proportion of participants with a clinically significant level of symptoms, at least moderate, in need of assessment and possibly, intervention. The cut-off point for moderate symptomatology on the PHQ-9 scale is 15 (29) and ten on the GAD-7 scale (30).

Data Analysis

Data were analyzed with a 95% confidence interval, using SPSS 24.

We used Student's *t*-test to compare groups in continuous variables and the Mann-Whitney test to compare proportions between two groups. We explored the differences in PHQ-9 and GAD-7 scores across time, using One-Way ANOVA repeated measures to assess changes in means with *post-hoc* Bonferroni comparisons and Cochran's Q test with McNemar's *post-hoc* Bonferroni-adjusted alpha to evaluate the changes in cut-off proportions between the different surveys. We also calculated the partial eta square to understand the effect of time in the depressive and anxiety symptomatology scores across time.

Ethical, Registration, and Guidelines Considerations

This study comprises comprehensive longitudinal research on first-year university students' mental health, including an experimental single-blind randomized control trial.

(ISRCTN970936), moreover registered as an observational study to analyze the effects of COVID-19 in this cohort (ISRCTN63459073).

It complies with the relevant national and institutional committees' ethical standards on human experimentation and the Helsinki Declaration of 1975, as revised in 2008. The Institute of Public Health of the University of Porto ethics committee approved the research with the ID reference CE18096. All participants signed an informed consent digital form according to the Helsinki and Oviedo Conventions.

To avoid possible inadequacies in the study reporting, we followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (31) guidelines in the construction and preparation of the study.

RESULTS

Participants

In October 2019, our cohort included 623 participants. In June 2020, the number of participants decreased to 401, and in March 2021, 366 participants answered our questionnaire. Our sample included the 366 participants with answers in all of these three surveys.

In the last survey, participants' mean age was 20.71 (SD = 1.42), and 71.3% ($n = 261$) were women and came from all 14 schools of the University of Porto.

Compared with the sample in October 2019, the participation rate was 58.7%, but we did not observe significant differences between participants and dropouts on depressive and anxiety symptomatology. In October 2019, the 366 participants included in the final sample presented a total score of 9.53 (SD = 3.27) on the depressive symptomatology scale, while the dropouts ($n = 257$) showed a mean score of 9.57 (SD = 3.56) [$t_{(2,621)} = -0.07$, $p = 0.95$]. On the anxiety symptomatology scale, at the moment of the first survey, included participants obtained a mean of 9.74 (SD = 4.25), and dropouts showed a mean of 9.86 (SD = 4.05) [$t_{(2,621)} = -0.23$, $p = 0.82$].

In March 2021, 65% ($n = 238$) of the participants knew someone infected with COVID-19, and 20.2% ($n = 74$) were infected themselves. Most of the participants (68.6%, $n = 251$) reported going to sleep later after the beginning of the pandemic, resulting in a mean of 6.77 (SD = 1.13) hours asleep per night.

Self-Reported Satisfaction With Online Teaching and Social Interaction

Ensuing the pandemic, participants showed low satisfaction levels with online teaching, with a mean of 38.32% (SD = 25.57) in 2020 and 34.25% (SD = 29.42) in 2021. Even though we observed a decrease, the difference was not significant, as shown in **Figure 1**. On the other hand, satisfaction with social interaction also experienced a significant decline: a mean of 37.35% (SD = 23.83) in 2020 to 24.41% (SD = 21.08) in 2021 (**Figure 1**).

We did not identify a significant difference between gender and satisfaction scores over time in any measures. In satisfaction with online teaching, the effect was [$F_{(1)} = 0.18$, $p = 0.67$], and in satisfaction with social interaction was [$F_{(1)} = 0.93$, $p = 0.34$].

Clinical Symptomatology

As we can observe in **Table 1**, **Figure 2**, the mean score of depressive symptomatology significantly increased after the beginning of the pandemic. The observed changes are significant from each time point with the other, as *post-hoc* tests showed a $p < 0.001$ in each comparison. We also observe a significant time effect, as the eta squared is higher than 0.14.

The proportion of students with moderate-severe and severe depressive symptomatology increased significantly after the pandemic and kept growing. *Post-hoc* tests using McNemar's with Bonferroni-adjusted alpha level showed significant differences in the proportion distributions between all surveys.

No significant interaction was detected between the mean scores throughout time, knowing someone infected or being

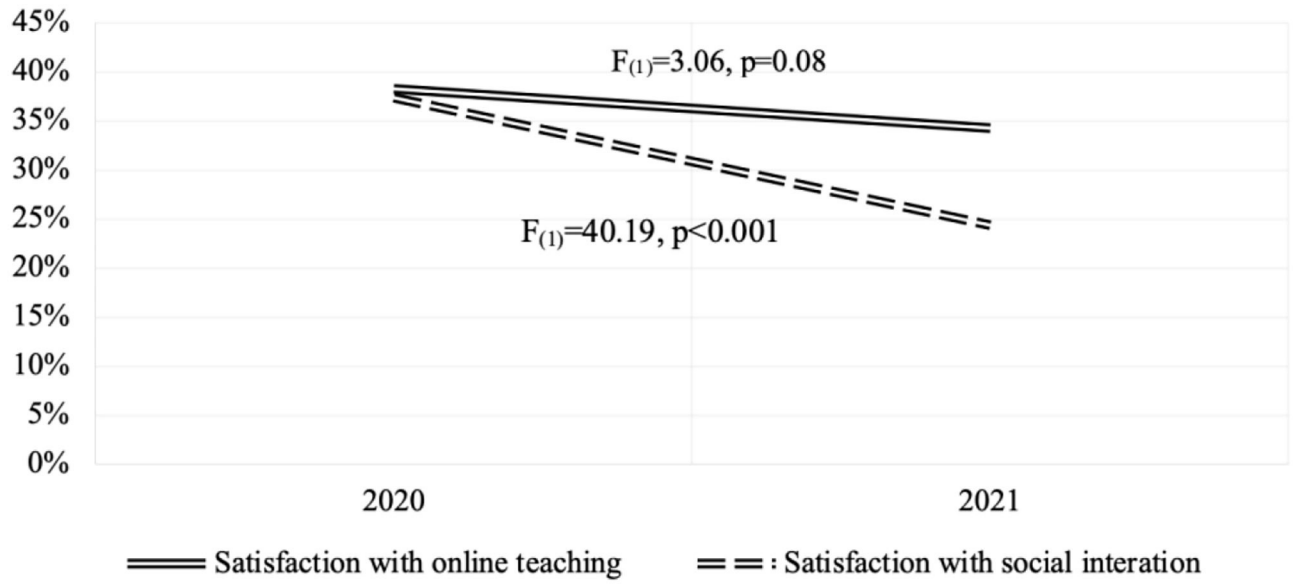

FIGURE 1 | Evolution of satisfaction with online teaching and social interaction between 2020 and 2021.

TABLE 1 | Depressive and anxiety symptomatology changes across time.

		Oct 2019	June 2020	March 2021	Test	η^2
PHQ-9	<15 (n)	78.4% ($n = 287$)	62.5% ($n = 229$)	51.2% ($n = 187$)	$\chi^2_{(2)} = 54.11, p < 0.001$	0.17
	≥15 (n)	21.6% ($n = 79$)	37.5% ($n = 137$)	48.6% ($n = 179$)		
GAD-7	<10 (n)	53.9% ($n = 287$)	34.6% ($n = 127$)	40.3% ($n = 147$)	$\chi^2_{(2)} = 22.90, p < 0.001$	
	≥10 (n)	46.1% ($n = 79$)	65.4% ($n = 239$)	59.7% ($n = 219$)		0.06

infected. Nonetheless, we observed a significant effect of being infected with COVID-19 and the moderate-severe and severe depressive symptomatology in 2021, where 60.5% of those who scored 15 points or above got COVID-19 ($f = 0.15$, $p < 0.05$). This effect corresponds to an odds-ratio of developing depressive clinically relevant symptomatology of 2.18 (CI = 1.06–4.45).

Time also revealed a significant effect on anxiety symptomatology, yet there was a slight decrease in the symptomatology mean from 2020 to 2021 (**Table 1**). The *post-hoc* test revealed that the differences are only significant between the 2019 survey and 2020 and 2021 individually ($p < 0.001$). Between 2020 and 2021, the difference was no longer significant ($p = 0.89$). The observed eta squared indicates a medium effect of time.

We also observed a significant increase in the proportion of moderate-severe and severe anxiety symptomatology from 2010 to 2020. McNemar's with Bonferroni-adjusted alpha level *post-hoc* test did not show a significant difference between 2020 and 2021 ($p = 0.11$).

In the anxiety symptomatology, no significant interaction was detected between the mean scores nor proportions throughout time, knowing someone infected or being infected.

Participants with more severe depressive and anxiety symptoms reported less satisfaction with online teaching and social interaction (**Table 2**), with a significant Pearson correlation between depressive and anxiety symptomatology total score and satisfaction with online teaching and social interaction.

Along 2020 and 2021, depressive symptomatology correlated negatively both with satisfaction with online teaching (respectively $r = -0.59$, $p < 0.001$; $r = -0.41$, $p < 0.001$) and with social interaction (respectively $r = -0.66$, $p < 0.001$; $r = -0.47$, $p < 0.001$). Similarly, in 2020 and 2021, negative correlations occurred between anxiety symptomatology and online teaching ($r = -0.47$, $p < 0.001$; $r = -0.36$, $p < 0.001$) and satisfaction with social interaction ($r = -0.49$, $p < 0.001$; $r = -0.48$, $p < 0.001$).

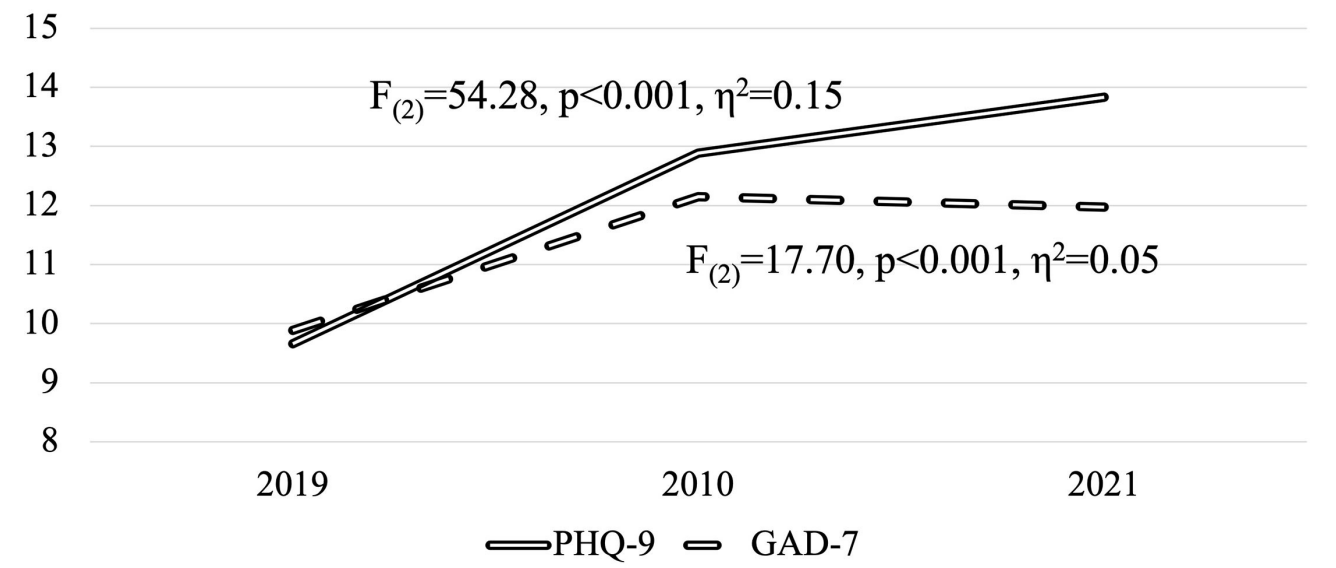

FIGURE 2 | Evolution of PHQ-9 and GAD-7 mean scores between 2019, 2020, and 2021.

TABLE 2 | Satisfaction with online teaching and social interaction according to depressive and anxiety symptomatology.

			June 2020 M (SD)	March 2021 M (SD)
PHQ-9	Satisfaction with online teaching	<15	44.0 (25.10)	37.74 (29.74)
		≥15	33.7 (27.22)	30.52 (26.56)
		Test	$t_{(364)} = 4.88, p < 0.001$	$t_{(364)} = 2.68, p < 0.01$
	Satisfaction with social interaction	<15	43.41 (23.32)	27.20 (23.86)
		≥15	30.54 (21.34)	20.26 (23.11)
		Test	$t_{(364)} = 7.09, p < 0.001$	$t_{(364)} = 3.34, p < 0.01$
GAD-7	Satisfaction with online teaching	<15	49.15 (24.80)	39.93 (29.87)
		≥15	35.41 (25.91)	29.64 (19.69)
		Test	$t_{(364)} = 4.88, p < 0.001$	$t_{(364)} = 3.86, p < 0.001$
	Satisfaction with social interaction	<15	47.28 (23.09)	28.95 (24.01)
		≥15	33.11 (22.12)	20.44 (22.06)
		Test	$t_{(364)} = 7.99, p < 0.001$	$t_{(364)} = 4.03, p < 0.001$

Help-Seeking Behaviors

As we can observe, in **Table 3**, there was an increase in treatment access after the pandemic, but these changes were not significant: $\chi 2_{(2)} = 1.78$ $p = 0.4$. The most significant change observed has to do with the symptomatology measured in the different periods of mental health care treatment: before the pandemic, the number of students who received treatment and did not score above the cut-off in any of the scales is considerably higher than after the pandemic. We also observe that more than half of the students with mild or severe depressive and anxiety symptomatology did not get treatment during the pandemic (62.1% in June 2020, $n = 227$, and 56.1% in March 2021, $n = 205$), a number significantly higher than pre-pandemic (48.5%, $n = 177$).

DISCUSSION

One of the leading life alterations in university students' lives was the closing of universities, which meant the learning setting and the impossibility of face-to-face interactions with peers and professors. From a research perspective and for professors and policy-makers, student satisfaction and engagement are essential in higher education (16).

In our sample, satisfaction with online teaching was low both in the 2020 and 2021 surveys. The international research on students' satisfaction with online teaching is scarce with mixed results. For instance, only 25.6% of students manifested low satisfaction with one specific e-learning module (16). On the other hand, most Indian medical and nursing students reported

TABLE 3 | Global treatment proportions throughout time and according to clinical symptomatology.

		October 2019 (n)	June 2020 (n)	March 2021 (n)
Students who received mental health-related treatment		19.9% ($n = 73$)	22.5% ($n = 82$)	21% ($n = 77$)
Symptomatology of those who received treatment	Under cut-offs	36.5% ($n = 134$)	24.7% ($n = 90$)	23.9% ($n = 87$)
	Above cut-off in one scale	28.5% ($n = 104$)	22.7% ($n = 83$)	24.2% ($n = 89$)
	Above cut-off in both scales	35% ($n = 128$)	52.6% ($n = 193$)	52% ($n = 190$)
Symptomatology of those who did not receive treatment	Under cut-offs	51.5% ($n = 188$)	37.9% ($n = 139$)	43.9% ($n = 161$)
	Above cut-off in one scale	33.4% ($n = 122$)	30.2% ($n = 110$)	25% ($n = 90$)
	Above cut-off in both scales	15.1% ($n = 56$)	31.9% ($n = 117$)	31.1% ($n = 115$)

dissatisfaction with online teaching, with 42% of the sample reporting very dissatisfied or dissatisfied (18). Since this is an essential issue for student engagement and academic success, more research is needed to understand the factors underlying students' perspectives on the educational settings. In a study with academics from Italian universities, participants agreed that distant education could not substitute the value of learning with personal interactions (19).

Regarding satisfaction with social interaction, we observed a significant decrease from 2020 to 2021; this decline may be due to the tiredness of the students after more than 1 year of restrictions and the more restricted lockdown measures at the moment of the 2021 survey.

Regarding sleeping patterns, our sample revealed a similar result to the existing literature (10, 11), with most students reporting fewer hours asleep and going to sleep later than before the pandemic.

Depressive symptomatology significantly increased over 18 months from the pre-pandemic period throughout the second pandemic lockdown. In 2021, almost half of the sample presented moderate-severe to severe depressive symptomatology. Even though sex or knowing someone infected with COVID-19 did not significantly affect depressive symptomatology, getting the illness significantly increased the risk of depression.

We also observed a significant correlation between satisfaction with online teaching and satisfaction with social interaction and depressive symptomatology. Students who scored above the cut-off for moderately severe and severe depressive symptoms presented significantly lower levels of satisfaction with online teaching and social interaction, an expectable consequence of depression.

Anxiety symptoms also significantly increased from 2019 to 2020. Even though we see a slight decrease from 2020 to 2021, the difference was not significant and may indicate adaptation and habituation mechanisms acting as protectors and promoting student resilience. We also found no significant interaction with sex, knowing someone infected, or getting the illness.

However, correlations between satisfaction with social interaction, online teaching, and anxiety symptoms were as significant as those found for depressive symptomology. Nonetheless, participants who scored above the cut-off in the anxiety scale presented significantly lower satisfaction levels in online teaching and social interaction.

Despite the apparent mental health detriment spanning 18 months from 2019 to 2020 and 2021, the investment in the promotion of mental health care and the development of virtual educational solutions (20, 21), the number of students receiving treatment did not significantly increase after the beginning of the pandemic. The WHO mental health survey estimated that only 23.1% of the students with mental illness received adequate treatment (22). This number was obtained pre-pandemic and is higher than the one obtained in our sample in 2019. This difference may be illusory, resulting from the inclusion of Portugal in the high-income group, which may not represent the actual rate since there is still vital work to be done in terms of mental health care accessibility and availability (32).

Although the difference in the global proportion of students who received treatment did not significantly change, we observed a change in the clinical symptomatology of those who got help: the proportion of students receiving mental health treatment in 2020 and 2021 with clinically relevant symptomatology was higher than in 2019. Still, more than half of the students with mild or severe depressive and anxiety symptomatology did not get treatment during the pandemic, a number significantly higher than pre-pandemic.

One limitation of our study is the dropout rate: we lost 41.3% of our sample, increasing the risk of selection bias due to increased online activity in general and online research accrued due to the pandemic. However, there are no differences between participants, and 366 subjects is a good participant number for a longitudinal study.

One main strength of our study is that we can compare data pre and post-pandemic in the same sample, surpassing some of the limitations identified in other research, as cross-sectional

data mainly was used (5–8). Also, cohort studies may minimize sampling bias and are more robust to accurately identify the effects of the COVID-19 lockdown on mental health methodology (33). Likewise, we only included participants with answers in all the evaluation moments, reducing the risk of bias.

Students from all different schools and courses of the university were included, which is a significant strength of our research. Most studies on the subject include only health sector university students.

To our knowledge, this is the first study in Portugal to evaluate the actual mental health help-care seeking in university students presenting data on treatment care before and after the pandemic.

Future research could explore further the relationship between satisfaction with online teaching, depressive and anxiety symptomatology, and academic engagements and results. It would also be interesting to examine further the evolution of clinical symptomatology after the end of the restricted confinement measures in the same sample.

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 Institute of Public Health of University of Porto. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

VC: conceived the main idea of the study, to the design and implementation of the research, the analysis and interpretation of the results, and led the writing of the manuscript with input from all authors. IR: contributed to the design and implementation of the research. RG: contributed to the planning and supervision of the research, analysis and interpretation of the results, and manuscript writing.

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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.2021.783776/full#supplementary-material

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Medical Students Show Lower Physical Activity Levels and Higher Anxiety Than Physical Education Students: A Cross-Sectional Study During the COVID-19 Pandemic

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Objective: This study aimed to compare the time in physical activity (PA) [light (LPA), moderate and vigorous (MVPA)] and sedentary behavior (SB) (weekdays, weekends, or both) between Medical (MED) and Physical Education (PE) students who underwent remote classes imposed by the COVID-19. In addition, we compared symptoms of depression and anxiety and sleep quality.

Methods: A cross-sectional study (272 MED and 95 PE students). The International Physical Activity Questionnaire (IPAQ), Beck Inventory (Anxiety, Depression), and Pittsburgh Sleep Quality were used to assess PA and SB, anxiety and depression symptoms, and quality of sleep, respectively. The data are presented as median and interquartile intervals 25–75.

Results: We observed statistically significant differences between MED and PE students for MVPA [MED: 165 min per week (0–360) vs. PE: 420 min per week (180–670), $p < 0.001$], SB Total [MED: 10 h per day (8–12) vs. PE: 7 h per day (5–10), $p < 0.001$)], and anxiety symptoms [MED: 13 points (5–23) vs. PE: six points (2–16), $p < 0.001$)].

Conclusion: Together, our findings indicate that MED students spent less time in MVPA and more time in SB than PE students. MED students also presented worse mental health in the pandemic situation imposed by the COVID-19.

Keywords: sedentary behavior, university, exercise, coronavirus – COVID-19, student

INTRODUCTION

The COVID-19 pandemic (1) led the world population to adopt preventive measures, such as hygiene habits, and to maintain social distancing and home isolation to control the spread of the virus. In this scenario, common activities were drastically affected, such as work routine, (2) leisure-related activities (3), and regular classes at schools and universities (4).

Home isolation may impact levels of physical activity (PA, defined as activity that gets your body moving, to increase energy expenditure above resting levels) (5) and sedentary behavior

(SB, defined as waking behavior characterized by an energy expenditure ≤ of 1.5 metabolic equivalents, while in a sitting, reclining, or lying posture) (6). Indeed, recent data showed that PA and SB were drastically affected by the COVID-19 pandemic (7). This scenario was inevitable due to the lack of vaccinations early in the pandemic.

PA and SB are associated with mental health and sleep quality (8). For example, high levels of PA are related to lower symptoms of depression and anxiety (9) and greater sleep quality (10). On the other hand, elevated SB is associated with depression and anxiety symptoms (11). Furthermore, home isolation due to the COVID-19 pandemic has been related to worsening mental health in the general population (12, 13). Moreover, negative mental alterations such as depression and anxiety symptoms may lead to a poor physical activity-related lifestyle (e.g., lower PA and higher SB), establishing a "vicious cycle" among these conditions (11, 14).

Students were drastically affected by the COVID-19 pandemic since education systems adopted remote classes. Under normal conditions, most university students already did not meet the recommendation of PA and spent approximately 7–8 h per day in SB (15). In the same way, we observed that more than two thirds of Brazilian medical students did not meet the recommendation of PA and spent more than 8 h per day in SB during the pandemic (14). This poor physical activity-related lifestyle may impair sleep quality and increase the depression and anxiety symptoms commonly observed in MED students (16, 17). Interestingly, most Brazilian physical education (PE) students meet physical activity recommendations (18). In fact, a recent meta-analysis (15 studies, 3,245 students) indicates that between two-thirds and all (71 to 100%) Brazilian PE meet PA recommendations.

Although it is still possible to speculate that the PA and SB of PE students were negatively influenced during the COVID-19 pandemic, in the same way as MED students, due to the change from regular classes to remote classes. On the other hand, despite the possible negative impact of the pandemic on PA and SB, engagement of PE students in the practical demands related to the physical education classes characteristic of their course and associated internships, may confer some advantage compared to MED students. However, this assumption still needs to be elucidated.

Another important point related to the routines of MED students is activities to assist the population during a pandemic, particularly students enrolled in the second half of the course (6th to 12th semesters). Furthermore, lack of resources and staffing, coupled with reduced staff numbers through contamination with the virus, may have further increased the stressful situations related to medical work demand (19). In this scenario, it is reasonable to assume that MED students from different semesters may present distinct mental health, as well as different times of PA and SB due to time taken with patient care. Therefore, it is feasible to compare the first half of the course with the second half of the course.

Thus, the current study aimed to compare the levels of PA [light (LPA), moderate and vigorous (MVPA)] and SB (on weekdays, weekends, or both) between MED and PE students who underwent remote classes, imposed due to the COVID-19 pandemic. In addition, we compared depression and anxiety symptoms and sleep quality of MED and PE students, and the first and second halves of the courses. We hypothesized that MED students would spend less time in PA and more time in SB and demonstrate worse mental health than PE students, with differences between the first and second halves of the MED course.

METHODS

Study Design and Participants

This is a cross-sectional study, which was approved by the local Ethics and Research Committee (approval number: 4.049.214), and followed the precepts of the Declaration of Helsinki. The data were collected between September 2020 and February 2021. All students agreed and signed the consent form. Students aged ≥18 years from MED (1st to 12th semester) and PE (1st to the 8th semester) were invited to participate in the study. Participants were contacted via message application or e-mail. If the participant agreed to participate, they were sent an online form containing the consent form and questionnaires to assess demographic characteristics, PA, SB, depression and anxiety symptoms, and sleep quality. For better comprehension of the collected information, initially, the student representative of the groups (WhatsApp group administrator) sent the research questionnaire link directly to the WhatsApp group. After 4 days, the authors (TB and KC) were added to these WhatsApp groups and again sent the research questionnaire link and were available to clarify any doubts. Of 1,400 students from 30 distinct classes contacted, 367 students (MED: 272 = 27% of all MED students; PE: 95 = 24% of all PE students) answered the questionnaire. No students directly stated that they did not want to participate in the survey. Despite the groups being unbalanced, we emphasize that, in percentage terms, ∼25% of the students in each course were evaluated.

Demographic Characteristics and Self-Perception During the COVID-19 Pandemic

A questionnaire was included to collect data on age, sex, semester of the course, the city lived in before enrolling on the course, the practice of a physical exercise program, COVID-19 diagnosis, use of tobacco and alcohol, and questions about self-perception of worsening of the level of PA and SB during the period of the COVID-19 pandemic.

Sample Size Calculation

The sample size was determined using G-Power software (version 3.1.2 – Universitat Kiel, Germany), inputting an α error (0.05) and power (1 – β error = 0.90). Since the literature is scarce concerning comparisons of PA and SB between MED and PE students, we assumed an arbitrary moderate effect size (Cohen' d) of 0.4. Calculations were based on an independent *t*-test, and the total sample size was determined 180 patients (i.e., 90 students in each group).

Measures

Physical Activity and Sedentary Behavior Assessment

The times of PA (LPA, MVPA) and SB (weekdays, weekends, or both) were assessed by the International Physical Activity Questionnaire (IPAQ), which contains eight questions about PA and SB considering the routine of the previous seven days. This tool is widely used and validated for the Brazilian population (20). The IPAQ shows good reliability (Spearman correlation coefficients = 0.80) and test–retest reliability (Spearman correlation coefficients = 0.80), and presents high correlations with other measures of physical activity (accelerometer = 0.70 to 0.80) (21).

Anxiety and Depression Symptom Assessment

Anxiety and depression symptoms were assessed by the Beck Anxiety Inventory (BAI) and Beck Depressive Inventory (BDI) (22, 23), which are composed of 21 multiple-choice statements, each with four possible responses (0–3). Thus, the final score ranges from 0 to 63 points. The BAI shows good reliability (Cronbach's alpha coefficient = 0.95) and test–retest reliability (Pearson's r = 0.73 to 0.96), and presents high correlations with other measures of anxiety (State-Trait Anxiety Inventory = 0.58; Diary Anxiety = 0.54) (24). The BAI is a widely used tool, validated for the Brazilian population (25). The cut-off point adopted to identify symptoms of low and high anxiety followed that shown in a previous study (26): <13 points (low anxiety symptoms) and ≥ 13 points (high anxiety symptoms).

The BDI is also a validated tool for the Brazilian population (27) and shows good reliability (Cronbach's alpha coefficient = 0.85) and test–retest reliability (Pearson's r = 0.76), and presents high correlations with other measures of depression, including the Center for Epidemiologic Studies of Depression (Pearson's r = 0.66–0.86) and Hamilton Rating Scale for Depression (Pearson's r = 0.66–0.75) (28). The cut-off point adopted to identify symptoms of low and high depression followed that shown in previous studies (29): <10 points (symptoms of low depression) and ≥ 10 points (symptoms of high depression).

Sleep Assessment

Sleep quality was assessed by the Pittsburgh Sleep Quality Index (PSQI), validated for the Brazilian population (30). The PSQI contains questions about the subject's sleep habits during the previous month. For example, bedtime, time to fall asleep, time to wake up, and actual h of sleep, in addition to the frequency (1, 2, or 3 times a week) of difficulty falling asleep in 30 min, waking up at night/dawn, getting up at night to go to the bathroom, difficulty breathing, coughing, snoring, cold, heat, nightmares, other reasons. The final score ranges from 0 to 21 points. The measure consists of 19 individual items, creating seven components (Subjective sleep quality; Sleep latency; Sleep duration; Habitual sleep efficiency; Sleep disturbances; Use of sleeping medication; Daytime dysfunction) and a Global PSQI score (sum of the 7 components). The PSQI shows good reliability (Cronbach's alpha coefficient = 0.82) (31) and test–retest reliability (a intraclass correlation coefficient = 0.81) (32), and presents high correlations with other measures of sleep quality (i.e., clinical diagnosis of insomnia, the ISI score, some variables of polysomnography) (32). In addition, the most commonly reported cut-off point for MS in a recent meta-analysis (33) was adopted: <6 points (good sleep quality) and ≥6 points (poor sleep quality).

Statistical Analysis

Data are presented as mean (standard deviation), or median and interquartile range (IQR) for continuous variables. Categorical variables are shown as absolute and frequencies (%). Normality and equality of variances were tested using the Kolmogorov-Smirnov test and Levene test, respectively. Non-parametric data are shown as median and interquartile range (IQR: 25 – 75). The Mann-Whitney test was used to assess differences between groups (PE and MED) and between the first and second halves of the courses (1st to 4th and 5th to 8th in PE; 1st to 6th and 7th to 12th in MED). Logistic regression models were used to evaluate the association between course (MED or PE), and dichotomous variables: MVPA (<300 min per week vs ≥300 min per week), SB (< than 8 h vs ≥ than 8 h). Additionally, the association between course (MED or PE) and continues variables: anxiety symptoms (points of BAI), depression symptoms (points of BDI), and sleep quality (points of PSQI) were evaluated. Results from the logistic regression models were presented as odds ratios (ORs). The presence of relationships between numerical variables (MVPA, SB, Anxiety and Depression symptoms, and, Sleep Quality), was examined with the Spearman Correlation Test. Data were analyzed using IBM SPSS Statistics, version 22 (SPSS Inc., Chicago, IL, USA). The significance level was set at $P \leq 0.05$.

RESULTS

Table 1 details the main sample characteristics. In brief, 1,400 students from 30 distinct classes were contacted, of which 367 students (MED: 272; PE: 95) answered the questionnaire and were included in the analysis. The sample of MED students was predominantly composed of females (79%), while the sample of PE students was composed mainly of males (63%). The median ages for MED and PE students were 21 and 25 years, respectively. Sixty-seven percent (67%) of the MED students were inactive (<300 min per week), compared to only thirty-four percent (34%) of the PE students. Seventy-nine percent (79%) of the MED students and 57% of the PE students reported spending more than 8 h in SB.

Table 2 presents a comparison between MED and PE students regarding the sleep variable PSQI. Considering the Global PSQI score, we did not verify a significant difference between the groups ($p > 0.05$). However, when comparing specific components of PSQI, we observed greater scores in sleep duration and habitual sleep efficiency for MED students compared to PE students (both $p < 0.05$). On the other hand, PE students showed greater scores for use of sleeping medication and daytime dysfunction than MED students (both $p < 0.05$).

Figure 1 presents the comparisons between MED and PE students regarding: panel A - Anxiety symptoms (BAI); panel B - Depression symptoms (BDI); panel C - Light physical activity; panel D - Moderate and vigorous physical activity; panel E -

TABLE 1 | Sample characteristics of medical (MED) and physical education (PE) students.

Variable	MED (*N* = 272)	PE (*n* = 95)
Age (years)	21.0 (19.3–23.0)	25.3 (20.0–30.0)
Sex Female	215 (79%)	35 (36.8%)
Male	57 (21%)	60 (63.2%)
The first half of the courses (1st to 4th PE or 1st to 6th MED)	221 (81.2%)	53 (55.8%)
The second half of the courses (5th to 8th PE or 7th to 12th MED)	51 (18.8%)	42 (44.2%)
MVPA Physically inactive (<300 min per week)	184 (67.7%)	33 (34.8%)
Physically active (≥300 min per week)	89 (32.3%)	62 (65.2%)
SB ≥ than 8 h Yes	216 (79.4%)	55 (57.9%)
No	66 (20.6%)	40 (42.1%)
Have you performed systematic physical exercises in the last 6 months? (This includes weight training, swimming, dancing, or any other type of activities, performed as part of your routine)		
Yes	181 (66.5%)	74 (77.9%)
No	91 (33.5%)	21 (22.1%)
Anxiety symptoms 0 to 12 points (low anxiety symptoms *)	135 (49.6%)	73 (76.8%)
>12 points (high anxiety symptoms *)	137 (50.4%)	22 (23.2%)
Depression symptoms 0 to 10 points (low depression symptoms **)	132 (48.5%)	59 (62.1%)
>10 points (elevated depression symptoms **)	140 (51.5%)	36 (37.9%)
Sleep quality Good sleep quality (<6 points) ***	125 (46.0%)	53 (55.8%)
Poor sleep quality (≥6 points) ***	147 (54.0%)	42 (44.2%)
Have you had a COVID-19 diagnosis? Yes	30 (11.0%)	16 (16.8%)
No	242 (89.0%)	79 (83.2%)
Do you consider that the COVID-19 pandemic changed your level of physical activity and SB?		
Yes	226 (83.1%)	64 (67.4%)
No	46 (16.9%)	31 (32.6%)
Do you consider that the COVID-19 pandemic changed your level of anxiety symptoms?		
Yes	220 (80.9%)	56 (58.9%)
No	52 (19.1%)	39 (41.1%)
Do you consider that the COVID-19 pandemic changed your level of depression symptoms?		
Yes	150 (55.1%)	32 (33.7%)
No	122 (44.9%)	63 (66.3%)
Do you use cigarettes? Yes	40 (14.7%)	6 (6.3%)
No	232 (85.3%)	89 (93.7%)
Do you use alcohol? [0.5pt] Yes	180 (66.2%)	41 (43.2%)
No	92 (33.8%)	54 (56.8%)

*SB, sedentary behavior; MVPA, moderate and vigorous physical activity; *Based on the cut-off of Sæmundsson et al. (26). **Based on the cut-off of Gomes et al. (27). *** Based on the cut-off of Rao et al. (33).*

TABLE 2 | Comparison between Medicine and Physical Education students regarding the sleep variable Pittsburgh Sleep Quality Index.

PSQI Components	Medicine students (*N* = 272) Median – Q1-Q3	Physical Education students (*N* = 95) Median – Q1-Q3	*p*-value
Subjective sleep quality	1 (1–2)	1 (1–2)	0.707
Sleep latency	2 (1–2)	1 (1–2)	0.173
Sleep duration	1 (0–2)	2 (0–2)	0.058
Habitual sleep efficiency	0 (0–1)	0 (0–1)	0.022
Sleep disturbances	1 (1–1)	1 (1–1)	0.569
Use of sleeping medication	0 (0–0)	0 (0–0)	<0.001
Daytime dysfunction	1 (1–2)	1 (0–2)	<0.002
Global PSQI score	7 (4–10)	7 (4–10)	0.509

All PSQI components are presented in total points (0–3). Global PSQI score presented in total points (0–21). PSQI, Pittsburgh Sleep Quality Index.

Sedentary behavior days of week; panel F - Sedentary behavior days of the weekend; panel G - Sedentary behavior total.

The MED students presented worse scores related to anxiety symptoms [median above the cut-off for high anxiety symptoms – >12 points - SÆMUNDSSON et al. (2011)] (26), physical activity - LPA and MVPA (median lower than recommendation of 300 min per week), and SB days of week and total (more than 8 h per day) in comparison to PE students.

Table 3 presents a comparison (Mann-Whitney Test) between the first and second halves of the courses (1st to 4th and 5th to 8th in PE; 1st to 6th and 7th to 12th in MED) regarding anxiety symptoms (BAI), depression symptoms (BDI), and variables related to the level of physical activity (LPA and MVPA) and SB (week, weekend, and total).

The first and second halves of the courses (1st to 4th and 5th to 8th in PE; 1st to 6th and 7th to 12th in MED) did not present differences for anxiety and depression symptoms, physical activity (LPA and MVPA), and SB (week, weekend, and total). Furthermore, for sleep quality (PSQI), we did not verify differences between the first and second halves of the course in MED (1st to 6th and 7th to 12th), but differences were verified between the first and second halves of the course in PE (1st to 4th and 5th to 8th), for sleep latency and sleep disturbances.

Table 4 presents a logistic regression association of course (MED or PE) and meeting the MVPA recommendation, accumulated <8 h of SB, High Anxiety symptoms (<12 points), High Depression symptoms (<10 points), and Poor Sleep Quality (≥6 points).

The course was associated with an increase in meeting MVPA recommendations (OR = 3.87, 95%CI 2.27–6.59 $p < 0.001$) and a decrease in reporting >8 h per day of SB (OR = 0.28, 95%CI 0.17–0.47 $p < 0.001$.

Table 5 presents a relationship (Spearman Correlation) between MVPA, SB, Anxiety symptoms, Depression symptoms, and Sleep Quality.

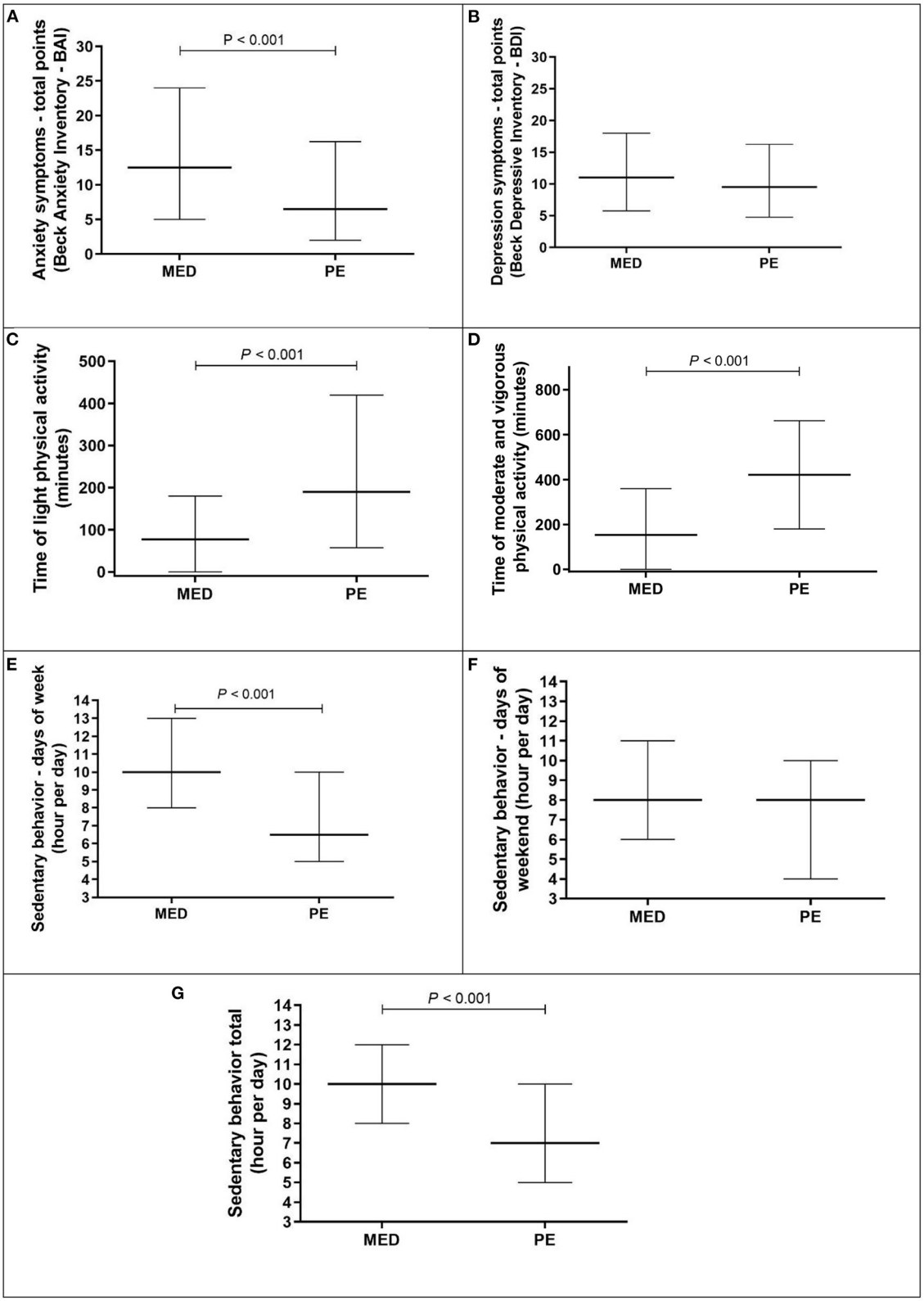

FIGURE 1 | Comparison between medical (MED) and physical education (PE) student regarding anxiety symptoms, depression symptoms, time of light, moderate and vigorous physical activity, and time of sedentary behavior (week, weekend, and total). Data present in median and interval interquartile (25–75). Anxiety Symptoms and Depression symptoms present in total points (0–63). LPA and MVPA are present in minutes per week. Sedentary behavior of week, weekend, and Total are present in hour per day. **Panel A** - Anxiety symptoms (BAI); **panel B** - Depression symptoms (BDI); **panel C** - Light physical activity; **panel D** - Moderate and vigorous physical activity; **panel E** - Sedentary behavior days of week; **panel F** - Sedentary behavior days of the weekend; **panel G** - Sedentary behavior total.

TABLE 3 | Comparisons (Mann-Whitney Test) between the first and second halves of the courses (1st to 4th and 5th to 8th in PE; 1st to 6th and 7th to 12th in MED) regarding anxiety symptoms (Beck Anxiety Inventory - BAI), depression symptoms (Beck Depressive Inventory - BDI), level of physical activity and sedentary behavior (IPAQ).

	Medicine students (*N* = 272) Median – Q1-Q3		**p-value**	**Physical Education students (*N* = 95) Median – Q1-Q3**		***p*-value**
	The first half of the course (*N* = 221)	**The second half of the course (*N* = 51)**		**The first half of the course (*N* = 53)**	**The second half of the course (*N* = 42)**	
Anxiety Symptoms	13 (6–24)	11 (4–21)	0.079	10 (2–19)	5(2–12)	0.074
Depression symptoms	11 (5–18)	12 (6–16)	0.746	11 (4–18)	9 (4–13)	0.329
LPA	90 (50–240)	60 (40–150)	0.451	150 (80–410)	180 (82–420)	0.735
MVPA	160 (80–360)	180 (450)	0.652	420 (180–725)	470 (202–660)	0.831
SB week	10 (8–13)	10 (8–12)	0.723	6 (4–10)	7 (5–10)	0.299
SB weekend	8 (5–11)	10 (7–12)	0.057	6 (4–10)	8 (4–13)	0.442
SB Total	9 (7–12)	10 (8–13)	0.653	6 (4–9)	7 (5–10)	0.221
Subjective sleep quality	1 (1–2)	1 (1–2)	0.363	1 (1–2)	1 (1–2)	0.063
Sleep latency	2 (1–2)	1 (1–3)	0.846	2 (1–2)	1 (0–2)	0.033
Sleep duration	1 (1–2)	1 (1–2)	0.152	2 (1–2)	2 (1–2)	0.633
Habitual sleep efficiency	1 (1–2)	1 (1–2)	0.488	1 (0–1)	1 (0–1)	0.658
Sleep disturbances	1 (1–1)	1 (1–1)	0.389	1 (1–2)	1 (1–1)	0.003
Use of sleeping medication	1 (1–2)	1 (1–2)	0.703	1 (0–2)	1(0–2)	0.927
Daytime dysfunction	1 (1–2)	1 (1–2)	0.746	1 (0–2)	1(0–1)	0.314
Global PSQI score	7 (4–10)	7 (4–11)	0.079	7 (5–10)	6 (3–9)	0.069

Anxiety Symptoms and Depression symptoms presented in total points (0–63). LPA and MVPA presented in minutes per week. SB week, SB weekend, and SB Total, presented in an hours per day. All PSQI components are presented in total points (0–3). Global PSQI score presented in total points (0–21). LPA, light physical activity; MVPA, moderate and vigorous physical activity; SB, sedentary behavior; PSQI, Pittsburgh Sleep Quality Index.

TABLE 4 | Regression logistic association of course (MED or PE) and meet MVPA recommendation, accumulated <8 h of SB, Anxiety symptoms (<12 points), Depression symptoms (<10 points), and Poor Sleep Quality (≥6 points).

	OR	**95% CI**		***p***
MVPA	3.87	2.27	6.59	<0.001
Sedentary behavior	0.28	0.17	0.47	<0.001
Anxiety symptoms	0.58	0.31	1.07	0.08
Depression symptoms	1.27	0.67	2.39	0.46
Sleep Quality	1.27	0.70	2.31	0.43

CI, confidence interval; OR, odds ratio. Odds of those who referred MVPA ≥ 300 min per week vs. those that referred MVPA <300 min per week having depressive symptoms (BDI>12 points) and anxiety symptoms (BAI>10 points), Sleep quality (PSQI ≥ 6 points.

Significant correlations were observed of MVPA and Depression symptoms (−0.23 $p < 0.001$), SB and Anxiety symptoms (0.17 $p < 0.001$), Anxiety symptoms and Depression symptoms (0.67 $p < 0.001$), Depression symptoms and Sleep quality (0.58 $p < 0.001$), and Sleep Quality and Anxiety symptoms (0.55 $p < 0.001$).

DISCUSSION

The current study aimed to compare MED and PE students during the COVID-19 pandemic, considering the time of PA (LPA and MVPA) and SB (week, weekend, and both), symptoms of anxiety and depression, and sleep quality. Our main finding indicates that MED students perform shorter MVPA, longer SB, and have more anxiety symptoms than PE students. In addition, we observed better scores of sleep duration and habitual sleep efficiency and worse scores of use of sleeping medication and daytime dysfunction in MED students than PE students. However, the Global PSQI score was similar between groups. We also highlight the lack of differences between the first and second halves of the course in MED (1st to 6th semesters and. 7th to 12th semesters) and in PE (1st to 4th semesters and 5th to 8th semesters) considering the symptoms of anxiety and depression, LPA, MVPA, and SB (week, weekend, and total). In addition, no differences were observed for initial and final semesters in sleep quality (PSQI) for MED students, while for PE students, initial and final semesters presented differences in sleep latency and sleep disturbances components, but not for the Global PSQI score. PE students present ORs (OR = 3.87, 95%CI 2.27–6.59 $p < 0.001$) of meeting MVPA recommendations. Significant correlations were verified of MVPA and Depression symptoms and Anxiety symptoms, as well as Anxiety symptoms and Depression symptoms, Depression symptoms and Sleep quality, and Sleep Quality and Anxiety symptoms.

The respective prevalences of elevated anxiety and depression symptoms in MED (50.4 and 51.5%) were higher than the prevalence of anxiety (31.9%) summarized in 17 studies (n = 63,439) and depression (33.7%) summarized in 14 studies (n = 44,531) (34). The absolute value prevalence of elevated anxiety and depression symptoms in PE (23.2 and 37.9%) was similar or

TABLE 5 | Relationship (Spearman Correlation) between MVPA, SB, Anxiety symptoms, Depression symptoms, and Sleep Quality.

	MVPA	Sedentary behavior	Anxiety symptoms	Depression symptoms	Sleep Quality
MVPA	—	**−0.20****	**−0.22****	**−0.23****	−0.10
Sedentary behavior	**−0.20****	—	**0.17****	**0.13***	0.01
Anxiety symptoms	**−0.22****	**0.17****	—	**0.67****	**0.55****
Depression symptoms	**−0.23****	**0.13****	**0.69****	—	**0.58****
Sleep Quality	−0.10	0.01	**0.55****	**0.58****	—

*Spearman correlation. *indicates that the correlation is significant; $p < 0.05$. **indicates that the correlation is significant; $p < 0.001$. MVPA, Moderate and vigorous physical activity.*

better than presented in the meta-analysis, which could have been influenced by the MVPA and SB levels.

The relationship between lower MVPA and higher symptoms of depression and anxiety in the general population is well-described in the literature (35, 36) and in MED students (37), suggesting that inactive MED students may present higher anxiety and/or depressive symptoms. Our findings confirm, at least partially, our initial hypothesis as we observed elevated physical inactivity (lower MVPA and higher SB) and higher anxiety symptoms in MED students than PE students, who were more active and reported fewer symptoms of anxiety. Some studies are available that evaluate the duration of PA and SB, and a meta-analysis including 15 studies carried out with PE students indicated that they meet the MVPA recommendation. However, this situation is not repeated with MED students, since more than two thirds of our group did not meet the MVPA recommendations (14). Although it was not our objective to investigate the reasons for these differences, it should be emphasized that PE students, in addition to having a lower workload than MED students (approximately half the workload), have curricular components with a strong practical character, which preserve an active lifestyle (38). In contrast, medical students spend more time in SB and perform less physical activity (39), which is justified in part due to a more significant load of theoretical classes.

Additionally, we highlight the extensive literature indicating that MED students and even medical professionals present impairments in mental health (14, 40). Although this situation may be partially attributed to the high SB time and reduced MVPA typical of MED students, associated with high study and workloads, and pressure to succeed from society and family, it may contribute to impairments in mental health.

Especially during the pandemic, a systematic review with 64 studies indicated that restrictions to reduce COVID-19 transmission affected PA and SB in the general population (7). In this scenario, studies indicate worsening mental health of MED students (14, 39). Since studies comparing different courses are still scarce, we compared a physically active course (PE) with a lower physically active course (MED). Our data align with other studies that evidenced that more time in MVPA and less time in SB may influence mental health (11, 41, 42).

It is well documented that the pandemic impacts sleep quality (43). When considering Sleep Quality (PSQI), a recent meta-analysis including 31 studies ($n = 5{,}153$) showed poor sleep quality in 60.4% of the sample analyzed (44), which is higher than our results in MED (54.0%) and PE (44.2%) students. Even though we verified significant differences between the components Habitual sleep efficiency, use of sleeping medication, and daytime dysfunction, the global PSQI score did not present differences. A recent study showed that the use of the internet, fear of leaving the house, and self-medication were the most common sleeping difficulties (45).

Finally, from a constructive perspective, our study allows us to speculate on the importance of organizing university environments, especially those used by medical students, to favor students reaching the PA recommendations and reducing their SB. In fact, a recent study highlighted the necessity of shared responsibility for students to perform more time in PA that resides at a political level, in welfare organizations, and in the educational institutions (46). One example of action is flexible learning spaces at school to allow students to spend less time sitting and more time standing and moving around (47), and the possibility of accessing outdoor and nature-based PA, as this exposure has a positive effect on different emotional parameters (e.g., anxiety, depression, stress) (48). Sporting activities can also be an important strategy to increase the PA time of students, as they provide health benefits for practitioners, and also lead to the attainment of the academic performance goals that educational institutions aspire to (49).

In relation to practical applications, considering the well-described relation of PA and anxiety and depression symptoms, which are common in medical students (frequent problems with anxiety and depression symptoms, not meeting the PA recommendation, and presenting high SB), we suggest there is a strong need to facilitate medical students to spend more time in PA and to reduce SB. We highlight the importance of providing strategies to increase the PA of university students, especially MED students, who showed poor physical activity levels (15). In this way, competitive university sports, which are already quite popular and offer recreational sports opportunities, represent alternatives to reduce SB and increase physical activity levels. Another possibility is encouraging the use of active behaviors, such as using stairs in university buildings, using spaces with dynamic characteristics for eating, classes, and computers (e.g., high benches, standing desks, or tables where the student participates in the theoretical actions while standing), and awareness of the importance of breaking prolonged sedentary behavior, among other actions. Finally, we suggest a strong need to facilitate medical students to spend more time on PA and to reduce SB.

Strengths and Limitations

The strengths of this study included university students with different characteristics of PA (MED and PE), with high COVID-19 exposure in São Paulo City. Our study is not free of limitations. First, we included only one university. Second, despite the wide use of self-report tools for PA and SB measures, mental health may underestimate our findings. Finally, we could not investigate possible psychiatric conditions, such as a diagnosis of depression or anxiety disorders, in more detail.

CONCLUSION

In conclusion, our results indicate that MED students spend less time in MVPA and more time in SB than PE students and presented worse mental health in the pandemic situation imposed by COVID-19.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics and Research Committee of Santo Amaro University (approval number: 4.049.214). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TM and KS: conceptualization, methodology, formal analysis, investigation, writing original draft, writing review and editing, and visualization. TG, AS, LN, and AB: writing original draft and writing review editing. SG: formal analysis and writing review editing. CF: conceptualization, methodology, writing original draft, and writing review editing. FR: writing review editing. LN: conceptualization, methodology, formal analysis, writing original draft, and writing review, supervision. All authors contributed to the article and approved the submitted version.

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Look After Yourself: Students Consistently Showing High Resilience Engaged in More Self-Care and Proved More Resilient During the COVID-19 Pandemic

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The COVID-19 pandemic has prompted severe restrictions on everyday life to curb the spread of infections. For example, teaching at universities has been switched to an online format, reducing students' opportunities for exchange, and social interaction. Consequently, their self-reported mental health has significantly decreased and there is a pressing need to elucidate the underlying mechanisms—ideally considering not only data collected during the pandemic, but also before. One hundred seventeen German university students aged 18-27 were assessed for known resilience factors (optimism, self-care, social support, generalized self-efficacy) and subsequently completed surveys on stress experiences and mental health every 3 months over a period of 9 months before the outbreak of the pandemic and once during the first lockdown in Germany. For each timepoint before the pandemic, we regressed participants' mental health against the reported stressor load, such that the resulting residuals denote better or worse than expected outcomes, i.e., the degree of resilient functioning. We then tested whether different expressions in the resilience factors were predictive of distinct resilient functioning trajectories, which were identified through latent class growth analysis. Finally, we investigated whether trajectory class, resilience factors, and perceived stress predicted resilience during the pandemic. Results show rather stable resilient functioning trajectories, with classes differing mainly according to degree rather than change over time. More self-care was associated with a higher resilient functioning trajectory, which in turn was linked with the most favorable pandemic response (i.e., lower perceived stress and more self-care). Although findings should be interpreted with caution given the rather small sample size, they represent a rare examination of established resilience factors in relation to resilience over an extended period and highlight the relevance of self-care in coping with real-life stressors such as the pandemic.

Keywords: self-care, latent class growth analysis, resilience, COVID-19 pandemic, mental health

INTRODUCTION

On March 11, 2020, in response to the rapidly increasing number of cases and growing list of affected countries, the World Health Organization (WHO) declared the coronavirus disease 2019 (COVID-19) a global pandemic (1). Governments worldwide began imposing restrictions on everyday social life to curb the spread of infections. Germany entered its first lockdown in mid-March 2020, closing all non-essential stores, cultural and sports facilities, restaurants, bars, kindergartens, schools, universities, and banning public meetings of more than two people (2, 3). For most, these measures meant an abrupt and serious change in their habits and lifestyle. Although restrictions were gradually lifted in the beginning of May 2020 (4), many measures remained in place or were reintroduced over the course of at least 1.5 years as the country navigated further waves of the pandemic (5). Because of its pervasive impact, the pandemic has been described as a complex, multidimensional stressor that disrupts individuals' daily lives as well as social systems in general, prevents access to protective factors, and has no foreseeable end (6). In line with this, many studies have shown increases in mental health problems and worsening of pre-existing conditions (7, 8). Vulnerable populations include university students whose elevated and rising prevalence rates of depression and anxiety have previously been recognized as a growing problem (9–11). Indeed, evidence from cross-sectional studies investigating students during the pandemic in, e.g., China (12), Spain (13), Germany, and Egypt (14), as well as Italy (15) showed alarming rates of mental health problems, psychological distress, depressive symptoms, and significantly higher levels of psychopathology compared to general workers, respectively. Matos Fialho et al. (16) surveyed over 5,000 German students and reported a perceived increase in workload which was associated with significant stress and worry. However, results from longitudinal studies that include assessments prior to the pandemic (and therefore can investigate changes within the same individuals) are less clear. While some report a pandemic-related rise in mental health problems among students [e.g., (17, 18)], others did not observe a meaningful increase (19, 20). Previous research on mental health symptom trajectories following adversity has shown that resilience, or the maintenance of mental health, is, in fact, the most common response (21). Researchers in the field of resilience have advocated for more investigations of protective features and predictors of good mental health in the face of significant pandemic-related stress (22, 23). Factors that have been established as resilience-promoting include optimism (24), social support (25, 26), perceived self-efficacy (27, 28), and self-care (29, 30).

So far, studies examining the impact of the COVID-19 pandemic on students' mental health focused primarily on identifying risk factors, and these efforts are often hampered by the lack of assessments prior to the outbreak of the pandemic. Here, we analyzed longitudinal data collected both during and before the first pandemic-related lockdown in Germany. Specifically, we aimed at predicting students' resilient functioning during the pandemic as a function of previous resilience trajectories, aforementioned resilience-promoting factors, and perceived stress. In addition, we investigated trajectory class-dependent differences in resilience factors at baseline. We expected distinct differences in students' resilient functioning trajectories over the multiple pre-pandemic assessments (e.g., decreasing, increasing, or stable trajectories). Based on the literature, we hypothesized that differences in optimism, social support, perceived self-efficacy, and self-care would distinguish putative resilience trajectory types. With respect to the pandemic, we assumed that it was associated with increased stress and poorer mental health among students. We expected that a more favorable resilient functioning trajectory (i.e., consistently high or increasing levels), higher expression in the resilience factors, and lower perceived stress would be predictive of better resilience during the lockdown.

MATERIALS AND METHODS

Participants

We used data from a large-scale longitudinal intervention study in which university students were assigned to either a resilience training or a wait-list control group. Here, we considered only the 316 control participants who did not undergo any training. These participants came from two different cohorts and were matched according to data collection time points (see section Procedure for details). Since we operationalized resilient functioning as the residual resulting from the regression of mental health on experienced stress (see section Data Preparation and Statistical Analyses for details), we only included participants who provided complete data for predictor and criterion at all time points. Thus, the residuals always represent deviations from the expected relationship based on the same population. In addition, three participants had to be excluded from the analysis: one had duplicate data from both cohorts, one had not reported any stressful events at baseline, and one reported an extremely high frequency of microstressors at one time point (> 5 *SD* from sample mean). The final sample comprised 133 students aged 18-27 (75% female, age: $M = 20.56$, $SD = 1.76$; 67% belonging to the later cohort), all of whom were fluent in German, had not received psychotherapeutic or psychiatric treatment within the last 5 years, reported no regular alcohol or drug use, no self-harming behavior or suicidal ideation within the last 6 months, and had not experienced a major traumatic event. Nearly all these participants completed a follow-up online survey, yielding a sample of 117 students (74% female, age: $M = 21.69$, $SD = 1.76$; 66% belonging to the later cohort) for analyses focusing on resilient functioning during the pandemic. Only one participant reported having tested positive for COVID-19 and experiencing symptoms including fever which were treated at home. 6% stated they belonged to a risk group for a severe course of the disease and 5% had been quarantining at home. This study was approved by the ethics committee of the Institute of Psychology, Johannes Gutenberg-University, Mainz, Germany (2018-JGU-psychEK-001, 27/03/2018), and was conducted in accordance with the Declaration of Helsinki.

Procedure

Participants took part in an initial 1.5 h on-site assessment (T0) in the Mainz Behavioral and Experimental Laboratory (MABELLA) at Johannes Gutenberg-University Mainz. Upon arrival, they received information on the study and planned procedures and gave written informed consent. Participants then provided self-report data on demographics and established resilience factors; namely, optimism, self-care, social support, and generalized self-efficacy. They also completed questionnaires measuring stressor load, mental health, and well-being. Following this baseline assessment, participants were asked to fill out the latter questionnaires online every 3 months over a 9-month period before the outbreak of the pandemic (T1-T3). During the first pandemic-related lockdown in Germany, we conducted another online follow-up (T4; 27 April to 13 May 2020) in which participants were again asked to report on their stress experiences and mental health, but this time against the specific backdrop of the ongoing pandemic. In addition, we re-assessed the aforementioned resilience factors. Upon completion of each session, participants were remunerated with 15 €. Note that, in order to match the data of the two cohorts by time of assessment and to ensure an equal number of assessments before the pandemic, we had to disregard the first two time points of the first cohort. We accounted for possible effects of previous sessions in this cohort by including cohort as a covariate in our analyses. **Figure 1** illustrates the timing of data collection for both cohorts separately and relates it to pandemic events. The following section provides details on the questionnaires we used for this study.

Questionnaires

First, we describe the questionnaires used for the resilience factors listed before at T0. Optimism was measured using the corresponding three-item subscale of the German version of the revised Life Orientation Test [LOT-R; (31); original English version by (32)], which has an acceptable internal consistency (Cronbach's $\alpha = 0.69$). Self-care was assessed using the mean across all 12 items of the Hamburg Self-Care Questionnaire [HamSCQ; (33)], subsuming the subscales pacing (i.e., mindful handling of oneself and one's limits) and positive experience (i.e., accepting and enjoying positive behaviors; Cronbach's $\alpha > 0.9$ for both scales). The 14-item short form of the Social Support Questionnaire [F-SozU-K14; (34); Cronbach's $\alpha = 0.94$] was included as a measure of social support, and the German version of the Generalized Self-Efficacy Scale [GSE; (35); 10 items; Cronbach's $\alpha > 0.7$] provided an indicator of generalized self-efficacy.

Second, we list the stress and mental health questionnaires that participants completed at T0-T4. The German version of the Brief Symptom Inventory-18 [BSI-18; (36); original English version by (37)] uses six items each to capture psychological distress in the past week via the subscales somatization, depression, and anxiety. However, here we used the Global Severity Index (GSI) which covers all items and has excellent internal consistency [Cronbach's $\alpha = 0.93$; (38)]. The German version of the WHO Well-Being Index [WHO-5; (39); original English publication by (40)] was used as another indicator of mental health, comprising five items that refer to the past 2 weeks (Cronbach's $\alpha = 0.92$). Participants also completed the Mainz Inventory of Microstressors [MIMIS; (41)] which measures the frequency and intensity of 58 microstressors (e.g., commute to work, problem with a pet, time pressure) within the past week. A 27-item life events checklist [(42); adapted from (43)] provided a count of more severe stressors (e.g., death of a friend, law violations, serious financial problems) encountered in the past 3 months. Since the checklist also includes items that may not be perceived as stressful by all participants (e.g., marriage plans, child starting school), we only counted life events if they were rated as at least a bit burdensome (i.e., 1 on a scale ranging from 0 = not at all burdensome to 4 = very burdensome). At T0, participants were instructed to rate all events they had experienced up to that date.

Third, we elaborate on additional questionnaires assessed at T4 (i.e., during the lockdown). These included items on COVID-19 risk group status, infection, symptom severity, and quarantine, as well as a 29-item list of stressors specific to the context of the pandemic (44). For stressors that had occurred to them, participants provided intensity ratings on a scale from 1 (not at all burdensome) to 5 (extremely burdensome) and we calculated stressor count as well as mean scores reflecting stressor burden. We also assessed participants' agreement with government-mandated restrictions and the degree to which they were following official recommendations. For both items, we used a Likert scale ranging from 1 (not at all) to 5 (very). In addition, we measured perceived stress using the German version of the Perceived Stress Scale [PSS; (45); original English version by (46)]. The PSS can be split into the subscales helplessness and self-efficacy, comprising six and four items, respectively. However, here we used the total score across all items as an indicator of general subjective stress level in the past seven days (Cronbach's $\alpha = 0.88$). Whereas, optimism, self-care, and generalized self-efficacy were re-assessed using the same instruments as at T0, we used the 4-item subscale perceived emotional support of the Berlin Social Support Scales [BSSS; (47); Cronbach's $\alpha = 0.81$] to assess social support during the pandemic. The BSSS items were presented in the past tense and participants were instructed to refer to the past 4 weeks.

Data Preparation and Statistical Analyses

We calculated a measure of resilient functioning for each time point T0-T4 based on the following variables: the GSI of the BSI-18, the WHO-5, the frequency of microstressor encounters, and the count of stressful life events. In computing the score, we followed established procedures described in previous publications [e.g., (48–51)]. To obtain a single indicator of both mental health and stress, we first conducted a principal component analysis of the standardized GSI and WHO-5 scores and the standardized microstressor and life events scores, respectively. To match the WHO-5 response format, we used the inverted score of the GSI such that higher values indicated fewer symptoms i.e., a more positive outcome. The extracted first component taken to reflect mental health was then regressed on the first component representing stressor load. The resulting residuals therefore denoted better

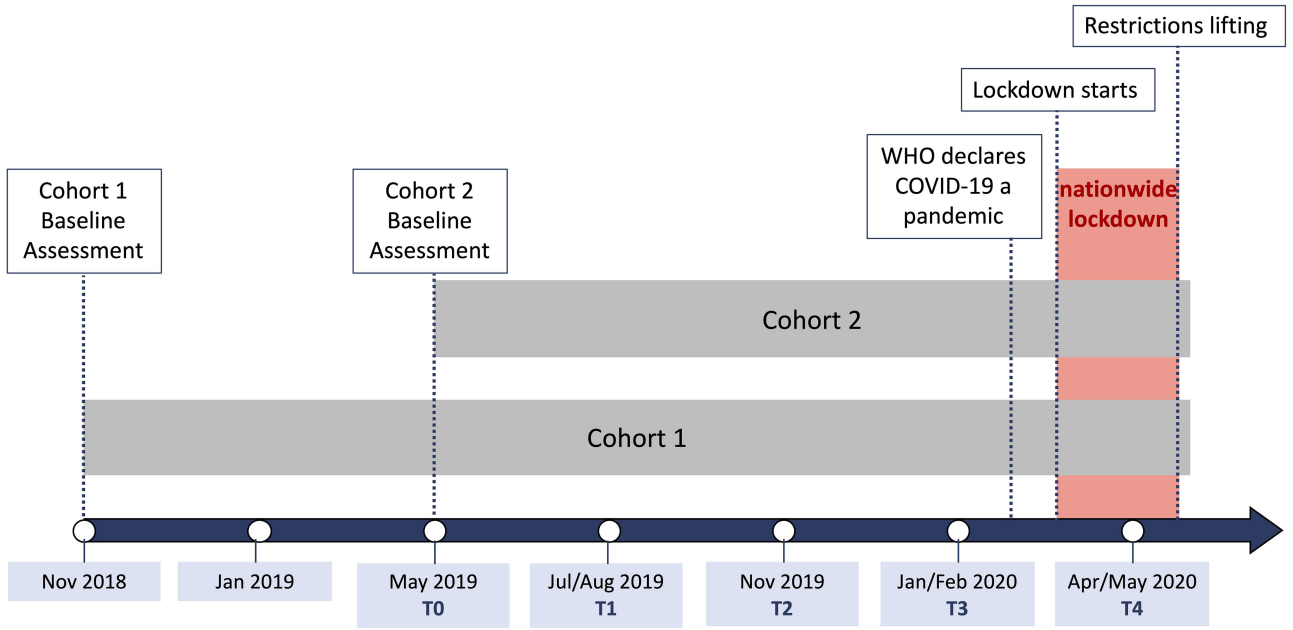

FIGURE 1 | Timing of data collection.

or worse than expected mental health based on the given stress experience. Hence, we obtained a continuous measure of resilient functioning.

For our investigation of distinct classes of resilient functioning trajectories, we followed instructions by Wickrama et al. (52). Prior to conducting a latent class growth analysis (LCGA) to identify trajectory classes, we determined its appropriateness through univariate growth curve modeling. We fitted an unconditional single growth curve (linear and quadratic) to the resilient functioning scores from T0-T3 and verified adequate model fit (53) based on the root mean square error of approximation (RMSEA $\leq$ 0.05), the Comparative Fit Index (CFI $\geq$ 0.95), the Tucker-Lewis Index (TLI $\geq$ 0.95), and the standardized root mean square residual (SRMR $\leq$ 0.07). Next, we compared LCGA results for unconditional models with one to five classes, fixing all within-class variances to zero. Unlike LCGA, growth mixture modeling (GMM) does not assume homogeneous growth curves within classes and freely estimates within-class variances. It is therefore generally preferred, but our attempts at such a model failed to converge, perhaps reflecting sample size constraints. We decided to use LCGA to ensure model convergence. We specified 500 random sets of starting values and 10 final optimizations to avoid local maxima (54). The optimal number of trajectory classes was determined by comparing standard fit indices listed below, examining latent class membership probabilities, and considering theoretical interpretability. Lower values of the Akaike information criterion (AIC), the Bayesian information criterion (BIC), and the sample size adjusted BIC (SSABIC) suggest better model fit. Entropy values approaching 1 indicate high classification accuracy, and a significant adjusted Lo-Mendell-Rubin likelihood ratio test (adj. LMR-LRT) and bootstrapped LRT (BLRT) show that adding a class significantly improves model fit (55).

To investigate the different resilience factors assessed at T0 as predictors of latent trajectory class, we performed a multinomial logistic regression analysis. First, we checked for extreme values [above the third quartile plus three times the interquartile range (IQR) or below the first quartile minus three times the IQR; (56)] and for multicollinearity (i.e., correlation coefficients of $r > 0.70$) among predictors. Then we set up our model including gender, age, and cohort as predictors alongside the resilience factors.

We analyzed the impact of the pandemic by conducting paired samples *t*-tests to compare participants' stressor load and mental health before the lockdown (T3) with assessments during the lockdown (T4).

Finally, we used multiple regression to examine the predictive value of trajectory class, resilience factors (re-assessed during the pandemic), and perceived stress on participants' resilient functioning during the lockdown. Class-dependent differences in resilient functioning during the pandemic were further investigated by comparing all groups. We applied Holm-Bonferroni correction for multiple comparisons.

Analyses were mainly performed in R, version 4.0.5 (https://www.r-project.org), latent trajectory classes, however, were identified using Mplus, version 7.3 (57).

RESULTS

Resilient Functioning Scores

The principal component analysis conducted for each of the five time points (T0-T4) resulted in components for mental health and stressor load, each of which explained above 60%

of variance. As intended, higher values in mental health components indicated better mental health and higher values in stressor load components reflected higher stressor load. Results of the linear regressions performed for each time point showed that stressor load was a significant predictor of mental health (see **Supplementary Table 1** for detailed results). Participants reported lower mental health with increasing stressor load. The resulting residuals were taken to reflect participants' level of resilient functioning (see **Supplementary Figure 1** for visualization).

Growth Curve Modeling

A linear growth curve model of the resilient functioning scores from T0-T3 showed excellent fit to the data (CFI = 1.000; TLI = 1.000; RMSEA = 0.000; SRMS = 0.021). Although the mean slope was not significantly different from zero ($p > 0.05$), an intercept-only model (assuming no change in resilient functioning over time) demonstrated much worse data fit (CFI = 0.833; TLI = 0.875; RMSEA = 0.153; SRMS = 0.093). Significant variance of intercept and slope (both $p < 0.001$) also indicated interindividual differences in initial levels of resilient functioning as well as in change over time, suggesting the appropriateness of investigating potentially underlying distinct trajectory classes with LCGA. To test for curvilinear patterns of change, we incorporated a quadratic term into the model, but resulting fit indices showed only slight improvement (CFI = 1.000; TLI = 1.000; RMSEA = 0.000; SRMS = 0.009) and information criteria were higher, suggesting worse model fit (e.g., $BIC_{linear} = 1543.654$; $BIC_{quadratic} = 1557.599$). The nested χ^2 difference test was also not significant ($\chi^2_{DIFF} = 0.726$ well below critical cut-off value of 7.81, based on $\alpha = 0.05$ and $df = 3$), therefore we retained the more parsimonious linear model.

Latent Class Growth Analysis

We compared fit indices of unconditional models with one to five latent classes (**Table 1**). Decreases in AIC, BIC, and SSABIC across consecutive models, reflected better model fit with increasing number of classes. However, information criteria increased from the four-class to the five-class solution, indicating worse fit of the latter model. Entropy was highest for the three-class solution, although classification accuracy was similar for the four-class solution. In fact, adj. LMR-LRT ($p = 0.011$) and BLRT ($p < 0.001$) indicated significant improvement in model fit for the four-class solution compared to the three-class solution. Moreover, one of the three latent classes contained only eight participants, barely more than the recommended minimum of 5% of the total sample (52). We therefore selected the four-class model which also had high average latent class probabilities (0.93, 0.89, 0.87, and 0.87, for classes 1-4, respectively), meaning that participants were assigned to the latent class to which they were most likely to belong.

In the four-class model (**Figure 2**), the largest class comprised 46.6% of the sample, with participants showing the expected level of resilient functioning (intercept $M = -0.24 \pm 0.11$, $p = 0.032$) with a marginal increase over time (slope $M = 0.13 \pm 0.07$, $p = 0.055$). Because resilient functioning was operationalized as the residual from the regression of mental health on stressor load, values around zero denote the expected level of mental health given reported stress experience. Therefore, these participants exhibited neither high nor low, but rather expected or "medium" levels. The second-largest class (28.6%) followed a stable trajectory at "high" levels of resilient functioning (intercept $M = 0.88 \pm 0.29$, $p < 0.002$; slope $M = 0.04 \pm 0.10$, $p = 0.706$), i.e., participants consistently reported better than expected mental health given their stressor load. A third class, "medium-to-low" (15.8%), was characterized by expected levels of resilient functioning at baseline (intercept $M = 0.34 \pm 0.30$, $p = 0.254$) and a marked decline over time (slope $M = -0.70 \pm 0.13$, $p < 0.001$). The last class (9%) included participants at rather "low" levels of resilient functioning (intercept $M = -2.27 \pm 0.41$, $p < 0.001$), but whose trajectories indicated some improvement over time (slope $M = 0.42 \pm 0.20$, $p = 0.035$).

To better compare the four trajectories, **Table 2** provides details on demographics, resilience factors at baseline, and average mental health and stressor load across T0-T3 of each class. In addition, for each class, we plotted the trajectories of the variables from which the resilient functioning score was derived (**Supplementary Figure 2**).

Predictors of Resilient Functioning Trajectory Class

We investigated the resilience factors (optimism, self-care, social support, and generalized self-efficacy) assessed at T0 as predictors of most likely latent class membership in a multinomial logistic regression analysis. Data screening revealed no apparent problems in terms of extreme outliers or multicollinearity among predictors. Overall, the model demonstrated satisfactory fit [$\chi^2_{(21)} = 68.05$, $p < 0.001$; McFadden $R^2 = 0.21$], correctly classifying 60% of the cases. However, prediction accuracy was not very good for smaller classes, likely reflecting unbalanced class sizes and ultimately sample size constraints. Whereas, 82% of participants assigned to the medium trajectory class and 53% of participants assigned to the high trajectory class were classified correctly, the rate of correct classification for the low and medium-to-low trajectory classes was only 33 and 24%, respectively. We set the low trajectory class as the reference category, comparing each of the other classes to this group. Only self-care emerged as a significant predictor of latent class membership. Compared to the low trajectory class, participants in the high and medium-to-low classes engaged in more self-care. Detailed results for all predictors included in the model are reported in **Table 3**.

Stress and Mental Health During the Lockdown

We analyzed data across the whole sample to characterize the impact of the COVID-19 pandemic, irrespective of resilient functioning trajectory class. Most of the participants agreed with government-mandated restrictions ($M = 4.22$, $SD = 0.81$) and reported that they followed recommendations to contain the spread of the virus ($M = 4.50$, $SD = 0.57$). Of 29 pandemic-specific stressors, participants experienced on average 10.4 ($SD = 3.20$; intensity: $M = 3.23$, $SD = 0.65$) with the

TABLE 1 | Goodness of fit statistics for one- to five-class models of resilient functioning trajectories.

Model	AIC	BIC	SSABIC	Entropy	Adj. LMR-LRT (*p*)	BLRT (*p*)
One-class	1666.932	1684.274	1665.295	–	–	–
Two-class	1556.772	1582.785	1554.317	0.781	<0.001	<0.001
Three-class	1536.484	1571.168	1533.211	0.809	0.431	<0.001
Four-class	**1503.506**	**1546.861**	**1499.414**	**0.790**	**0.011**	**<0.001**
Five-class	1504.952	1556.979	1500.042	0.690	0.499	0.460

AIC, Akaike information criterion; BIC, Bayesian information criterion; SSABIC, sample-size adjusted BIC; Adj. LMR-LRT, adjusted Lo-Mendell-Rubin likelihood ratio test; BLRT, bootstrapped likelihood ratio test. Information for the model ultimately selected were bolded.

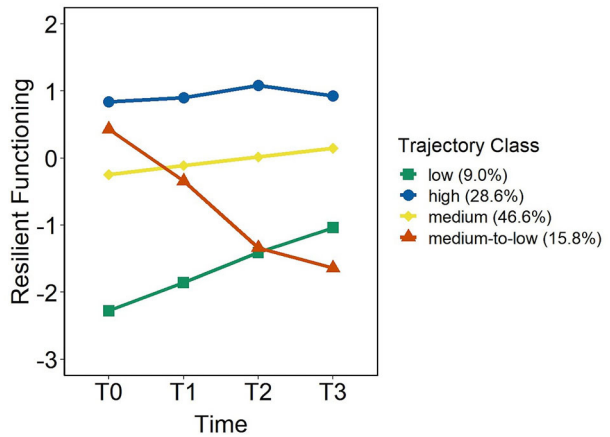

FIGURE 2 | Trajectories of resilient functioning from T0-T3 according to the four-class model.

most frequent being media reports (100%), loss of opportunity for recreational activities (97%), and loss of social contacts (90%). PSS scores indicated moderate levels of perceived stress overall ($M = 21.14$, $SD = 3.39$). Comparisons of data assessed at T3 and T4 showed no significant change in the frequency of microstressors [$t_{(116)} = 1.38$, $p = 0.170$] or the count of stressful life events [$t_{(116)} = -1.08$, $p = 0.283$]. Note that at T4 participants reported on stressful life events in the past 3 months (i.e., including the weeks before the pandemic). The comparison of inverted GSI scores of the BSI-18, assessed during and before the pandemic, revealed a significant decrease in symptoms during the lockdown [$t_{(116)} = -2.71$, $p = 0.008$]. Correspondingly, WHO-5 scores showed a significant increase [$t_{(116)} = -2.17$, $p = 0.032$], reflecting improved well-being during the lockdown.

Predicting Resilient Functioning During the Lockdown

Using multiple regression analysis, we examined resilient functioning trajectory class, resilience factors, and perceived stress as predictors of resilient functioning during the pandemic. Importantly, we focused on indices of optimism, self-care, perceived emotional support, and generalized self-efficacy re-assessed during the lockdown (see **Table 2** for descriptive statistics by trajectory class). The data were checked for extreme outliers and parametric assumptions, with no apparent problems. There was also no evidence of multicollinearity among predictors (generalized variance inflation factors < 3; see **Supplementary Table 2** for zero-order correlations among predictors). All continuous predictors were mean centered and the reference level for resilient functioning trajectory class was set to the low trajectory class. The overall model was significant [$F_{(8, 108)} = 20.20$, $p < 0.001$] and the adjusted R^2 indicated that 57% of the variation in resilient functioning was accounted for. We conducted a separate regression that included age, gender, and cohort as covariates, but a model comparison indicated no significant improvement [$F_{(3, 105)} = 1.07$, $p = 0.363$]. We therefore retained the more parsimonious model with six predictors. In this model, trajectory class, self-care, and perceived stress emerged as significant predictors (see **Table 4** for all results). Since the assumptions for ANOVA were not met, we conducted a Kruskal-Wallis rank sum test and Dunn's test with Holm-Bonferroni correction to follow up on class-dependent differences in resilient functioning. Results revealed significant differences [$\chi^2_{(3)} = 53.37$, $p < 0.001$, $\eta^2{}_H = 0.44$] with participants in the high trajectory class showing significantly higher resilient functioning than participants in all other classes (all $p < 0.001$) and participants in the low trajectory class showing lower resilient functioning than participants in all other classes (low vs. medium: $p = 0.008$; low vs. medium-to-low: $p = 0.075$). The contrast of medium vs. medium-to-low ($p = 0.456$) was not significant. More self-care and lower perceived stress was predictive of higher resilient functioning scores. Descriptive statistics (**Table 2**) indicated that participants in the high trajectory class took greater care of themselves during the pandemic compared to participants in the other classes, especially those in the low trajectory class. Hence, including an interaction term of class x self-care in the regression model yielded significant improvement in model fit [$F_{(3, 105)} = 3.93$, $p = 0.011$] and the coefficient for medium-to-low class $\times$ self-care was significant ($p = 0.031$). This improved model explained 60% variation in resilient functioning during the lockdown (see **Table 4** for results of both models).

DISCUSSION

In this study, we explored students' resilient functioning over a 9-month period before the outbreak of the COVID-19 pandemic and investigated links with baseline assessments of established

TABLE 2 | Demographics, resilience factors at baseline, average stress and mental health across T0-T3, and resilience factors and perceived stress during the pandemic by class.

	Trajectory classes				Test statistic	*p*
	High	**Medium**	**Medium-to-low**	**Low**		
Demographics						
n (%)	38 (28.6)	62 (46.6)	21 (15.8)	12 (9.0)		
Cohort (% later cohort)	68.4	56.5	90.5	75.0	$\chi^2_{(3)} = 8.73$	0.033
Gender (% female)	65.8	77.4	76.2	91.7	$\chi^2_{(3)} = 3.72$	0.293
Age in years, *M* (*SD*)	20.55 (1.74)	20.35 (1.56)	21.29 (2.26)	20.42 (1.68)	$\chi^2_{(3)} = 3.99$	0.262
Resilience factors at baseline						
Optimism, *M* (*SD*)	9.26 (1.73)	7.87 (2.36)	7.86 (2.54)	6.08 (2.71)	$F_{(129)} = 6.80$	**<0.001**
Self-care, *M* (*SD*)	4.38 (0.42)	3.93 (0.49)	4.19 (0.50)	3.25 (0.94)	$\chi^2_{(3)} = 26.16$	**<0.001**
Social Support, *M* (*SD*)	4.51 (0.36)	4.35 (0.49)	4.21 (0.58)	3.88 (0.72)	$\chi^2_{(3)} = 10.60$	0.014
Generalized self-efficacy, *M* (*SD*)	30.45 (3.45)	28.76 (3.27)	27.57 (4.58)	24.83 (3.19)	$F_{(129)} = 8.54$	**<0.001**
Average mental health and stressor load across T0–T3						
Inverted GSI of the BSI-18, *M* (*SD*)	66.95 (3.00)	61.43 (5.28)	54.48 (6.65)	44.29 (6.22)	$\chi^2_{(3)} = 74.84$	**<0.001**
WHO-5, *M* (*SD*)	69.39 (8.14)	51.19 (9.37)	43.81 (9.16)	31.83 (9.78)	$F_{(3, 129)} = 71.51$	**<0.001**
Frequency of microstressor encounters, *M* (*SD*)	48.39 (21.32)	49.98 (22.09)	55.58 (21.43)	62.10 (24.51)	$\chi^2_{(3)} = 4.42$	0.219
Count of stressful life events, *M* (*SD*)	3.07 (1.47)	2.86 (1.45)	3.07 (1.26)	4.44 (1.96)	$\chi^2_{(3)} = 6.81$	0.078
Resilience factors and perceived stress during the pandemic (T4)						
Optimism, *M* (*SD*)	9.09 (1.87)	7.14 (2.39)	6.06 (2.96)	5.36 (2.06)	$F_{(3, 113)} = 10.61$	**<0.001**
Self-care, *M* (*SD*)	4.10 (0.70)	3.66 (0.74)	3.51 (1.10)	2.83 (0.56)	$\chi^2_{(3)} = 20.17$	**<0.001**
Perceived emotional support, *M* (*SD*)	14.75 (1.44)	14.21 (2.12)	13.11 (3.41)	12.45 (2.38)	$\chi^2_{(3)} = 8.68$	0.034
Generalized self-efficacy, *M* (*SD*)	31.59 (3.16)	28.46 (3.46)	27.17 (6.02)	24.64 (2.94)	$\chi^2_{(3)} = 28.06$	**<0.001**
Perceived stress, *M* (*SD*)	19.66 (2.78)	21.48 (3.51)	21.00 (3.53)	23.91 (2.17)	$F_{(3, 113)} = 5.19$	**0.002**

Inverted GSI of the BSI-18, inverted Global Severity Index of the Brief Symptom Inventory-18 (higher scores indicate better mental health); WHO-5, World Health Organization Well-Being Index. Where the requirements for analysis of variance (ANOVA) were not met, the Kruskal-Wallis rank sum test was used instead. For data assessed during the pandemic, 117 participants provided complete data and were included in the analyses. To account for multiple tests, we set the significance at a Bonferroni adjusted alpha level of 0.0125 for analyses of baseline and T0-T3 data and 0.01 for analyses of pandemic data. All significant p-values were bolded.

TABLE 3 | Multinomial logistic regression results for predicting resilient functioning trajectory class.

	High vs. low			Medium vs. low			Medium-to-low vs. low		
Predictor	***B* (*SE*)**	***OR* (95% *CI*)**	***p***	***B* (*SE*)**	***OR* (95% *CI*)**	***p***	***B* (*SE*)**	**OR (95% CI)**	***p***
Optimism	0.29 (0.21)	1.34 (0.89-2.02)	0.157	0.14 (0.18)	1.15 (0.81-1.63)	0.450	0.10 (0.20)	1.10 (0.75-1.63)	0.621
Self-care	2.69 (0.90)	14.80 (2.56-85.68)	**0.003**	1.19 (0.74)	3.28 (0.77-13.93)	0.107	2.49 (0.90)	12.06 (2.07-70.32)	**0.006**
Social support	0.58 (0.86)	1.78 (0.33-9.63)	0.504	0.32 (0.73)	1.37 (0.33-5.71)	0.661	−0.10 (0.80)	0.91 (0.19-4.36)	0.903
Self-efficacy	0.20 (0.15)	1.22 (0.90-1.64)	0.192	0.20 (0.14)	1.22 (0.93-1.61)	0.157	0.04 (0.15)	1.04 (0.77-1.40)	0.817
Age	−0.08 (0.24)	0.93 (0.58-1.48)	0.750	−0.07 (0.22)	0.93 (0.61-1.42)	0.745	0.09 (0.23)	1.09 (0.70-1.69)	0.704
Gender	−1.79 (1.22)	0.17 (0.02-1.81)	0.141	−1.09 (1.15)	0.34 (0.04-3.24)	0.347	−0.99 (1.25)	0.37 (0.03-4.31)	0.429
Cohort	−1.56 (1.05)	0.21 (0.03-1.63)	0.135	−1.62 (0.96)	0.20 (0.03-1.29)	0.090	0.17 (1.21)	1.19 (0.11-12.63)	0.885

B, parameter estimate; SE, standard error; OR, odds ratio; CI, confidence interval. All significant p-values ($p < 0.05$) were bolded.

resilience factors and with resilience during the first pandemic-related lockdown in Germany. Four distinct trajectories of pre-pandemic resilient functioning were identified: high, low, medium, and medium-to-low (i.e., progressive decline). Most participants' trajectories could be described as rather stable at expected levels of resilience. Given that we operationalized resilient functioning as the residual resulting from the regression of mental health on stressor load, it was expected that most

TABLE 4 | Multiple regression results showing predictors of resilient functioning during the lockdown.

Predictor	*B* (95% *CI*)	*SE*	*β*	*t*	*p*
Model without interaction					
Resilient functioning trajectory					
High	1.62 (0.98–2.25)	0.32	0.63	5.07	**<0.001**
Medium	0.83 (0.29–1.37)	0.27	0.36	3.06	**0.003**
Medium-to-low	0.68 (0.07–1.28)	0.30	0.21	2.22	**0.028**
Optimism	0.05 (−0.03–0.13)	0.04	0.11	1.17	0.244
Self-care	0.35 (0.12–0.58)	0.11	0.25	3.06	**0.003**
Perceived emotional support	0.01 (−0.06–0.08)	0.04	0.02	0.34	0.735
Generalized self-efficacy	0.03 (−0.02 to −0.07)	0.02	0.11	1.24	0.217
Perceived stress	−0.05 (−0.09 to −0.00)	0.02	−0.14	−2.11	**0.037**
R^2 (adjusted)	0.60 (0.57)				
F	20.20				
P	**<0.001**				
Model with interaction					
Resilient functioning trajectory					
High	2.35 (1.38–3.33)	0.49	0.91	4.78	**<0.001**
Medium	1.38 (0.48–2.29)	0.46	0.60	3.04	**0.003**
Medium-to-low	1.27 (0.33–2.20)	0.47	0.40	2.68	**0.009**
Optimism	0.02 (−0.06–0.10)	0.04	0.04	0.38	0.704
Self-care	−0.18 (−1.058–0.69)	0.44	−0.13	−0.41	0.681
Perceived emotional support	0.00 (−0.07–0.07)	0.03	0.00	0.02	0.984
Generalized self-efficacy	0.02 (−0.02–0.07)	0.02	0.09	1.10	0.274
Perceived stress	−0.05 (−0.09–0.00)	0.02	−0.14	−2.11	**0.037**
Interaction: resilient functioning trajectory × self-care					
High × self-care	0.28 (−0.69–1.25)	0.49	0.10	0.58	0.567
Medium × self-care	0.52 (−0.40–1.45)	0.47	0.23	1.12	0.266
Medium-to-low × self-care	1.10 (0.10–2.03)	0.49	0.38	2.19	**0.031**
R^2 (adjusted)	0.64 (0.60)				
F	16.96				
P	**<0.001**				

Dependent variable: resilient functioning during the pandemic. The reference category for resilient functioning trajectories was the low trajectory class. All significant p-values ($p < 0.05$) were bolded.

participants would fall close to the regression line. However, the second-largest class showed higher than expected levels of resilient functioning and only a small proportion of the sample demonstrated markedly lower resilience. In line with this, studies tracking the course of psychological outcomes in the wake of a traumatic event (58–60), generally find that most participants maintained good levels of mental health. Moreover, because we focused on trajectories of resilience during everyday life, we observed relatively low counts of stressful life events that could affect students' mental health. In fact, trajectories seemed to be best distinguished by intercept rather than slope, suggesting little perturbation by stress. Although university students have been reported to show increased prevalence rates of anxiety and depression (9–11), we had initially screened potential participants for eligibility for the intervention study, thus our sample represents rather healthy students. They may not have faced very severe stressors or already have adaptive strategies at hand for coping with stress. Indeed, our analyses showed that participants with consistently high levels of resilient functioning scored highest on optimism, self-care, social-support, and perceived self-efficacy while participants with markedly lower levels of resilient functioning scored lowest. This confirms our expectation that higher expressions in these established resilience-promoting factors should go along with better mental health despite stress. However, in a multinomial logistic regression, only self-care emerged as a significant predictor of resilient functioning trajectory class. Self-care generally describes health-promoting behaviors, such as adequate sleep, healthy eating, exercise, and relaxation (61, 62). Previous research in different student populations has linked greater engagement in self-care to lower levels of stress and greater well-being (63–66). Self-care has also been reported to weaken the association between stress and quality of life (67). Our findings are in line with this and expand upon existing research in students by focusing specifically on resilience.

To investigate the effects of the pandemic as a global stressor, we first sought to assess all students' perceived stress

as well as potential changes in their mental health and stressor load compared to the last assessment prior to the lockdown (independent of resilient functioning trajectory). All participants reported having experienced some pandemic-specific stressors, such as alarming reports by the media, but levels of perceived stress were moderate overall. We did not observe any significant increase in stressor load, nor any decrease in mental health. On the contrary, participants reported less symptoms of mental health problems and increased well-being during the pandemic. This was unexpected but ties in with a previous report on changes from before the pandemic to the first lockdown in a sample of the general population in Germany (68). Kohls et al. (69) provided a very comprehensive picture of over 3,000 university students assessed during this lockdown. According to their reports, more than half of the sample did not feel personally affected by the pandemic at that time and a majority perceived not only negative, but also positive aspects. In line with this, Ahrens et al. (68) discuss the concept of psychosocial gains from adversity (70), surmising that the pandemic, as a collectively experienced adverse event, may have strengthened social bonds.

Critically, the picture is very different when considering other populations. In March 2020, the WHO issued advice on how best to deal with the pandemic, paying particular attention to groups such as healthcare staff, carers of children, or older adults (71). Many studies have reported alarming rates of stress and mental health problems among healthcare workers during the first wave of the pandemic (72–74). It is crucial to note, however, that the first wave of the pandemic is unlikely to be representative of how students fared during subsequent waves. To date, there is a lack of research on stress and well-being during the later stages of the pandemic, but large-scale longitudinal projects are ongoing (75). In a preprint, Shevlin et al. (76) observed that most people consistently showed low levels of anxiety and depression and trajectories appeared to stabilize over the first year of the COVID-19 pandemic. Similarly, Prati and Mancini (77) noted that lockdowns did not show uniformly detrimental effects and most people appeared resilient. However, based on a systematic review of the prevalence of post-traumatic stress disorder in the wake of infectious disease pandemics in the 21st century, Yuan et al. (78) cautioned that more studies with longer follow-up times were needed to fully characterize the impact of this pandemic.

We found previous levels of resilient functioning to be predictive of students' resilience during the first lockdown. Specifically, those who had exhibited consistently high resilience and engaged in more self-care behaviors during the pandemic were characterized by high resilient functioning. However, given that students in our sample did not appear to be negatively affected by the lockdown and considering that self-care predicted higher resilience at baseline (i.e., several months before the outbreak of the pandemic), we cannot be sure that self-care presents a critical factor in dealing with pandemic-related stressors. Rather, it seems that self-care is generally important for mental health in the face of everyday life stress. It may be, however, that self-care played a more important role than other resilience factors during the first lockdown. After all, pandemic events were largely uncontrollable and associated with a loss of social contacts, thus, active coping driven by high perceived self-efficacy and the maintenance of social networks was complicated. This may have brought the self and, in turn, self-care behaviors to the fore. In general, intervention studies aiming to boost self-care behaviors, could show significant reductions in stress and depressed mood (79, 80). In cross-sectional studies comparing different coping strategies and protective factors during the initial stages of the pandemic, keeping regular routines, going outside, and limiting screen time emerged as particularly effective health-promoting behaviors (13, 81). Ornell et al. (82) also list self-care behaviors among mental health recommendations during pandemics. Given the severe strain healthcare workers in particular are under, psychosocial support programmes have been called for (83) and some hospitals have acted quickly to implement appropriate measures (84). Notably, many have advocated for organizations to promote self-care as an effective strategy to reduce stress and prevent mental health problems (85–87). Blake et al. (88) developed a digital learning package to promote well-being in healthcare workers during the pandemic, involving healthcare staff in the design process. A core component of the resulting package forms strategies for better self-care, underscoring the importance of self-care for mental health. Future studies should therefore determine the critical contribution of self-care to resilient functioning in students, especially during the later stages of the pandemic.

Some limitations must be considered when interpreting the findings of this study. First, our sample was rather small and the observed effects may therefore not be very robust. Given the unexpected and unprecedented outbreak of the COVID-19 pandemic, most studies that investigated its effects are cross-sectional in nature. Since we had data on students' stress and mental health available from before the pandemic, we focused on following up with these participants. While this restricted our sample size, our findings can shed further light on how characteristics assessed prior to the pandemic link to students' response to the first lockdown. Second, we are lacking potentially very interesting follow-up data from subsequent waves of the pandemic. Third, our sample is selective since we only assessed students from one university in Germany. Research has uncovered striking differences in the impact of the pandemic by country (89, 90), and initial regulations in Germany were county-specific (91), complicating comparisons even between different regions within the country.

Although findings should be interpreted with caution, they represent a rare examination of established resilience factors in relation to resilience over an extended time period and highlight the relevance of self-care in coping with real-life stressors such as the pandemic.

DATA AVAILABILITY STATEMENT

Data and code (including Mplus files) are available on the Open Science Framework: https://osf.io/embcr/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the Institute of Psychology, Johannes Gutenberg-University, Mainz, Germany. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LM and MW: conceptualization. LM: methodology, software, formal analysis, writing-original draft preparation, and visualization. ES, SS, EE, and AB: investigation. LM and ES: data curation. LM, ES, and MW: writing-review and editing. MW: supervision and funding acquisition. ES, SS, EE, AB, and MW: project administration. 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/fpsyt.2021.784381/full#supplementary-material

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Distance Learning Effects Among Italian Children and Parents During COVID-19 Related School Lockdown

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Background: During the COVID-19 pandemic, both children and their parents experienced consequences related to distance learning (DL). However, positive and negative effects have varied greatly among families, and the specific factors explaining these differences in experiences are still underexplored. In this study, we examined children's executive functions (EF) and parents' psychological well-being in relation to negative and positive effects of DL on both children and their parents.

Method: Participants were 637 Italian parents (92% mothers) with a child (48% male) aged between 6 and 19 years involved in DL due to school closures during the first wave of the COVID-19 pandemic. Data were collected using an online survey. We performed three fixed-order hierarchical multiple regression analyses with child age and sex, children's EF deficits, and parents' psychological well-being as independent variables, and DL-related negative effects (on the child and on the parent) and DL-related positive effects as dependent variables.

Results: The results of the regression analyses showed that for negative effects of DL, younger age and greater EF deficits explained most part of the variance. Specifically, regarding negative effects on children, the most important factor was EF deficits, whereas regarding negative effects on parents, child age was the most important factor. For positive effects of DL, all variables explained only a small part of the variance. Child age was the most important factor, but EF deficits and parents' psychological well-being also had a significant impact.

Conclusions: The effects of DL during school closures vary widely across families. Our findings indicate that intervention efforts need to consider background variables, child factors, as well as parent factors when supporting families with homeschooling in times of pandemic.

Keywords: distance learning, COVID-19, executive functions, parents' well-being, children

INTRODUCTION

Effects of Distance Learning Among Italian Families During the COVID-19 Pandemic

Children, adolescents, and their parents have experienced important modifications to daily life activities due to the COVID-19 pandemic. Previous research has shown that school closures and the consequent distance learning (DL) have resulted in psychosocial problems for children (1, 2). In many countries, schools were not able to quickly adapt their teaching to an online format, which often caused increased levels of stress and worry for parents who suddenly had to take responsibility for the teaching role (3). However, there has been little research examining the specific contribution of child and parent factors to differences between families in their adjustment to DL. Understanding which families have experienced the most problems is essential to prevent long-term effects of the COVID-19 pandemic on both children and their parents, and to be well-prepared for possible future school lockdowns.

During the COVID-19 pandemic, the governments of 188 countries imposed school lockdowns which severely modified the education for over 1.7 billion children and adolescents worldwide. This decision, although perhaps necessary, disrupted the daily lives of many families because school is an essential source of physical and mental health; indeed, the general lockdown had a profound and complex negative impact on families (2). For children, school closures had a negative effect not only on learning (4), but also on psychological health (2). More specifically, previous research (3) found that between 17.4 and 27.6% of parents reported general negative experiences related to DL for their child. In addition, high rates of symptoms of depression (22.6–43.7%) and anxiety (18.9–37.4%) among children and adolescents have been reported during the pandemic (2). For parents, school closures were highly challenging due to the need to take on the role of being both a teacher and parent for the child. Calvano et al. (5) investigated a range of different stressors for German parents during the COVID-19 pandemic, and found that school closures were one of the most challenging, with as many as 56% reporting high or extremely high burden. In addition, Thorell et al. (3) showed that a substantial proportion of parents reported negative experiences linked to DL, with worrying and stress exceeding 40% of families across several European countries. Interestingly, some studies also reported positive experiences related to DL for both children and their parents (3, 6). Due to the COVID-19 pandemic, several external stressors for parents (e.g., business meetings, guests, business trips) have disappeared. In addition, mastering the challenges of the COVID-19 situation together may have strengthened family cohesion (6). Finally, children troubled by school due to bullying or other stressors may have experienced the situation of DL as relieving (6). Overall, these findings emphasize that families varied greatly with regard to their experiences of DL, but little is known about specific child and parental factors contributing to these differences.

Previous studies have underlined that background variables such as socio-economic status (SES) and child age and sex are of importance in managing critical situations (7). As for child factors, executive functions (EF) has been found to be strongly related to general psychosocial adjustment (8, 9) and academic achievement [e.g., (7–9)]. With regard to parental factors, psychological well-being, specifically positive mental health, has been shown to play a crucial role in people's positive adjustment during times of crisis (10).

The overall aim of the present study was therefore to examine whether background factors (i.e., child age, child sex, and SES), children's EF deficits and parents' psychological well-being were associated with negative and positive effects of DL during the COVID-19 pandemic.

Background Factors and DL-Related Outcomes

Albeit important, many previous studies examining the psychological effects of the COVID-19 pandemic did not examine the role of background factors (2), such as child age, child sex and family's SES (7). SES has commonly been indexed by family income or parental educational level. However, previous research has shown that parental educational level is more strongly associated with children's academic outcomes compared to income (11). A few studies have shown larger DL-related negative effects for younger compared to older children (3), and larger lockdown-related effects on families with low compared to high parental educational level (12). With regard to child sex, whilst in developing countries there are larger negative effects of DL on girls because of a disproportionate increase in unpaid household work (13), in Western countries we can expect smaller or no differences between boys and girls.

Executive Function Deficits and DL-Related Outcomes

EF is an umbrella term for higher-order cognitive functions required to direct behavior toward a goal (14). It includes inhibition (i.e., the ability to inhibit dominant responses), working memory (i.e., maintaining task-relevant information in mind), shifting (i.e., switching between different tasks), and planning (i.e., choosing the necessary actions and the right order to reach a goal) (14). The ability to direct behavior toward a goal is a key to successfully complete most academic tasks (15), and executive functioning is therefore strongly related to academic achievement (16–18). During school closures, the demands on executive skills have most likely increased as DL requires the child to plan his/her own schoolwork to a much greater extent compared to normal schooling, to maintain attention even though the teacher is only shown on the screen or not at all, and to inhibit the home-environmental distractions during online lessons. In line with this, Hai et al. (19) found significant associations between EF deficits and difficulties adjusting to DL. However, these results are limited to children with Attention Deficit Hyperactivity Disorder (ADHD).

Psychological Well-Being and DL-Related Outcomes

Positive mental health, a key aspect of psychological well-being, can be defined as the presence of general emotional,

psychological, and social well-being (20). Individuals characterized by positive mental health typically have a high sense of control and can adaptively cope with unexpected situations (21). Previous research also found associations between high parental self-efficacy and greater family well-being due to the preserved ability to provide competent, high-quality parenting even when faced with challenges and adversity (10). Good parenting skills become particularly crucial when children are confined at home. In line with this, less parental coping skills in relation to lockdown measures were associated with higher parental stress, poorer parent-child relations, and increased child behavioral problems (5). In an Italian sample involving parents of first grade children, the association between parents' difficulties with managing their children's DL and perceived stress was no longer significant when taking the effect of parental self-efficacy into account (22). In addition, positive mental health assessed before the pandemic has been identified as a predictor of lower burden during the first phase of the COVID-19 pandemic (23). However, the role of positive mental health for parents in relation to DL and the independent effects on parent and child factors on DL during COVID-related school lockdown has not yet been investigated.

Aim of the Present Study

As described above, previous research has demonstrated that DL during the COVID-19 pandemic has had an important impact on both children (1–3) and their parents (3, 5, 22). However, there is a lack of knowledge concerning the specific factors that could explain differences between families. Understanding the sources of variability in outcomes related to DL in times of school closure is crucial to provide support based on the needs of individual families. Thus, the aim of the present study was to examine the contribution of background factors (i.e., child age, child sex, and parental educational level), child factors (i.e., children's executive deficits), and parent factors (i.e., parents' psychological well-being) to both positive and negative effects of DL during the COVID-19 pandemic.

Based on previous research (3), we expected lower child age to be related to more negative effects of DL on both children and their parents. Considering the few, inconsistent results of previous research examining the effects of child sex on DL, we did not formulate any a priori hypothesis in this regard. In relation to parental educational level, we expected lower parental education to be linked to more negative effects of DL for both parents and their children (12, 24). In terms of child factors, we expected that EF deficits would be associated with DL-related negative outcomes for the child (19). In terms of parent factors, parents' psychological well-being would primarily be related to less DL-related negative outcomes on parents (23) and to positive effects of DL on family (10).

METHODS

Participants and Procedure

All participants of the present study were part of an international study (3) conducted in seven European countries with the aim to investigate parental experiences of DL due to school closures during the early phase of the COVID-19 pandemic (i.e., April through June, 2020). Inclusion criteria for the present study were: (1) being the parent of a child (aged 6–19 years) receiving DL due to school closure during the COVID-19 pandemic; (2) being Italian (i.e., living in Italy and speaking mostly or only Italian in the home setting); (3) having a child without any mental health problems. If parents had more than one child receiving DL, they were asked to respond to the survey referring to their oldest child.

For the purpose of this study, we focused on parents of children with typical development ($n = 667$), excluding reports from parents who had a child with mental health problems. In addition, to ensure the accuracy of data analysis, questionnaires with more than 25% of missing data were considered invalid and not included. This resulted in a few participants (30/667) being excluded. The final sample included 637 participants. More specifically, we included 587 (92%) mothers and 45 (7%) fathers (5 respondents chose to not report their gender). Parental educational level (based on both parents) was up to 8th grade for 66 (11%) families, up to high-school diploma for 276 (43%) families, up to a bachelor's degree for 236 (37%) families, and up to a master's degree or a Ph.D. for 59 (9%). Target children were 304 (48%) males and 329 (52%) females (4 families did not report their child's gender) aged between 6 and 19 years ($M = 10.8$, $SD = 3.24$), with 339 (53%) children attending 1st to 5th grade, 183 (29%) attending 6–8th grade, and 115 (18%) attending high school.

Parents reported that children (1st−8th grade) spent on average 4 h/day on DL, whereas adolescents (9–13th grade) spent on average 5 h/day on DL. For children, 35% of the time devoted to schoolwork was spent on self-studies, 35% in contact with a parent, 24% in contact with a teacher, and 7% in contact with peers. Adolescents spent 45% of the time devoted to schoolwork on self-studies, 40% in contact with a teacher, 8% in contact with peers, and 7% in contact with a parent.

Data were collected using an anonymous digital survey distributed *via* social media, schools, and parent networks. Several schools from different socio-economic areas were asked to support the study by distributing the link. The study was approved by the ethics committee of the School of Psychology at University of Padua (protocol no. 3620). Written informed consent was obtained from parents before they took part in the study.

Materials

The online questionnaire was originally created for the cross-cultural study (3) and focused on several aspects of parents' experiences of DL. In the present study, we included three domains: negative effects of DL on children, negative effects of DL on parents, and positive effects of DL on the family. Items were developed based on a previous qualitative study (unpublished data) which examined what aspects of family functioning that parents thought were most strongly affected by school closure during the COVID-19 pandemic. In addition, the present study included a measure of children's EF deficits and a measure of parents' psychological well-being. These measures are described in more detail below.

Negative Effects of DL on Children

The following five items measured parents' perceptions of negative effects of DL for the child: (1) "My child finds particularly difficult to sustain his/her attention when schooling takes place from home"; (2) "During homeschooling, my child often gets distracted by other things when s/he/ should be studying"; (3) "Homeschooling puts too high demands on the child to plan his/her own schoolwork"; (4) "For my child is impossible to work well because of homeschooling"; (5) "Homeschooling has negative effects on the child's life". Each item was rated on a scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), with higher scores indicating more negative effects for the child. Cronbach's alpha was 0.82.

Negative Effects of DL on Parents

The following five items measured parents' perceptions of negative effects of DL for themselves: (1) "As a parent, I need to take an active part in homeschooling to make sure that my child is doing the work that s/he is supposed to do"; (2) "My child has difficulties with carrying out homeschooling without having an adult at home who can support him/her"; (3) "I feel stressed because of the extra work that homeschooling demands of me as a parent"; (4) "I am worried that my child will not be able to handle school as well as s/he normally does because of homeschooling"; (5) "Homeschooling has had negative effects on my own life". Each item was rated on a scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), with higher scores indicating more negative effect of DL for parents. Cronbach's alpha was 0.88.

Positive Effects of DL on Family

The following three items measured parents' perceptions of positive experiences of DL: (1) "I see certain advantages with the fact that my child is homeschooled"; (2) "Homeschooling has positive effects on the child's life"; (3) "Homeschooling has positive effects on my own life". Each item was rated on a scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), with higher scores indicating greater positive effects. Cronbach's alpha was 0.79.

Background Variables

Parents were asked to report their child's age and sex. Moreover, parental educational level for both the child's mother and father was measured using a 4-point scale (1 = completed < 8th grade; 2 = completed some years of high school, without obtaining the high-school diploma; 3 = high-school diploma and/or some years of university; 4 = master's degree or a Ph.D.). In our analyses, we averaged the score for the mother and the father.

Children's Executive Function Deficits

Children's EF deficits were measured using an abbreviated (8 items) version of the Childhood Executive Functioning Inventory (CHEXI; 25). The CHEXI is freely available in many different languages (www.chexi.se), and previous studies have shown that this questionnaire has good test-retest reliability (25). It has also been shown to be related to daily life functioning (e.g., academic achievement) (26). The CHEXI includes two subscales measuring working memory (e.g., "My child has difficulty remembering lengthy instructions") and inhibition (e.g., "My child has difficulty stopping an activity immediately upon being told to do so"). Each item is rated on a scale ranging from 1 ("definitely not true") to 4 ("definitely true"), with higher scores indicating greater EF deficits. Parents were asked to report their child's executive functioning during the last 6 months. In this study, we used the short version to keep the number of items as low as possible and thereby hopefully optimize the response rate. Cronbach's alpha was 0.90.

Parents' Psychological Well-Being

The Positive Mental Health scale (PMH-scale; (20) was used to assess psychological well-being and positive mental health in parents. The scale assessed emotional, psychological and social aspects of individual well-being. Participants rated statements such as "I enjoy my life", "In general I am confident", "I am in a good physical and emotional condition" on a 4-point Likert scale ranging from 1 ("do not agree") to 4 ("agree"). Higher scores indicated more positive mental health. Cronbach's alpha was 0.81.

Statistical Analyses

Data analyses were conducted using R (27). First, all variables included in the study were standardized. Second, Pearson correlations were used to investigate intercorrelations among all variables. Third, three hierarchical linear regression analyses were run to evaluate the specific contribution of the independent variables in relation to DL-related negative effects (on either children or parents) and DL-related positive effects. The order of predictors was selected *a priori*. In the first step, we entered child sex and age to test for their effects on DL-related effects and to control for their association with the other predictors (i.e., EF deficits and parents' psychological well-being). Children's EF deficits were then entered in the second step, as previous research has emphasized that executive functioning is fundamental for academic achievement (18). Finally, parents' psychological well-being was entered in the last step, as parental functioning was likely to play an important role in the adjustment to lockdown measures, specifically with regard to DL previous research has shown that parents had to take on responsibility for schooling due to the lack of online teaching (3, 5, 10). Finally, the interaction effect of EF deficits and psychological well-being was also examined in relation to all three outcomes.

RESULTS

Table 1 presents correlations among all variables (DL-related effects, child age and sex, parental educational level, children's EF deficits and parents' psychological well-being). The results showed that negative effects of DL on parents and children were strongly associated, and both these variables were also negatively associated with positive effects of DL. Child age was significantly associated with all other variables, with younger age being related to more negative effects on both parents and children and less positive effects. Child sex was significantly associated with negative effects of DL and EF deficits, male being related to more negative effects and higher EF deficits.

TABLE 1 | Descriptive statistics and correlations among study variables ($N = 637$).

	2	3	4	5#	6	7	8	Mean (SD)
Negative effects of DL on child	0.76***	−0.48***	−0.28***	0.08*	−0.07	0.55***	−0.19***	2.90 (0.94)
Negative effects of DL on parents		−0.48***	−0.50***	0.11**	0.05	0.53***	−0.24***	3.37 (1.12)
Positive Effects of DL			0.28***	−0.02	−0.02	−0.22***	0.22***	2.19 (0.86)
Child age				−0.09*	−0.16***	−0.33***	0.09*	10.80 (3.24)
Child sex#					0.07	0.16***	−0.06	–
Parental educational level						−0.04	0.08*	2.63 (0.76)
Children's EF deficits							−0.33***	19.10 (6.78)
Parents' psychological well-being								26.07 (4.41)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; DL, distance learning; EF, executive functions.*
#*Point-biserial correlation.*

TABLE 2 | Hierarchical multiple regression analysis with negative effects (on children and parents) and positive effects of DL as the dependent variables and background factors, EF deficits and parent's psychological well-being as independent variables ($N = 637$).

	Negative effects of DL on children			Negative effects of DL on parent			Positive effects of DL		
	β	AdjustedR^2	ΔR^2	β	AdjustedR^2	ΔR^2	β	AdjustedR^2	ΔR^2
Step 1		0.08			0.25			0.07	
Age	−0.28***			−0.50***			0.28***		
Child sex	0.06			0.07			0.01		
Step 2		0.30	0.22		0.39	0.14		0.09	0.02
Children's EF deficits	0.51***			0.38***			−0.08*		
Step 3		0.31	0.01		0.41	0.02		0.12	0.03
Parents' psychological well-being	−0.01			−0.08*			0.17***		

*$p < 0.05$, ***$p<0.001$; EF, executive functions.*

Parental educational level was negatively associated with child age and positively associated with parents' psychological well-being, but it was not significantly associated with any DL-related effects. Hence, parental educational level was not included in the regression models. With regard to associations between child/parent factors and DL-related effects, all three outcome variables were significantly associated with both children's EF deficits and parents' psychological well-being.

Next, we conducted a hierarchical regression analysis for each dependent variable[1]: negative effects of DL on child, negative effects of DL on parent, and positive effects of DL on family (see **Table 2**). With regard to negative effects of DL on children, the background variables included in the first step explained 8% of the variance. In the second step, the effect of EF deficits was significant, with this step explaining 22% of the variance. Parents' psychological well-being (entered in the third step) had no significant effect. With regard to negative effects of DL on parents, the background variables explained 25% of the variance. EF deficits had a significant effect, explaining 14% of the variance. Parents' psychological well-being also had a significant effect, but it explained only an additional 2% of the variance. Finally, for positive effects of DL, background variables explained 7% of the variance. In the second step, the effect of EF deficits was significant and explained 2% of the variance. In the third step, parents' psychological well-being was significant but only explained 3% of the variance. Thus, in total, the variables included in the present study could only explain 12% of the variance in positive effects of DL. No significant interaction effects of children's EF deficits and parents' psychological well-being were found for any of the three dependent variables.

DISCUSSION

Several recent investigations have explored the negative impact of DL on psychological health, but few studies have examined

[1]We evaluated if the assumptions of our regression model were met, using a procedure recommended by Peña & Slate (28) *via* the gvlma package. We evaluated assumptions of linearity, homoscedasticity, uncorrelatedness, and normality on the residuals of our final regression model. Regarding negative effects of DL on children the Global test indicated that the assumptions of the regression model could not be rejected, $\chi^2(4) = 6.93$; $p = 0.29$ (skewness: $\chi^2(4) = 0.25$, $p = 0.97$; curtosis: $\chi^2(4) = 0.34$, $p = 0.90$; link function: $\chi^2(4) = 0.14$, $p = 0.06$; homoscedasticity: $\chi^2(4) = 0.19$, $p = 0.61$). Regarding negative effects of DL on parent the Global test indicated that the assumptions of the regression model could not be rejected, $\chi^2(4) = 5.06$; $p = 0.28$ (skewness: $\chi^2(4) = 0.002$, $p = 0.96$; curtosis: $\chi^2(4) = 0.001$, $p = 0.98$; link function: $\chi^2(4) = 1.49$, $p = 0.22$; homoscedasticity: $\chi^2(4) = 3.56$, $p = 0.06$). Regarding positive effects of DL the Global test indicated that the assumptions of the regression model could not be rejected, $\chi^2(4) = 7.22$; $p = 0.13$ (skewness: $\chi^2(4) = 0.37$, $p = 0.23$; curtosis: $\chi^2(4) = 0.87$, $p = 0.09$; link function: $\chi^2(4) = 0.03$, $p = 0.08$; homoscedasticity: $\chi^2(4) = 0.68$, $p = 0.09$). Thus, our model met the assumptions required to perform regression analysis.

the extent to which child and parent factors contribute to differences between families regarding their experiences of DL. Understanding the specific child and parent factors that impact on parents' management of their children's DL is essential to tailor interventions aimed at reducing possible long-term effects related to DL. The main goal of the present study was to investigate the role of background factors, child factors, and parental factors in explaining differences in the perception of negative and positive effects of DL due to school closures imposed during the first wave of the COVID-19 pandemic. Specifically, three outcomes were assessed: negative effects of DL on children, negative effects of DL on parents, and positive effects of DL on the family. Regarding DL-related negative effects, we found that both background factors and children's EF deficits explained most part of the variance, but there were some noteworthy differences. For DL-related negative effects on children, EF deficits were the most important factor, whereas child age was the most important factor for negative effects on parents. Regarding DL-related positive effects, all variables explained only a small part of the variance. Child age was the most important factor, but children's EF deficits and parents' psychological well-being also had a significant impact.

The Role of Background Factors

The present study examined several background variables (i.e., child age and sex, and parental educational level) and how they contributed to Italian families' adjustment to DL. There is ample evidence suggesting that the effects of stressful events vary significantly depending on the age of the child and the family's SES. More specifically, younger children are more likely to be affected by their parents' stress generated by the pandemic, and parental stress has been found to be linked to more child behavior problems at school (29). Moreover, children and adolescents with low family SES seem to have more difficulties coping with stressful life situations than their peers with high SES (7). In the present study, we assessed SES as parental educational level, since previous research has found parental education to be most strongly associated with children's academic outcomes (11). With regard to effects of age, our results are consistent with at least one previous study finding larger negative effects for families with younger compared to older children (3). Child age had a particularly strong impact on DL-related negative effects on parents. Generally, during the lockdown, parents had to meet various demands simultaneously: homeworking, financial difficulties, and loss of social support (5). Moreover, parents of younger children had to take over the role of teachers due to children's difficulties with self-regulation, attentional focusing, academic motivation, and limited autonomy with managing electronic devices involved during DL-related activities. Thus, younger children required greater support from their parents to cope well with DL (30).

Surprisingly, parental educational level was not significantly associated with DL-related effects within the present study, and this variable was therefore not further considered in the regression analyses. This finding is inconsistent with previous studies showing that families with lower (vs. higher) parental educational level reported a stronger impact on DL-related effects (12). A possible explanation may be the homogeneity in parental education in our sample, with families with a low parental education being underrepresented.

Finally, parents of boys experienced greater negative effects compared to parents of girls. This was expected, considering that previous research has shown that girls performed significantly better than boys during DL (31, 32), probably due to a higher motivation for learning and more functional study habits. However, it should be noted that the effect of child sex was negligible in our study.

The Role of Children's EF Deficits

Our study showed that children's EF deficits were strongly associated with DL-related negative effects on both children and parents. This finding is in line with previous research showing that children's EF deficits have an adverse effect on academic achievement [e.g., (7–9)], and that children with preexisting EF deficits are more vulnerable to the negative psychological impact of the COVID-19 pandemic (33). In addition, this pattern is consistent with studies showing that children with neurodevelopmental disorders known to be related to EF deficits (e.g., ADHD) found DL particularly challenging [e.g., (20, 34)]. Our findings highlight that variation in EFs in non-clinical samples is also of relevance. Thus, following the Research Domain Criteria [RDoC; (35)], efforts should be directed toward the identification of underlying deficits (e.g., EF deficits) in order to provide individualized support, rather than assuming that all children with or without a certain disorder have the same difficulties. The results of the present study also showed that children's EF deficits are an important factor contributing to DL-related negative outcomes on parents, possibly due to the higher demands on children's executive skills in the context of DL activities such as self-study and the ability to plan one's own schoolwork (3). Thus, children with more EF deficits may require more assistance from their parents to perform adequately (36), therefore increasing parents' perception of negative effects on their life related to DL.

The Role of Parents' Psychological Well-Being

Previous research has shown that parents' psychological well-being, self-efficacy, and positive mental health are essential aspects when facing challenges and adversity (10, 22, 23). Individuals with better positive mental health before the pandemic reported lower burden during the first phase of the COVID-19 outbreak (23). However, this last study did not investigate effects related to DL, nor the independent effects of parents' psychological well-being when controlling for other factors. In the present study, we found a significant negative association between parents' psychological well-being and DL-related negative effects on both children and their parents, but this association did not remain significant for DL-related effects on children when including EF deficits in the previous step of the regression analysis. This shows that there

is an overlap between EF deficits and parents' psychological well-being, especially in relation to effects on children. As regards DL-related positive effects, our research underlined the major role of parents' positive mental health. Altogether, our findings are consistent with previous studies (5, 10, 23) suggesting that greater parental self-efficacy and better parental coping with lockdown measures are related to more positive parental experiences of DL and increased family well-being. Moreover, our study expands the results of previous work on Italian parents (22), which found that the association between parents' difficulties in managing their children's DL and levels of perceived stress was no longer significant after controlling for parental self-efficacy.

Strengths and Limitations

The present study had several strengths, the inclusion of large sample of Italian families with at least one child experiencing DL during the first wave of the COVID-19 pandemic; the collection of data during school closures due to the national lockdown imposed by the Italian government, rather than the reliance on retrospective reports; and the inclusion of three different measures of DL-related effects on families—negative impact on children, negative impact on parents, as well as positive impact. Albeit sharing some variance, the DL-related effects were specific as suggested by the fact that different factors (i.e., background variables, child factors, and parental factors) contributed in unique ways to the three outcomes (37). With regard to limitations, we relied on cross-sectional data rather than investigating abilities before and during DL and the direction of the effects could therefore not be established. For instance, it is possible that DL-related negative effects cause lower levels of parental psychological well-being, rather than the other way around. In support of this view, previous research [e.g., (37)] has shown that DL during the COVID-19 pandemic has led to increased parental stress, which in turn decreased parents' psychological well-being. Reciprocal relations indicating that parents' psychological well-being and their effects of DL influence each other over time are also possible. Secondly, we relied on parents' perceptions of child outcomes rather than on children's own reports. This was necessary as we included children as young as 6 years of age. In addition, self-reports could be problematic as children may struggle to describe their difficulties *via* a self-report measure, choosing extreme options and basing their responses on a single experience (38). Adults more often judge their experiences holistically, and parental reports should therefore be regarded as a primary source of information about children's adjustment. Thirdly, we did not use validated measures to assess DL-related effects. However, we developed the items based on the results from a small qualitative study in which parents were asked to describe the effects of DL on family functioning. Based on the results of this study, it became clear that the COVID-19 pandemic is a unique event that has posed new challenges, and available questionnaires were therefore not able to evaluate the most relevant aspects. More research is warranted to evaluate the psychometric properties of the measures included in the present study. Finally, despite attempts to recruit participants *via* schools in a range of different socio-economic areas, families with a low level of parental education were underrepresented.

Conclusions and Future Directions

The present study offers a comprehensive investigation of the contribution of background factors, children's EF skills, and parents' psychological well-being in relation to DL-related effects. After the inclusion of background variables, often omitted in prior work, we found more severe impacts on families with a younger compared to an older child. For negative DL-related effects on parents, the age of the child was the most important variable. Children's EF deficits were the variable that was most strongly related to negative DL-related effects on children, but played a key role also for negative effects on parents. Moreover, high levels of parental psychological well-being seemed to work as a protective factor. As a next step, studies might assess long-term effects and consider other factors that could potentially influence the experience of DL, such as parenting style, parents' availability in supporting their children's DL, quality of sleep, school schedules, and previous academic performance. Our finding that EF deficits significantly contributed to DL-related negative effects on children suggests that future research might consider how to best limit the negative consequences of EF deficits in the school setting in case of future school closures. For instance, previous studies conducted before the pandemic have shown that reducing task length, dividing tasks into sub-units, giving explicit instructions, providing help with organizing school work, and regular feedback from an adult or peer are effective strategies (26, 36). Through a more complete understanding of the complex relation between background factors and child and parent factors, we are better equipped to provide individualized support to families and thereby hopefully reduce long-term negative effects of school closures during the COVID-19 pandemic on children's learning and family life.

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 University of Padua, Padua, Italy. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LT developed the study concept. GC performed the testing. GC, IM, and LT performed the data analysis. GC and IM drafted the manuscript. UM, MR, and LT provided revisions. All authors contributed to the article and approved the submitted version.

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The Association Between Dry Eye Disease With Depression, Anxiety and Sleep Disturbance During COVID-19

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Objective: This study aimed to investigate the relationship between dry eye disease (DED) with anxiety and depression. Additionally, the mediating effect of sleep quality on this relationship was explored.

Methods: 321 patients with DED were recruited from Tianjin Medical University Eye Hospital clinic and surveyed using demographic questionnaires, the Ocular Surface Disease Index (OSDI), Hospital Anxiety and Depression Scale (HADS), and Pittsburgh Sleep Quality Index (PSQI). Regression analysis and the bootstrap method were used to investigate the influence of sleep on the relationship between DED, anxiety and depression.

Results: Among the patients with DED, 86 (26.79%), 85 (26.48%), and 54 (16.82%) patients presented with anxiety, depression, and both anxiety and depression respectively. The OSDI and PSQI score were positively correlated with depression and anxiety (all $p < 0.01$). The direct effects of OSDI on depression and anxiety were significant ($P < 0.01$). Additionally, the bootstrap test showed significant mediating effects of subjective sleep quality [95% CI [0.003–0.016] (depression); [0.001–0.011] (anxiety)] and sleep latency [95% CI [0.001–0.010] (depression); [0.001–0.008] (anxiety)]. These results indicated that the severity of DED symptoms, as measured by the OSDI score, affected anxiety and depression through a direct and an indirect pathway mediated by subjective sleep quality and sleep latency.

Conclusions: The results indicated that there was a significant correlation between DED and anxiety and depression. Moreover, subjective sleep quality and sleep latency were a mediator of the relationship between DED symptoms and anxiety and depression.

Keywords: dry eye disease, anxiety, depression, dry, sleep, COVID-19

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INTRODUCTION

Since December 2019, coronavirus disease 2019 (COVID-19) has swept the world and has been declared a global public health emergency by the World Health Organization. COVID-19 is an infectious disease caused by severe acute respiratory syndrome corona virus 2 (SARS-COV-2) with droplets and contact as the main modes of transmission (1).COVID-19 is characterized by high

infectivity and mortality. The cumulative number of confirmed cases worldwide was 200,174,883 and of deaths were 4,255,892, respectively, until August 5, 2021.

The widespread and rapid dissemination of COVID-19 has caused serious mental health stress to the public, such as anxiety, depression, and sleep problems (2–4). Meanwhile, during COVID-19 outbreak, individuals' isolation at home and the use of electronic devices have increased greatly (5).Long-term use of electronic products will inevitably cause eye diseases, such as dry eyes disease, myopia (6, 7).

Previous research (8) found ocular problems in COVID-19 patients, with conjunctival congestion as the primary symptom (9), while eye pain, photophobia and dry eye were also reported (10). Dry eye disease (DED) is a common ocular surface disease, with patients complaining of discomfort including dryness, foreign body sensation, burning sensation, photophobia, and eye pain, which can affect their the quality of life (11, 12). DED patients with chronic eye discomfort may also experience emotional problems such as anxiety and depression (13–15).

Several studies (16–19)have found the prevalence of depression in dry eye patients to be around 25–53.7% and anxiety around 39–63.6%. The severity of signs and symptoms in patients with DED did not change concomitantly. Kim et al. (20) found that the discomfort of DED and anxiety-depression were correlated; however, several studies concluded the opposite (21–23). Since the relationship between the symptoms of DED and anxiety and depression is unclear, it is crucial to conduct further research. Moreover, sleep disorders are another serious problem in patients with DED. In addition, patients with DED are more likely to have sleep problems than other eye diseases (18). Wu et al. (24) have found that DED patients with sleep disorders are more likely to experience anxiety and depression. Ayaki (25) found that subjective sleep quality was closely associated with anxiety and depression in women with DED. Sleep and mental problems in patients with DED have been the main interest of many researchers, but the precise association between the different components of sleep and anxiety and depression is not clear.

Various studies have found an increase in anxiety, depression, and sleep disorders during the COVID-19 epidemic (4, 26, 27). However, the relationship between sleep and mood problems in individuals with DED during the COVID-19 pandemic is unclear. Therefore, we want to investigate whether there is a correlation between DED, sleep, anxiety and depression. Furthermore, we try to explore the mediating effect of sleep on the relationship between DED and anxiety and depression in patients during the COVID-19 pandemic.

MATERIALS AND METHODS

The 321 patients with DED were recruited between May and July 2021 at Tianjin Medical University Eye Hospital in China. Approval was obtained from the Medical ETHICS Committee of Tianjin Medical University Eye Hospital. The procedures used in this study adhered to the tenets of the declaration of helsinki. informed consent was obtained from all participants included in the study.

Participants were literate adults aged >18 years with an Ocular Surface Disease Index (OSDI) score of ≥13 points. We excluded patients who had complications from anterior ocular segment diseases except for DED, patients with a history of ophthalmic surgery in the last 3 months, patients with severe glaucoma, bilateral cataract, and exclude systemic diseases such as autoimmune diseases, severe cardiopulmonary diseases, allergic diseases, and neurologic or psychiatric disorders. Previously diagnosed anxiety and depression were also excluded. In addition, patients who received anti-allergy drugs and contraceptives were excluded. Patients with an alcohol and drug dependence history, those taking anti-anxiety and antidepressant drugs, with serious medical conditions that prevented them from completing the questionnaire, who were unable to care for themselves, severely illiterate, and pregnant and lactating women were also excluded. Demographic and medical data were collected.

Evaluation of DED

All participants completed the OSDI questionnaire, a self-administered questionnaire that assesses the severity of self-reported DED. Based on the total OSDI score, each participant's condition was classified as normal (0–12 points), mild (13–22 points), moderate (23–32 points), and severe (33–100 points). A score of ≥13 points led to a diagnosis of DED.

Sleep Quality Assessment

Patients' sleep quality in the last 1 month was measured using the Pittsburgh Sleep Quality Index (PSQI). It consists of seven dimensions, namely subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medicine, and daytime dysfunction. Each dimension is scored on a scale of 0–3, and dimension scores are cumulated to a total PSQI score ranging from 0 to 21, with higher total scores indicating poorer sleep quality. Patients with total scores >7 were considered to have poor sleep.

Emotion Status Assessment

The Hospital Anxiety and Depression Scale (HADS) questionnaire was created by Zigmond and Snaith (28) to screen for anxiety and depression among patients in general hospitals. The scale contains 14 items, divided into two subscales containing seven items each to assess depression and anxiety. The scale is scored on a 4-point scale (0–3), and the cut-off points for anxiety and depression are total scores of 8 points. HADS has good reliability and validity values (29), and is widely used to screen for anxiety and depression.

Statistical Analysis

Statistical analyses were performed using the SPSS software (version 23.0; IBM Corp., Armonk, NY, USA).The normality of each continuous variable was tested. Continuous variables that conform to the normal distribution are expressed as Mean ± SD, and those that do not are expressed as median (IQR).Using independent *t*-test or $\chi 2$ test for continuous and categorical

variables, respectively. When the theoretical frequency (T) was $1 \leq T < 5$, a corrected $\chi 2$ test was used.We used Spearson's correlation to analyze the associations between the scores on the OSDI, PSQI and subscales, and HADS. Multiple linear hierarchical regression models were applied to test the mediating role of total PSQI and subscales scores in the relationship of DED with anxiety and depression. Prior to the mediation analysis, all continuous variables were pooled to eliminate multicollinearity. We used *B* as an unstandardized regression coefficient to describe the significant of direct and indirect effects, *Beta* as a standardized regression coefficient to describe the weight of them. The mediating role of sleep quality was further tested using a bootstrap analysis of 5,000 samples. All tests were two-sided, and statistical significance was set at $p < 0.05$.

RESULTS

This study included 321 patients with DED (89 men and 232 women).The age of them was 48.41 ± 15.15. General patient characteristics are presented in **Table 1**. We found no difference in sleep between men and women with DED. Menopausal women were more likely to have poor sleep ($p < 0.05$).In addition, age and education levels were also affected factors of sleep ($p < 0.05$).

Among participants, 86 (26.79%), 85 (26.48%), and 54 (16.82%) presented with anxiety, depression, and both anxiety and depression, respectively. A total of 52 (16.20%) patients reported good sleep, and 269 (83.80%) reported poor sleep. In addition, DED patients who had poor sleep were more likely to be anxious and depressed (**Table 2**).

The mean OSDI score was 45.90 ± 15.90 points. We found that 243 (75.70%) patients with DED were categorized as severe according to the OSDI score, while 18 (5.61%) and 60 (18.69%) patients were categorized as mild and moderate, respectively.

The results of the correlation analyses are presented in **Table 3**. The OSDI score was significantly correlated with anxiety and depression, as well as with PSQI total score and subjective sleep quality and sleep latency. PSQI total score, subjective sleep quality, and sleep latency were significantly correlated with anxiety and depression.

Hierarchical regression analyses (**Tables 4**, **5**) revealed that more severe DED (i.e., higher OSDI scores) was associated with poorer subjective sleep quality ($B = 0.012$, $p = 0.000$), longer sleep latency ($B = 0.009$, $p = 0.027$), and depressive ($B = 0.034$, $p = 0.003$) and anxiety symptoms ($B = 0.032$, $p = 0.003$). Poorer subjective sleep quality ($B = 0.411$, $p = 0.024$) and longer sleep latency ($B = 0.314$, $p = 0.027$) were both associated with anxiety symptoms (**Table 4**). Additionally, poorer subjective sleep quality ($B = 0.678$, $p = 0.000$) and longer sleep latency ($B = 0.447$, $p = 0.002$) were both associated with depressive symptoms (**Table 5**).

Our primary hypothesis (**Figure 1**) was that the association of DED severity, as measured by the OSDI scores, with depressive and anxiety symptoms would be mediated by poorer subjective sleep quality and longer sleep latency (**Table 6**). In mediation model 1, the effect of DED on anxiety symptoms was positive and significant, with a standardized estimate of 0.141 (95% CI [0.006–0.048]). This effect was significantly mediated by subjective sleep quality, with a standardized estimate of 0.026 (95% CI [0.001–0.011]).

In mediation model 2, the effect of DED on anxiety symptoms was positive and significant, with a standardized estimate of 0.152 (95% CI [0.006–0.050]). This effect was significantly mediated by sleep latency, with a standardized estimate of 0.015 (95% CI [0.001–0.008]).

In mediation model 3, the effect of DED on depressive symptoms was positive and significant, with a standardized estimate of 0.126 (95% CI [0.005–0.046]). This effect was significantly mediated by subjective sleep quality, with a standardized estimate of 0.041 (95% CI [0.003–0.016]).

In mediation model 4, the effect of DED on depressive symptoms was positive and significant, with a standardized estimate of 0.147 (95% CI [0.008–0.050]). This effect was significantly mediated by sleep latency, with a standardized estimate of 0.021 (95% CI [0.001–0.010]).

In the four models, the confidence interval excluded zero, indicating a significant indirect effect of DED on anxiety and depressive symptoms *via* mediators.

DISCUSSION

This study examined the relationship between DED and anxiety and depression, and whether this relationship is mediated by sleep. The results showed that the relationship of DED with anxiety and depression was mediated by subjective sleep quality and sleep latency. Wu et al. (24) found that DED patients with sleep disorders were more likely to be anxious and depressed, which is consistent with our findings.

Eye discomfort symptoms caused by DED may negatively affect mood and mental health (15, 30, 31).The causal relationship between DED and depression remains unclear. However, some factors have been used to explain this association. First, the two diseases are homologous (32); in particular, both share common risk factors, including female sex and menopause. This suggests that sex hormones play an important role in the development of both diseases. Second, somatization is present in 80% of patients with depression (33), which may play a role in exacerbating DED symptoms. In addition, we propose two potential mechanisms: subjective sleep quality and sleep latency, which may help explain the relationship of DED with anxiety and depression.

Several studies (24, 34–37) have found that DED patients suffer from sleep disorders, short sleep duration, poor sleep quality, insomnia, and sleep apnea. This may be due to the fact that tears are produced by the lacrimal glands, which are innervated by the parasympathetic and sympathetic nerves (38). Sleep disorders have been reported to increase the level of stress hormones, including cortisol, epinephrine, and norepinephrine (39), and decrease parasympathetic activity and increase sympathetic tone. Sleep disorders cause mild activation of the hypothalamic-pituitary-adrenal axis in humans, leading to diuresis and excessive natriuresis (40, 41); in addition,

TABLE 1 | Comparison of demographics in patients with DED With good sleep or poor sleep.

Group	DED with good sleep (n = 52)	DED with poor sleep (n = 269)	χ^2	P
Sex			0.003	0.959
Male	12 (25.53%)	35 (74.47%)		
Female	40 (20.62%)	154 (79.38%)		
Menstruation			6.131	0.013
Menopause	14 (10.85%)	115 (89.15%)		
Non menopause	25 (13.97%)	154 (86.03%)		
Age[a]	40.87 ± 14.59	49.87 ± 14.86	4.013[b]	0.000
Family status			1.505	0.220
Married	44 (15.33%)	243 (84.67%)		
Single	8 (23.53%)	26 (76.47%)		
Education levels				
Primary Education	2 (6.67%)	28 (93.33%)	12.275	0.006
Middle School Education	6 (9.23%)	59 (90.77%)		
High School Education	9 (11.25%)	71 (88.75%)		
University or higher	35 (23.97%)	111 (76.03%)		
Household location			0.909	0.340
Urban	44 (17.19%)	212 (82.81%)		
countryside	8 (12.31%)	57 (87.69%)		
BMI index			2.370	0.499
<18.5	3 (23.08%)	10 (76.92%)		
18.5≤BMI<25	33 (17.10%)	160 (82.90%)		
25≤BMI<30	12 (12.24%)	86 (87.76%)		
≥30	4 (23.53%)	13 (76.47%)		
Course of disease			0.105	0.991
≤1 year	24 (15.56%)	124 (84.44%)		
1-3 year	19 (15.70%)	102 (84.30%)		
3-5 year	6 (16.67%)	30 (83.33%)		
≥5 year	3 (18.75%)	13 (81.25%)		
Frequency of visit (Within one year)			4.732	0.193
First visit	28 (17.83%)	129 (82.17%)		
<6 times	17 (13.28%)	111 (86.72%)		
6-12 times	3 (12.00%)	22 (88.00%)		
>12 times	4 (36.36%)	7 (63.64%)		

[a]*Mean ± SD,* [b]*independent t-test.*

TABLE 2 | Comparison of anxiety and depression in patients with DED with good or poor sleep.

	DED with good sleep (n = 52)	DED with poor sleep (n = 269)	t	P
Anxiety	4.75 ± 3.13	5.90 ± 3.04	−2.475	0.014
Depression	3.96 ± 2.94	5.75 ± 3.20	−3.738	0.000

the circadian rhythm of hormones in the renin-angiotensin-aldosterone system is significantly altered (41). It has been suggested that a potential mechanism for dehydration in sleep disorder may involve a reduction in nocturnal blood pressure and a decrease in the renin-angiotensin-aldosterone system hormones (42). Altered levels of these hormones and excess diuresis can thus cause a state of relative dehydration, which can affect tear production.

Subjective sleep quality and latency are important components of sleep. Decreased sleep quality disrupts higher-level cognitive functions, such as cognitive control (43, 44). Cognitive control allows for effective emotion regulation (45), and the ability to regulate emotions provides a critical connection between sleep quality and mood disorders (46). Additionally, when participants with sleep problems view negative emotional pictures, the functional connections between brain regions

TABLE 3 | Descriptive statistics and intercorrelations between analyzed variables.

	Descriptive	1	2	3	4	5	6	7	8	9	10	11
1. OSDI[a]	45.90 (15.90)	–										
2. Anxiety[a]	5.71 (3.08)	0.189**	–									
3. Depression[a]	5.46 (3.22)	0.164**	0.643**	–								
4. PSQI[a]	14.69 (6.89)	0.181**	0.208**	0.294**	–							
5. SSQ[b]	1.00 (1.00)	0.194**	0.168**	0.230**	0.679**	–						
6. SL[b]	1.00 (3.00)	0.122*	0.135*	0.196**	0.611**	0.486**	–					
7. SD[b]	2.00 (3.00)	0.157**	0.014	0.047	0.531**	0.466**	0.352**	–				
8. HSE[b]	1.00 (2.00)	0.186**	0.083	0.132*	0.574**	0.416**	0.435**	0.630**	–			
9. SDE[b]	6.00 (6.00)	0.099	0.196**	0.309**	0.712**	0.285**	0.226**	0.077	0.193**	–		
10. USM[b]	0.00 (0.00)	0.073	0.142*	0.170**	0.394**	0.260**	0.248**	0.213**	0.255**	0.113*	–	
11. DD[b]	2.00 (2.00)	0.068	0.064	0.061	0.546**	0.425**	0.282**	0.247**	0.117*	0.123*	0.187**	–

*[a]Mean (SD), [b]Median (IQR), *P < 0.05,**P < 0.01. SSQ, Subjective Sleep Quality; SL, Sleep Latency; SD, Sleep Duration; HSE, Habitual Sleep Efficiency; SDE, Sleep Disturbance; USM, Used Sleep Medication; DD, Daytime Dysfunction.*

TABLE 4 | Mediation analysis of PSQI,SSQ,SL on the relationship between the OSDI and anxiety.

	B	*Beta*	SE	*t*	*P*
OSDI on anxiety	0.032	0.167	0.011	3.030	0.003
OSDI on PSQI	0.085	0.197	0.024	3.581	0.000
PSQI on anxiety (indirect effect)	0.084	0.188	0.025	3.398	0.001
OSDI on anxiety (direct effect)	0.025	0.130	0.011	2.352	0.019
OSDI on anxiety	0.032	0.167	0.011	3.030	0.003
OSDI on SSQ	0.012	0.206	0.003	3.761	0.000
SSQ on anxiety (indirect effect)	0.411	0.127	0.181	2.269	0.024
OSDI on anxiety (direct effect)	0.027	0.141	0.011	2.517	0.012
OSDI on anxiety	0.032	0.167	0.011	3.030	0.003
OSDI on SL	0.009	0.123	0.004	2.222	0.027
SL on anxiety (indirect effect)	0.314	0.123	0.141	2.229	0.027
OSDI on anxiety (direct effect)	0.029	0.152	0.011	2.750	0.006

SSQ, Subjective Sleep Quality; SL, Sleep Latency.

responsible for cognitive control (medial prefrontal areas) and emotional responses (amygdala) are reduced, resulting in poor individual decision-making over time, such as not seeking support, self-harm, persistent fear and distress, and anxiety and depression (47). Cognitive behavioral therapy for insomnia (CBT-I) includes relaxation, stimulus control, and cognitive therapy (48). Moreover, Ashworth et al. (49) found that CBT-I improved subjective and objective sleep quality and reduced depressive symptoms.

Prolonged sleep latency is considered one of the hallmarks of depression (50). Chronic pain and discomfort in DED may cause central sensitization, a common feature of patients with chronic pain; central sensitization is related to the plasticity of the central nervous system (51), a process in which the nervous system's response is progressively enhanced (52), eventually leading to pain despite low levels of peripheral stimulation. This pain response further prolongs sleep latency and ultimately triggers negative mood, anxiety, depressive symptoms in patients, as has been demonstrated in several studies including breast cancer patients (53). During the COVID-19, people were isolated at home and their use of visual display terminal (VDT) devices increased (54).Increased use of VDT can cause many physical discomforts, such as eye strain, musculoskeletal symptoms, headaches, and sleep problem (55). Individuals who use VDT for more than 6 h/day are more likely to have sleep problems (56). Some studies have also found a significant correlation between VDT use and difficulty in falling asleep. Reducing the use of VDT may alleviate the symptoms of DED and increase sleep quality.

This study has several limitations. First, we adopted a cross-sectional study, therefore, it was difficult to establish causal relationships between DED, sleep quality, anxiety, and depression. Second, the current data were collected using self-report scales, with their inherent limitations. Future studies could utilize objective methods, such as polysomnography, to draw more accurate conclusions about sleep outcomes. Third, Galor

TABLE 5 | Mediation analysis of PSQI,SSQ,SL on the relationship between the OSDI and depression.

	B	*Beta*	SE	*t*	*P*
OSDI on depression	0.034	0.168	0.011	3.041	0.003
OSDI on PSQI	0.085	0.197	0.024	3.581	0.000
PSQI on depression (indirect effect)	0.125	0.268	0.025	4.934	0.000
OSDI on Depression (direct effect)	0.023	0.115	0.011	2.119	0.035
OSDI on depression	0.034	0.168	0.011	3.041	0.003
OSDI on SSQ	0.012	0.206	0.003	3.761	0.000
SSQ on depression (indirect effect)	0.678	0.201	0.187	3.628	0.000
OSDI on depression (direct effect)	0.026	0.126	0.011	2.284	0.023
OSDI on depression	0.034	0.168	0.011	3.041	0.003
OSDI on SL	0.009	0.123	0.004	2.222	0.027
SL on depression (indirect effect)	0.447	0.168	0.147	3.052	0.002
OSDI on depression (direct effect)	0.030	0.147	0.011	2.680	0.008

SSQ, Subjective Sleep Quality; SL, Sleep Latency.

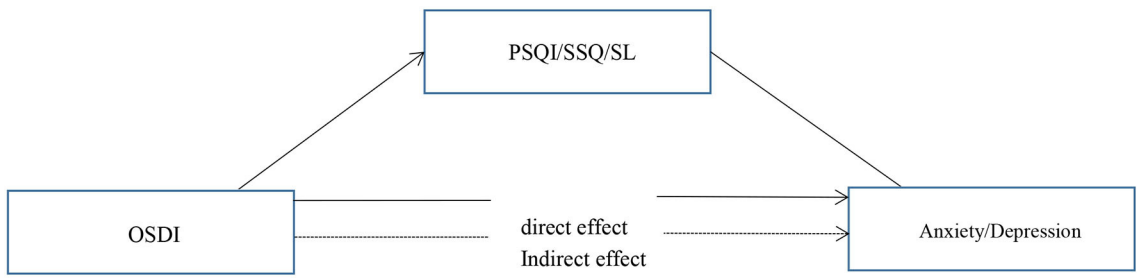

FIGURE 1 | The proposed model of relationships between variables.

TABLE 6 | Bootstrap results for the mediation analysis.

Variables	Estimate	SE	LL95%CL	UL95%CL
OSDI on anxiety (direct effect)	0.025	0.011	0.003	0.046
PSQI on anxiety (indirect effect)	0.007	0.037	0.003	0.014
OSDI on depression (direct effect)	0.023	0.115	0.002	0.043
PSQI on depression (indirect effect)	0.011	0.053	0.002	0.013
OSDI on anxiety (direct effect)	0.027	0.141	0.006	0.048
SSQ on anxiety (indirect effect)	0.005	0.026	0.001	0.011
OSDI on depression (direct effect)	0.026	0.126	0.005	0.046
SSQ on depression (indirect effect)	0.008	0.041	0.003	0.016
OSDI on anxiety (direct effect)	0.029	0.152	0.006	0.050
SL on anxiety (indirect effect)	0.003	0.015	0.001	0.008
OSDI on depression (direct effect)	0.030	0.147	0.008	0.050
SL on depression (indirect effect)	0.004	0.021	0.001	0.010

SSQ, Subjective Sleep Quality; SL, Sleep Latency.

et al. (36) found that insomnia was more severe in the high pain group of patients with DED. We used the OSDI questionnaire in our assessment of DED, but we did not scale eye pain separately. In future studies we will also focus on eye pain. In addition, the participants in this study were Chinese and constituted an urban community sample from similar areas. Future studies should include larger and more diverse samples.

CONCLUSIONS

This study showed that many patients with DED experience anxiety, depression, and sleep disorders. Our preliminary research supports subjective sleep quality and sleep latency as mediators between DED and both anxiety and depression. These preliminary findings highlight the need to further explore the role of sleep in the relationship between DED and mood.

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 Medical Ethics Committee of Tianjin Medical University Eye Hospital. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

QH, ZC, and CX: material preparation, data collection, and analysis were performed. The first draft of the manuscript was written by QH and all authors commented on previous versions of the manuscript. All authors contributed to the study conception, design, read, and approved the final manuscript.

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Gender Differences in COVID-19 Lockdown Impact on Mental Health of Undergraduate Students

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Background: Prolonged university closures and social distancing-imposed measures due to the COVID-19 pandemic obliged students to at-home learning with online lectures and educational programs promoting potential social isolation, loneliness, hopelessness, and episodes of clinical decompensation.

Methods: A web-based cross-sectional survey was carried out in a university institute in Milan, Northern Italy, to assess the COVID-19 lockdown impact on the mental health of the undergraduate students. We estimated the odds ratios (OR) and the corresponding 95% confidence intervals (CI) using adjusted logistic regression models.

Results: Of the 8,177 students, 12.8% reported depressive symptoms, 25.6% anxiety, 8.7% insomnia, and 10.6% reported impulsive tracts, with higher proportions among females than males. Mental health symptoms were positively associated with caring for a person at home, a poor housing quality, and a worsening in working performance. Among males compared with females, a poor housing quality showed a stronger positive association with depressive symptoms and impulsivity, and a worsening in the working performance was positively associated with depressive and anxiety symptoms. In addition, the absence of private space was positively associated with depression and anxiety, stronger among males than females.

Conclusions: To our knowledge, this is the first multidisciplinary consortium study, involving public mental health, environmental health, and architectural design. Further studies are needed to confirm or refute our findings and consequent recommendations to implement well-being interventions in pandemic conditions.

Keywords: COVID-19, undergraduate student, mental health, gender, lockdown

INTRODUCTION

Italy holds one of the highest COVID-19 clinical burden worldwide and the Lombardy region—one of the richest and most productive area in the whole of Europe—was among the first hit in Europe and, within Italy, accounts for >50% of all COVID-19 deaths (1). Lockdown measures have been adopted by the Italian government in order to help curb the pandemic, including, by March 5, school and university closures (2). The life of millions of Italians suddenly changed, and lifestyle habits have been substantially modified (3), with anticipated short-term consequences on physical and mental health (4, 5).

University education is a crucial period in a transitional age, between adolescence and adulthood, because of the higher distress that students are exposed to compared with the general population (6). Emancipation, financial self-sufficiency, career choices, and intimate and friendship relationships are just some of the challenges that undergraduate students are faced with.

These years coincide with the peak period of risk for the onset of mental disorders since ∼75% of all lifetime mental disorders have their onset prior to the age of 24 (7). In particular, mental disorders during this period can be associated with negative effects on the development of young people, including worsening academic performance, dropout from university, and long-term negative impact on later adult labor market functioning, relationship functioning, and health (8, 9).

Psychological response following exposure to stressful events is extremely heterogeneous. People can show a high degree of resilience and quickly return to normal lives or develop different kinds and degrees of psychiatric symptoms. Males and females present different reactions to stress, different ways to manage stress, and to perceive their ability to do so. Findings from the literature suggest that while females are more likely to report physical symptoms associated with stress, they better connect with others in their lives, and at times, these connections are important to their stress management strategies (10).

In the COVID-19 lockdown context, prolonged university closures and social distancing-imposed measures obliged students to at-home learning with online lectures and educational programs promoting potential social isolation, loneliness, hopelessness, and episodes of clinical decompensation (11). For over 2 months of stay-at-home orders, houses became the only place where students slept, ate, studied, practiced sports, and socialized.

To the best of our knowledge, original studies investigating mental health consequences of COVID-19 lockdown on Italian undergraduate students are still scant and conducted on small samples (12, 13). We aimed to evaluate the impact of COVID-19 mandatory confinement on the mental health of the Italian undergraduate student population with particular regard to gender differences and housing quality.

METHODS

Survey Sample

We used data from a large web-based cross-sectional survey conducted in the Lombardy region to assess the mental health impact of the first wave of COVID-19 mass quarantine restrictions. Details were described elsewhere (14). In brief, a web-based survey questionnaire was sent by mail from April 1, 2020 to May 1, 2020 to all personnel from Politecnico di Milano, a scientific–technological university institute in Milan, Lombardy Region, Italy. The total sample ($N = 9{,}261$) consisted of undergraduate students, PhD students, teaching staff, and administrative personnel, aged ≥ 18 years old. The survey was anonymous, and confidentiality of information was assured. A written consent was given to all individuals before participating in the questionnaire/study. Participants were allowed to terminate the survey at any time they desired and no monetary rewards were given for completing the questionnaire.

We restricted our study on the subsample of 8,177 students, to avoid recruitment bias and yield a homogeneous group, separately among males ($n = 4{,}095$) and females ($n = 4{,}082$).

Questionnaire

The questionnaire, filled in through a free Google Forms platform, consisted of three main sections. The first one investigated general characteristics of participants, including gender, current age, marital status, education level, and subjective impact of the mandatory confinement on working performance. The second section consisted of the administration of some evaluation scales of the mental health status, designed to recognize depressive and anxiety symptoms, insomnia, and impulsivity traits. The third section investigated the physical and architectural housing characteristics.

Study Outcomes

We derived the outcomes of the study from four evaluation scales designed to recognize depressive and anxiety symptoms, insomnia, and impulsivity traits. We used the following cutoffs to obtain binary outcomes:

1. For the nine-item Patient Health Questionnaire (PHQ-9) (15), we considered the cutoff for depressive symptoms at ≥15 (moderate and severe depressive symptoms);
2. For the seven-item Generalized Anxiety Disorder (GAD-7) (16), we considered the cutoff for anxiety symptoms at ≥10 (moderate and severe anxiety symptoms);
3. For the seven-item Insomnia Severity Index (ISI) (17), we considered the cutoff for insomnia at ≥15 (moderate and severe);
4. For the Barratt Impulsiveness Scale-11 (BIS-11) (18), we considered the cutoff for trait impulsivity at ≥70, and below or above the highest quartile for the three impulsivity components (i.e., attentional, motor, and non-planning).

Exposure Factors

In line with previous studies in the field of Environmental Psychology and Evidence-Based Design (19, 20), we considered as possible associated factors to mental health some selected physical and architectural housing characteristics, including the apartment dimension (in terms of net square meters), the presence/absence of a livable outdoor space (balcony or garden), the view typology (green or buildings), and a score to define the quality of the indoor space. The score was obtained by

a set of seven parameters: natural lighting, acoustic comfort, thermohygrometric comfort, need for artificial lighting during the day, presence/absence of soft qualities in the living area, such as art objects or greenery/plants, and presence/absence of privacy. Then, we considered three categories of the quality of the indoor area as high (6–7 satisfied parameters), medium (4–5 satisfied parameters), or poor (0–3 satisfied parameters). Finally, we considered as potential factors associated to mental outcomes as caring for a person at home during the confinement and the subjective impact of the mandatory confinement in terms of worsening in working performance.

Statistical Analysis

The analyses were conducted separately by sex. Proportions of the mental health outcomes between males and females were compared using the chi-square test. As the main analysis, we estimated odds ratios (OR) of reporting mental health symptoms, and the corresponding 95% confidence intervals (CI), using adjusted logistic regression models. The models included age and the variables that showed a p-value < 0.25 in the multivariable models as dependent variables, i.e., caring for a person at home (no/yes), apartment dimension (>100 mq, 81–100 mq, and <80 mq), the quality indoor score (high, medium, and poor), and a worsening in working performance (none/little and much/very much) (21).

As a secondary analysis, we estimated the associations between each outcome and selected components of the indoor quality score, in order to explore which of them were more linked to mental health symptoms.

We verified the heterogeneity among strata of sex using the Cochran's Q test statistic (22). We carried out the aforementioned statistical analyses with the SAS software, version 9.4 (SAS Institute, Cary, NC, USA), and the software R version 3.4.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

A total of 8,177 students completed the survey, and the overall response rate (ORR) was around 31.5%. Of the 8,177 students, 12.8% reported depressive symptoms, 25.6% anxiety, 8.7% insomnia, and 10.6% reported impulsive tracts. These proportions were higher among the females than among males, with 15.4% of females reporting depressive symptoms, 33% anxiety, 9.5% insomnia, and 11.4% impulsivity (**Table 1**).

TABLE 1 | Distribution of 8,177 students according to the mental health outcomes and sex.

	Total *N* = 8,177		Males *N* = 4,095		Females *N* = 4,082		*p*-value*
	N	%	*N*	%	*N*	%	
Patient health questionnaire (PHQ-9)							
<15	7,127	87.2	3,674	89.7	3,453	84.6	<0.001
≥15	1,050	12.8	421	10.3	629	15.4	
General anxiety disorder (GAD-7)							
<10	6,080	74.4	3,345	81.7	2,735	67.0	<0.001
≥10	2,097	25.6	750	18.3	1,347	33.0	
Insomnia severity index (ISI)							
<15	7,466	91.3	3,773	92.1	3,693	90.5	0.01
≥15	711	8.7	322	7.9	389	9.5	
Barratt impulsiveness scale (BIS-11)							
<70	7,307	89.4	3,691	90.1	3,616	88.6	0.02
≥70	870	10.6	404	9.9	466	11.4	
Barratt impulsiveness scale: attentional							
<I quartile (8–12)	1,229	15.0	670	16.4	559	13.7	
I–III quartile (13–17)	4,598	56.2	2,333	57.0	2,265	55.5	<0.001
>III quartile (18–30)	2,350	28.7	1,092	26.7	1,258	30.8	
Barratt impulsiveness scale: motor							
<I quartile (11–16)	1,777	21.7	798	19.5	979	24.0	
I–III quartile (17–20)	3,642	44.5	1,853	45.3	1,789	43.8	<0.001
>III quartile (21–36)	2,758	33.7	1,444	35.3	1,314	32.2	
Barratt impulsiveness scale: non-planning							
<I quartile (11–19)	1,553	19.0	808	19.7	745	18.3	
I–III quartile (20–25)	4,005	49.0	2,015	49.2	1,990	48.8	0.09
>III quartile (26–40)	2,619	32.0	1,272	31.1	1,347	33.0	

Chi-squared test ($p \leq 0.05$ identifies statistically significant differences between males and females).

TABLE 2 | Odds ratio* (OR) and their 95% confidence intervals (CI) for symptoms of depression [nine-item Patient Health Questionnaire (PHQ-9) ≥ 15], anxiety [seven-item Generalized Anxiety Disorder (GAD-7) ≥ 10], insomnia [Insomnia Severity Index (ISI) ≥ 15], and impulsivity [Barratt Impulsiveness Scale-11 (BIS-11) ≥ 70] according to selected factors, in males and females, separately.

	Total	PHQ-9 (≥15 vs. <15)		GAD-7 (≥10 vs. <10)		ISI (≥15 vs. <15)		BIS-11 (≥70 vs. <70)	
	N	Males	Females	Males	Females	Males	Females	Males	Females
Caring for a person at home									
No	6,986	1	1	1	1	1	1	1	1
Yes	1,191	1.75 (1.32–2.31)	1.28 (1.01–1.63)	1.43 (1.14–1.79)	1.49 (1.24–1.79)	**2.12 (1.59–2.83)**	**1.19 (0.90–1.58)**	1.38 (1.04–1.82)	0.96 (0.73–1.26)
Apartment dimension (mq)									
>100	4,860	1	1	1	1	1	1	1	1
81–100	1,787	1.09 (0.83–1.43)	0.86 (0.68–1.08)	1.08 (0.88–1.33)	0.89 (0.75–1.07)	1.30 (0.98–1.73)	0.76 (0.57–1.02)	1.07 (0.83–1.39)	0.84 (0.64–1.09)
≤80	1,530	1.31 (1.00–1.73)	1.23 (0.98–1.55)	1.18 (0.94–1.47)	1.17 (0.98–1.41)	1.16 (0.85–1.58)	1.05 (0.8–1.38)	1.02 (0.77–1.35)	1.27 (0.99–1.63)
Balcony livable									
Yes	5,964	1	1	1	1	1	1	1	1
No	2,213	1.05 (0.83–1.33)	1.24 (1.02–1.52)	0.94 (0.78–1.14)	1.15 (0.98–1.35)	1.09 (0.84–1.41)	1.26 (0.99–1.6)	1.33 (1.06–1.68)	1.08 (0.86–1.35)
View from apartment									
Green	3,304	1	1	1	1	1	1	1	1
Buildings	4,873	1.16 (0.92–1.46)	1.03 (0.85–1.24)	0.97 (0.82–1.16)	0.90 (0.78–1.04)	1.25 (0.97–1.61)	1.01 (0.81–1.26)	1.07 (0.86–1.33)	1.01 (0.82–1.24)
Quality indoor score									
High	3,335	1	1	1	1	1	1	1	1
Medium	3,560	**2.09 (1.56–2.80)**	**1.37 (1.11–1.70)**	1.52 (1.24–1.86)	1.45 (1.24–1.69)	1.36 (1.01–1.83)	1.57 (1.22–2.02)	1.18 (0.92–1.51)	0.99 (0.79–1.23)
Poor	1,282	**4.75 (3.44–6.57)**	**2.62 (2.04–3.37)**	3.08 (2.42–3.93)	2.25 (1.83–2.76)	3.05 (2.19–4.26)	2.01 (1.47–2.75)	**2.25 (1.67–3.03)**	**1.40 (1.06–1.86)**
Worsening in working performance									
None/little	5,532	1	1	1	1	1	1	1	1
Much/very much	2,645	**5.57 (4.42–7.01)**	**3.53 (2.94–4.24)**	**3.06 (2.58–3.62)**	**2.29 (1.98–2.63)**	2.92 (2.29–3.71)	2.11 (1.7–2.63)	1.93 (1.56–2.39)	1.72 (1.40–2.10)

**Estimates obtained from multivariable logistic regression models, adjusted for age at interview, caring for a person at home, apartment dimension (mq), worsening in working performance, and quality indoor score.*
Significant differences are highlighted in bold.

Considering the three impulsivity components, the attentional one was more frequently reported among females, while the motor one was more frequently reported among males. Non-planning impulsivity was similarly reported among males and females.

Table 2 shows the associations between selected exposures and mental health symptoms. Caring for a person at home was positively associated to all the studied outcomes among both sexes, except for impulsivity among females. In addition, caring for a person at home had a stronger association to insomnia among males (OR 2.12, 95% CI: 1.59–2.83) compared with females (OR 1.19, 95% CI: 0.90–1.58). Similarly, a poor housing quality was positively associated to all symptoms, with stronger associations among males compared with females for depressive symptoms (OR 4.75, 95% CI: 3.44–6.57 vs. 2.62, 95% CI: 2.04–3.37) and impulsivity (OR 2.25, 95% CI: 1.67–3.03 vs. 1.40, 95% CI: 1.06–1.86). Finally, a worsening in working performance showed positive associations with all symptoms among both sexes, with stronger associations among males than females for depressive and anxiety symptoms. **Table 3** shows the association between the quality indoor score and the three impulsivity components. Compared with high-quality score, a poor-quality indoor score was positively associated to attentional and non-planning impulsivity traits, similarly in both sexes (**Table 3**). These associations were higher among the males than females (with a significant difference for the medium-quality score). No associations emerged with the motor impulsivity.

Figure 1 shows the associations between three selected components of the indoor quality score (i.e., absence of natural lighting, acoustic discomfort, and absence of private space) and the four mental health outcomes. The absence of a private space at home was the architectural parameter mainly associated to mental health symptoms, with the strongest positive associations among males for depressive symptoms (OR 1.91, 95% CI: 1.46–2.50) and anxiety (OR 1.83, 95% CI: 1.46–2.30). Among females, the strongest positive associations emerged with insomnia (OR 1.43, 95% CI: 1.08–1.91) and impulsivity (OR 1.43, 95% CI: 1.09–1.89). The differences between males and females were statistically significant for the PHQ-9 outcome (p for heterogeneity $= 0.007$) and borderline for the GAD-7 ($p = 0.051$). Finally, the absence of natural lighting and acoustic discomfort showed positive associations with the studied outcomes, with the strongest ones between the absence of natural lighting and depression, and between acoustic discomfort and anxiety among females. However, these associations were not statistically different with those among males.

DISCUSSION

The mental health impact of the COVID-19 mandatory confinement on undergraduate Italian students was worst among females than males. Mental health symptoms were positively associated to caring for a person at home, living in a poor housing quality, and a worsening in working performance. Male students who were caring for a person at home during the confinement reported more frequent insomnia than females. Similarly, males who lived in a poor housing quality reported more frequent depressive symptoms and impulsivity than females, as well as males who declared a worsening in working performance reported more frequent depressive and anxiety symptoms than females. In addition, a poor housing quality was associated also to attentional and non-planning impulsivity, and males who lived in the absence of a private space reported more frequently depression and anxiety than females.

Our findings should be interpreted in light of the pervasive impact that the national lockdown adopted to contain the spread of the infection may have had on physical and mental health.

The result that females compared with males, among undergraduate students, worsened their mental health status more, is in line with current national and international COVID-19 literature that estimates a greater risk in females than males in developing depression, anxiety, paranoid ideations, post-traumatic stress symptoms, sleep disorders, and a worsening in the interpersonal sensitivity dimension (13, 23–26).

Caring for a person at home can be a source of emotional distress, especially for the youth (27). As reported by our findings, in the time of the COVID-19 lockdown restrictions, being forced to stay together and sharing the same living space for many weeks/months resulted in a worsening of the burden of the caregiver with a higher prevalence of sleep disturbance in males than in females.

Depressive and anxiety symptoms were more likely observed in undergraduate males who reported a worsening in working performance. Compared with females, the reduced ability of males to cope with adversity and to tolerate uncertainty without knowing what their future will be (28) could explain

TABLE 3 | Odds ratio* (OR) and their 95% confidence intervals (CI) for the association between the quality indoor score and the three impulsivity components, in males and females, separately.

	BIS: attentional		BIS: motor		BIS: non-planning	
	Males	Females	Males	Females	Males	Females
Quality indoor score (ref: high)						
Medium	1.18 (1.01–1.39)	1.06 (0.91–1.23)	1.05 (0.91–1.21)	0.87 (0.75–1.01)	**1.33 (1.14–1.54)**	**1.05 (0.90–1.21)**
Poor	1.77 (1.43–2.20)	1.46 (1.19–1.80)	1.05 (0.86–1.29)	1.14 (0.93–1.39)	1.61 (1.31–1.98)	1.37 (1.12–1.67)

**Estimates obtained from multivariable logistic regression models, adjusted for age at interview, caring for a person at home, apartment dimension (mq), and worsening in working performance. Reference category: 1.*
Significant differences are highlighted in bold.

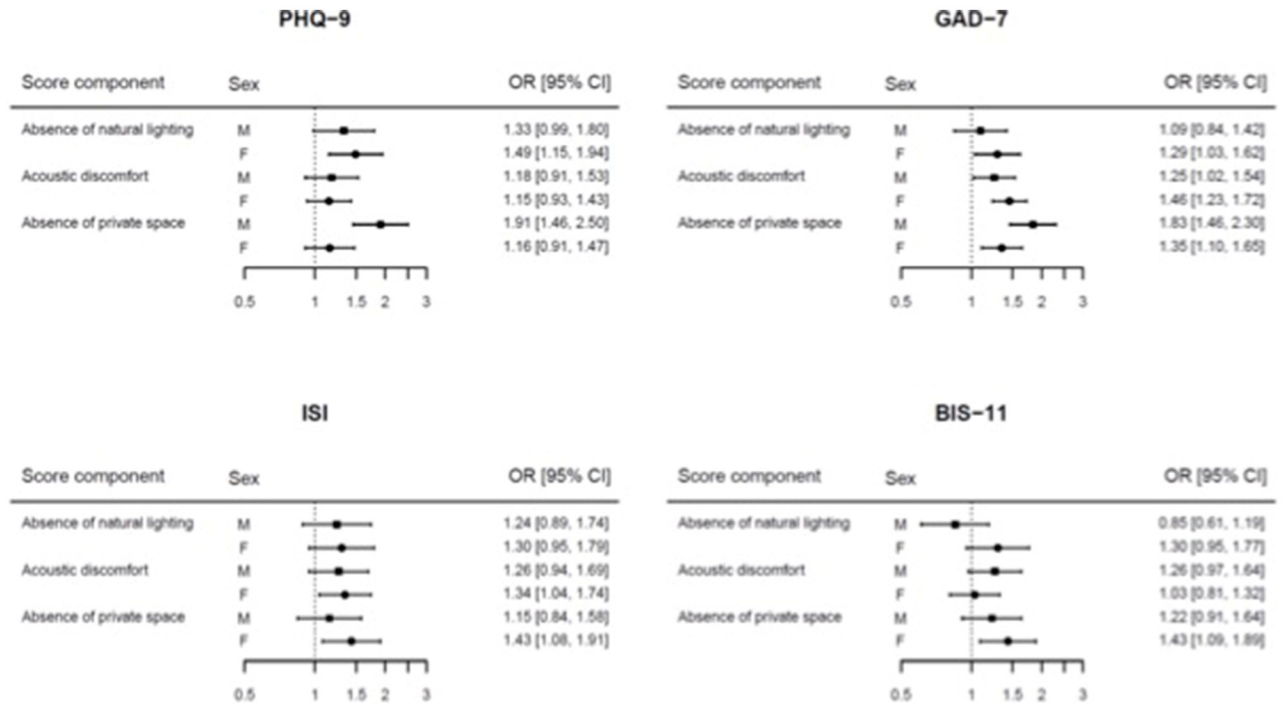

FIGURE 1 | Forest plot of the odds ratio (OR) and their 95% confidence intervals (CI) for the association between three selected components of the quality indoor score and the four mental health outcomes.

the difficulties to plan effective study sessions and keep the concentration on online university courses with mental health consequences.

Findings from our survey reported a strong positive association between poor housing quality and mental health outcomes such as depressive symptoms and impulsivity, mainly observed in undergraduate males, with particular regard to attentional and non-planning impulsivity. The association observed between a poor-quality indoor space that do not guarantee adequate privacy and a worsening in depressive symptoms and impulsivity can be interpreted both in light of higher fear of infection as well as a proxy for lower socioeconomic status with consequent higher uncertainty about the future associated to household-level economic impact of the COVID-19 response (29).

As confirmed by recent evidence from the literature, impulsivity traits, male gender, and young age are considered risk factors for gambling onset especially among low socioeconomic status youth (30, 31). In the COVID-19 era, this is even more important because the development of technology, which facilitates the possibility of gambling from home and the period of isolation caused by the COVID-19 pandemic resulted in more opportunities to gamble online (32).

This study needs to be interpreted in the light of several strengths and limitations. Among its strengths, the large homogeneous sample size and the use of validated evidence-based psychiatric assessment tools. Among its limitations, the use of self-reporting questionnaires, the cross-sectional study design, the low response rate, and the enrollment of students from a single university that limited the generalizability of the results. In particular, the cross-sectional design study does not allow inferences on the temporal relationship between the variables and only shows measures of associations. Moreover, no information on the mental health status of the participants before the COVID-19 outbreak are available. Last, housing physical characteristics have been investigated with an *ad-hoc* not questionnaire due to the scant evidence published in the literature.

In the first weeks of the pandemic, March 2020, a panel of experts convened by the UK Academy of Medical Sciences and a mental health research charity (MQ: Transforming Mental Health) set out immediate priorities and longer-term strategies for research and encouraged the collection of high-quality data on the COVID-19 impact on mental health across the whole population, with particular regard to vulnerable populations including the youth, through the integration across different disciplines and sectors (33). To our knowledge, this is the first multidisciplinary consortium study, involving public mental health, environmental health, and architectural design, conducted on a large sample of undergraduate students in Lombardy, the Italian region most affected by the pandemic, exploring the effects of the COVID-19 lockdown restrictions on a rich set of mental health outcomes.

University years coincide with the peak period of risk for the onset of mental disorders (34), and they are associated with a significant increase in risky health behaviors (35). Considering the importance of undergraduate students to the future social capital of society and the potential negative impact of mental health problems on their lives, prevention and early treatment of mental health problems in these specific years represent a key public health priority (36–38).

Results from our study confirm a built environment as a key determinant of health, whose quality builds on the availability of resources, site location planning, and green spaces. An interdisciplinary approach involving urban planning, public mental health, environmental health, epidemiology, and sociology, is needed to inform welfare and housing policies centered on population well-being, especially in the COVID-19 times.

Further studies are needed to confirm or refute our findings and consequent recommendations to implement well-being interventions in pandemic conditions. A careful and comprehensive analysis of risk and protective factors in the individual and environmental context should be performed in order to early detect peculiar needs of care as well as plan and implement appropriate and targeted interventions centered on vulnerable population health (39).

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Approval was given by IRCCS Ospedale Policlinico San Martino of Genoa. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AAm, AM, and SC conceptualized the study. FS and DB curated the data. PB performed the formal analysis. AB and AC conducted the investigation. AAg and GS formulated the methodology. SC and MA were in charge of the project administration. CS, SC, and MA supervised the study. AAm and AO wrote the original draft. CS, GS, SC, and MA reviewed and edited the manuscript. All authors have read and agreed to the present version of the manuscript.

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Correlation of Childhood Psychological Abuse and Neglect With Mental Health in Chinese College Students During the COVID-19 Pandemic

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Experience of childhood maltreatment is a major factor affecting adult mental health. The purpose of this study was to understand the association of childhood psychological abuse and neglect with mental health in college students during the COVID-19 pandemic. An online questionnaire survey was conducted from February 21 to March 12, 2020. The participants were 200 students at a university of physical education in Shaanxi Province, China. Participants completed the Child Psychological Abuse and Neglect Scale and the Mental Health Self-Report Questionnaire. Regarding childhood maltreatment experience, 52.5% of respondents screened positive for childhood psychological abuse, 55.8% for psychological neglect, and 43.6% for both. Moreover, 37.6% of participants screened positive for psychological health problems during the pandemic. Childhood psychological abuse and neglect were positively associated with mental health problems during the COVID-19 pandemic. A regression analysis revealed that the reproving dimension of psychological abuse was a risk factor for mental health problems in college students during the COVID-19 pandemic.

Keywords: psychological abuse and neglect, mental health, COVID-19, childhood maltreatment, college students

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INTRODUCTION

To stop the spread of COVID-19, most of the world's governments, including that of China, adopted unprecedented social isolation measures, such as lockdowns, minimizing outings, social distancing, and canceling or minimizing meetings (1). These measures undoubtedly impacted the psychological state of various populations. The unpredictability and uncertainty of life, as well as economic changes associated with the COVID-19 pandemic are major stressors that have led to psychological distress, with college students at a higher risk (2). College students may also have struggled with loneliness, isolation, and severe psychological distress during the pandemic due to school closures and alienation from classmates and friends (3). Although the vast majority of colleges and universities have adopted measures, such as online learning and tutors to guide classes remotely, psychological interventions to popularize epidemic knowledge, and other measures to relieve students' psychological pressure and maintain a normal school life (4), many students have experienced varying degrees of psychological problems after the resumption of school (5). This has seriously affected the physical and mental health of college students. Therefore, it is especially important to identify factors that might exacerbate college students' psychological problems in response to stressful events, such as childhood maltreatment.

Child maltreatment has long-term negative effects on the physical and mental health of individuals, and is one of the main risk factors leading to psychological problems in adolescents (6). It is thus reasonable to consider that child maltreatment may increase the probability of psychological problems during stressful events in college students. Since the 1960s, child maltreatment has become a worldwide public health problem. Child maltreatment, including abuse (physical, psychological, and sexual) and neglect (psychological and physical), is one of the world's most troubling problems (7, 8). Psychological abuse and neglect are the core issues of childhood maltreatment, which refers to continuous, repeated inappropriate behavior toward a child for which one has responsibilities and obligations and/or to which one is close. Some examples of maltreatment include intimidation, abasement, interference, indulgence, and emotional neglect (9). Psychological abuse and neglect are among the strongest predictors of psychological problems, more so than physical or sexual abuse (6).

According to Young's schema theory (10), psychological abuse and neglect are closely related to the schemas of a loss of self-worth (such as emotional deprivation and cognition of social isolation), which can cause the development of negative internal work patterns toward themselves, and thus have lasting harmful effects on an individual's physical and mental health (6). In line with this hypothesis, it has been found that psychological abuse and neglect increase negative emotional regulation and coping strategies (11)—such as emotional inhibition and rumination, which are predisposing factors for depression (12)—as well as emotional inhibition and avoidance strategies (13, 14).

These studies indicate that psychological abuse and neglect may be risk factors for a variety of psychological problems. However, it should be noted that most of these studies have focused on psychological disorders in adulthood, and few have focused on psychological problems during stressful events. Although psychological abuse is known to bring greater risks to the development of young people, not all victims of childhood abuse exhibit more psychological problems in adolescence. Indeed, a considerable number of individuals still achieve healthy development after experiencing psychological abuse (15). Therefore, it is particularly important to understand the impact of psychological abuse experience on the occurrence of psychological problems during the epidemic, and to provide effective psychological guidance and intervention strategies for college students in future public health emergencies. Based on the above theories and empirical research, we proposed the following two hypotheses: (1) Childhood abuse and neglect are positively correlated with mental health problems during the epidemic; (2) Psychological abuse and neglect can predict the incidence of psychological problems during the epidemic.

MATERIALS AND METHODS

Participants

The study's participants were college students at a university of physical education in Shaanxi Province, China, all of whom were required to isolate at home from February 21 to March 12, 2020. A questionnaire was created on Wenjuanxing (www.wjx.cn), an online survey platform. Adopting convenience sampling, the questionnaire link was distributed through the class WeChat group of the respondents on campus. Students volunteered to participate in the survey and filled in the questionnaire by clicking the link or scanning the two-dimensional code (system lucky draw after submission of Wenjuanxing). The questionnaire was anonymous and all stored data were confidential. A total of 200 questionnaires were returned. After removing questionnaires with missing and/or invariable responses, 181 valid questionnaires remained. The average age of participants was 21.32 ($\pm$1.311) years. Of the final sample, 65 respondents (35.9%) were male and 116 (64.1%) were female; 27 (14.9%) were freshmen, 18 (9.9%) sophomores, 38 (21.0%) juniors, 78 (43.1%) seniors, and 20 (11.0%) postgraduates; 44 (24.3%) majored in physical education and 137 (75.7%) majored in other subjects.

Sample Size Adequacy

A *post-hoc* power analysis using G∗Power version 3.1.9.7 (Franz Faul, Kiel University, Germany) was used to determine the adequacy of the sample size (16). Using the medium effect size ($D = 0.3$, $\alpha = 0.05$), for a sample size of 181, the statistical efficacy (1-ß) obtained estimated to test the hypotheses of this study was 0.99, thus justifying the adequacy of our sample size.

Measurement Instruments

The Child Psychological Abuse and Neglect Scale

This self-report questionnaire was developed by Deng et al. (17) as a retrospective measurement instrument applicable to Chinese people. It mainly investigates the psychological abuse experience of an individual in childhood (younger than 18 years), including family abuse, neglect, and the ways in which guardians treated them. It contains 31 items, each rated on a five-point (0–4) scale. The two subscales, respectively, assess psychological abuse and psychological neglect. The psychological abuse subscale contains 14 items in the three dimensions of reproving, intimidation, and interference. The sum of the scores of the three dimensions is used to measure psychological abuse, with a higher total score indicating more severe abuse. The psychological neglect subscale contains 17 items that assess the three dimensions of emotional neglect, educational neglect, and physical neglect. The sum of the scores for these three dimensions is used to measure neglect-maltreatment, with a higher total score indicating more severe neglect-maltreatment. The quotient of the total score and the number of items in a subscale is defined as the factor score. A factor score $\geq$1 is considered positive (17). The test-retest reliability values of the overall scale, psychological abuse subscale, and psychological neglect subscale were 0.82, 0.80, and 0.76, respectively (18).

The Mental Health Self-Report Questionnaire

The Mental Health Self-Report Questionnaire [SRQ-20; (19)] contains 20 "yes" or "no" questions. A response of "yes" is scored as 1, and a response of "no" as 0; thus, the highest possible score is 20. This questionnaire primarily screens for common post-disaster psychological reactions, such as depression, anxiety, and physical discomfort, with a higher score indicating more severe psychological problems. The reference cut-off score indicating

the need for clinical intervention is 7 [i.e., care should be given to respondents scoring higher than 7; (19)]. The split-half reliability of the questionnaire is 0.748, the Cronbach's alpha reliability coefficient of each item is 0.778–0.789, and the Cronbach's alpha reliability coefficient of the overall questionnaire is 0.792 (20). A comprehensive analysis of the reliability of the SRQ-20 is provided in the user's guide to the SRQ-20 issued by the WHO (19).

Procedure

Approval from the ethics committee of Xi'an Physical Education University was received before the study began. Respondents provided online informed consent online before completing the questionnaire. All participants were told that their privacy would be protected and that they were free to withdraw from the study at any time. The anonymity of the study was also emphasized before data collection. In view of the fact that students were taking online classes during the questionnaire distribution period, the second author distributed the questionnaires through the class WeChat group with the help of the monitor or the teacher.

Data Analysis

Collecting data via a self-report questionnaire introduced the possibility of common method errors. Therefore, respondents were reassured that their data would be anonymous. The statistical analysis was carried out using SPSS version 22.0 (IBM Corp., Armonk, NY, United States). Before statistical analysis, the skewness and kurtosis in the frequency statistics were used to test the normal distribution of the data. The skewness and kurtosis of all variable data were <1, which indicates that the data had an approximately normal distribution. The subsequent data analysis was carried out in three steps. First, descriptive statistics were used to present demographic data. The prevalence rate of child abuse was calculated according to the cut-off score adopted by Deng et al., including a mean score of psychological abuse ≥1 and a mean score of neglect ≥1 (17). The detection rate of psychological problems among college students during the COVID-19 pandemic was calculated according to the WHO cut-off score of the SRQ-20 (19). Second, a correlation analysis was performed to explore the relationship between psychological abuse and neglect and psychological problems during the COVID-19 pandemic. Third, a binary logistic regression analysis was performed to obtain odds ratios (OR) and 95% confidence intervals (CIs).

RESULTS

Demographic Characteristics of Participants

A participant was considered to have experienced childhood psychological abuse or neglect if their score averaged ≥1 on the respective subscales. On this basis, 95 (52.5%) screened positive for psychological abuse, 101 (55.8%) for neglect, and 79 (43.6%) for both. According to the SRQ-20 scores, 68 (37.6%) of respondents screened positive for psychological problems during the COVID-19 pandemic. **Table 1** shows the results for childhood trauma and the SRQ-20 scores of participants according to their different demographic characteristics.

Descriptive statistics for all variables are presented in **Table 1**. There were differences in the interference dimension between different grades. Specifically, there were significant differences between freshmen and sophomores, and between juniors and seniors ($F = 2.71$, $p = 0.03$). *Post-hoc* comparisons showed that freshman students had a significantly higher interference dimension score (1.25 ± 0.84) than sophomore (0.57 ± 0.72, $p < 0.01$), junior (0.78 ± 0.74, $p = 0.02$) and senior (0.88 ± 0.77, $p = 0.03$) students.

We compared the psychological conditions of students with and without psychological abuse and psychological neglect during the epidemic. The results revealed significantly higher SRQ-20 scores indicating more severe psychological problems in students with psychological abuse and psychological neglect (in the **Supplementary Table 1**).

Correlations Between Childhood Trauma and the SRQ-20 Scores

The correlations between childhood trauma and the SRQ-20 scores during the COVID-19 pandemic were analyzed. As shown in **Table 2**, the SRQ-20 scores were positively correlated with the dimensions of psychological abuse and neglect. Specifically, the SRQ-20 scores was positively related to reproving ($r = 0.57$, $p < 0.01$), intimidation ($r = 0.52$, $p < 0.01$), interference ($r = 0.43$, $p < 0.01$), emotional neglect ($r = 0.44$, $p < 0.01$), educational neglect ($r = 0.42$, $p < 0.01$), physical neglect ($r = 0.36$, $p < 0.01$). Correlation analysis showed that higher scores in the dimensions of psychological abuse and neglect were associated with more severe psychological problems.

In addition, the results of the correlations between the dimensions of childhood trauma were presented in the **Supplementary Table 2**. Correlation analysis showed reproving was positively related to intimidation ($r = 0.82$, $p < 0.01$), interference ($r = 0.69$, $p < 0.01$), emotional neglect ($r = 0.72$, $p < 0.01$), educational neglect ($r = 0.62$, $p < 0.01$) and physical neglect ($r = 0.59$, $p < 0.01$). Intimidation was positively related to interference ($r = 0.63$, $p < 0.01$), emotional neglect ($r = 0.69$, $p < 0.01$), educational neglect ($r = 0.58$, $p < 0.01$) and physical neglect ($r = 0.52$, $p < 0.01$). Interference was positively related to emotional neglect ($r = 0.53$, $p < 0.01$), educational neglect ($r = 0.49$, $p < 0.01$) and physical neglect ($r = 0.40$, $p < 0.01$). Emotional neglect was positively related to educational neglect ($r = 0.82$, $p < 0.01$) and physical neglect ($r = 0.77$, $p < 0.01$). Educational neglect was positively related to physical neglect ($r = 0.71$, $p < 0.01$).

Effect of Childhood Maltreatment Experience on the SRQ-20 Scores

Psychological problems were taken as the dependent variable (the SRQ-20 score ≥7 indicates psychological problems, and the assigned value was 1; the SRQ-20 score <7 indicates no psychological problems, and the assigned value was 0), and the dimensions of psychological abuse and neglect were taken as independent variables. The binary logistic regression analysis

TABLE 1 | Differences in demographic variables of childhood trauma and the SRQ-20 scores.

Variable		*n* (%)	Reproving	Intimidation	Interference	Emotional neglect	Educational neglect	Physical neglect	The SRQ-20 scores
Grade	Freshmen	27 (14.40)	1.80 ± 1.01	1.67 ± 1.01	1.25 ± 0.84	1.54 ± 0.68	1.61 ± 1.07	1.36 ± 0.73	8.44 ± 5.409
	Sophomore	18 (9.90)	1.10 ± 0.69	1.22 ± 0.98	0.57 ± 0.72	1.37 ± 0.74	1.42 ± 0.89	1.10 ± 0.88	5.33 ± 5.369
	Junior	38 (21.00)	1.18 ± 1.08	1.11 ± 0.89	0.781 ± 0.74	1.13 ± 0.76	1.13 ± 0.95	0.88 ± 0.81	5.34 ± 5.649
	Senior	78 (43.10)	1.41 ± 1.05	1.41 ± 0.88	0.88 ± 0.77	1.25 ± 0.78	1.21 ± 1.07	1.00 ± 0.90	6.73 ± 5.419
	Postgraduate	20 (11.60)	1.35 ± 1.01	1.20 ± 0.62	1.04 ± 0.62	1.16 ± 0.67	1.19 ± 0.74	1.06 ± 0.72	5.75 ± 5.056
F			1.86	1.90	2.71*	1.49	1.20	1.38	1.635
p			0.12	0.11	0.03	0.21	0.31	0.24	0.167
Gender	Male	65 (36.50)	1.49 ± 1.05	1.38 ± 0.87	0.87 ± 0.79	1.41 ± 0.73	1.26 ± 1.02	1.17 ± 0.83	6.770 ± 5.545
	Female	116 (63.50)	1.32 ± 1.01	1.32 ± 0.92	0.92 ± 0.76	1.19 ± 0.75	1.28 ± 1.00	0.98 ± 0.85	6.27 ± 5.432
t			1.08	0.43	−0.39	1.96*	−0.12	1.42	0.592
p			0.28	0.67	0.70	0.05	0.91	0.16	0.555
Major	PE major	44 (24.30)	1.36 ± 1.04	1.43 ± 0.90	0.89 ± 0.72	1.30 ± 0.84	1.28 ± 1.01	1.11 ± 0.91	7.360 ± 6.329
	Non-PE major	137 (75.70)	1.39 ± 1.03	1.31 ± 0.90	0.91 ± 0.78	1.26 ± 0.72	1.27 ± 0.99	1.03 ± 0.82	6.150 ± 5.145
t			−0.14	0.76	−0.11	0.36	0.07	0.60	0.285
p			0.89	0.45	0.91	0.72	0.95	0.55	0.202

*$p < 0.05$.

TABLE 2 | Correlation between childhood trauma and the SRQ-20 scores.

	Reproving	Intimidation	Interference	Emotional neglect	Educational neglect	Physical neglect
The SRQ-20 scores	0.57**	0.52**	0.43**	0.44**	0.42**	0.36**

**$p < 0.01$.

showed that the reproving dimension of psychological abuse ($\beta = 0.78$, OR = 2.19, 95%CI = 1.11–4.30, $p = 0.02$) was a risk factor for psychological problems in college students during the COVID-19 pandemic in **Table 3**.

In addition, the results of multicollinearity analysis were presented in the **Supplementary Table 3**. The results showed that there is no collinearity problem [tolerance (TOL): reproving: 0.25, intimidation:0.30, interference:0.51, emotional neglect:0.21, educational neglect:0.31, physical neglect:0.38; variance inflation factor (VIF): reproving:4.07, intimidation:3.32, interference:1.96, emotional neglect:4.84, educational neglect:3.26, physical neglect:2.61].

TABLE 3 | Logistic regression analysis of childhood abuse experience and the SRQ-20 scores.

	β	S.E.	Wals	*P*-value	OR	95%CI
Reproving	0.78	0.35	5.14	0.02	2.19	1.11–4.30
Intimidation	0.39	0.36	1.19	0.28	1.48	0.73–2.96
Interference	−0.08	0.32	0.06	0.81	0.92	0.49–1.74
Emotional neglect	0.32	0.50	0.40	0.53	1.38	0.51–3.68
Educational neglect	0.19	0.31	0.37	0.54	1.20	0.66–2.19
Physical neglect	−0.21	0.33	0.38	0.54	0.81	0.42–1.57
Constant	−2.11	0.40	27.28	<0.01	0.12	

DISCUSSION

The COVID-19 pandemic has affected the mental health of different populations to varying degrees (2). However, previous studies have mainly focused on the effect of external factors, such as concerns about COVID-19 infection, delayed graduation, employment prospects (5), the amount of negative information received during the epidemic, gender, and place of birth (21). Few studies have examined the effects of internal psychological factors on mental health, such as whether psychological abuse and neglect increase the psychological problems of college students during stressful events. Therefore, this study examined the association of psychological abuse and neglect with mental health in college students during the COVID-19 pandemic. As expected, childhood abuse and neglect were predictive of the incidence of psychological problems during the pandemic. These results extend our understanding of the factors that influence psychological problems in college students during stressful events.

The dimensions of psychological abuse and neglect in this study were positively associated with the psychological problems of college students during the COVID-19 epidemic. Specifically, the higher the degree of child abuse, the higher the incidence of psychological problems when exposed to stressful situations. This result is consistent with previous findings that people with childhood abuse experience are more likely to show various psychological problems when facing stressful events in adulthood (22, 23), and even post-traumatic stress disorder (11). This result

can be explained by the theory of helplessness (24). Namely, when people repeatedly suffer from psychological abuse and neglect during childhood, various needs remain unmet and they feel unable to control their environment, leading to a sense of helplessness. This increases the susceptibility to depression (25) and anxiety (14). Furthermore, there is already strong evidence that child maltreatment can lead to abnormal changes in the cortisol response and differences in the morphology of the hippocampus, amygdala, and prefrontal lobe, thereby increasing the possibility of depression (26). Thus, the experience of child maltreatment may increase an individual's susceptibility to stress during public health events, thereby affecting mental health.

This study also identified the risk factors of psychological abuse and neglect that are more likely to cause psychological problems. Scolding in psychological abuse may increase the risk of psychological problems. Scolding is mainly based on verbal humiliation (9). The results of two studies have indicated that high school students who have experienced humiliation are more likely to have physical symptoms and exhibit compulsive behaviors than students with no such experience. Interpersonal sensitivity, depression, anxiety, hostility, phobia, paranoia, psychotic symptoms (13), and the scores of each symptom factor tend to increase with the degree of humiliation (27). Furthermore, as a bad parenting method, scolding can also cause estrangement from parents (28). Another large-scale study conducted in five provinces in China showed that alienation from parents is associated with an increased risk of psychological problems in college students during the COVID-19 pandemic (29). In the present study, only those who experienced scolding had a higher risk of psychological problems during stressful events. A study have pointed out that scolding is negatively correlated with more positive personalities than other forms of psychological abuse and neglect, and positively correlated with negative personalities (30). Long-term experience of negative experiences, such as scolding, humiliation, and a lack of warmth and family security, can lead to low self-esteem and a tendency to develop negative personality traits in adulthood, such as introversion, depression, anxiety, a closed personality, and unhealthy interpersonal relationships. Child with dominant negative personalities grew up in an environment in which they were often scolded, lacked self-confidence, and tended to be timid and hesitant, showing a closed personality (30).

STRENGTHS AND LIMITATIONS

Good mental health quality is particularly important in the face of stressful events such as the COVID-19 pandemic. Although schools and relevant departments have provided various preventive measures and policies, the incidence of psychological problems among college students is still worrying, and researchers should address the issues of psychological prevention and control. The effects of psychological abuse and neglect during childhood sometimes only become apparent later in life, such as mental health issues in college students during stressful events. Therefore, identifying the inherent risk factors that affect college students in the face of stressful events provides useful information for improving the response strategies for stressful public health events, identifying high-risk students, and developing psychological crisis interventions for specific populations.

Our research also has some limitations. First, the sample size of this survey was small, and the sample was limited to specific groups from sports colleges. Moreover, because this survey explicitly assessed childhood experiences, there may have been memory and information biases, so the sample may be underrepresented. In addition, strong correlations between variables were found in this study, but only one variable showed significance in the binary regression analysis, after which we conducted a multicollinearity analysis. The results showed that tolerance (TOL) was >0.1 and variance inflation factor (VIF) was <10, therefore we assumed that the problem of collinearity could be ignored (31, 32). Concerning the inconsistency between the correlation analysis and regression analysis, we believe that it may be related to the insufficient sample size. Future research should expand the sample size. Second, we adopted a cross-sectional design, which means that a causal relationship cannot be inferred; longitudinal studies or intervention experiments are needed to better test causality. Third, this study only collected data from Chinese college students, and adopted a rating scale for psychological abuse and neglect with Chinese characteristics. However, psychological abuse and neglect are deeply embedded in the cultural framework of different countries, which means that people have different understandings of childhood abuse and neglect in different cultural backgrounds. The understanding of neglect is different between cultures, which limits the generalizability of the results.

CONCLUSION

In this study, psychological abuse and neglect were positively correlated with the mental problems of college students during the COVID-19 pandemic, and the experience of reproving increased the risk of psychological problems. This study allows us to better understand the relationship between child abuse and mental health during stressful events, which may facilitate the development of stressful event intervention programs.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by School of Exercise and Health Sciences, Xi'an Physical Education University. Written informed consent from the participants's legal guardin/next of kin was not required for

this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

ZZ designed this survey, commented and revised the manuscript, and wrote the final version. PL contributed to recruiting participants, data collection, and writing the initial draft. LH were responsible for data analysis. All authors contributed to the final draft 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/fpsyt.2021.770201/full#supplementary-material

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The Impact of the COVID-19 Pandemic on Affect, Fear, and Personality of Primary School Children Measured During the Second Wave of Infections in 2020

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In relation to the COVID-19 pandemic outbreak, a large body of research has identified a negative impact on individuals' affectivity, frequently documented by increased prevalence of anxiety and depression symptoms. For children, this research was less extensive, was mainly based on caregivers' reports and neglected personality assessment. In order to measure the impact of the pandemic, and the fears it caused, on primary school children's affect and personality, 323 (180 boys and 143 girls) Italian third, fourth and fifth graders were assessed between October and November 2020, namely during the second wave of COVID-19 infections in Italy, with validated self-reports of affect (Positive and Negative Affect Scale for Children, PANAS-C), fear of COVID-19 (Fear of COVID-19 Scale, FCV-19S) and personality (junior Temperament and Character Inventory, jTCI). In comparison with PANAS-C and jTCI normative scores collected prior to the pandemic, data obtained from children in 2020 showed unchanged affect scores in the overall sample, a decrease of Positive Affect in girls, and a decrease in the Harm Avoidance and an increase in the Self-Transcendence scales of personality. Fear of COVID-19 scores were positively correlated with Negative Affect scores and negatively predicted by children's personality profile of resilience (calculated using scores on the Harm Avoidance and the Self-Directedness scales of personality). These results suggested that Italian primary school children, especially boys, maintained their pre-pandemic levels of affect (or restored them after the first COVID-19 wave) and partially diverged from the typical development of personality in an apparently positive sense, namely toward more courageous/optimistic and spiritual profiles. This sort of children's post-traumatic growth might also be attributed to children's family and education systems, which should continue to be supported to promote and maintain community mental health.

Keywords: children, personality, affect, COVID-19, mental health, anxiety, depression, spirituality

INTRODUCTION

After the outbreak of the worldwide COVID-19 pandemic in early 2020 and the consequent public health policies put in action to contain the waves of infections, a large body of research has documented a worsening of public mental health. Various systematic reviews and meta-analyses reported increased emotional distress and increased risk for psychiatric disorders among the adult general population during 2020 (1–9). Less research has explored the impact of the pandemic emergency on the emotional well-being of children; the relevant reviews though resulted in reporting a negative psychological impact related to COVID-19 (10–16). Although the risk of death from COVID-19 is negligible for children and adolescents, they can nevertheless be as susceptible as adults to the psychological impact of the pandemic and its response measures (e.g., obligation to stay at home, interruption of both regular school and extracurricular activities attendance, physical distancing).

Most of the studies included in the above-mentioned reviews found that individuals' levels of anxiety and depression were the most frequent indicator of psychological distress, both in adults and children. Anxiety and depression are two forms of human suffering which have distinct and overlapping features. According to the model of Clark and Watson (17), they may share a component of general emotional distress, which can be labeled as negative affect (NA), and are differentiated by the levels of positive affect (PA), which is characteristically lower in depression than in anxiety. This model, together with the resulting scale for measuring positive and negative affectivity (i.e., the Positive and Negative Affect Scale, PANAS) (18), has been largely used both on adults and younger people (19–23). Positive and negative affect, considered as the set of transient and enduring evaluative feelings experienced by a person in response to salient events/conditions (24), can be therefore regarded as critical markers of the psychological condition of persons also in respect to the impact of the COVID-19 related crisis. It seems therefore particularly important to assess the levels of positive and negative affect in the population during the COVID-19 pandemic and to compare them with the normative levels collected before the pandemic. This pre- vs. during pandemic comparison, which has been performed for measures such as anxiety, depression and psychological well-being [e.g., (25–27)], has not been frequently carried out so far on affect scores. A study on a thousand full-time adult workers during the early stages of the pandemic in Germany revealed that their positive and negative affectivity did not change between December 2019 and March 2020, but decreased between March and May 2020 (28). A smaller study on adolescents ($n = 34$) and their parents ($n = 67$) conducted in the Netherlands revealed that adolescents' positive or negative affectivity did not change between 2018–19 and March 2020, while parents significantly reported a more negative affect in March 2020 in comparison to 2018–19 (29). The only existing study that assessed positive and negative affect of children ($n = 34$) during the pandemic (April-July 2020) and compared these scores with data collected prior to the pandemic ($n = 101$) did not find any difference in affect scores (30). The scarce information on this important aspect of individuals' mental health during the pandemic, in particular for children, urgently calls for a wider investigation.

In relation to negative affectivity, a salient emotion experienced by many persons during the pandemic is the fear of COVID-19. A self-report measure on this feeling was indeed developed in early 2020, the Fear of COVID-19 Scale (FCV-19S) (31). In this tool, for which factor analyses generally indicated a unidimensional structure, people are asked to evaluate both the physical and mental components of their fear of COVID-19. The FCV-19S has been extensively used since its introduction and made it possible to estimate the distribution of scores in separate samples (32), compare scores between samples of different countries (32, 33), and compare scores of a same population obtained in different time points (e.g., during the first vs. second wave of COVID-19) (34). The FCV-19S was originally developed for adults, but it was also employed in youth samples, in particular in adolescents (35–37). Nevertheless, given its small number of items, the relatively simple form of its statements and of the 5-point response scale in which respondents indicate their level of agreement with the statements, the FCV-19S was also administered to children as small as 7 years of age (38). Similarly to what is done in adults, it would thus be useful to further explore the depth and prevalence of fear of COVID-19 using the FCV-19S in children of different countries and during different phases of the pandemic, with the aim of providing children with the best environmental and psychological support in relation to this specific emotional sequelae of the pandemic.

An overarching aspect taken in consideration in many studies on the affective repercussion of the pandemic crisis is personality. Most of these studies assessed individuals' personality traits in combination with other measures, with the aim to link specific traits to various outcomes of interest, such as the level of distress, the way of perceiving the emergency, the form of behavioral adjustments to the emergency, and the degree of compliance to safety rules [e.g., (39–44)]. These studies were all carried out on adult samples. Although adults' personality is relatively stable, referring to "individual differences in characteristic patterns of thinking, feeling and behaving" (45), a number of researches have investigated whether the pandemic crisis has come to significantly change the overall personality profile of the population.

Studies on healthy adults' self-reports of personality collected during the pandemic did not gave a definite answer to this question: most of the studies found out that the scores collected during the pandemic with instruments such as the Brief HEXACO Inventory (46), the International Personality Item Pool's IPIP-NEO (47), the reduced Temperament and Character Inventory (48), the Personality Inventory for the DSM-5–Brief Form (49), or the various versions of the Big Five Inventory (50–53) remained stable (i.e., remained within one standard deviation of the normative means) in comparison with those collected before it [e.g., (39, 54–57)]. Other studies, however, found that scores changed beyond one standard deviation from the normative means [e.g., (58, 59)], or found significant changes in the pre- vs. during pandemic comparisons of scores: for example, significant changes were observed, using the Big Five Inventory-2 questionnaire (53), in the neuroticism and extraversion traits of

the big-5 model of personality in a sample of 2,137 U.S. citizens who were tested before (early February 2020) and during (second half of March 2020) the pandemic outbreak in the U.S. (60). In yet another study, significant changes were observed in all the big-5 traits of personality in 480 alleged healthcare workers when using linguistic analyses of their social media data collected before (February 2020) and during (between February and April 2020) the pandemic (61).

Childhood is an important period of life for the development of an individual's personality, because in this period the interaction between individuals' inborn traits and their personal life events increasingly organizes the course of children's action, emotion and cognition and their subsequent personality development (62). The personality of children may therefore face important developmental changes: however, the evaluation of the psychological impact of the COVID-19 related crisis on children's personality can be performed by detecting possible changes in the typical development of personality. Such changes can be monitored, for example, on the basis of age-appropriate normative scores (collected prior to the pandemic) of instruments for personality assessment such as the Big Five Questionnaire for Children (63) or the junior Temperament and Character Inventory (64). Yet, the question of whether the psychological impact of the COVID-19 related crisis may have changed typical personality development of children has not been answered so far. It would also be useful to replicate in children the studies that highlighted which personality dimensions were associated with the health outcomes previously investigated in adults such as well-being and anxiety/depression.

Moreover, as evidenced in many studies on adults (44, 65–68), even for children a key factor impacting the individual ability to cope with the distress caused by the pandemic could be linked to the personality aspect of resilience. More in particular, in the seven-dimension model of personality measured by the Temperament and Character Inventory (TCI) (69) or its junior version (jTCI) (64), high and low resilience profiles can be effectively measured by focusing on the two dimensions of harm-avoidance (a temperamental trait reflecting the tendency to avoid behaviors due to intense response to aversive stimuli expressed as fear of uncertainty, quick fatigability, shyness of strangers, and pessimistic worry) (70) and self-directedness (a character trait referring to self-determination, self-acceptance, responsibility and reliability, and to being able to control, regulate, and adapt behavior in accordance to one's own goals and values) (70), which are respectively negatively and positively related to resilience (71–73). Thus, besides considering personality for either trying to monitor its possible changes after the pandemic or for investigating its general association with the affective impact of the pandemic, focusing on children's resilience profiles may also help explaining in a more specific way why the COVID-19 related crisis has affectively impacted some individuals differently from others.

In sum, in our study data on positive and negative affect, fear of COVID-19 and personality were collected in a sample of Italian primary school children. All data were collected through children's self-reports while they were at school. For affect, the Positive and Negative Affect Scale for Children (PANAS-C) (74, 75) was used, for the fear of COVID-19 the Fear of COVID-19 Scale (FCV-19S) (31, 76) and, for personality, the junior Temperament and Character Inventory (jTCI) (64, 77). Assessment was carried out between October and November 2020, during the second wave of the pandemic in Italy. The main aim of the study was (i) to compare normative PANAS and jTCI data (collected on independent samples of children before the pandemic) with data obtained during the pandemic period. In particular, in the period of assessment, Italian children had just returned to school after more than 6 months of school closure and the country was facing the ascending phase of the second pandemic wave without certainties about the degree of its sanitary, economic and social impact. The secondary aim of the study was (ii) to assess the levels of fear of COVID-19 in these same children and to link their levels of fear, positive affect and negative affect with their personality characteristics. This was done first by correlating the PANAS-C and FCV-19S with the jTCI scores and then by assessing the differences in PANAS-C and FCV-19S scores in two separate children groups: one with a low-resilience personality profile and the other with high-resilience. In this way, the present study tried to address some relevant questions that have partially or completely been overlooked in the literature so far: were affect and personality profiles of primary school children assessed during the second wave of the pandemic different from those collected in age-matched children before the pandemic? How were the primary school children's personality characteristics in 2020 related to children's levels of fear of COVID-19, positive affect and negative affect, also considering the aspect of high and low resilience?

MATERIALS AND METHODS

Participants

Twenty-one classes from 14 primary schools of the North-East part of Italy (Friuli-Venezia Giulia region) participated in the assessment of the present study, as the initial stage of a successive attentional and self-regulation training program. A total of 361 third, fourth, and fifth graders were assessed. After excluding the data from 38 children (18 questionnaires were not complete, three questionnaires had been completed by children with intellectual disabilities, 17 jTCI reports had no valid responses for control items), the final sample consisted of 323 children (grade: 103 third, 75 fourth, 145 fifth; sex: 180 boys, 143 girls).

Measures

Affect

Positive and negative affect were measured with the Italian version of the Positive and Negative Affect Scale for Children (PANAS-C) (74, 75). This tool was originally developed and validated on 9- to 12-year-old children, but it was also used for third graders [e.g., (78, 79)]. It is the child version of PANAS, the most frequently used scale to assess positive (PA) and negative affect (NA) in adults (18). In PANAS-C, respondents are asked to rate on a 5-point Likert scale (ranging from 1 = never to 5 = always) how often during the last weeks they have experienced

each of the 30 positive or negative listed moods that in the tool are expressed by adjectives or very short expressions. In the Italian version, PA score is the sum of scores for 11 items and NA score is the sum of scores for 13 items. Example items are "Active" (for PA) and "Afraid" (for NA). Both the original and the Italian validation of PANAS-C showed two clearly differentiated factors (PA and NA) and good internal consistency reliability (alpha $\geq$ 0.85). For data collected for the present study in 2020, Cronbach's alphas were: 0.84 for PA and 0.87 for NA.

Personality

Personality was assessed with the Italian version of the junior Temperament and Character Inventory (jTCI) (64, 77). This is the child version of the widely known TCI personality inventory (69). It was developed and validated on 9- to 12-year-old children, and consists of 108 true/false items. Respondents are asked to express their general concordance/discordance with each statement. The jTCI has four temperament scales (Novelty Seeking, NS; Harm Avoidance, HA; Reward Dependency, RD; Persistence, P) and three character scales (Self-Directedness, SD; Cooperativeness, C; Self-Transcendence, ST). Temperament scales model the inborn neurobiological tendencies toward early emotions and the resultant behavioral reactions to distinct environmental stimuli. Character scales model, at the intra-, inter- and trans-personal level of the individual, the result of the interaction between temperament traits, socio-cultural influences, life events and intentional training. Example items are: "I get tense and worried in unfamiliar situations" (HA), "I often try new things for fun or thrills" (NS), "I don't open up much even with friends" (RD), "I work long after others give up" (P), "I feel strong enough, to master everything somehow" (SD), "I take good care not to hurt somebody with my actions" (C), "I believe in a higher force connecting all living beings" (ST). Cronbach's alphas for data collected for the present study in 2020 were: 0.63 for NS (18 items), 0.74 for HA (22 items), 0.47 for RD (nine items), 0.35 for P (six items), 0.65 for SD (20 items), 0.65 for C (20 items), 0.49 for ST (10 items).

Fear of COVID-19

The fear of COVID-19 was measured with the Italian version of the Fear of COVID-19 Scale (FCV-19S) (31, 76). This tool consists of seven items with a five-point rating scale (ranging from 1 = strongly disagree to 5 = strongly agree) and was developed for adults; nonetheless, it has been used in children as young as 7 years old (36–38). Example items are "I am very afraid of the coronavirus-19" and "I cannot sleep because I'm worrying about getting (or having) coronavirus-19". As FCV-19S is recognized as an uni-dimensional measure (32), a total score is provided, with higher scores corresponding to greater fear of COVID-19. The FCV-19S showed good internal consistency (seven items; Cronbach's alpha = 0.80) when applied to children in our study. This was consistent for the different grades (alpha = 0.82 for third graders, alpha = 0.76 for fourth graders, alpha = 0.79 for fifth graders). Results of a confirmatory factor analysis using diagonally weighted least squares method on data of our study [$\chi^2(14) = 32.3$, $p < 0.01$; Root Mean Square Error of Approximation (90% Confidence Interval) = 0.06 (0.03;0.09), Comparative Fit Index = 0.99, Standardized Root Mean square Residual = 0.07] revealed an acceptable fit for the seven-item single-factor construct (80).

Procedure

The study was carried out between October 13, 2020 and November 6, 2020. In this period Italy was experiencing the second wave of COVID-19 infections, which peaked on November 13, 2020 with 40,902 new daily cases and 550 daily deaths (81). In the Friuli-Venezia Giulia region, where the study took place, the restrictions applied in the initial weeks of the study (until November 6, 2020) were: compulsory face masks in public areas, distance learning in high schools and universities, no service after 12 a.m. for bars serving food and restaurants. After November 6, tighter restrictions were introduced: stay-home mandate between 10 p.m. and 5 a.m., closure of shopping malls during weekends and holidays, 50% capacity reduction on public transport, closure of indoor recreational and cultural venues, closure of indoor gyms, pools and leisure venues, and prohibition of non-professional contact sports (82). People had been informed by mass media that the pandemic was going to get worse before it got better.

Paper questionnaires were administered by school instructors to their pupils during teacher-led classes. The teachers had been previously instructed by researchers, during an online group meeting, in the procedure to be followed for administering the questionnaires: they had to read the instructions of each questionnaire to the class, explain any word/expression that the children had asked to clarify and refrain from suggesting any response to their students during the filling of the questionnaires.

Parents of all participants provided written informed consent for their children's inclusion in the study. The study was approved by the Ethics Committee of the University of Udine and all procedures performed in the study were in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments. Finally, all data were analyzed anonymously and data confidentiality was ensured.

Statistical Analysis

Data analysis was conducted using R, version 3.6.3 (83). Power analysis was performed with GPower, version 3.1 (84). Missing values in participants' responses were found to be <2% and were imputed with the mean score of the whole sample for the corresponding item.

Primary analysis involved (i) testing the difference between the distribution of the PANAS-C and jTCI data obtained in October-November 2020 and the distribution of data from the PANAS-C and jTCI datasets obtained during the validation of these questionnaires in Italy (74, 76). The difference was tested using robust independent samples *t*-tests separately for boys, girls, and boys and girls together. Bonferroni correction for multiple comparisons was applied in each separate group.

The PANAS-C validation dataset included data of fourth and fifth graders collected in 2014 (n = 331, 51.7% boys). The jTCI validation dataset included data of third, fourth and fifth graders collected in 2010–2011 (n = 238 after removing data without valid responses for control items,

TABLE 1 | Characteristics of the samples used in the study.

	Sample studied during the COVID-19 pandemic	Samples studied before the COVID-19 pandemic		
	PANAS-C, jTCI, FCV-19S (October-November 2020)	PANAS-C validation (2014)	jTCI validation (2010–2011)	jTCI unpublished (2019)
n	323	331	238	101
Boys	180	171	124	47
Girls	143	160	114	54
Third graders	103	0	89	0
Fourth graders	75	112	77	0
Fifth graders	145	219	72	101

PANAS-C, Positive and Negative Affect Scale for Children; jTCI, junior Temperament and Character Inventory; FCV-19S, Fear of Covid-19 Scale.

TABLE 2 | Comparison of Positive and Negative Affect Scale for Children (PANAS-C) data collected in Italian fourth and fifth graders before [2014, (75)] and during the COVID-19 pandemic (October-November 2020).

Group	Scale	PANAS-C score before the pandemic (2014)	PANAS-C score during the pandemic (Oct-Nov 2020)	*t* [95% CI]	p_{Bonf} (effect size)
Boys	PA	42.0 ± 8.4	43.1 ± 6.5	−1.2 [−2.7;0.7]	0.46 ($d = -0.14$)
	NA	25.8 ± 7.6	24.7 ± 7.2	1.4 [−0.5;2.9]	0.34 ($d = 0.16$)
Girls	PA	43.0 ± 8.1	40.4 ± 7.5	2.5 [0.6;4.6]	0.02 * (d = 0.33)
	NA	27.4 ± 8.3	26.9 ± 7.9	0.4 [−1.6;2.5]	1.00 ($d = 0.06$)
Boys and Girls	PA	42.5 ± 8.3	42.0 ± 7.0	0.8 [−0.8;1.8]	0.87 ($d = -0.10$)
	NA	26.6 ± 8.0	25.6 ± 7.5	1.5 [−0.3;2.3]	0.27 ($d = 0.12$)

PA, Positive Affect; NA, Negative Affect. Asterisk indicates significant difference ($p < 0.05$).*

52.1% boys). For jTCI, data from a group of fifth graders ($n = 101$, 46.5% boys) collected by our research group in February 2019 (i.e., about 1 year before the COVID-19 pandemic outbreak) in schools of the same area (about 30 km away) in which data were collected for the present study in 2020. Fifth graders' jTCI normative data collected in 2010–2011 were thus compared with jTCI data collected in 2019 to verify if any change had occurred with time. Participant demographic characteristics of all these samples are detailed in **Table 1**.

Secondary analysis involved (ii) descriptive statistics for FCV-19S scores, Pearson's correlation of jTCI scores with PANAS-C and FCV-19S scores, and the comparison of PANAS-C and FCV-19S scores between low-resilience (LR) and high-resilience (HR) personality profiles groups of the 2020 dataset. LR and HR groups were obtained, as done in a previous work of our research group (85), by partitioning the whole sample on the basis of individual HA and SD scores from the jTCI questionnaire, since, as mentioned in the Introduction, these two scales have been reported as the most influential TCI scales on adults' self-reports of resilience (HA inversely and SD directly related to resilience) (71–73). The partitioning procedure was performed using the k-means algorithm (86) on the participants' standardized HA and SD scores. Comparison of PANAS-C and FCV-19S scores between LR and HR groups was performed using robust independent samples *t*-tests.

Sample size was determined by voluntary study participation in 2020 ($n = 323$) and by normative sample sizes of PANAS-C ($n = 331$) and jTCI ($n = 238$). In a statistical power analysis performed in terms of sensitivity, the sensitivity of study design for the primary analyses of our study was tested by comparing the effect sizes observed in the current study with the Minimum Detectable Effects (MDEs) obtained from the desired minimum statistical power of 0.80, an α level of 0.05, and the sample sizes employed in each pre- vs. during pandemic comparison. This power analysis revealed that the study design was generally sensitive enough to detect the differences of interest (in PANAS-C: for PA in girls $d = 0.33$, $d_{MDE} = 0.37$; in jTCI: for HA in boys $d = 0.36$, $d_{MDE} = 0.33$; for HA in boys and girls, $d = 0.29$, $d_{MDE} = 0.24$; for ST in boys and girls, $d = 0.26$, $d_{MDE} = 0.24$; effect sizes observed in the current study can be found in **Tables 2**, **3**). For all tests, effects are reported as significant at $p < 0.05$.

TABLE 3 | Comparison of the junior Temperament and Character Inventory (jTCI) data collected in Italian third, fourth and fifth graders before [2010–2011, (77)] and during the COVID-19 pandemic (October-November 2020).

Group	Scale	jTCI score before the pandemic (2010–2011)	jTCI score during the pandemic (Oct-Nov 2020)	*t* [95% CI]	p_{Bonf} (effect size)
Boys	NS	7.6 ± 3.1	7.1 ± 2.9	1.4 [−0.2;1.2]	1.00 ($d = 0.17$)
	HA	9.4 ± 4.5	7.9 ± 4.0	3.1 [0.6;2.5]	0.02* ($d = 0.36$)
	RD	4.2 ± 1.7	4.0 ± 1.9	1.1 [−0.2;0.6]	1.00 ($d = 0.13$)
	P	3.7 ± 1.4	3.9 ± 1.3	−1.1 [−0.5;0.1]	1.00 ($d = -0.13$)
	SD	11.6 ± 3.0	12.4 ± 3.1	−2.2 [−1.5;−0.1]	0.19 ($d = -0.26$)
	C	14.0 ± 3.0	14.3 ± 3.1	−0.9 [−1.0;0.4]	1.00 ($d = -0.11$)
	ST	5.2 ± 2.1	5.6 ± 2.0	−2.1 [−1.0;0.0]	0.27 ($d = -0.24$)
Girls	NS	6.3 ± 3.1	5.5 ± 2.8	2.0 [0.0;1.5]	0.31 ($d = 0.25$)
	HA	10.3 ± 4.0	9.6 ± 4.1	1.4 [−0.3;1.7]	1.00 ($d = 0.17$)
	RD	5.0 ± 1.6	4.9 ± 1.9	0.4 [−0.3;0.5]	1.00 ($d = 0.05$)
	P	3.7 ± 1.4	4.0 ± 1.3	−1.8 [−0.6;0.0]	0.48 ($d = -0.23$)
	SD	12.5 ± 3.7	12.5 ± 3.5	−0.1 [−0.9;0.9]	1.00 ($d = -0.01$)
	C	15.1 ± 2.3	15.8 ± 2.3	−2.3 [−1.2;−0.1]	0.14 ($d = -0.29$)
	ST	5.3 ± 2.1	5.9 ± 1.9	−2.2 [−1.1;−0.1]	0.18 ($d = -0.28$)
Boys and Girls	NS	6.9 ± 3.2	6.4 ± 3.0	2.2 [0.1;1.1]	0.21 ($d = 0.19$)
	HA	9.9 ± 4.3	8.7 ± 4.1	3.3 [0.5;1.9]	<0.01* ($d = 0.29$)
	RD	4.6 ± 1.7	4.4 ± 1.9	1.3 [−0.1;0.5]	1.00 ($d = 0.11$)
	P	3.7 ± 1.4	4.0 ± 1.3	−2.0 [−0.5;0.0]	0.29 ($d = -0.17$)
	SD	12.0 ± 3.4	12.4 ± 3.3	−1.5 [−1.0;0.1]	1.00 ($d = -0.13$)
	C	14.5 ± 2.7	15.0 ± 2.9	−1.9 [−0.9;0.0]	0.44 ($d = -0.16$)
	ST	5.2 ± 2.1	5.8 ± 2.0	−3.0 [−0.9;−0.2]	0.02* ($d = -0.26$)

NS, Novelty Seeking; HA, Harm Avoidance; RD, Reward Dependence; P, Persistence; SD, Self-Directedness; C, Cooperativeness; ST, Self-Transcendence. Asterisk indicates significant difference ($p < 0.05$).*

RESULTS

Affect

The comparison of fourth and fifth graders' data collected before the pandemic ($n = 331$, 51.7% boys) with fourth and fifth graders' data collected in 2020 ($n = 220$, 59.1% boys) generally showed no differences in positive and negative affect, except for a difference in girls' positive affect [$t(198.5) = 2.5$, $p_{Bonf} = 0.02$]: in 2020 girls self-reported a significantly lower positive affect than girls in 2014 (see **Table 2**, **Figure 1A**).

Personality

The comparison of jTCI data collected before the pandemic in 2010–2011 ($n = 238$, 52.1% boys) with data collected in 2020 ($n = 323$, 55.7% boys) showed a significant difference in HA scores in boys [$M_{2010-2011} > M_{2020}$, $t(245.2) = 3.1$, $p_{Bonf} =$

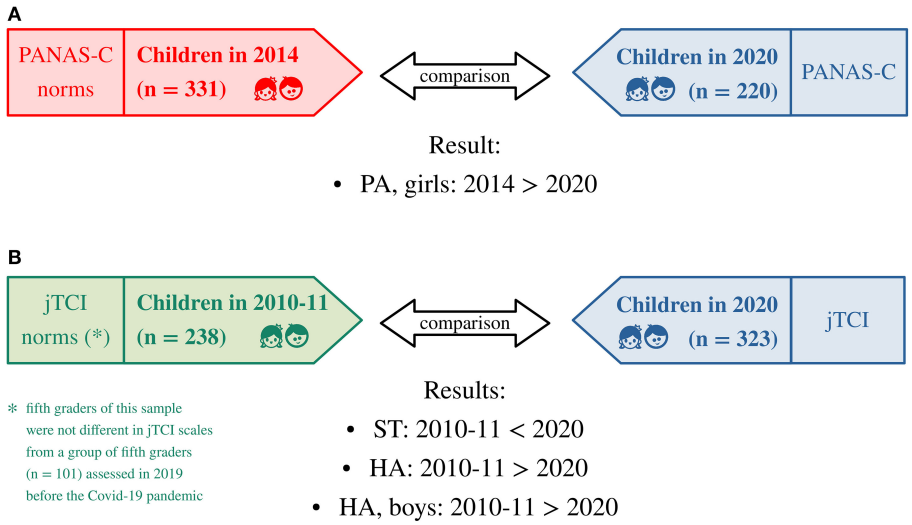

FIGURE 1 | Primary analyses of the study. **(A)** Comparison of PANAS-C scores collected during the pandemic with normative PANAS-C scores collected in 2014 (75) (the normative sample included fourth and fifth graders' data and, therefore, only data of fourth and fifth graders assessed in 2020 were included in the analysis). **(B)** Comparison of jTCI scores collected during the pandemic with normative jTCI scores collected in 2010–11 (77). PANAS-C, Positive And Negative Affect Scale for Children; PA, Positive Affect; jTCI, junior Temperament and Character Inventory; HA, Harm Avoidance; ST, Self-Transcendence.

0.02] and in the full sample of boys and girls [$M_{2010-2011} > M_{2020}$, $t(501.0) = 3.3$, $p_{Bonf} = 0.006$]. A significant difference in ST scores [$M_{2010-2011} < M_{2020}$, $t(494.9) = -3.0$, $p_{Bonf} = 0.02$] was also observed in the full sample of boys and girls. Children assessed during the pandemic showed lower HA and higher ST scores than children assessed before the pandemic in 2010–2011 (see **Table 3**, **Figure 1B**). It is worth noting that no difference was observed between fifth graders' jTCI data collected in 2010–2011 and fifth graders' jTCI data collected in 2019 (for all scales, in boys/girls/boys and girls: $|t| < 2.4$, $p_{Bonf} > 0.12$).

Fear of COVID-19

There were extremely few missing values (0.25% of the total number of responses). Participants' average score (boys: 11.6 ± 3.4, girls: 12.7 ± 3.2, boys and girls: 12.1 ± 3.4, see **Table 4**, **Figure 2A**) was close to that obtained in a sample of 340 girls during the second wave of COVID-19 in Iran (M = 12.1 for third graders, M = 12.8 for fourth graders, M = 10.6 for fifth graders; data collected from July to November 2020, $n = 340$, 100% girls, age: 10.1 ± 1.7 years) (38), but lower than scores obtained during the first wave of COVID-19: in Canadian children the average FCV-19S score was 14.1 ± 5.7 (data collected between April and May 2020, $n = 144$, 51.4% boys, age: 9 to 12 years) (36), in Turkish children/adolescents was 18.9 ± 6.3 (data collected from April to June 2020, $n = 381$, 50.4% males, age: 15.4 ± 2.4 years) (37) and in Italian adults was 16.9 ± 6.1 (data collected from 18 March to 21 March 2020, $n = 249$, 8.0% men, age: 34.5 ± 12.2 years) (76).

Correlations

Table 5 depicts the correlation matrix of PANAS-C, FCV-19S and jTCI measures. The exploration of the relationship between affectivity and personality showed that: positive affect (PA) was positively correlated with P, SD and ST, as well as negatively correlated with HA; negative affect (NA) was positively correlated with NS and HA, as well as negatively correlated with P and SD. The exploration of the relationship between fear of COVID-19 and personality showed that fear was positively correlated with HA and negatively correlated with SD. Moreover, correlation analysis showed a positive relationship between negative affect and fear of COVID-19 (see also **Figure 2B**).

TABLE 4 | Descriptive statistics of the Fear of COVID-19 Scale (FCV-19S) scores collected during the pandemic (October-November 2020).

Group	FCV-19S total score (Oct-Nov 2020)
Boys	11.6 ± 3.4
Girls	12.7 ± 3.2
Boys and Girls	12.1 ± 3.4

Low and High Resilience Profile Groups

Based on individuals' standardized HA and SD scores, the whole group of children assessed in 2020 was partitioned in a low-resilience (LR; $n = 135$, 51.9% boys) and a high-resilience (HR; $n = 188$, 58.5% boys) group. In comparison with children in the HR group (see **Table 6**, **Figure 2C**), children in the LR group had significantly lower PA scores [$t(158.5) = 2.5$, $p = 0.01$], higher NA scores [$t(146.9) = -5.4$, $p < 0.0001$] and higher FCV-19S scores [$t(185.2) = -4.9$, $p < 0.0001$]. No difference between the two groups was observed in term of gender composition [χ^2 (1, $N = 323$) = 1.2, $p = 0.28$].

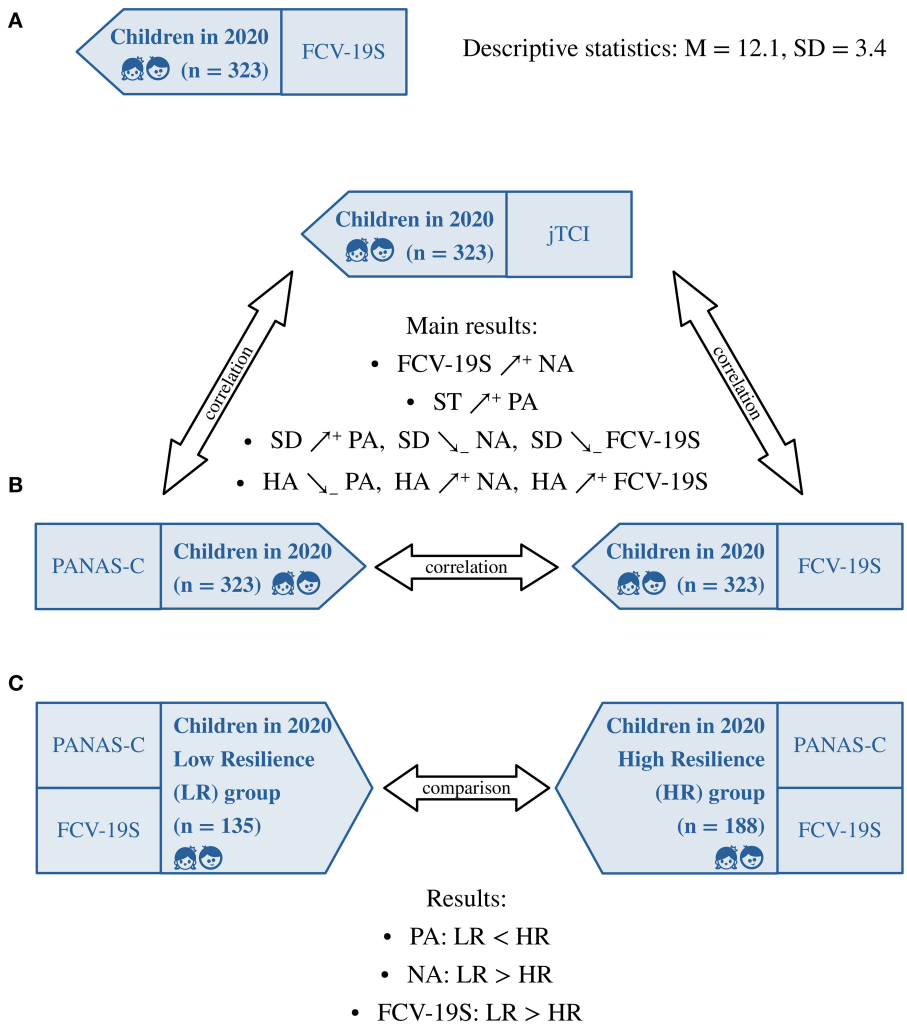

FIGURE 2 | Secondary analyses of the study. **(A)** Descriptive statistics of FCV-19S scores. **(B)** Correlation of PANAS-C, FCV-19S and jTCI scores collected during the pandemic. **(C)** Comparison of PANAS-C and FCV-19S scores collected during the pandemic between a Low-Resilience and a High-Resilience personality profile group (the two groups were obtained partitioning the whole study sample on the basis of individuals' HA and SD scores from the jTCI questionnaire). PANAS-C, Positive And Negative Affect Scale for Children; PA, Positive Affect; NA, Negative Affect; FCV-19S, Fear of COVID-19 Scale; jTCI, junior Temperament and Character Inventory; HA, Harm Avoidance; SD, Self-Directedness; ST, Self-Transcendence; ↗+, positive correlation; ↘_, negative correlation.

DISCUSSION

This study investigated primary school students' self-reports during the second wave of COVID-19 in Italy. Three questionnaires were used, one for assessing students' temperament and character dimensions of personality (jTCI), one for positive and negative affect (PANAS-C), and one for fear of COVID-19 (FCV-19S). Data analysis focused on: (i) comparing the affect and personality scores obtained during the pandemic with same-graders' scores obtained before the pandemic (during the validation of the affect and personality questionnaires in Italy); in the data collected during the pandemic (ii) describing the distribution of fear of COVID-19 scores, correlating affect and fear of COVID-19 with personality scores, and comparing affect and fear of COVID-19 scores between a low-resilience and a high-resilience profile group.

In the pre- vs. during pandemic comparison of affect scores, no differences were found in terms of positive and negative affect in the overall sample (boys and girls). A significant difference between data collected before and during the pandemic, however, was found in girls' positive affect: in 2020 girls self-reported a significantly lower positive affect than girls in 2014. There are few studies that collected primary school children's self-reports during the COVID-19 pandemic and that could compare their data with those collected prior to the pandemic (30, 87–90). The only existing study that carried out this comparison using children's self-reports of affectivity (30) found out that positive or negative affect scores collected in 34 healthy children (age: 11.9 ± 1.2 years) by using the shortened 10-item PANAS-C in

TABLE 5 | Correlation matrix of the PANAS-C, FCV-19S and jTCI scores obtained during the COVID-19 pandemic (October-Novembre 2020).

Measure	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. PANAS–C PA									
2. PANAS–C NA	−0.24**								
3. FCV.19S	0.01	0.25***							
4. jTCI NS	−0.04	0.15*	−0.08						
5. jTCI HA	−0.23***	0.35***	0.28***	−0.03					
6. jTCI RD	0.15	−0.07	−0.02	−0.27***	−0.01				
7. jTCI P	0.15**	−0.16*	0.04	−0.24***	−0.22***	0.19***			
8. jTCI SD	0.16*	−0.26***	−0.17**	−0.27***	−0.32***	0.21***	0.38***		
9. jTCI C	0.15	−0.06	0.07	−0.42***	−0.03	0.24***	0.28***	0.32***	
10. jTCI ST	0.13*	0.06	0.11	−0.06	0.09	0.07	0.08	−0.12	0.24***

*PANAS-C, Positive and Negative Affect Scale for Children; PA, Positive Affect; NA, Negative Affect; FCV-19S, Fear of COVID-19 Scale; jTCI, junior Temperament and Character Inventory; NS, Novelty Seeking; HA, Harm Avoidance; RD, Reward Dependence; P, Persistence; SD, Self-Directedness; C, Cooperativeness; ST, Self-Transcendence. Asterisks indicate significant correlations (*p < 0.05, **p < 0.01, ***p < 0.001).*

TABLE 6 | Differences in the low-resilience (LR) and high-resilience (HR) profile groups.

Questionnaire	Measure	Group		*t* [95% CI]	*p* (effect size)
		LR	HR		
PANAS-C	PA	40.9 (7.5)	43.0 (6.9)	2.5 [0.4;3.8]	0.01* ($d = 0.28$)
	NA	28.6 (8.8)	23.4 (6.8)	−5.4 [−7.0;−3.2]	< 0.0001*** ($d = -0.60$)
FCV-19S	Total score	13.2 (3.6)	11.3 (2.9)	−4.9 [−3.0;−1.3]	< 0.0001*** ($d = -0.55$)

*PANAS-C, Positive and Negative Affect Scale for Children; PA, Positive Affect; NA, Negative Affect; FCV-19S, Fear of COVID-19 Scale (*p < 0.05, ***p < 0.001).*

California from 22 April to 29 July 2020 did not differ from data collected in other pediatric studies conducted prior to the pandemic ($n = 101$); nonetheless, the same children assessed in that study during 2020 reported significantly greater state anxiety (measured with the State Anxiety Inventory for Children) (91) compared to children assessed prior to the pandemic. It is therefore possible that measurements of children's affectivity, such as PANAS-C, could not capture the psychological impact of the COVID-19 pandemic on children that has instead been reported in other pre- vs. during pandemic studies in terms of anxiety (87, 88), depression or post-traumatic symptoms (89). Two of these three studies (87, 88), however, included samples of children and adolescents up to 17 years without distinguishing children from adolescents in the analyses, when various studies [e.g., (92, 93)] and reviews (12, 16) reported greater severity of anxiety, depression and stress symptoms in adolescents than in primary school children during 2020. It is worth noting that a study on 166 fourth graders (84 boys and 82 girls) carried out in Korea in September and October 2020 (90) detected unchanged levels of life satisfaction, measured with the Satisfaction with Life Scale (94), with respect to data collected in 2018 and 2019.

In the pre- vs. during pandemic comparison of personality scores performed in the present study, a significant change was observed in the overall sample in harm avoidance (decreased in 2020) and self-transcendence (increased in 2020) scores. In the biopsychosocial model of personality, on which the Temperament and Character Inventory is based, harm avoidance is the dimension of temperament linked to worry/pessimism, fear of uncertainty, shyness and fatigability (64, 77, 95). Although temperament should bear a greater stability throughout life compared to character (96), among the temperamental traits harm avoidance is considered to be the most susceptible to mood and anxiety (97, 98), as well as to experiences such as trainings [e.g., (99, 100)] or therapy [e.g., (101, 102)]. In our study, a decreased level of harm avoidance in the overall sample was observed in comparison with pre-pandemic data, which was mainly due to the decrease of scores in boys. This means that in this dimension of temperament, children self-reported in 2020 a generally healthier profile than children assessed in 2010–2011. This result seems to be in contrast with the increase of children's anxiety and depression symptoms which were generally reported, although not consistently [e.g., Ravens-Sieberer et al. (88) observed no significant increase in the prevalence of depressive symptoms before vs. during the pandemic], in the previous literature focusing on the pandemic period. When comparing the results of the various studies on the impact of the pandemic, an important issue concerns when and where these studies were carried out, because the environmental conditions during the different phases/waves of the pandemic could have differently influenced the mental condition of people that were exposed to them: for example, children in our study were experiencing the second wave of COVID-19 in Italy, but were back to school in September 2020 after their schools had remained closed since the outbreak of the pandemic in February 2020, and could therefore find themselves in a different condition than their German or Swedish peers who returned to school in May 2020 or who did not experience school closures (103). That being said, the change in Italian children's harm avoidance may look like a positive rebound in terms of optimism, courage and energy after the possibly traumatic experience of the first wave of COVID-19 and

the hard lockdown imposed in Italy. The fact that this change remained within one standard deviation from normative scores suggests, however, that children's personality did not change dramatically from pre-pandemic levels and, in particular, toward excessive and unhealthy fearlessness and imprudence profiles.

The observed decrease in harm avoidance scores from pre-pandemic levels was accompanied by the increase from pre-pandemic levels in the character trait of self-transcendence, although no correlation was found between these two variables. In the biopsychosocial model of personality, self- transcendence is the dimension of character linked to fantasy/daydreaming, transpersonal identification and spiritual acceptance (64, 77, 95). Changes in adults' self-transcendence have repeatedly been observed in response to trainings/therapy and medical treatment (104–108). Self-transcendence and spirituality are recognized as useful coping strategies for managing stressful life events (109, 110) and it is therefore possible that children in our study drew on their spiritual resources in response to the pandemic crisis for developing resilience. This possibility can be encompassed within the concept of post-traumatic growth, defined as "positive change experienced as a result of the struggle with trauma" (111), one of whose domains being precisely spiritual change: various meta-analytic studies revealed that post-traumatic growth is in general positively associated with spirituality in adults and children (112–115). During the COVID-19 emergency, large portions of the population had to simultaneously confront, directly or not, confinement, illness and death. Such an experience can have stimulated the development of spirituality/self-transcendence, understood as the discovery or making sense of the experience itself: this healing process can pass through an initial crisis, as reported for example in a study on adults during the first days of the COVID-19 lockdown in Italy, where 1,250 adults self-reported significantly worse levels of mental health and lower levels of spiritual well-being in comparison with pre-pandemic normative data (116). As seen for harm avoidance, the change in self-transcendence observed in our study also remained within one standard deviation from normative levels, which can be interpreted as a significant but not dramatic modification of character maturity (at the transpersonal level).

In our study, children's fear of COVID-19 was also assessed and, despite the paucity of other observations of this measure in children, the participants' average score seemed to be similar to that obtained by other studies during the second wave of COVID-19 (in Iranian girls) and lower than those obtained during the first wave (in Canadian children, Turkish children/adolescents and in Italian adults). A significant decrease from the first to the second wave in the fear of COVID-19 scores (assessed with the same scale used in our study) has been observed, for example, in adult Slovakians (34). This can be viewed as the result of the individual and institutional adaptation to the pandemic after the initial emergency response. Importantly, in our study children's fear of COVID-19 scores resulted to be positively correlated with harm avoidance scores and negatively correlated with self-directedness scores. As already mentioned, these two scales have been reported as the most influential Temperament and Character Inventory scales on adults' self-reports of resilience [harm avoidance negatively and self-directedness positively related to resilience, (71–73)] and thus, in the present study, children with a weaker resilience profile self-reported higher fear of COVID-19 scores than children with a stronger resilience profile. In the analysis of the two resilience profile groups, it was also observed that children in the low resilience profile group self-reported significantly higher negative affectivity and lower positive affectivity than children in the high resilience profile group.

Other salient results coming from the correlations between the study variables were: harm avoidance directly related to negative affect and inversely related to positive affect; persistence [the temperament trait linked to determination to achieve a goal despite frustration or fatigue, (64, 77, 95)] and self-directedness directly related to positive affect and inversely to negative affect; self-transcendence directly related to positive affect. These results seem to confirm that children with lower personality tendency toward worry/pessimism, fear of uncertainty, shyness and fatigability (trait of harm avoidance) and higher personality tendency to self-identification as an integral part of the universe as a whole (trait of self-transcendence) were likely to live with more positive and less negative feelings than children with the opposite features of personality. Results indicate also that the same condition of experiencing more positive and less negative feelings was also related to personality traits of maturity, autonomy and reliability (trait of self-directedness), as well as of diligence and determination (trait of persistence).

The present study has some strengths, in comparison with similar studies, as well as several limitations. The strengths include (i) the fact that children's self-reports, rather than proxy reports, were used and (ii) that these self-reports were obtained in classroom, rather than online. The limitations include that (i) pre- vs. during pandemic differences in the study measures have been related exclusively to the pandemic, whereas other individual and contextual factors may have influenced these differences; (ii) differently from jTCI (for which the normative dataset and a dataset collected in 2019 were used as pre-pandemic datasets), for PANAS-C it was not possible to obtain a dataset collected immediately before the pandemic, that confirmed the normative dataset collected in 2014; (iii) pre- vs. during pandemic differences in the study measures were observed using different groups of children, which seems the best way to assess an average change in a population (comparing it with a normative sample), but, at the same time, due to the fact that assessment is performed at group levels, cannot take into account individual longitudinal changes in single children; (iv) the FCV-19S is a tool developed and validated for adults, although children in our study filled it easily (very few missing responses) and results seemed to be consistent with those obtained using the other study measures; (v) results were obtained in Italy immediately before the peak of the second wave of infections of COVID-19 and it is not possible to know to what extent these results can be generalizable to other periods and countries, as previously discussed.

In conclusion, our findings suggest that Italian primary school children, exposed to the first wave of COVID-19 and the hard lockdown imposed in Italy during

spring 2020, and assessed during the ascending phase of the second wave of the pandemic in Italy, had affect scores generally in line with normative data collected prior to the pandemic and personality profiles denoting increased levels of courage/optimism and spirituality in comparison with the typical, pre-pandemic, profiles of children's personality.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

FF and CC: conceptualization. AM, FF, AP, and CC: methodology. AM: software, writing—original draft preparation, and visualization. AM and CC: validation and formal analysis. AM and AP: investigation. FF and CC: resources, supervision, and funding acquisition. AM, CU, AB, and EC: data curation. CU, EC, CC, and AB: writing—review and editing. AM, AP, and CC: project administration. All authors have read and agreed to the published version of the manuscript.

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Impacts of Stress and Risk Perception on Mental Health of College Students During the COVID-19 Pandemic: The Mediating Role of Coping Efficacy

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Object: In this study, we aimed to explore the influences of pandemic stress, risk perception, and coping efficacy on the mental health of Chinese college students during the COVID-19 pandemic.

Methods: A nationally representative sample of Chinese college students ($N = 3{,}381$, $M_{age} = 20.85$, $SD_{age} = 1.31$) took part in an online survey during the COVID-19 pandemic. Correlation coefficients, structural equation modeling, and other statistical analysis methods were used for data analysis.

Results: (1) The Chinese college students' pandemic stress and perceived pandemic risk were found to be moderate (3.51 ± 0.83, 3.45 ± 0.94), whereas their perceived infection risk was lower (2.10 ± 0.67). Their mental health during the COVID-19 pandemic was found to be good (3.80 ± 0.73). (2) The quality of their mental health was significantly and negatively associated with pandemic stress, perceived pandemic risk, and perceived infection risk. The level of their mental health was significantly and positively associated with coping efficacy, and their coping efficacy was significantly and negatively associated with pandemic stress, perceived pandemic risk, and perceived infection risk.

Conclusion: Coping efficacy played a partial mediating role in the relationship between pandemic stress and mental health, coping efficacy played a partial mediating role in the relationship between perceived infection risk and mental health, and coping efficacy played a complete mediating role in the relationship between perceived pandemic risk and mental health. Our findings show the importance of fostering college students' coping efficacy to improve their mental health during the COVID-19 pandemic.

Keywords: coping efficacy, epidemic stress, risk perception, mental health, college students

INTRODUCTION

The COVID-19 pandemic broke out in late 2019 in Wuhan, China. The pandemic was officially recognized as one of the greatest "public health emergencies in the world" by the WHO on January 31, 2020, and it reached pandemic status throughout the world on March 11, 2020. As a major public health emergency, the COVID-19 pandemic has caused serious threats and heavy losses to health and lives all over the world. As of November 20, 2021, more than 257 million people had been infected worldwide with a death toll exceeding 5.15 million according to the WHO. In addition, the COVID-19 pandemic has caused panic, anxiety, and depression among those affected by it. This chain reaction triggered by negative emotion can be expected to further endanger the public's mental health, especially among children and adolescents (1–3). It is worth mentioning that a latest and global systematic review, which was conducted during the COVID-19 pandemic between January 1, 2020, and January 29, 2021, and included 204 countries and territories, showed that daily COVID-19 infection rates and reductions in human mobility were associated with an increased prevalence of major depressive disorder and anxiety disorders. Female subjects were affected more by the pandemic than male ones in terms of major depressive disorder and anxiety disorders, and younger subjects were more affected than older ones in terms of major depressive disorder and anxiety disorders (4). Therefore, it is particularly important to investigate mental health status and its influencing factors on young college students during the COVID-19 pandemic.

Pandemic Stress, Risk Perception, and Mental Health

Besides the current COVID-19 pandemic, the SARS epidemic broke out in 2003, the H1N1 pandemic in 2009, and the Ebola epidemic in 2014, all of which caused serious losses of life and damage to health throughout the world. Therefore, researchers in academia conducted a series of empirical research on the relationship between stress response, risk perception, and mental health in the abovementioned major public health events. This research consistently found the impacts of stress and risk perception on mental health during these pandemic (5–10).

Specifically, a previous study on SARS explored the patterns and characteristics of Chinese college students' stress response and their levels of anxiety (SAS) and depression (SDS). The results show that panic was the most important element in the acute stress response related to SARS, followed by a defensive response and cognitive appraisal of the situation surrounding the epidemic, which played a moderating role. The stress response of college students had a significant impact on anxiety and depression (11). However, this study also found that the SAS and SDS could not be used to distinguish between the emotional responses of college students in high-incidence areas and non-high-incidence ones. It can be seen that, on the one hand, using a single self-rating scale of anxiety and depression might be problematic for accurately measuring the level of mental health (11). On the other hand, when facing major public health events, the public's mental health is directly related to their stress and risk perception, but most of the above studies mainly measured anxiety or depression. Therefore, future research should use more comprehensive measures of mental health and explore the causes and determinants of individual mental health during the pandemic (12–15).

The Role of Coping Efficacy in the Relationship Between Stress, Risk Perception, and Mental Health

It is very important to explore the mediation between stress, risk perception, and mental health. Previous research shows that general self-efficacy plays an important role in the relationship between stress coping and mental health (16–18). Coping efficacy refers to an individual's belief in whether they can deal with the emotional environment and emotions aroused by a situation (19). Relative to general self-efficacy, coping efficacy is domain-specific (20). Tong (21) developed a coping efficacy questionnaire and compared the predictive power of both coping efficacy and general self-efficacy on college students' mental health during the SARS epidemic. The results show that coping efficacy plays a more important role than general self-efficacy in determining the severity of somatic symptoms, depression, and anxiety (21). In addition, other related studies find that coping efficacy was significantly and positively associated with individual stress coping and social adaption (22–24).

Two conceptual frameworks guide such mediation hypotheses. According to the stress coping theory, the mandatory lockdown to control COVID-19 may be seen as a stressor, which may endanger college students' mental health (25, 26). Besides this, and according to self-efficacy theory, coping efficacy plays an important mediating role in the relationship between college students' stress, risk perception, and mental health during COVID-19 pandemic (18, 22). Therefore, this study attempts to construct a model of the relationship between pandemic stress, risk perception, coping efficacy, and mental health (**Figure 1**). As shown in **Figure 1**, college students may have experienced some degree of stress response and perceived pandemic risk when facing the outbreak of COVID-19 in China. On the one hand, college students' pandemic stress and levels of risk perception may have a direct impact on their mental health. On the other hand, college students' pandemic stress and levels of risk perception may also have an indirect impact on their mental health through the mediating role of coping efficacy. This is because coping efficacy can not only buffer the negative impacts of pandemic stress and risk perception on mental health (21, 23, 24), but also directly promote good mental health (19, 20). The objective of this study was to explore the relationship between college students' stress, risk perception and mental health during the COVID-19 pandemic. Based on this objective and hypothesis, we select a nationally representative sample of Chinese college students as participants and use a structural equation model (path analysis) to test the relationship between college students' pandemic stress, risk perception, coping efficacy, and mental health.

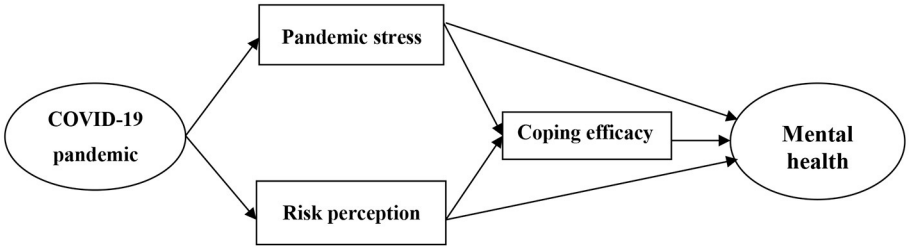

FIGURE 1 | The relationship model of pandemic stress, risk perception, coping efficacy, and mental health.

METHODS

Participants and Design

An anonymous cross-sectional survey was conducted from February 11–March 1, 2020 (18–27 days after Chinese New Year and during winter vacation for college students) by using online questionnaires. A snowball sampling strategy was adopted with a focus placed on recruiting college students living in mainland China during the COVID-19 pandemic. The college students surveyed were from 28 provinces, including Guangdong, Guangxi, Anhui, Hubei, Zhejiang, Hunan, Beijing, Jiangxi, Shandong, Henan, and Heilongjiang. The average age of the college students was 20.85 ± 1.31 years.

The inclusion criterion was that the subjects needed to be full-time college students. The exclusion criteria included the following: (a) self-reported COVID-19 diagnosis ($n = 13$) and (b) failure to pass the internal consistency checks ($n = 97$). It was specified on the questionnaire that the return of the completed questionnaire implied that informed consent had been given. Ethical approval was obtained from the ethics committee of the corresponding author's affiliated university. The analyzed sample included 3,381 college students.

Measures

General Health Questionnaire

The General Health Questionnaire (GHQ-12) is composed of 12 items and is considered to be the best mental health measurement tool, which is considered to have good reliability and validity (14, 27, 28). Likert 5-point scoring was used. The higher the score, the better the mental health. The data of 1,690 participants were used to conduct a confirmatory factor analysis on the GHQ-12. The chi-square value = 67.35, DF = 39, $P = 0.09$, chi-square value/DF = 1.73, GFI = 0.99, AGFI = 0.98, NFI = 0.98, IFI = 0.99, CFI = 0.99, RMSEA = 0.02. The Cronbach's α coefficient of the GHQ-12 was 0.88.

Pandemic Stress Assessment Questionnaire for COVID-19

Referring to the SARS stress study (29), four items were used to measure the pandemic stress felt by the population during the COVID-19 outbreak, which included questions such as "How much stress have you felt during the COVID-19 pandemic?" Likert 5-point scoring was used. The higher the score, the more the perception of pandemic stress. First, the data of 1,691 subjects were used to analyze the exploratory factors of pandemic stress in relation to the four items, and one factor with a characteristic root >1 was extracted, whereas the interpretation rate was 69.13%. Then, the data of the other 1,690 subjects were used to analyze the confirmatory factors of pandemic stress in relation to the four items, and it was found that the chi-square value = 2.57, DF value = 1, $P = 0.16$, chi-square value/DF = 2.19, GFI = 1.00, AGFI = 0.98, NFI = 1.00, IFI = 1.00, CFI = 1.00, and RMSEA = 0.04. The Cronbach's α coefficient was 0.85.

Risk Perception Self-Rating Questionnaire for COVID-19

Referring to the Xie et al. (6) risk perception self-rating questionnaire (SARS) combined with knowledge of the COVID-19 pandemic situation, a seven-item risk perception self-assessment questionnaire, was developed for this study. Likert 5-point scoring was used. First, an exploratory factor analysis of risk perception was conducted with the data of 1,691 subjects, and two factors with feature roots >1 were extracted with a cumulative interpretation rate of 67.94%. Factor 1 can be called "perceived pandemic risk"; its explanation rate is 43.86%. Factor 2 can be called "perceived infection risk"; its explanation rate is 24.09%. Then, the data of the remaining 1,690 subjects were used to conduct a confirmatory factor analysis on the risk perception self-assessment questionnaire. The chi-square value = 20.36, DF = 8, $P = 0.07$, chi-square value/DF = 2.55, GFI = 0.98, AGFI = 0.97, NFI = 0.98, IFI = 0.98, CFI = 0.99, RMSEA = 0.04. The Cronbach's α coefficient of the pandemic risk subscale was 0.81, the Cronbach's α coefficient of the infection risk subscale was 0.72, and the Cronbach's α coefficient of the entire questionnaire was 0.80.

Coping Efficacy Questionnaire

The questionnaire was developed by Tong (21) and had a total of 17 items, which were divided into three dimensions: competence, confidence, and cognitive appraisal. The questionnaire is often used to measure the evaluation of an individual's coping ability in a state of stress. We used Likert-style four-point scoring. The higher the score, the higher the coping efficacy. The confirmatory factor analysis of the coping effectiveness questionnaire showed that the chi-square value = 76.83, DF = 46, $P = 0.06$, chi-square value/DF = 1.67, GFI = 0.98, AGFI = 0.97, NFI = 0.98, IFI = 0.99, CFI = 0.99, and RMSEA = 0.03. The Cronbach's α coefficient of competence was 0.93, the Cronbach's α coefficient

TABLE 1 | Descriptive statistics of the entire sample ($n = 3{,}381$).

Variables	$M \pm$ SD or n (%)
Background variables	
Age (years)	20.85 ± 1.31
Sex	
Male	1,364 (40.34)
Female	2,017 (59.66)
Grade	
First-year	861 (25.47)
Second-year	852 (25.20)
Third-year	840 (24.85)
Fourth-year	828 (24.48)
Pandemic stress	3.51 ± 0.83
Risk perception	
Pandemic risk	3.45 ± 0.94
Infection risk	2.10 ± 0.67
Mental health	3.80 ± 0.73

of confidence was 0.84, the Cronbach's α coefficient of cognitive appraisal was 0.72, and the Cronbach's α coefficient of entire questionnaire was 0.86.

Statistical Analysis

Independent t-tests were used to test the significance of between-group differences. Pearson correlations were used to test the associations between mental health and its related influencing factors. A structural equation model (path analysis) with full information likelihood estimation was used to test the hypothesized mediation model for mental health. Tests for the direct, indirect, and total effects were based on 2,000 bootstrapped samples. Effect estimates and bias-corrected 95% confidence intervals (CI) were derived. The indices of good fit included the root mean square error of approximation (RMSEA) < 0.06, comparative fit index (CFI) > 0.95, etc. Analyses were conducted using SPSS 22.0 and AMOS 22.0. A two-sided p below 0.05 was considered statistically significant.

RESULTS

Sample Characteristics

First, college students' sociodemographic characteristics, pandemic stress, risk perception, and mental health were documented in **Table 1**. The level of pandemic stress and perceived pandemic risk were found to be moderate, whereas the perceived infection risk appeared to be lower. The level of mental health of college students during the COVID-19 pandemic was found to be good.

Second, we tested for gender differences in relation to the college students' pandemic stress, risk perception, and mental health. The results showed that there were significant gender differences in the data ($t = -11.98$, $p < 0.001$). Female college students (3.22 ± 0.82) felt higher levels of pandemic stress than male college students (2.85 ± 0.87). There were significant gender differences in terms of the perceived pandemic risk ($t = -7.28$, $p < 0.001$). The perceived pandemic risk of female college students (3.53 ± 0.90) was higher than that of male college students (3.28 ± 0.99). There were significant gender differences in perceived infection risk levels ($t = -4.35$, $p < 0.001$). The perceived infection risk of female college students (2.14 ± 0.66) was higher than that of male college students (2.03 ± 0.69). There was no gender-based difference in college students' mental health ($t = 1.22$, $p > 0.05$).

TABLE 2 | Correlations between pandemic stress, risk perception, coping efficacy, and mental health.

	1	2	3	4	5
1. Pandemic stress	1				
2. Pandemic risk	0.49***	1			
3. Infection risk	0.25***	0.18***			
4. Coping efficacy	−0.17***	−0.05**	−0.38***	1	
5. Mental health	−0.33***	−0.15***	−0.30***	0.59***	1

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

Relationship Between Stress, Risk Perception, Coping Efficacy, Mental Health

First, we tested the correlations between college students' pandemic stress, risk perception, coping efficacy, and mental health. The results are shown in **Table 2**. It can be seen that there are significantly negative correlations between college students' mental health and pandemic stress, pandemic risk, and infection risk, respectively, and that there is a significantly positive correlation with coping efficacy.

Second, we constructed a model of the relationship between college students' pandemic stress, risk perception, coping efficacy, and mental health by using a structural equation model (path analysis) (**Figure 2**). The chi-square value = 0.93, DF = 1, $P = 0.33$, chi-square value/DF = 0.93, GFI = 1.00, AGFI = 1.00, NFI = 1.00, IFI = 1.00, CFI = 1.00, and RMSEA = 0.01. On the one hand, college students' pandemic stress and perceived infection risk had a directly negative predictive effect on their mental health. On the other hand, coping efficacy played a partial mediating role in the relationship between pandemic stress and mental health; coping efficacy played a partial mediating role in the relationship between perceived infection risk and mental health; and coping efficacy played a complete mediating role in the relationship between perceived pandemic risk and mental health. In addition, the total effect of each variable on mental health was 54% of which the total direct effect was 23%. The effect of each variable on coping efficacy was 16%.

DISCUSSION

College Students' Pandemic Stress, Risk Perception, and Mental Health

Overall, Chinese college students' levels of pandemic stress and risk perception during the COVID-19 pandemic were relatively low, and their mental health was found to be good. Further, the gender-difference test showed that the levels of pandemic stress

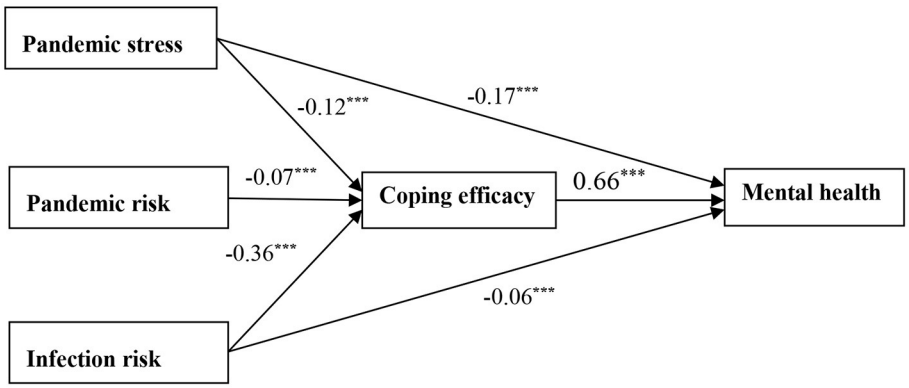

FIGURE 2 | Relationship between pandemic stress, risk perception, coping efficacy, and mental health. ***$p < 0.001$.

and risk perception among female college students were slightly higher than those of male college students. The results were partially consistent with those of Ma et al. (3) and Santomauro et al. (4), which showed that female subjects were affected more by the pandemic than male ones in terms of depression and anxiety. This might be the case because female college students are usually more sensitive to stressful situations. In addition, owing to the need for pandemic control, college students were "forbidden" to leave their homes and could not get together with classmates, relatives, or friends, which might have a greater impact on female college subjects (13, 30). However, although the subjects generally felt some degree of pandemic stress and perceived some risks, their mental health appeared to be good. The results were consistent with those of the related study by Xin et al. (8). In addition, the result was partially consistent with another study, which showed mental health and loneliness reported by young people were lower in China than that in the United Kingdom during the COVID-19 pandemic (14). On the one hand, this might be the case because the Chinese Spring Festival and winter vacation played a double-buffering role during the outbreak of COVID-19 in China. On the other hand, these results might stem from the fact that Chinese people responded positively and cooperated with the authorities in efforts to control the COVID-19 pandemic, so the outbreak was effectively controlled within a short period (31). This context might have played an important role in maintaining college students' mental health and alleviating the negative impacts of stress and infection risk on their mental health (8, 14).

The Role of Coping Efficacy in Relationship Between Stress, Risk, and Mental Health

First, we found that college students' pandemic stress and perceived infection risk had a significantly and negatively predictive effect on their mental health. Higher levels of pandemic stress and perceived infection risk among the subjects were not conducive to maintaining good mental health. These results were consistent with those of the relevant studies conducted by Xie et al. (6) and Tong (11) in relation to the SARS epidemic. The results were partially consistent with those of Wen et al. (7) and Zhang et al. (10), which showed that people's perceived risk and the perceived stress of the COVID-19 pandemic had a negative predictive effect on their anxiety levels. These results prove that both pandemic stress and perceived risk were two important factors affecting college students' mental health. Therefore, it is important to provide psychological counseling and promote support from families, schools, and society for affected college students during the COVID-19 pandemic to help them maintain good mental health (13, 28, 30).

Second, we found that college students' pandemic stress and perceived infection risk had an indirect predictive effect on mental health through the partial mediating role of coping efficacy. This result was consistent with those of Wang et al. (23) and Ma et al. (24), which showed that college students' coping efficacy had a greatly positive impact on their mental health. Therefore, our finding demonstrates the importance of fostering coping efficacy to enhance college students' mental health. In addition, we found that coping efficacy played a complete mediating role in the relationship between perceived pandemic risk and mental health, which might indicate that there was no direct relationship between pandemic risk and mental health. College student's perceived pandemic risk indirectly affected mental health through coping efficacy. It can be seen that, although both concepts belong to the domain of risk perception, perceived pandemic risk and perceived infection risk could be distinct psychological constructs that have different effects on mental health, which is worthy of further exploration in future research.

LIMITATIONS AND FUTURE RESEARCH

Our survey belongs to the domain of quantitative research and lacks qualitative analysis. In the future, in-depth interviews could be combined with case studies and follow-up research. In addition, our results draw on cross-sectional data using structural equation model. Although we recruited a large sample, this design cannot be used to draw conclusions about causal relationship. Future research will require the use of a longitudinal

survey or intervention design. Finally, the Chinese context of our study and the present global situation differed in many ways in terms of aspects, such as social distancing restrictions. It is important to validate our results by comparing them with results obtained in other contexts and identify similarities and differences with other countries and regions.

PRACTICAL IMPLICATIONS

First, the current research further reveals the impact of the COVID-19 pandemic on the mental health of young college students and the causes and determinants of mental health problems. This will help to carry out targeted interventions for the mental health of college students as well as interventions to treat those who develop a mental disorder (4). Second, in view of the cultivable characteristics of self-efficacy, those responsible for the design and organization of college education and extracurricular activities should consider providing more opportunities for college students to engage in exercise with the aim of continuously improving students' coping efficacy, which will not only help improve their mental health, but also greatly enhance their learning and lives (18, 23, 24).

CONCLUSION

The results show that coping efficacy was one potential mechanism mediating the relationship between pandemic stress, risk perception, and mental health. Coping efficacy played a partial mediating role in the relationship between pandemic stress, perceived infection risk, and mental health; Additionally, coping efficacy played a complete mediating role in the relationship between perceived pandemic risk and mental health.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

LH and FX designed this study. FX wrote the paper. All authors contributed to the article and approved the submitted version.

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University Students Adjusting to COVID-19 Stressors: Exploratory and Confirmatory Factor Analyses of the COVID-19 Stressors Questionnaire

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The psychological effects of COVID-19 have been documented in the past year, but scarce literature exists on the nature of COVID-19 stressors. Using a random split sample of 1199 young adult university students, results of exploratory factor analyses (EFA) identified a four-factor structure in the COVID-19 Stressors Questionnaire (C19SQ), which were labeled Resource Constraints, Social Restrictions, Future Uncertainty, and Health Concerns. This model was supported by a confirmatory factor analysis (CFA) when run on the other split sample of 1139 university students. Higher levels of COVID-19 stress were positively associated with anxiety and depressive symptoms and negatively associated with sleep duration, sleep quality, and the number of exercise days. COVID-19 stress also uniquely predicted poor university adjustment. This study demonstrated the link between COVID-19 stressors and mental and physical health symptoms, thus providing support for conceptualizing the psychological impact of the pandemic as adjustment problems for some individuals.

Keywords: COVID-19, factor analyses, depression, anxiety, stressor, adjustment, young adulthood

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INTRODUCTION

The COVID-19 pandemic is having devastating health, economic, political, social, and psychological impact on individuals and the society. These adverse outcomes are widespread and becoming increasingly pervasive, with its long-term effects still largely unknown. In terms of psychological impact, evidence is accumulating to show worsening mental health status in the different populations (Ettman et al., 2020; McCracken et al., 2020; Verma and Mishra, 2020). The adverse effects can be especially tumultuous for young adults since they are at a developmental stage that is associated with the most intense exploration of life's possibilities including personal lives, relationships, and work (Arnett, 2000; Holmes et al., 2020). When the pandemic struck, many facets of human activities were curtailed, and social distancing measures have limited young people's opportunities for life exploration and experiences, thus adding an additional layer of instability and uncertainty. It is thus important to explore how the pandemic is experienced by young adults.

Compared to rates of psychological distress before the pandemic, Essadek and Rabeyron (2020) found that prevalence of depression, anxiety, and distress were much higher than those normally observed in the student population during the pandemic. In a longitudinal study, Huckins et al. (2020) compared the mental health status of college students before and during the pandemic. Relative to previous academic terms, an increase in anxiety and depressive symptoms were reported

in the first academic term impacted by COVID-19. In another longitudinal study surveying loneliness among United Kingdom adults, Bu et al. (2020) identified young adults (18–30 years) and being a student, among different risk factors, that heightened the risk of loneliness during the pandemic. Although informative, these studies primarily focused on the psychological effects of the pandemic, rather than the specific stressors associated with the effects. Hence, this study attempts to fill this gap in the literature, by identifying pandemic-related stressors that are salient for young adult population.

COVID-19 stressors are conceptualized as potential sources of stress. Consistent with the definition of stressors in the diagnostic criteria for Adjustment Disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, American Psychiatric Association, 2013), stressors may be "a single event or multiple stressors," and they may be "recurrent or continuous." Applying this definition, the COVID-19 pandemic is associated with multiple continuous and pervasive stressors in the domains of health, family, school, and social life. With no clear endpoint of the pandemic in sight, the multiple COVID-19 stressors may become continuous. Consequently, these stressors are expected to impact student functioning until the stressors and their consequences are terminated or up until six months beyond that. Additionally, the "stressors may affect a single individual, an entire family, or a larger group or community." In fact, COVID-19 stressors are affecting almost everyone in the world to different extent, some worse than others. Lastly, these COVID-19 stressors are also beyond one's individual control given many necessary top-down changes imposed by governments and institutional entities. For university students COVID-19 stressors are likely to be additive to the stress inherently associated with the developmental task of adjusting to university life, such as being away from parents' home, living at a new place, learning new things, completing internship, and graduating and transitioning to full-time employment. Taken together, COVID-19 stressors are considered to be conceptually similar to the stressors as defined in the criteria for Adjustment Disorder (American Psychiatric Association, 2013). Failure to adapt to these stressors can result in significant stress response that are associated with increased distress and significant impairment in daily functioning.

To understand the psychological impact of COVID-19, many studies developed instruments to measure symptoms of phobia, posttraumatic stress, fear, and anxiety (Ahorsu et al., 2020; Arpaci et al., 2020; Forte et al., 2020; Mertens et al., 2020; Petzold et al., 2020; Pérez-Fuentes et al., 2020; Varshney et al., 2020). Due to their focus on specific sets of symptomatology, many scales have a unidimensional structure (Ahorsu et al., 2020; Petzold et al., 2020; Pérez-Fuentes et al., 2020), which can be insufficient for understanding individuals' experience during the pandemic. Furthermore, some researchers have argued that concepts of phobia, trauma, and posttraumatic stress cannot be applied to most people since the majority do not encounter life-threatening personal or health situations (Kazlauskas and Quero, 2020). On the other hand, many are affected for social, economic, and political changes that can become significant sources of stress. Furthermore, several studies did not evaluate the construct validity of their measures (Geldsetzer, 2020; Qiu et al., 2020; Zhong et al., 2020), thus limiting the utility of these instruments. Even fewer studies developed instruments to measure specific COVID-19 stressors and evaluated their impact on functioning (Kira et al., 2020; Zurlo et al., 2020; Ahuja, 2021). One study that did, investigated a sample of university students and identified three factors from their seven-item COVID-19 Student Stress Questionnaire (C19SSQ) (Zurlo et al., 2020). These were Relationships and Academic Life, Isolation, and Fear of Contagion. Although informative, this measure has limited content validity and unstable factor structure due to the small number of items for three factors. Other studies based on the general adult population showed more versatility in identifying COVID-19 stressors. They found factors related to routine disruption, future uncertainty, economic hardships, risk of infections, social problems, and systemic limitations (Kira et al., 2020; Ahuja, 2021). To address the limitations of current measures of COVID-19 stressors, this study attempted to develop more items to be representative of the COVID-19 stressors experienced by university students.

Goals of Present Study

The goals of the study were to develop a measure of COVID-19 stressors relevant for university students, called the COVID-19 Stressors Questionnaire (C19SQ), and to analyze its factor structure. Another goal was to empirically demonstrate the relationship between the COVID-19 pandemic and the increased in psychological distress symptoms. Extending Zurlo et al. (2020)'s study, we considered a more comprehensive list of stressors, increased the number of items in C19SQ, and tested it with a larger sample. As predictive validity evidence was lacking in many COVID-19 measures reviewed here, we also considered the extent to which the C19SQ predicted university adjustment in students.

As part of the evaluation of the convergent validity of C19SQ, we hypothesized that COVID-19 stressors would be positively associated with anxiety and depressive symptoms. On the other hand, COVID-19 stressors would be negatively associated with a sense of belonging to the university, the overall adjustment to the university environment, and academic performance. Since stress has been consistently associated with a reduction of physical activity and sleep (Baglioni et al., 2010; Alvaro et al., 2013; Chekroud et al., 2018), we also hypothesized that COVID-19 stressors would be negatively associated with exercise and sleep. Group differences in terms of gender, race, and year of study were also investigated. Females and racial/ethnic minority groups were hypothesized to experience higher levels of COVID-19 stress (Horesh et al., 2020; Ruprecht et al., 2020).

MATERIALS AND METHODS

Participants

A total of 2,345 undergraduate students from a university consented to participate in the online survey. This sample size was based on approximately 10% of the university population to ensure representativeness. A total of 92.3% of the participants completed the entire survey. The rest completed 4% to 92% of

the survey. Data was collected between September and November 2020, during which a mask mandate was in place. After excluding seven students who were over 30 years or/and in their fifth year of study, the final sample comprised 1,309 females, 861 males, and 168 students who did not complete the section with the gender question. The mean age was 21.59 years (*SD* = 1.92 years, Range: 17 to 29 year). The racial composition based on those who reported the information was 86.8% Chinese, 3.9% Malay, 5.5% Indian, and 3.8% Others. In terms of the year of study, 562 students were in the first year; 627, in the second year; 596, in the third year; and 385, in the fourth year.

Procedure

The framework in **Figure 1** was developed to identify the direct and indirect effects of COVID-19 on young adults enrolled in universities across different domains of functioning, including health, family, school, and social life. Based on this framework, items were constructed to ensure adequate coverage across these domains. A literature search in the Psycinfo database and Google was also conducted in May 2020 to identify comparable measures of COVID-19 stressors. Relevant items not already in the scale were adapted for inclusion. In the next stage, the first author conducted a focused group discussion with a research staff and three psychology undergraduate students to brainstorm for more items, verify the face validity of the items, as well as refine and adapt them for cultural and language appropriateness. These procedures resulted in a 27-item C19SQ (**Table 1**). Even though the number of items in the initial pool was low, the use of a theoretical framework ensured good content validity.

An advertisement about the survey was sent to the emails of university students via their respective schools/colleges. Interested participants provided their consent and completed the survey online at their convenience. Data collection took place between October and December 2020. 75% of randomly selected participants received a $10 e-voucher at the end of the study. This study has received ethical approval from the Institutional Review Board at Nanyang Technological University.

Measures

COVID-19 Stressors Questionnaire

The C19SQ initially comprised 27 items assessing the extent to which participants worry about health issues (6 items), family and home problems (6 items), school changes (7 items), social lives (5 items) and the future (3 items). Participants rated on a 4-point scale (1 = Not at all, 2 = A little, 3 = Sometimes, and 4 = A lot), the extent to which they were concerned about various aspects of life affected by the COVID-19 pandemic. High mean scores on this questionnaire indicated greater endorsement of COVID-19-related stress.

Patient Health Questionnaire-8

The Patient Health Questionnaire-8 (PHQ-8) which excluded the suicidal ideation item, was used in the present study to measure depressive symptoms. Participants self-reported about their experience of eight symptoms on a 4-point scale (1 = Not at all, 2 = A little, 3 = Sometimes, and 4 = A lot). The scale anchors were labeled differently as the original scale to facilitate consistency across various questionnaires in the survey. Higher mean scores on this scale indicated higher levels of depressive symptoms. The internal consistency estimates for this scale in the present study were 0.85 and 0.84 for males and females, respectively.

Generalized Anxiety Disorder-7

The Generalized Anxiety Disorder-7 (GAD-7) assesses seven symptoms of anxiety and their severity. Participants rated themselves on a 4-point scale (1 = Not at all, 2 = A little, 3 = Sometimes, and 4 = A lot), which was also labeled differently

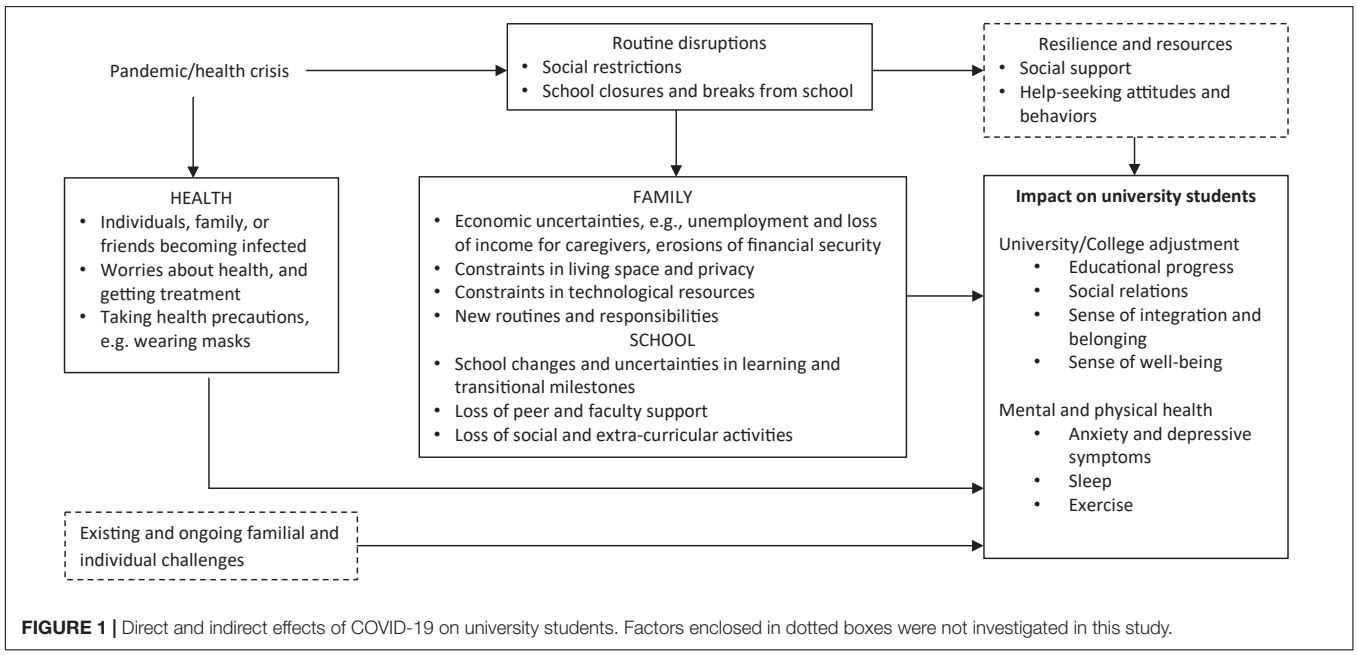

FIGURE 1 | Direct and indirect effects of COVID-19 on university students. Factors enclosed in dotted boxes were not investigated in this study.

TABLE 1 | Standardized pattern coefficients for the two-factor, four-factor, and five-factor solutions in the first round of EFAs.

	Abbreviated items (During the past few weeks, I worry about. . .)	Two-factor		Four-factor				Five-factor				
		1	2	1	2	3	4	1	2	3	4	5
1	Myself getting sick from COVID-19	0.22	0.23		0.67				0.68			
2	Attending online lessons	0.33	0.23	0.23		0.31		0.51				0.31
3	Not being able to socialize with friends and relatives	0.71		0.68				0.39		0.52		
4	Changes in routines and schedules	0.55		0.48				0.55		0.27		
5	What is going to happen in the future	0.26	0.46	0.22	0.22		0.43		0.21		0.41	
6	Someone close to me becoming sick	0.25	0.35		0.61				0.62			
7	Having to take health precautions	0.48		0.29	0.40				0.39			
8	Not doing well in tests and exams		0.52				0.44				0.43	
9	Not being able to engage in recreational activities	0.71		0.73						0.66		
10	Going/commuting to school	0.24	0.36		0.32	0.41			0.31			0.39
11	Losing my freedom to travel to different places	0.59		0.55						0.49		
12	Arguments and conflicts at home		0.45			0.55					0.22	0.50
13	Completing my internship or degree		0.69			0.24	0.54				0.56	0.23
14	Whether school is a safe place because of COVID-19	0.24	0.42		0.57	0.21			0.56			
15	Space and privacy constraints at home		0.44			0.57					0.20	0.53
16	My future (e.g., education, career, and relationships)		0.70				0.80				0.83	
17	Not being able to see a doctor, counselor, or dentist	0.38	0.24		0.27	0.43			0.29			0.43
18	Not being able to attend outside school activities	0.81		0.80						0.83		
19	Not being able to participate in school activities and events	0.73		0.74						0.74		
20	Drifting away from friends socially	0.49		0.47						0.40	0.20	
21	Availability of food and supplies	0.34	0.26		0.32	0.39			0.34			0.40
22	Not being able to seek help from teachers and professors	0.30	0.33			0.45						0.44
23	More family responsibilities		0.47			0.59					0.20	0.55
24	Whether I have the skills and ability to cope with the future		0.72				0.78				0.79	
25	Money problems		0.57			0.25	0.42				0.45	0.23
26	Large number of COVID-19 cases	0.38	0.27		0.61				0.61			
27	Not having the technological resources to learn from home	0.29	0.24			0.48						0.47

Coefficients < 0.2 are not reported. N = 1180. Two-factor solution: $\chi^2(298) = 2354.79$, $p < 0.01$; RMSEA = 0.08; CFI = 0.79; SRMR = 0.06. Four-factor solution: $\chi^2(249) = 1056.70$, $p < 0.01$; RMSEA = 0.05; CFI = 0.92; SRMR = 0.03. Five-factor solution: $\chi^2(226) = 782.82$, $p < 0.01$; RMSEA = 0.05; CFI = 0.94; SRMR = 0.03.

from the original scale. Higher mean scores indicated higher levels of anxiety symptoms. The internal consistency estimates were 0.90 and 0.89 for males and females, respectively.

Social Integration

The four-item Social Integration (SI) scale was used to measure students' sense of belonging to the university. This scale was adapted from the National Survey of Student Engagement (Kuh, 2001). Examples of items were "I feel that I am part of [university name]" and "I feel comfortable being myself at [university name]." The internal consistency estimates were 0.87 for males and 0.88 for females.

College Adjustment Questionnaire

University adjustment was measured by the 14-item College Adjustment Questionnaire (CAQ) which includes three domains of college adjustment, namely, Educational, Relational, and Psychological. A 5-point scale was used by participants to indicate how true certain statements about college or university experiences apply to them at the time of the survey (1 = Very inaccurate, 2 = Moderately inaccurate, 3 = Neither inaccurate or accurate, 4 = Moderately accurate, and 5 = Very accurate). Higher mean scores indicate better college adjustment. The internal consistency estimates for the overall scale were 0.88 for both males and females.

Grade Point Average

Given the option of 10 Grade Point Average (GPA) bands (1 = 0 to 0.49, 2 = 0.5 to 0.99, 3 = 1.0 to 1.49, 4 = 1.5 to 1.99, 5 = 2.0 to 2.49, 6 = 2.5 to 2.99, 7 = 3.0 to 3.49, 8 = 3.5 to 3.99, 9 = 4.0 to 4.49, and 10 = 4.5 to 5.0), participants reported their latest GPA scores as a measure of their academic performance.

Sleep and Exercise

Participants reported on the number of hours of actual sleep per night, as well as the quality of their sleep. These items were adapted from the Pittsburg Sleep Quality Index (Buysse et al., 1989). Additionally, they also reported the number of days they exercise per week for more than 10 min each time.

Analyses

Principal component and parallel analyses (O'Connor, 2000) were conducted in SPSS Version 25 on a randomly split half

of the sample. These results were compared, and the scree plot was inspected to determine the number of factors to retain in the subsequent exploratory factor analyses (EFAs). Based on theoretical considerations, individual items were reviewed in terms of how they were related to other items and common COVID-19 stressors identified in the literature. EFAs based on different number of factors were tested and compared in Mplus Version 8.4 (Muthén and Muthén, 1998–2017), using the maximum likelihood estimator that generates standard errors robust to non-normality and non-independence of observations (MLR). The Geomin oblique rotation was used to allow for correlation among factors. In general, items with rotated factor loadings < 0.4 were excluded from further analyses while maintaining appropriate scale length. Models with fewer cross-loadings were preferred since they would exhibit lower factor intercorrelations and were more likely to approximate a simple structure. Model fit was evaluated based on RMSEA was ≤ 0.06, CFI ≥ 0.95, or SRMR ≤ 0.08 (Hu and Bentler, 1999). Items and factors were continuously reviewed for their theoretical relevance in multiple runs of EFAs.

After the final EFA model was determined, a confirmatory factor analysis (CFA) was run on the other half sample to confirm the factor structure. Preliminary analyses showed no significant differences between the two randomly split samples on all the dependent variables. Both modification indices and theoretical considerations were used to help with improvement of model fit in re-runs of the CFAs. Although reported, Chi-square was not used as an index of model fit since trivial differences between the sample and estimated population covariance matrices often led to significant Chi-square with large samples (Tabachnick and Fidell, 2007). Factor reliability was evaluated based on Cronbach's alpha, with values > 0.70 being acceptable.

For convergent validity investigations, the associations between C19SQ and other relevant self-report variables were evaluated based on Pearson's product-moment correlation coefficients. Scores for the factors were based on means of items that load on those factors confirmed by the CFA results. Hierarchical multiple regression analysis was then used to assess the incremental validity of C19SQ in predicting college adjustment of students during the current pandemic, beyond the measures of academic achievement, mental health symptoms, and social integration. These covariates were selected since they were expected to be significantly correlated with the outcome measure. Hence, CAQ was regressed on GPA, SI, PHQ, and GAD in the first block of the regression model; C19SQ was then entered in the second block. The change in variance (ΔR^2) in the second block provided evidence about the incremental validity of the C19SQ. In the last series of analyses, groups of students based on gender, race, and year of study were compared in terms of their C19SQ scores using a *t*-test or a non-parametric test of difference.

Missing data in the dataset was minimal (3.46%) and was accommodated using full information maximum likelihood in Mplus for the EFA and CFA analyses. As 19 and 21 cases were missing on all C19SQ items, they were excluded from the EFAs and CFAs, respectively. In correlational analyses, all available data pertaining to the measures were used. Due to listwise deletion, 178 cases (7.61%) were excluded from the regression analyses. Overall, statistical power was reasonably assured given the big sample size.

RESULTS

A principal components analysis (PCA) conducted on about half the sample (n = 1199) indicated that five components had eigenvalues > 1.0. According to a parallel factor analysis which was compared with the PCA results, four factors should be retained. Examining the scree plot, only two factors were at and above the "elbow". Given these results, EFAs were conducted for two-factor, four-factor, and five-factor solutions (**Table 1**). Comparing the pattern matrices for the different solutions, the two-factor solution had nine items with low pattern coefficients of < 0.4, which would entail removing too many items in the next step. On the other hand, the four- (Item 2 and 21) and five-factor (Item 7 and 10) solutions had only two such items each. Additionally, based on maximum likelihood estimates with robust standard errors, the two-factor model did not fit the data well while the other models showed better fit. Hence, the two-factor solution was no longer considered in subsequent analyses.

In the four- and five-factor solutions, the patterns of loadings were largely similar. In both solutions, Item 1, 6, 7, 14, and 26 loaded on one factor; 3, 9, 11,18, 19, and 20 loaded on another factor; 5, 8, 13, 16, 24, and 25 loaded on another factor; and 10, 12, 15, 17, 22, 23, and 27 loaded on another factor. On the other hand, Item 2, 4, and 21 loaded differently in the two solutions. In the five-factor solution, Item 2 and 4 loaded on a fifth factor. Item 21 which was about the availability of food and supplies, appeared to load better in the five-factor solution, together with items about home and resources. On the other hand, it was together with other items about health in the four-factor solution, which was not as appropriate. Overall, the consistent pattern of loadings of all other items indicate stability in four of the factors in the solutions.

In the second round of EFAs, items with low pattern coefficients were removed and the four- and five-factor solutions were re-run. After dropping Item 2 and 21 for the four-factor model and Item 7 and 10 for the five-factor model, both the revised models showed improvements in fit. There were fewer cross-loadings in the four-factor model (6 items) than the five-factor model (9 items). 15 out of 25 items in the four-factor model had loadings > 0.5, compared to 14 out of 25 items in the five-factor solution.

In the third round of EFAs, additional items, 10 and 22 were dropped in the four-factor model, while item 20 was dropped from the five-factor model, due to the pattern coefficients being < 0.4. Comparing between the 23-item four-factor model and the 24-item five-factor model, both appeared to achieve adequate fit to the data. However, the five-factor model continued to have 9 items cross-loading on more than one factor while the four-factor model reduced to five items. Having only two indicators for the fifth factor might risk problems of underidentification and non-convergence. Further analyses also indicated poor reliability of the fifth factor ($\alpha = 0.60$) and poor

discrimination between this factor and another factor due to their high latent factor correlation (0.83). Hence, the five-factor model was rejected, and the four-factor model was retained (**Table 2**). No more items were excluded even though three pattern coefficients in the four-factor model were < 0.4, to avoid shortening the scale further. As shown in **Table 2**, The four factors were labeled Health Concerns (Item 1, 6, 7, 14, and 26), Social Restrictions (Item 3, 4, 9, 11, 18, 19, and 20), Future Uncertainty (Item 5, 8, 13, 16, 24, and 25), and Resource Constraints (Item 12, 15, 17, 23, and 27).

Using the second split sample ($n = 1139$), a confirmatory factor analysis on the 23 items showed that a four-factor solution did not attain an adequate fit, $\chi^2(224, n = 1118) = 1292.40$, $p < 0.05$, RMSEA = 0.06, CFI = 0.88, and SRMR = 0.06. Based on the modification indices, Item 18 and 19 were allowed to covary since both were related to school activities. problems experienced in the home setting. Next, considering that Item 25 was about money problems due to COVID-19 and could be consistent with the Resource Constraints factor, this item was re-specified to load on Resource Constraints. Last, Item 12 and 15 were also allowed to covary since both were related to home issues. With these stepwise re-specifications, the model as illustrated in **Figure 2**, attained a good fit based on RMSEA and SRMR criteria, $\chi^2(222, n = 1118) = 983.17$, $p < 0.05$, RMSEA = 0.055, CFI = 0.90, and SRMR = 0.05. According to the latent factor correlations, the significant correlations among the five factors were mostly in the medium-strong range (0.52–0.68). The reliability estimates of the factors based on the Cronbach alpha were 0.76 for Resource Constraints (6 items); 0.86 for Social Restrictions (7 items), 0.80 for Future Uncertainty (5 items), and 0.77 for Health Concerns (5 items). The estimate for the 23-item scale was 0.90.

To establish convergent validity with related variables, the C19SQ was correlated with PHQ, GAD, SI, CAQ, GPA, as well as sleep and exercise indicators. **Table 3** shows the correlation matrix among these variables by gender. The C19SQ total score showed large and positive correlations with PHQ and GAD. The expected negative correlation between C19SQ and CAQ were also large and significant. With SI, it showed small to moderate negative correlation. C19SQ showed small to moderate negative correlations with sleep hours per night and sleep quality. Lastly, C19SQ was significantly correlated with the number of days of exercise per week for males but not for females. C19SQ and its factors were generally not significantly associated with GPA but GPA was positively associated with CAQ.

To test the effects of C19SQ on college adjustment over and beyond the existing psychological distress that students may already experience, two multiple regression models were tested. In the first regression model, the predictors, PHQ, GAD, SI, and GPA, accounted for a significant amount of variance in CAQ, $R^2 = 0.43$, $F(4, 2155) = 412.74$, $p < 0.01$, $R^2_{adjusted} = 0.43$. All predictors remained uniquely predictive of CAQ, with standardized regression coefficients in the medium range (0.20 < effect sizes < 0.30). When C19SQ was entered into the second block [$\beta = -0.19$, $t(2154) = 10.02$, $p < 0.01$,

TABLE 2 | Standardized pattern coefficients for the final four-factor solution after excluding Item 2, 10, 21, and 22.

	Abbreviated item (During the past few weeks, I worry about. . .)	Resource constraints	Social restrictions	Future uncertainty	Health concerns
1	Myself getting sick from COVID-19				0.69
3	Not being able to socialize with friends and relatives		0.65		
4	Changes in routines and schedules		0.50		
5	What is going to happen in the future			0.42	0.22
6	Someone close to me becoming sick				0.62
7	Having to take health precautions		0.30		0.41
8	Not doing well in tests and exams			0.44	
9	Not being able to engage in recreational activities		0.73		
11	Losing my freedom to travel to different places		0.54		
12	Arguments and conflicts at home	0.68			
13	Completing my internship or degree	0.21		0.53	
14	Whether school is a safe place because of COVID-19				0.57
15	Space and privacy constraints at home	0.68			
16	My future (e.g., education, career, and relationships)			0.82	
17	Not being able to see a doctor, counselor, or dentist	0.35			0.27
18	Not being able to attend outside school activities		0.82		
19	Not being able to participate in school activities and events		0.75		
20	Drifting away from friends socially		0.46		
23	More family responsibilities	0.60			
24	Whether I have the skills and ability to cope with the future			0.80	
25	Money problems	0.25		0.39	
26	Large number of COVID-19 cases				0.62
27	Not having the technological resources to learn from home	0.37			

Coefficients < 0.2 are not reported. $\chi^2(167, n = 1180) = 638.50$, $p < 0.01$; *RMSEA = 0.05; CFI = 0.94; SRMR = 0.03.*

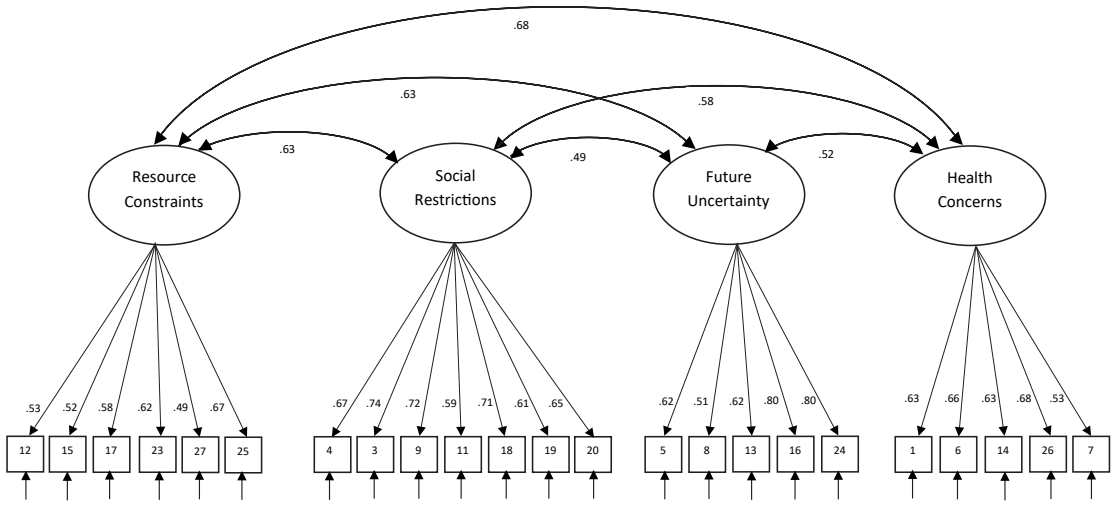

FIGURE 2 | Standardized factor loadings and latent factor correlations for the final 23-item four-factor CFA model.

TABLE 3 | Correlation matrix of measured variables.

	Females *n* = 1309 *M* (*SD*)	Males *n* = 861 *M* (*SD*)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.C19SQ	2.05 (0.52)	1.99 (0.54)		0.78**	0.82**	0.77**	0.74**	0.47**	0.51**	−0.43**	−0.002	−0.14**	−0.17**	−0.24**	−0.05
2.CRes	1.73 (0.60)	1.64 (0.57)	0.80**		0.48**	0.54**	0.46**	0.43**	0.44**	−0.34**	−0.01	−0.17**	−0.14**	−0.23**	−0.05
3.CSocial	1.95 (0.68)	1.99 (0.72)	0.84**	0.54**		0.45**	0.50**	0.32**	0.31**	−0.33**	−0.01	−0.04	−0.12**	−0.16**	0.02
4. CFuture	2.68 (0.73)	2.54 (0.76)	0.78**	0.57**	0.49**		0.44**	0.50**	0.56**	−0.50**	−0.001	−0.21**	−0.16**	−0.23**	−0.10**
5.CHealth	1.94 (0.65)	1.86 (0.66)	0.77**	0.53**	0.54**	0.48**		0.23**	0.28**	−0.16**	0.03	−0.03	−0.11**	−0.15**	−0.05
6.PHQ	2.20 (0.63)	2.03 (0.63)	0.49**	0.49**	0.34**	0.49**	0.26**		0.73**	−0.53**	−0.03	−0.26**	−0.22**	−0.38**	−0.12**
7.GAD	2.24 (0.74)	2.00 (0.73)	0.54**	0.52**	0.37**	0.55**	0.31**	0.73**		−0.49**	−0.03	−0.19**	−0.20**	−0.35**	−0.09**
8.CAQ	3.01 (0.68)	3.14 (0.68)	−0.43**	−0.38**	−0.31**	−0.49**	−0.19**	−0.55**	−0.49**		0.23**	0.40**	0.23**	0.32**	0.16**
9.GPA	7.80 (2.24)	8.08 (2.10)	−0.01	−0.07	0.03	−0.05	0.04	−0.05	−0.05	0.26**		0.08**	0.08**	0.06*	0.04
10.SI	2.79 (0.55)	2.74 (0.61)	−0.18**	−0.19**	−0.07	−0.26**	−0.07*	−0.31**	−0.26**	0.47**	0.11**		0.07*	0.21**	0.10**
11.SleepD	2.63 (0.93)	2.70 (0.92)	−0.18**	−0.21**	−0.10**	−0.18**	−0.12**	−0.25**	−0.21**	0.26**	0.12**	0.10**		0.45**	0.07*
12.SleepQ	2.67 (0.67)	2.68 (0.69)	−0.27**	−0.31**	−0.16**	−0.29**	−0.12**	−0.48**	−0.37**	0.39**	0.06	0.24**	0.43**		0.12**
13.Exer	1.71 (1.84)	2.30 (1.98)	−0.12**	−0.11**	−0.05	−0.14**	−0.12**	−0.21**	−0.17**	0.18**	0.02	0.10**	0.06	0.14**	

** $p < 0.05$, ** $p < 0.01$. C19SQ = 23-item COVID-19 Stressors Questionnaire, CRes = C19SQ Resource Constraints subscale, CSocial = C19SQ Social Restrictions subscale, CFuture = C19SQ Future Uncertainty subscale, CHealth = C19SQ Health Concerns subscale, PHQ = Patient Health Questionnaire-8, GAD = General Anxiety Disorder-7, SI = Social Integration, CAQ = College Adjustment Questionnaire, GPA = Grade Point Average, SleepD = Sleep Duration, SleepQ = Sleep Quality, Exer = Exercise. Results for females and males are above and below the diagonal, respectively.*

pr^2 = 0.04], it accounted for ΔR^2 value of 0.02, $\Delta F(1, 2154) = 96.50$, $p < 01$, which might be considered a significant portion of incremental variance beyond the effects of the first block measures in the stringent model. The assumptions for running these multiple regression models, including normality of the CAQ, homoscedasticity of residues, and independence of responses were evaluated to be tenable.

Tests of groups differences on C19SQ indicated that females scored higher on C19SQ than males [Mean difference = 0.05, t (2168) = 2.48, $p < 0.05$, d = 0.11], though this might be considered a small effect. Test of homogeneity of variances across racial/ethnic groups indicated a significant difference. Hence, a non-parametric test of difference was conducted. A Kruskal-Wallis test showed that there was a statistically significant difference in C19SQ among the different race/ethnic groups. Dunn's paired comparisons with significance adjusted by Bonferroni correction for multiple tests indicated that that Malay students (Mean rank = 1,213, $p < 0.05$) and Indian students (Mean rank = 1,265, $p < 0.01$) scored significantly higher on C19SQ compared to their Chinese counterparts (Mean rank = 1,022). No other comparisons were significant. No significant differences were found among students from different years of study.

DISCUSSION

The present study developed a university student-specific COVID-19 stressor scale (C19SQ), identified its factor structure, and ensured convergent and predictive validity of this newly

developed scale. Findings from this study allow for a better understanding about the salient COVID-19 stressors experienced by university students. Results of the EFAs and CFA identified four underlying factors, namely, Resource Constraints, Social Restrictions, Future Uncertainty, and Health Concerns.

The specific factor of Resource Constraints identifies a significant area of stress for university students that includes limitations in technological resource, financial difficulties, difficulties accessing medical services, space and privacy constraints at home, as well as increased family responsibilities. This is consistent with other studies which found that university students lost employment opportunities and had to cope with financial insecurity during this pandemic (Essadek and Rabeyron, 2020; Kecojevic et al., 2020). As a result of sheltering-in-place and quarantine measures, some students also experienced constraints in living space and privacy which can lead to increased interpersonal conflicts (Alzueta et al., 2021). When healthcare systems are strained by high number of infection or social distancing measures, students may also be affected by limited access to health services. Hence, as a result of resource constraints, students may struggle to find and harness the resources they need for their well-being and development during this pandemic.

The factor of Social Restrictions also represents a significant stressor for university students who are considered emerging adults (Arnett, 2000). At this developmental stage, students are engaged in extensive exploration of life possibilities, including social connectedness and relationships with others. With the on-going pandemic, the range of social experiences is suddenly limited and may not become available again, such as internship or fieldwork experience, university-level sports competitions, and convocations. In addition to the loss of social opportunities, diminished social support from peers, faculty, and staff may also affect university adjustment. In fact, when schools closed, students who did not move back to their parents' homes, were found to be more vulnerable to stress, probably due to the loss of both formal and informal forms of social and academic support that are typically available in a university environment (Husky et al., 2020). Social restrictions can also increase feelings of loneliness, which in turn, are predictive of depressive and anxiety symptoms (Bu et al., 2020; Groarke et al., 2020). Hence, at a developmental stage when emerging adults typically form more extensive networks of social relations, social restrictions during the pandemic can be a significant source of stress for university students unable to develop or access their social network of support.

Future Uncertainty also emerged as another source of stress for university students who are at a developmental stage already characterized by change and uncertainty (Arnett, 2000). Not being able to tolerate uncertainty has been found to be associated with increased levels of generalized anxiety and other emotional distress (Boswell et al., 2013). Intolerance of uncertainty may be due to negative beliefs and appraisals about threat and coping, which results in maladaptive responses, in terms of emotions, cognitions, and behaviors (Freeston et al., 1994). Given so much uncertainty about the pandemic, questions abound concerning the effectiveness and side effects of vaccines, the recovery of the economy, and the safety of travel. Besieged by a continuous stream of misinformation on the internet, people are already coping with more uncertainty than usual (Rettie and Daniels, 2020). Worse for university students, uncertainty about their future is now further heightened by unknowns regarding how the pandemic will pan out and the impact on their future plans and aspirations.

During a pandemic, the factor of Health Concerns represents a ubiquitous source of stress for individuals and their families dealing with a heightened risk of infection, ill health, and even, death. Living in areas with high infectious spread of COVID-19 has been found to be a predictive factor of stress and depressive symptoms in a sample of university students (Tang et al., 2020). Many may be concerned about the highly contagious nature of the COVID-19 virus, the lack of good medical knowledge about the virus and its treatment, and the potential for health system to be quickly overwhelmed by high number of infections. This stress is further compounded when public health information is not consistent, or when there is poor adherence to public health advisories. Additionally, the prevalence of misinformation on social media is likely to increase worries about health risks. This may partly explain why increased phone use or media exposure by university students during the pandemic has been associated with higher levels of anxiety and depressive symptoms (Huckins et al., 2020; Kecojevic et al., 2020; Ma et al., 2020). Even though having health concerns may be typical during a pandemic, high and continuous levels of health concerns can become a source of stress and anxiety, resulting in indiscriminate avoidance of activities and difficulties coping with daily social and academic demands.

In terms of convergent validity, the C19SQ as an entire scale, exhibited large and significant positive associations with anxiety and depressive symptoms. Consistent with other studies, students who endorsed higher levels of COVID-19-related concerns, were more likely to experience anxiety or depressive symptoms. While other studies demonstrated higher rates of symptoms after the onset of the pandemic (Essadek and Rabeyron, 2020; Huckins et al., 2020), the results of this study more directly linked COVID-19 stressors, as measured by the C19SQ, with anxiety and depressive symptoms. At the same time, COVID-19 stress was negatively associated with social integration, university adjustment, and exercise and sleep patterns. Students experiencing more COVID-19 stress reported feeling lower sense of belonging to the university and adjusting more poorly to university life. Furthermore, they were also exercising and sleeping less, and having poorer sleep quality. Even after controlling for mental health symptoms, the sense of social integration, and academic results, COVID-19 stress remained a unique and significant predictor of university adjustment. Despite the small effect size, the findings suggest that COVID-19 stress contributed to poor university adjustment.

In terms of the physical health effects of COVID-19 stress, this study found that an increase in stress was associated with a reduction in the number of days students exercised and the number of sleep hours, as well as poorer quality sleep. The curtailment of social activities due to social distancing measures, including restrictions in the use of sporting and recreational facilities, may have expectedly led to a reduction of physical activity and a concomitant increase in sedentary

behavior (Giustino et al., 2020; Hall et al., 2020; Huckins et al., 2020). Given the reciprocal association between physical activity and mental health (Chekroud et al., 2018), a reduction of physical activity and exercising during COVID-19 is likely to reciprocally contribute to poorer mental health (Tang et al., 2020), with the effect expected to be more pronounced for those who usually lead a sedentary lifestyle (Lesser and Nienhuis, 2020). In general, university students are more susceptible to stress, anxiety, and depressive symptoms, as well as poor sleep and sleep behaviors, thus explaining how these are problems are consistently comorbid with one another (Alvaro et al., 2013; Peach et al., 2016), including during this pandemic.

Group Differences in the Effects of COVID-19 Stressors

In this study, female students reported experiencing more COVID-19-related stressors, as well as anxiety, and depressive symptoms. These results are consistent with other COVID-19 studies (Essadek and Rabeyron, 2020; Fitzpatrick et al., 2020; Rettie and Daniels, 2020; Tang et al., 2020), as well as epidemiological studies documenting higher rates of depression and anxiety among female adults. Minority groups, namely Malay and Indian students, were also found to experience higher levels of COVID-19 stress. Disparities in the experience of COVID-19 among groups from different racial/ethnic or socioeconomic backgrounds may operate at three levels, namely, exposure, susceptibility, and treatment access (Blumenshine et al., 2008). The relevance of these factors for understanding the increased in COVID-19 stressors among Malay and Indian university students in Singapore remain to be investigated. Lastly, no difference was found in the experience of COVID-19 stressors among university students from different years of study. This result contrasts with another study which found that senior year students were more likely to experience depressive and anxiety symptoms (Ma et al., 2020). In sum, findings of groups differences on the C19SQ are generally consistent with other COVID-19 studies on gender and minority group differences.

Implications

The current evidence linking COVID-19 stressors to the higher risk of psychological symptoms and poorer adjustment and functioning in the university supports the understanding of the psychological impact of COVID-19 as stress responses or adjustment reactions. Current university students not only have to deal with typical stressors related to developmental events during the stage of emerging adulthood, they also have to cope with additional COVID-19 stressors during this pandemic. Despite the current increase in challenges, it is expected that symptoms and functioning will improve when COVID-19 stressors are "terminated" or when individuals show increased coping ability to deal with the stress. Given that the COVID-19 pandemic is still ongoing, some stressors may continue to be impactful. For some individuals, their stress reactions may become chronic, putting them at a higher risk of comorbid physical and mental health challenges.

The identification of the specific COVID-19 stressors in terms of resource constraints, social restriction, future uncertainty, and health concerns, helps us to understand the operating mechanisms that result in the psychological effects of COVID-19. This will allow service providers to target these specific factors to mitigate the effects of COVID-19. Hence, it is recommended that supporting the mental well-being of university students includes (1) identifying practical resources to help them cope with daily functioning, (2) encouraging them to stay connected with others in creative ways and develop new social routines, (3) increasing their tolerance for future uncertainty, and (4) discussing their health concerns and referring them to accurate and reliable sources of information. Additionally, it is important to help students understand the factors contributing to their distress and validate their experience of change and uncertainty during this unprecedented time.

Limitations and Strengths

One of the limitations of the study may be that the initial item pool of 27 items was small, thus limiting content validity. However, this problem was mitigated with the use of a theoretical framework to guide item generation. To achieve a stable four-factor structure, only four items were excluded, reflecting the good quality of the items. Additionally, there are at least five items loading on each factor, which contributed to the reliability of each factor. Secondly, even though items were generated based on the broad domains of health, family, school, and social life, results from the factor analyses might not appear to support COVID-19 stress as "domain-specific" as first theorized. However, it should be noted that health and social life are related to Health Concerns and Social Restrictions, respectively. Furthermore, the interpretation and labeling of the factors were based on the psychological relevance and applicability of the constructs, such as Future Uncertainty and Resource Constraints. Thirdly, the current study used a cross-sectional dataset which would limit conclusions about the causal impact of COVID-19 stressors. Longitudinal monitoring of the effects of COVID-19 is thus expected to provide stronger evidence for understanding these effects. The fourth limitation may concern the generalizability of the results to university students in other countries since the experience of COVID-19 may differ based on different responses of countries and communities when faced with fluctuating infectious spread of COVID-19. Hence, the C19SQ should be evaluated for measurement invariance when used with other populations in future research.

This study has several strengths which include a large sample size of over 2,000 students, thus providing power for the analyses conducted, and allowing for more accurate estimates of effects. The study has also taken an additional step beyond the identification of symptomatology associated with COVID-19 by demonstrating the predictive validity of the C19SQ with respect to university adjustment, over and above other predictors of university adjustment in a stringent test of the effects of COVID-19.

The emergence of psychological symptoms as a result of the pandemic may not be unexpected given that most people

are trying to adjust and adapt to multiple stressors. While our understanding about the psychological impact of the pandemic has increased rapidly, the long-term effects of COVID-19 are still unknown and continue to be investigated. Given that adjustment disorder is one possible way that individuals could be affected by COVID-19, it is hoped that the clarification of the nature of stressors in this study can guide further understanding, prediction, and mitigation of the psychological effects 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 Nanyang Technological University IRB. Written informed consent for participation was not provided by the participants' legal guardians/next of kin because: All participants were university students over 17 years old. NTU IRB waived the requirement for parental consent.

AUTHOR CONTRIBUTIONS

MY: methodology, formal analysis, investigation, writing – original draft preparation, and resources. MY and HS: conceptualization, writing – review and editing, and funding acquisition. Both authors contributed to the article and approved the submitted version.

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The Relationship Between Attentional Bias, Anxiety Sensitivity, and Depression and Anxiety Symptoms: Evidence From the COVID-19 Pandemic in China

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Background: The COVID-19 pandemic has led to observed increases in reported mental health issues, such as depression and anxiety symptoms. There is evidence attentional bias is associated with depression and anxiety, and it has been further suggested that anxiety sensitivity has a role in both the development and maintenance of depression and anxiety symptoms. Understanding these relationships may help inform preventative interventions for those at risk of mental health concerns. The present study explores the role of anxiety sensitivity, specifically physical and cognitive concerns, as a potential mediator of the relationship between attentional bias with depression and anxiety symptoms.

Method: Participants ($n = 460$) were recruited from the general population in China, and completed an online survey between February and March, 2020 which included the Attention to Positive and Negative Information Scale (APNI), Anxiety Sensitivity Index-3 (ASI-3) and Depression, Anxiety and Stress Scale (DASS-21). After exploring the correlations between the measures, mediation analysis was performed to explore the role of anxiety sensitivity (physical and cognitive subscales) in the relationship between attentional bias and depression and anxiety (as measured by the DASS-21).

Results: The results indicated that negative attention bias was significantly positively correlated with physical and cognitive concerns, physical and cognitive concerns were significantly positively correlated with depression and anxiety, and negative attention bias was significantly positively correlated with depression and anxiety (all $ps < 0.001$). Physical and cognitive anxiety sensitivity mediated the relationship between negative attention bias and both anxiety and depression symptoms.

Conclusion: Negative bias was associated with levels of anxiety and depression, and physical and cognitive anxiety sensitivity mediated associations between negative bias and anxiety and depression symptoms. The study provides theoretical support for intervention and guidance on individual mental health during the pandemic, and helps individuals increase their concern to negative emotions.

Keywords: anxiety sensitivity, physical concerns, cognitive concerns, mental health, attention bias

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INTRODUCTION

Public health issues such as COVID-19 will not only have a huge impact on social production, life and economic conditions, but also affect the physical and mental health of the public. COVID-19 is sudden, because of its fast-spreading speed, wide range, and strong infectivity, it seriously threatens the safety of human life, and has adverse health effects (1). On January 30, 2020, COVID-19 was listed by the World Health Organization (WHO) as a public health emergency of international concern. At present, COVID-19 has had an extraordinary threat on all aspects of individual life, such as safety, health, and wellbeing. The effects also extend to mental health, with associated effects on anxiety, depression, panic and other negative emotions (2). Anxiety and depression are significant indicators of poor mental health (3). Empirical research suggests that mental health disorder, especially negative emotions such as anxiety and depression, are very common, which not only reduces life satisfaction, but also impairs life functioning (4–6).

Studies have suggested that cognition and emotion have interactions at the functional and neurological levels, which together constitute the basis of behavior (7–9). Cognition is a necessary condition for emotion generation. Attention, as an early stage of cognitive processing, will affect individual emotional experience.

Attentional bias is an automatic and uncontrollable unconscious tendency, which refers to prioritizing certain types of stimuli to increase our ability to process this information (10). A number of studies have suggested (11, 12) that anxiety and depression are associated with increased attention allocation to negative stimuli compared to neutral stimuli (i.e., an attentional negativity bias). Attentional bias can be measured both objectively and subjectively. Objective measurement refers to the research conducted from the perspective of behavioral cognition through experimentation (13–15). It is usually inferred by measuring the tendency to pay attention to one type of stimulus over another, such as smoking-related stimuli and neutral control stimuli (16). While subjective measurement meanwhile is typically collected through self-report measures such as the attention to positive and negative information scale which has shown good reliability and validity (17–20).

The cognitive theory of anxiety suggests that attention bias plays an essential role in the maintenance of anxiety (21). Some studies indicated that attention bias is closely relevant to anxiety and depression (22). For example, Joormann and Gotlib found that depressed individuals tend to pay attention to negative material and avoid positive material (23). Koster et al. found that individuals with anxiety attend toward threatening images by using images (threatening images and neutral images) as experimental materials to test the responses of subjects (24). EEG study indicates that negativity biases produce hyper-activation of fear circuits during non-conscious processing of anxiety and conscious processing of depression (25).

However, previous studies have explored the relationship between attentional bias and anxiety and depression (26), but there is a lack of further research on the mediating variables between attentional bias and anxiety and depression. Since the COVID-19, there have been a large number of studies exploring the mental health of people, studying the psychological conditions of different groups, focusing on psychological interventions, etc. (27, 28), but few studies have explored their anxiety from the cognitive level of individuals. Therefore, this study introduced another variable, anxiety sensitivity, to study the indirect effects of attentional bias on anxiety and depression.

Anxiety sensitivity (AS) refers to the fear of anxiety and sensations related to anxiety (29). Individuals with high AS tended to experience various negative emotions (30). AS is a key cognitive factor in the generation and maintenance of anxiety and depression, which can theoretically increase the risk of anxious and depressive psychopathology (31). Studies have found that individuals with high AS have an attention bias toward threat stimuli, which may trigger deeper negative emotions, which in turn deepens their attention to threat stimuli (32). Most research has focused on AS as a whole, and few studies have specifically explored its specific dimensions. AS has three dimensions: cognitive, physical and social concerns (33). Cognitive concern reflect fear of cognitive dyscontrol, physical concern reflect the fear of physical sensations accompanying anxiety, and social concern reflect the fear that an observable anxiety response will lead to social exclusion (34). Many studies have suggested that physical and cognitive mediate the relationship, but social concern was not found to be a significant mediator (35). Guo et al. (36) found that the mediating effect of social concern on anxiety and attentional control is not significant. But the study did not explore the mediating role of different dimensions of anxiety sensitivity between attention bias and other negative emotions.

Previous literature has not been clear on the relationship between attention bias, AS, anxiety and depression. To further the existing literature and integrating existing research results, the study examined the influence of negative bias on anxiety and depression, and further investigated the mediating role of physical and cognitive concerns. Furthermore, the study also investigated the mediating role of social concerns. Based on the above review, the following hypotheses for this study were: negative attention bias would be associated with anxiety and depression symptoms; physical and cognitive AS would mediate relations between negative attention bias and both anxiety and depression symptoms. This study has potential significance for understanding how attentional processing is related to anxiety sensitivity, and then lead to depression and anxiety symptoms during the COVID-19 pandemic. This understanding might be used to support public health messaging, and identify people at risk of poorer mental health during public health emergencies.

METHODS

Participants and Procedure

The study conducted a cross-sectional internet-based survey of Chinese adults from February to March 2020. This study used the widely popular Chinese social media application "WeChat" to invite participants (37). WeChat has location-based online communities. We arranged for WeChat community moderators from a large city in central China (within Henan province) to invite their residents through the app. It also includes some

participants from other provinces, including Beijing, Sichuan, Zhejiang, etc. The present study used the Survey Star online questionnaire. Electronic consent of all participants was obtained in this study. Before obtaining participant consent, they were informed that the survey was anonymous and confidential. And inform the participants that the purpose of this survey is to investigate your mental health, the results of the survey are only used for statistics and not for other purposes. All procedures in this study conformed to the ethical standards of the Chinese Psychological Association (https://www.cpsbeijing.org/) and are in line with the 1964 Helsinki Declaration and subsequent amendments or similar ethical standards. The study was approved by the Tianjin Normal University ethics committee (XL2020-21).

A total of 529 people participated and completed all scales. All the participants had normal vision or corrected vision, without any history of mental disorder. Survey Star provides a feature that prevents participants from answering the questionnaire multiple times, and it prompts participants to complete skipped items, so there is no missing data. We removed participants who were considered to not have given the study proper attention by either providing the same response to all items, or who completed the full questionnaire battery in <180 s. A total of 460 valid questionnaires were retained, with an effective rate of 86.96%. The average age of the participants was 25.38 years (SD = 8.73). There were 154 male participants (33.5%) and 306 female participants (66.5%).

Measures

The Attention to Positive and Negative Information Scale (APNI)

The APNI was developed by Noguchi et al. to measure attention bias toward positive or negative information (38). Lv et al. adapted a Chinese scale version, with a total of 30 items, divided into two dimensions: positive attention bias (19 items in total) and negative attention bias (11 items in total) (20). Items are rated on a 5-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"). In this study, the negative attention bias dimension was used to measure attention bias toward negative information. Internal consistency for the sample was 0.878.

Anxiety Sensitivity Index-3 (ASI-3)

The ASI-3 was developed by Taylor et al., mainly used to measure fear of anxiety-related symptoms based on the belief that they may have harmful personal consequences (33). The scale consists of three dimensions of physical, cognitive and social concerns. Each dimension has six items, for a total of 18 items. Items are rated on a 5-point Likert scale from 0 ("very little") to 4 ("very much") (39). Internal consistency for the present sample was 0.940 for the physical concern subscale, 0.924 for the cognitive concern subscale, and 0.888 for the cognitive concern subscale.

Depression, Anxiety, and Stress Scale (DASS-21)

The DASS-21 was initially developed by Lovibond et al. and the Chinese version was developed by Gong et al. (3, 40). The questionnaire has good reliability and validity among Chinese adults, with a wide range of applicability (41). Twenty-one items are rated over the past week on a 4-point Likert scale from 0 ("not applicable") to 3 ("very applicable"); higher scores reflect greater symptoms. The anxiety and depression sub-scales were used in this study, with Internal consistency of 0.890 and 0.917, respectively.

TABLE 1 | Mean, standard deviation, and correlation coefficient of each variable.

	1	2	3	4	5
1 APNI negative	–**				
2 DASS-21 depression	0.399***	–**			
3 DASS-21 anxiety	0.431***	0.876***	–**		
4 ASI-3 physical	0.408***	0.731***	0.783***	–**	
5 ASI-3 cognitive	0.449***	0.747***	0.772***	0.895***	–
M	35.18	4.68	5.05	5.90	6.53
SD	7.08	4.85	4.73	6.00	5.93

N = 460; ASI-3, Anxiety Sensitivity Index-3; DASS-21, Depression Anxiety Stress Scale-21; APNI, Attention to Positive and Negative Information Scale.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Data Analysis

Statistical analyses were conducted using the SPSS (v. 22.0 for Windows; IBM Corporation), the data were analyzed for descriptive statistical analysis, Pearson correlations and regression analysis. The study used deviation-corrected percentile bootstrapping to test the mediating effect. The mediation analyses were conducted using the Hayes Process Macro for SPSS with 95% bias corrected confidence interval (CI) based on 5,000 bootstrap samples (42). The mediating effect exists if the confidence interval does not include 0. According to the hypothesis of this research negative attention bias would be associated with anxiety and depression symptoms; physical and cognitive AS would mediate relations between negative attention bias and both anxiety and depression symptoms. The study have run two analyses, one without the social concern and one with to check for the effect.

RESULTS

Descriptive Statistics and Correlation Results

In order to explore relationships between negative attention bias and physical and cognitive concerns, anxiety and depression symptoms, Pearson correlations were conducted, and results are shown in **Table 1**. Specifically, negative attention bias was significantly positively correlated with physical concern (r = 0.408, $p < 0.001$) and cognitive concern ($r = 0.449$, $p < 0.001$), physical concern ($r = 0.731$, $p < 0.001$) and cognitive concern (r = 0.747, $p < 0.001$) were significantly positively correlated with depression, physical concern ($r = 0.783$, $p < 0.001$), and cognitive concern were significantly positively correlated with anxiety, and negative attention bias was significantly positively correlated with depression (r = 0.399, $p < 0.001$) and anxiety (r = 0.431, p < 0.001).

TABLE 2 | Regression analysis of variable relationships in models.

Outcome variable	Predictor variables	*R*	R^2	*F*	*β*	*t*
		0.440	0.193	36.382***		
ASI-3 physical	Sex				−0.157	−3.696***
	Age				−0.034	−0.797
	APNI negative				0.391	9.160***
		0.484	0.235	46.564***		
ASI-3 cognitive	Sex				−0.127	−3.070**
	Age				−0.123	−2.950**
	APNI negative				0.420	10.115***
		0.763	0.583	126.826***		
DASS-21 depression	Sex				0.006	0.192
	Age				0.017	0.527
	APNI negative				0.078	2.304*
	ASI-3 physical				0.304	4.396***
	ASI-3 cognitive				0.444	6.252***
		0.804	0.647	166.429***		
DASS-21 anxiety	Sex				−0.002	−0.066
	Age				0.016	0.539
	APNI negative				0.103	3.292*
	ASI-3 physical				0.450	7.062***
	ASI-3 cognitive				0.327	5.000***

All variables were standardized. ASI-3, Anxiety Sensitivity Index-3; DASS-21, Depression Anxiety Stress Scale-21; APNI, Attention to Positive and Negative Information Scale.
$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Mediation Models

With negative attention bias as independent variable, cognitive and physical concerns as mediating variables, anxiety and depression as dependent variables separately, multiple mediation analysis were conducted. The results indicate that negative attention bias was significantly associated with depression and anxiety symptoms ($\beta = 0.078$, $p = 0.022$; $\beta = 0.103$, $p = 0.001$, respectively). Physical and cognitive concerns were significantly associated with depression ($\beta = 0.304$, $p < 0.001$; $\beta = 0.444$, $p < 0.001$, respectively), and physical and cognitive concerns were associated with anxiety ($\beta = 0.450$, $p < 0.001$; $\beta = 0.327$, $p < 0.001$, respectively). Results are reported in **Table 2**. From the model, negative attention bias not only directly predicted depression and anxiety, but also indirectly predicted depression and anxiety through physical and cognitive concerns.

The study analyzed the mediating effect of physical and cognitive concerns between attention bias and depression severity. Results suggested that the indirect effect of physical concern on the influence of negative attention bias on depression was 0.081. Its bootstrapped 95% confidence interval for the indirect effect of "negative attention bias→ physical concern→ depression" was (0.044, 0.126). The 95% confidence interval did not contain 0, indicating that physical concern had a significant mediating effect. The indirect effect of cognitive concern on the influence of negative bias on depression was 0.128, and the bootstrapped 95% confidence interval for the indirect effect of "negative attention bias→ cognitive concern→ depression" was (0.083, 0.179).The 95% confidence interval did not contain 0, indicating that cognitive concern had a significant mediating effect (see **Table 3** and **Figure 1**). The finding indicates that physical concern and cognitive concern have significant mediating effects between negative attention bias and depression.

TABLE 3 | Analysis of the mediating effect of physical concern and cognitive concern on negative bias affecting depression.

	Effect	BootSE	BootLLCI	BootULCI
Total	0.209	0.027	0.158	0.264
ASI-3 physical	0.081	0.021	0.044	0.126
ASI-3 cognitive	0.128	0.025	0.083	0.179

ASI-3, Anxiety Sensitivity Index-3.

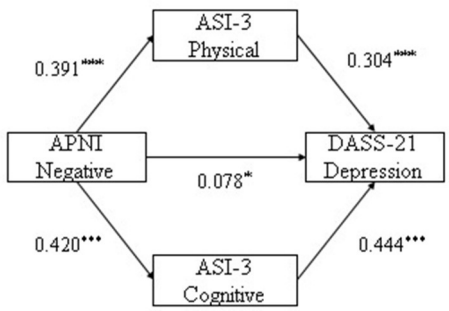

FIGURE 1 | The mediating pathway of physical and cognitive concerns in negative bias influence depression. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

BootSE, BootLLCI, and BootULCI refer to the standard error, lower limit and upper limit of the 95% confidence intervals of the indirect effects estimated by the percentile bootstrap method corrected by deviation, respectively, as follows.

Next the study analyzed the mediating effect of physical and cognitive concerns between negative attention bias and anxiety. Results indicated that the indirect effect of physical concern on the influence of negative attention bias on anxiety was 0.117, and its bootstrapped 95% confidence interval for the indirect effect of "negative attention bias→ physical concern→ anxiety" was (0.079, 0.163). The 95% confidence interval did not contain 0, indicating that physical concern had a significant mediating effect. The indirect effect of cognitive concern on the influence between negative bias on anxiety was 0.092, and the bootstrapped 95% confidence interval for the indirect effect of "negative attention bias→ cognitive concern→ anxiety" was (0.054, 0.136). The 95% confidence interval did not contain 0, indicating that cognitive concern had a significant mediating effect (see **Table 4** and **Figure 2**). The finding indicates that physical

TABLE 4 | Analysis of the mediating effect of physical concern and cognitive concern on negative bias affecting anxiety.

	Effect	BootSE	BootLLCI	BootULCI
Total	0.209	0.027	0.157	0.264
ASI-3 physical	0.117	0.022	0.079	0.163
ASI-3 cognitive	0.092	0.021	0.054	0.136

ASI-3, Anxiety Sensitivity Index-3.

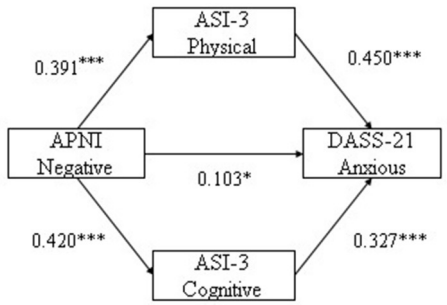

FIGURE 2 | The mediating pathway of physical and cognitive concerns in negative bias influence anxious. *$p < 0.05$, ***$p < 0.001$.

concern and cognitive concern have significant mediating effects between negative attention bias and anxiety.

In addition, the study also explored the mediating role of physical concern, cognitive concern, and social concern between negative bias and depression and anxiety, respectively. The results indicated that the regression coefficient of social concern was not significant (see **Table 5**), and the bootstrapped 95% confidence interval for the indirect effect of "negative attention bias→ social concern→ depression" was (−0.068, 0.001) (see **Table 6**). The 95% confidence interval of each parth contained 0. The bootstrapped 95% confidence interval for the indirect effect of "negative attention bias→ social concern→ anxiety" was (−0.034, 0.030) (see **Table 7**). The 95% confidence interval of each parth contained 0. These indicated the mediating effect of social concern was not significant.

DISCUSSION

Since December 2019, the COVID-19 has affected social production and personal life to varying degrees. With the development of society and economy, in the face of public emergencies, the public's ability to protect against risks economically has increased, but the psychological impact cannot be ignored. Therefore, more and more scholars have begun to explore the public's psychological conditions and risk perceptions behind public events from a psychological perspective (32). In February 2020, Guo et al. (43) surveyed the mental health status of 26,000 Chinese people through an online questionnaire, and found that 33% of the participants had a certain degree of depression, and 22.4% of the participants had obvious anxiety.

TABLE 5 | Regression analysis of variable relationships in models (physical, cognitive, and social concerns as mediating variables).

Outcome variable	Predictor variables	*R*	R^2	*F*	*β*	*t*
		0.440	0.193	36.382***		
ASI-3 physical	Sex				−0.157	−3.696***
	Age				−0.034	−0.797
	APNI negative				0.391	9.160***
		0.484	0.235	46.564***		
ASI-3 cognitive	Sex				−0.127	−3.070**
	Age				−0.123	−2.950**
	APNI negative				0.420	10.115***
		0.487	0.237	47.196***		
ASI-3 social	Sex				−0.075	−1.813
	Age				−0.153	−3.676**
	APNI negative				0.426	10.269***
		0.765	0.586	106.827***		
DASS-21 depression	Sex				0.010	0.325
	Age				0.009	0.293
	APNI negative				0.087	2.549*
	ASI-3 physical				0.323	4.627***
	ASI-3 cognitive				0.521	6.347***
	ASI-3 social				−0.114	−1.853
		0.804	0.647	138.392***		
DASS-21 anxiety	Sex				−0.002	−0.057
	Age				0.015	0.520
	APNI negative				0.104	3.272*
	ASI-3 physical				0.451	7.000***
	ASI-3 cognitive				0.331	4.369***
	ASI-3 social				−0.006	−0.114

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

TABLE 6 | Analysis of the mediating effect of physical, cognitive, and social concerns on negative bias affecting depression.

	Effect	BootSE	BootLLCI	BootULCI
Total	0.203	0.027	0.151	0.258
ASI-3 physical	0.082	0.021	0.048	0.132
ASI-3 cognitive	0.150	0.029	0.096	0.208
ASI-3 social	−0.033	0.017	−0.068	0.001

ASI-3, Anxiety Sensitivity Index-3.

During the pandemic, the incidence of public anxiety and depression has increased (44).

The present study focus on the relationship between cognition and emotion, especially explored the relationship between negative attention bias and anxiety and depression through

TABLE 7 | Analysis of the mediating effect of physical, cognitive and social concerns on negative bias affecting anxiety.

	Effect	BootSE	BootLLCI	BootULCI
Total	0.209	0.028	0.157	0.265
ASI-3 physical	0.118	0.022	0.078	0.165
ASI-3 cognitive	0.093	0.024	0.048	0.143
ASI-3 social	−0.002	0.016	−0.034	0.030

ASI-3, Anxiety Sensitivity Index-3.

physical and cognitive concerns (45). The results indicated that negative bias was significantly positively correlated with anxiety and depression, suggesting that negative bias is a potential influencing factor of anxiety and depression, which would induce negative emotion and have a negative influence on mental health development. During the pandemic, people will receive a lot of news about the COVID-19. Compared with individuals who pay more attention to positive information related to the pandemic, individuals who are biased toward negative news will have more negative emotions such as anxiety or depression. From the perspective of cognition, different cognitive styles will lead to differences in attention bias and affect individual emotional health to varying degrees, thus enhancing negative emotions such as anxiety and depression (46). This may also be one of the reasons why different individuals experience different anxiety and depression in the same context of the pandemic.

Negative attention bias and AS subscales were significantly positively correlated, indicating that when individuals have attention bias to negative information, their worries and fears about their own physical feelings and cognitions increase. The onion model of cognition suggests that cognitive processes and personality factors are interrelated and interact with each other (47). Consistent with previous studies, individual cognitive differences, such as attention bias to negative information, are reasons leading to high AS (27). During the pandemic, some individuals may pay too much attention to the negative information about the pandemic rather than the positive information. As shown in the results of this study, on the one hand, the attentional bias toward negative information will cause individuals to have stronger fears of their own physical sensations (such as sweating, shaking, etc.); on the other hand, it will also cause individuals to have a fear of cognitive dissonance.

According to correlation and regression results excessive worry about physiology and cognition were associated with negative emotions. As cognitive susceptibility factors of mental disorders, AS and its subscales are not only considered as risk factors leading to anxiety disorders, but also as important influencing factors of anxiety and depression (48). They are malleable and easy to be evaluated (49). In view of this, people with high AS may have a low tolerance for emotions such as anxiety, whereas individuals with low AS may have high tolerance (50). Previous studies have also suggested that there is a positive correlation between AS and negative emotions, and individuals with high AS tend to experience various negative emotional states (51). It can be inferred that during the pandemic, individuals with high AS tend to experience more negative emotions such as anxiety or depression. Results of the present study suggest that negative bias may affect anxiety and depression through the mediating effects of physical concern and cognitive concern, respectively. When an individual has attention bias toward negative information, the individual will have a fear of impaired cognitive control, and the individual's cognitive concern will further increase their negative emotional experiences such as anxiety and depression. Researchers believe that cognitive attention will trigger one's negative emotions by amplifying anxiety symptoms, thereby driving the relationship between AS and anxiety and depression (52). This is consistent with results of previous studies (53). Prior work has suggested that cognitive AS can increase anxiety and depression. Individuals with high cognitive concern believe that their symptoms, such as attentional decline or psychological incompetence will cause individuals to feel more uncomfortable, thus further enhancing negative emotional experience (35). The current research lacks evidence that social concern has mediating effect between negative bias and depression and anxiety. It indicates that, individuals pay less attention to society than their physical and cognitive concerns during the pandemic, that is, external evaluations may not trigger individual fear. It is consistent with the results of the previous studies, among the three dimensions of AS, only social concern does not work (36).

The current research on mental health is very necessary, and it is necessary to continue to strengthen public mental health science publicity and psychological counseling during the COVID-19. All sectors of society should gradually start to prevent and respond to mental health problems after the pandemic, and strengthen the construction of the social psychological service system and improve the public's mental health development in the future.

LIMITATIONS AND PROSPECTS

The current study investigated attention bias to negative information applied to the mediation effect of anxiety and depression, it still has several limitations. On the one hand, as a cross-sectional study, it is impossible to determine the causal relationship and direction between variables, and the self-reports cannot guarantee the objectivity and authenticity of the data. Future research can use longitudinal research to further study causality. On the other hand, besides the mediating effect of physical and cognitive concerns, there may also be some regulatory variables affecting the relationship between individual negative bias, anxiety and depression. Future studies may consider further exploring the relations of negative bias on mental health in more complex models.

CONCLUSION

In sum, the current study found that negative bias was associated with levels of anxiety and depression, and physical and cognitive AS mediated associations between negative bias and anxiety and depression symptoms. The findings

of this study provide theoretical support for intervention and guidance on individual mental health during the pandemic, and helps individuals increase their concern to negative emotions.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

SL designed the study protocol. XL conducted data collection, data management, cleaning, and analysis. SL and XL wrote the first draft of the paper. All authors contributed to the article and approved the submitted version.

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Measurement Invariance of the Questionnaire on the Internal Stigma of Internet Surfing Among Sino-Australian Undergraduates

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Background: The stigma of internet surfing is a relatively new area of study arising from the popularity of the internet. The Questionnaire on the Internal Stigma of Internet Surfing-9 (QISIS-9) was developed for the Chinese culture, so its suitability for use in other cultural contexts is uncertain. This paper examines the measurement invariance of the QISIS-9 among Sino-Australian undergraduates to verify the cross-cultural measurement invariance of QISIS-9 and promote cross-cultural (nationality) research regarding the internal stigma of internet surfing.

Methods: The Internal Stigma of Internet Surfing-9 (QISIS-9) was used to assess 200 Chinese undergraduates (50% female, $M_{age} = 19.78$) and 204 Australian undergraduates (76% female, $M_{age} = 21.10$), respectively.

Results: A confirmatory factor analysis (CFA) indicated that the single-factor model of QISIS-9 is acceptable with both Chinese and Australian undergraduates. However, the factor loading of Item 9, to which a reverse score is assigned, is not ideal for both samples. Thus, the item should be deleted. According to a multigroup confirmatory factor analysis (MCFA), QISIS-8, the revised version of QISIS-9, meets the strict measurement invariance among the Chinese and Australian participants. The QISIS-8 demonstrated appropriate internal consistency in the scores for both the Chinese and Australian undergraduates.

Conclusion: The new QISIS-8 can effectively assess the internal stigma of internet surfing among Chinese and Australian undergraduates, and it provides a frame of reference for further cross-cultural (border) comparisons.

Keywords: stigma, internal stigma of Internet surfing, QISIS, measurement invariance, Sino-Australian undergraduates

INTRODUCTION

Thirty-five percent of the world's population uses the internet, half of whom are youth. The latest internet report, produced in 2021, shows that 33.0% of netizens are under age 29 (1). According to a 2016 survey, 83% of Australian youth surfed the internet about three times a day and spent an average of 14 h each month on the internet (2). This amount of internet use contributes enormously to the study and life of undergraduates. However, excessive use of the internet has its negative effects, such as internet addiction, social alienation and stigma of internet surfing etc. that associate internet surfing with mental health problems. Negativity and facilitation coexist in the development of the internet. Identifying the patterns of use and guiding netizens into using the internet in positive ways are worthwhile pursuits.

China and Australia are home to a slew of data centers, but they have different cultures and eco-environments. Chinese culture is a collectivistic cultural model based on Han culture, and cognitive modes tend to converge and conform. Australia is a country of immigrants, where people of all races live together, but the western individualistic cultural system is dominant, and cognitive judgments and value evaluations are more personalized (3). Therefore, it is of great theoretical and practical significance to study the status quo and characteristics of the internal stigma of internet surfing among Sino-Australian undergraduates from a cross-cultural perspective.

Stigma

Goffman (4) was the first to frame the concept of stigma. He defines it as the derogatory and humiliating label that society attaches to individuals or groups who display conditions, attributes, quality, characteristics, or behaviors unacceptable in their own culture. Early research on stigma focused on individuals' unacceptable characteristics (4). Later, some scholars (5, 6) revised the concept and pointed out that this attribute conveys a depreciated social identity. The concept of stigma was first introduced to the Chinese academic community by Xie (7). Around 2000, the Chinese Mainland began research on stigma in medical science, sociology, social psychology, and anthropology. Guan (8) and Guo (9), for example, studied the conceptual characteristics of stigma and explored ways of stigma model building (8, 9). Stigma is generally regarded as a multidimensional composite comprising stereotype (negative cognitive appraisal), prejudice (negative emotional response), and discrimination (disposition to discriminating behavior) (5, 10).

The stigmas of physical and mental illnesses are foremost in Chinese and international research on stigmas (10–16). Research on the stigma of social identity comes in second place, covering race / nationality, sex, and special groups. The stigma of race/nationality has long been a hot topic among Western scholars (17–19). Western and Taiwanese researchers often study the stigma of gender discrimination from the feminist perspective (20–22), and most scholars on Chinese Mainland study the stigma of sex from the perspective of gender stereotypes (23–26). Western scholars look closely at homosexuals and drug abusers in their research of special groups (27–31), while Chinese scholars pay more attention on local issues, such as migrant workers (32–35), migrant populations (36, 37), and phoenix men (38–40). A new term, the stigma of internet surfing, has been coined amidst the rapid development of the internet and its potentially negative effects.

Stigma of Internet Surfing

The stigma of internet surfing is a relatively new area of study arising from the popularity of the internet. It was coined by Chinese scholar Lei et al. (41) to describe the negative stereotypes, prejudices, and discrimination of various internet behaviors on home computers and mobile devices (41). Lei and his partners (2012) developed the Questionnaire on the Internal Stigma of Internet Surfing among teenagers (QISIS) – adapted from a prior scale (e.g., internalized stigma of mental illness, ISMI) (42) and evaluated with the teenagers. The original QISIS was a four-point Likert-type scale including 13-item that loaded on a single factor: internal stigma of internet surfing (ISIS). The subsequent QISIS that consisted of 9 items, was developed by means of the exploratory and confirmatory factor analyses. The CFA indices for the unidimensionality of the QISIS were adequate (e.g., RMSEA = 0.051, CFI = 0.950, TLI = 0.936), and the internal consistency coefficients of the QISIS were acceptable to good (e.g., split-half reliability was 0.748, and the alpha coefficient was 0.855). Results indicated that girls and senior students display a higher degree of cognition of the stigma of internet surfing. Apparently, internet addiction is a good predictor of the stigma of internet surfing and highly addicted individuals show a higher degree of internal stigma (43). Lei and colleagues also found that the cognition of stigma provides the basis and conditions for the occurrence of the internal stigma of internet surfing. The internal stigma of internet surfing refers to the negative self-appraisal, self-perception and behavioral tendencies that individuals form after internalizing society's negative comments on and cognition of their internet behaviors (41).

Lei et al.'s (41) research shows that teenagers' cognition of the stigma of internet surfing and their internal stigma increase with age. Their developing self-awareness may lead to an increased comparison of the difference between their group and other groups as their cognition abilities improves and knowledge grows (41). In addition, Ugrin and Pearson (44) have been exploring ways to minimize overuse of the internet from the perspective of organizational management (44). Peter et al. (45) found that people often stigmatize online games because such games can encourage anger and guilt which might lead to serious communication disorders (45).

So far, there has been very little cross-cultural research on the stigma of internet surfing. Therefore, the current study is designed to investigate the stigma of internet surfing, especially the internal stigma of internet surfing, in the context of an oriental culture represented by China and a Western culture represented by Australia. No direct Australian research on the stigma of internet surfing is available, so we will carry out a comparative study of the use of the internet among Chinese and Australian late teenagers.

Comparison of the Use of the Internet Among Sino-Australian Teenagers and Their Mental Health

About 16.6% of Chinese netizens are under the age of 19, and 17.8% of them are between 20 and 29 (1). Chinese teenagers encounter the internet at a very young age, and the frequency of internet surfing among them increases yearly. The majority access the internet via mobile devices (46). They like information and apps on entertainment, and 62.5% of them play online games (47, 48). A recent survey shows that young students lack enthusiasm for online autonomous learning. Instead, they prefer to entertain themselves when online–specifically online games and interactions on social media dominate their use of the internet (49). Unfortunately, an individual's fear of negative evaluation exacerbates social anxiety, weakens self-control, and can cause excessive internet use (50). In turn, excessive use is often linked with poor academic performance in schools, and Cui et al. (51) found that internet addiction is rampant in less-democratic families (51).

Likewise, the internet is widely accessible in Australia, and 92% of teenagers have access to online education (52). The internet is a young Australian's major means for acquiring knowledge about politics, and it paves the way for young voters to get involved in political campaigns (2). However, excessive access of the internet can have an adverse impact on a teenager's academic performance (53). An extensive study shows that 55.2% of Australian teenagers communicate and play games on the internet, and 58.9% of them are addicted to the internet (54). Australian teenagers who overuse the internet and indulge in online games are more emotionally troubled and prone to problematic behaviors (55, 56). Unlike China, research and intervention programs aimed at addressing internet deviations and problems in Australia are mainly organized and financed by non-profit and private organizations. The government rarely gets involved in these efforts (57).

Young people in China and Australia display different mental health statuses in their cultures. Overall, Chinese and Australian undergraduates show moderate subjective senses of well-being. However, Chinese male students and liberal arts students show a lower subjective sense of well-being. But Chinese female students and science students have a higher subjective sense of well-being than Australian students. Research on affinity, coping strategies and mental stress among Chinese and Australian undergraduates shows that a clingy Australian couple will experience greater mental stress if they retreat and accuse themselves when coping with their problems, while a Chinese couple will experience greater mental stress and confusion only when they adopt the self-accusation strategy (58). According to Hu and Wang (59), Chinese youth who immigrated to Australia over the previous 5 years, often experience considerable mental stress and confusion (59).

Measurement Invariance

A critical, methodological issue in conducting cross-cultural research is measurement invariance. Measurement invariance describes the consistency in the outcome of tests that involve the same measurement tool and construct across different scenarios or samples such as genders, evaluators, testing media, cultural environments, and groups (60–62). Establishing measurement invariance is crucial for confirming that a measure is consistent across groups (e.g., male vs. female) (63). It is also a criterion for investigating whether a measure has the same functions across groups. In particular, a cross-cultural study should find out if different cultural groups have the same understanding of the same construct (62–64). If a tool that does not meet the requirements for measurement invariance is employed, researchers will be unable to determine whether the differences are trustworthy in their comparison of samples. In our investigation, if the QISIS test does not meet the requirements for cross-sample measurement invariance, we must proceed cautiously when trying to explain cross-cultural differences. If, however, the test meets the requirements for measurement invariance, our results will be more reliable.

The analysis of measurement invariance is currently implemented in two ways (65, 66): (1) multigroup confirmatory factor analysis (MCFA) under the framework of the structural equation model; (2) differential item functioning (DIF) under the framework of the item response theory. The current study adopts MCFA in its analysis of measurement invariance. The MCFA-based test method usually examines the comparison of nested models to establish measurement invariance, which includes configural invariance, weak invariance, strong invariance, and strict invariance. More specifically, configural invariance mainly verifies whether the formation or model of latent variables is the same (factor model equivalency). Weak invariance examines the relationship between observed variables (i.e., items) and latent variables (i.e., factors) based on configural invariance. In other words, it tests whether factor loading is invariant across groups. Strong invariance checks whether the intercept of observed variables (items) is invariant across groups based on weak invariance. Strict invariance further analyzes whether the error variance of observed variables (items) is invariant across groups based on strong invariance. Strict invariance suggests that the difference in scale score variation across groups reflects the difference in latent variable variation across groups.

As stated, the tool to test the internal stigma of internet surfing was first developed by Lei et al. (41) in their research with adolescents (41). Since it remains unknown to what degree the tool is applicable to undergraduates and what its psychometric properties are among Australian subjects, it cannot be applied in cross-cultural studies. To make the comparison of the internal stigma of internet surfing among Sino-Australian undergraduates applicable and effective, we will examine the measurement invariance of QISIS-9 among Sino-Australian undergraduates with a view to laying psychometric foundations for follow-up comparisons of the internal stigma of internet surfing among Chinese and Australian undergraduates.

METHODS

Participants

Chinese Samples

An offline survey was conducted among undergraduates at Chongqing University of Arts and Sciences in China. A total of 200 participants (50% female; 18–23 years old; mean age =

19.78; SD = 1.30) were recruited to complete the questionnaires, including 100 liberal arts students and 100 science students; 50 were freshmen, 66 were sophomores, 69 were juniors, and 15 were seniors. Additionally, several of participants were randomly selected for follow-up interviews based on the scores of the QISIS.

Australian Samples

An online survey was conducted among undergraduates at the University of Newcastle in Australia. A total of 204 participants (76% female; 18–30 years old; mean age = 21.10; *SD* = 3.28) were returned. In the current sample, 192 were from Europe and North America, 10 were from Asia, and 2 didn't indicate their nationality. All were freshmen. Moreover, several of participants were randomly selected for follow-up interviews based on the scores of the QISIS.

Procedure

The appropriate IRB approval was sought and obtained from the Chongqing University of Arts and Sciences (Review NO. 20180614) and the University of Newcastle (Reference NO. H-2018-0293), respectively. All Chinese participants provided written consent prior to completing the questionnaire, and all the Australian participants provided online informed consent prior to participation. Participants were informed that the study was voluntary, and they could discontinue at any time. In addition, participants were informed that their answers would remain anonymous and were invited to ask questions regarding the investigation.

Measures

The Questionnaire on the Internal Stigma of Internet Surfing-9 (QISIS-9) was developed by Lei et al. (41). It is a unidimensional questionnaire that covers nine items. Each item is scored on a four-point Likert-type scale from 1(*completely disagree*) to 4 (*completely agree*). The English version of the QISIS-9 was translated into English by the first and second authors, and was back translated into Chinese by the second and third authors. The final version was jointly produced by a Chinese psychology professor (the second author) and an Australian psychology professor (the fourth author) through inter-translation.

Statistical Analysis

The SPSS 22.0 was used to input the survey data, perform the descriptive statistics, and examine the internal consistency coefficient. The Mplus 8.0 was used to carry out the confirmatory factor analysis (CFA) and measurement invariance analysis. The following steps were taken in the analysis:

First, we performed the descriptive statistics of QISIS-9 that Chinese and Australian undergraduates get on the mean, standard deviation, skewness and kurtosis (see **Table 1**). Because the scores of the Chinese samples were beyond the range of −1 to +1 on skewness and kurtosis for all QISIS-9 items (except for Item 9), the MLM (maximum likelihood estimation with a mean-adjusted chi-square), was adopted in the confirmatory factor analysis (CFA) to examine the factor structure of the QISIS-9. It is robust to non-normality. The CFA was performed based on the following indicators (67): comparative fit index (CFI; ≥0.90 suggests an acceptable model fit), Tucker-Lewis index (TLI; ≥0.90 suggests an acceptable model fit), root-mean-square error of approximation (RMSEA; ≤0.08 indicates an acceptable model fit), and standardized root mean square residual (SRMR ≤0.08 indicates an acceptable model fit).

Second, the measurement invariance (MI) of QISIS-9 between Chinese and Australian samples was examined. In other words, multigroup confirmatory factor analysis (MCFA) was carried out successively to check the configural invariance, the weak invariance, the strong invariance and the strict invariance. Since the Chi-square difference test is susceptible to sample size (68), the present research will examine difference scores in CFI (ΔCFI), TLI (ΔTLI), and RMSEA (ΔRMSEA) to evaluate MI. According to Cheung and Rensvold (69), ΔCFI and ΔTLI < 0.01 supports MI (69). Chen (68) suggests ΔRMSEA < 0.015 supports MI (68). Following the MI, the latent means among Sino-Australian undergraduates were calculated to compare the differences between Chinese and Australian undergraduates. Specifically, the latent mean scores were computed by setting the Chinese group as the reference group (i.e., setting the QISIS mean to zero in the Chinese group) and freely estimating the latent means in the Australian group.

Third, the alpha coefficient and mean inter-item correlations (MIC) were used to examine the internal consistency of the QISIS-9 scores. An alpha coefficient bigger than 0.70 is acceptable (70), and a value of MIC within the range from 0.15 to 0.50 suggests satisfactory internal consistency (71).

RESULTS

Descriptive Statistics

Means, standard deviations, skewness, kurtosis, and correlations between items and total scale scores are shown in **Table 1**. The scores of Chinese participants on all QISIS-9 items show a positive skewed distribution (except for Item 9), indicating that the Chinese undergraduates have a relatively low score on the internal stigma of internet surfing and the scores that Australian undergraduates get on all QISIS-9 items show a normal distribution.

Factor Structure of the QISIS-9 in Sino-Australian Sample

The CFA indicated two findings: (1) the QISIS-9 shows unidimensionality among the Chinese undergraduates, all the fit indexes are acceptable (χ^2 = 84.366, *df* = 27, RMSEA = 0.063, CFI = 0.958, TLI = 0.945, SRMR = 0.041), and the factor loading value of all items is ideal (except for Item 9, the factor loading value of which is 0.171) (see **Table 2**); (2) QISIS-9 also shows unidimensionality among the Australian undergraduates (χ^2 = 129.766, *df* = 27, RMSEA = 0.109, CFI = 0.909, TLI = 0.878, SRMR = 0.054), and the factor loading value of all items is satisfactory (except for Item 9, the factor loading value of which is −0.11) (see **Table 2**). These results indicate that the factor loading of Item 9 among the Chinese and Australian undergraduates does not reach an acceptable level (<0.30). Thus, another CFA was performed excluding Item 9. The results indicate that: (1) the QISIS-8 shows unidimensionality among

TABLE 1 | Descriptive statistics of scores of Sino-Australian undergraduates in QISIS-9.

Item	China							Australia						
	Min	*Max*	*M*	*SD*	*SK*	*KU*	CITC	*Min*	*Max*	*M*	*SD*	*SK*	*KU*	CITC
Item-1	1	4	1.47	0.72	1.60	2.41	0.71	1	4	2.15	0.74	0.33	−0.05	0.67
Item-2	1	4	1.56	0.77	1.14	0.35	0.72	1	4	2.21	0.73	0.34	0.06	0.74
Item-3	1	4	1.48	0.67	1.40	1.84	0.72	1	4	2.21	0.70	0.03	−0.36	0.72
Item-4	1	4	1.51	0.73	1.47	1.89	0.70	1	4	2.11	0.78	0.37	−0.17	0.67
Item-5	1	4	1.55	0.74	1.33	1.43	0.65	1	4	2.07	0.75	0.25	−0.34	0.64
Item-6	1	4	1.52	0.76	1.41	1.34	0.59	1	4	1.98	0.67	0.32	0.16	0.65
Item-7	1	4	1.28	0.58	2.43	6.78	0.73	1	4	2.01	0.73	0.29	−0.24	0.72
Item-8	1	4	1.37	0.61	1.57	1.96	0.72	1	4	1.88	0.69	0.62	0.82	0.74
Item-9	1	4	2.24	0.92	0.17	−0.88	0.17	1	4	2.33	0.69	−0.18	−0.44	−0.13

SK, kewness; KU, kurtosis; CITC, Corrected Item Total Correlations.

TABLE 2 | Factor loading of items in QISIS-9 and QISIS-8.

Item	China		Australia	
	QISIS-9	QISIS-8	QISIS-9	QISIS-8
Item 1: I think I am useless when spending time on the Internet	0.56	0.56	0.56	0.56
Item-2: I think less of my abilities when spending time on the Internet	0.61	0.61	0.59	0.59
Item-3: I feel negative about myself when spending time on the Internet	0.52	0.52	0.58	0.57
Item-4: I feel inferior to others when spending time on the Internet	0.56	0.56	0.57	0.57
Item-5: I lower my self-expectation when spending time on the Internet	0.52	0.52	0.48	0.48
Item-6: I feel upset when spending time on the Internet.	0.48	0.48	0.46	0.46
Item-7: I feel guilty or embarrassed when spending time on the Internet	0.44	0.44	0.54	0.54
Item-8: I feel worthless when spending time on the Internet	0.46	0.46	0.52	0.52
Item-9: I feel confident about myself when spending time on the internet	0.17		−0.11	

QISIS, Questionnaire of the Internal Stigma of Internet Surfing.

the Chinese undergraduates ($\chi^2 = 76.552$, $df = 20$, RMSEA = 0.067, CFI = 0.960, TLI = 0.944, SRMR = 0.041), and the factor loading of all items is ideal (see **Table 2**); (2) the QISIS-8 shows an acceptable unidimensionality among the Australian undergraduates ($\chi^2 = 113.734$, $df = 20$, RMSEA = 0.116, CFI = 0.920, TLI = 0.888, SRMR = 0.052), and the factor loading of all items is satisfactory (see **Table 2**). Therefore, the QISIS-8 would be used in subsequent analysis of the measurement invariance.

Measurement Invariance

Taking previous methods in cross-cultural studies of measurement invariance (72, 73) as reference, the present study adopts the MCFA to test the MI of the scores that the Chinese and Australian undergraduates get in QISIS-8 (see **Table 3**).

Configural Invariance

Factor loading and intercept are roughly estimated and no assumption about identity is made in cross-cultural samples in investigating the configural invariance (test whether the form or model of latent variables is the same), so as to establish a baseline model for subsequent comparison of nested models. **Table 3** suggests that all the fit indexes of configural invariance in the present study basically meet psychometric requirements (e.g., CFI and TLI > 0.90) and that the scores of the Chinese and Australian undergraduates in QISIS-8 meet the requirements for configural invariance.

Weak Invariance

The same factor loading is set for the two sample groups to test the weak invariance after configural invariance was established. **Table 3** indicates that all the fit indexes of weak invariance meet psychometric requirements (e.g., CFI and TLI > 0.90). Although the value of ΔTLI is 0.01, the value of ΔCFI is smaller than 0.01, and the value of ΔRMSEA is smaller than 0.015. This pattern of results suggests that the scores of the Chinese and Australian undergraduates on the QISIS-8 meet the requirements for weak invariance.

Strong Invariance

The same measure intercepts are set for the two sample groups to test the strong invariance after weak invariance was established. **Table 3** shows that all the fit indexes of strong invariance meet psychometric requirements (e.g., CFI and TLI > 0.90). The value of ΔCFI is −0.011, while the value of ΔTLI is smaller than 0.01 and the value of ΔRMSEA is smaller than 0.015, respectively.

TABLE 3 | Measurement invariance model fit statistics for the QISIS-8 across Chinese and Australian undergraduates.

Model	χ^2	*df*	CFI	ΔCFI	TLI	ΔTLI	RMSEA	ΔRMSEA
Configural invariance	190.287	40	0.938	-	0.914	-	0.092	-
Weak invariance	197.720	47	0.936	−0.002	0.924	0.010	0.086	−0.006
Strong invariance	219.316	54	0.925	−0.011	0.923	−0.001	0.087	0.001
Strict invariance	245.133	62	0.925	0.000	0.932	0.009	0.081	−0.006

Df, degrees of freedom; CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; ΔCFI, change in comparative fit index relative to the preceding model; ΔTLI, change in Tucker-Lewis index relative to the preceding model; ΔRMSEA, change in root mean square error of approximation relative to the preceding model.

This pattern of results suggests that the scores of the Chinese and Australian undergraduates on the QISIS-8 meet the requirements for strong invariance.

Strict Invariance

The same measure intercepts are set for the two sample groups to test the strict invariance after strong invariance was established. **Table 3** indicates that all the fit indexes of strict invariance in the present study meet psychometric requirements (e.g., CFI and TLI > 0.90), the value of ΔCFI and ΔTLI is smaller than 0.01, and the value of ΔRMSEA is smaller than 0.015. This pattern of results reveals that the scores of the Chinese and Australian undergraduates on the QISIS-8 meet the requirements for strict invariance.

When the strict invariance was established, the differences in the scores that Chinese and Australian undergraduates get in QISIS-8 were examined. The results show that the Australian undergraduates manifest significantly higher scores in QISIS-8 than Chinese undergraduates do (mean difference $= 0.669$, $p < 0.001$).

Internal Consistency of QISIS

The alpha coefficient and the MIC were adopted to examine the internal consistency of QISIS-9 among the Chinese and Australian undergraduates. We have two findings: (1) The alpha coefficients of the scores that the Chinese and Australian undergraduates get for the QISIS-9 are 0.87 and 0.86, and the MICs are 0.46 and 0.41, both respectively; (2) After Item 9 was deleted in view of the results of the CFA, the alpha coefficients of the scores of the Chinese and Australian undergraduates in QISIS-8 are 0.91 and 0.91, and the MICs are 0.56 and 0.56, both respectively.

DISCUSSIONS

The QISIS-9 was developed for the Chinese culture, so its suitability for use in other cultural contexts is uncertain. The present study is the first to take samples from Chinese and Australian undergraduates in an effort to verify the cross-cultural measurement invariance of QISIS-9 and promote cross-cultural (nationality) research regarding the internal stigma of internet surfing. The results show that the QISIS-8, a revised version of QISIS-9 where Item 9 is deleted, is reliable and valid among both Chinese and Australian undergraduates. Furthermore, the revised QISIS-8 meets the strict measurement invariance across Sino-Australian undergraduates and demonstrates satisfactory internal consistency in the two groups.

Given that the QISIS-9 was originally based on Chinese senior high school students (41), its psychometric properties among undergraduates needed to be verified. Accordingly, the reliability and validity of the QISIS-9 among Chinese and Australian undergraduates were examined before the cross-cultural invariance analysis was conducted. The CFA and internal consistency coefficients demonstrate that the psychometric properties of QISIS-9 among the Chinese and Australian undergraduates are comparable and acceptable. But interestingly, the reverse-coded item (Item 9, "I feel confident about myself when spending time on the internet") in QISIS-9 was inferior to the other eight items (positively-coded for the internal stigma of internet surfing). More specifically, the reliability and validity, especially the value of the alpha coefficient, of QISIS-8 improved in CFA and internal consistency after deleting the reverse-coded Item 9. There are disagreements about whether reverse scored items should be used in questionnaires. For example, some scholars (74, 75) argue that such items may have a negative impact on the psychometric properties of questionnaires. Likewise, others (76, 77) point out that reverse scored items may have an impact on the factor structure of measurement tools (e.g., item wording effect). Following those studies, the current study also found that Item 9, a reverse-coded item in QISIS-9, had a negative impact on the psychometric properties of the QISIS-9. Thus, Item 9 was deleted, and the revised QISIS-8, which covers eight items, was developed and used to analyze the measurement invariance among the Sino-Australian undergraduates. This development will promote cross-cultural (nationality) research and comparison of the internal stigma of internet surfing.

The MCFA indicated that the strict measurement invariance (specifically configural, metric, scalar, and strict invariance) of the QISIS-8 across Chinese and Australian undergraduates has been observed. More specifically, the configural invariance suggests that the QISIS-8 has the same unidimensional structure across Chinese and Australian samples; the metric invariance demonstrates that the QISIS-8 has the same factor loadings among Chinese and Australian populations; the scalar and strict invariance further supports that the QISIS-8 has the same intercepts and residual invariance across Chinese and Australian undergraduates, respectively. Overall, the QISIS-8 supported the measurement invariance among the Chinese and Australian participants, suggesting that the QISIS-8 is simultaneously

applicable to the investigation and assessment of internal stigma of internet surfing among the Chinese and Australian undergraduates. Thus, the mean difference in internal stigma of internet surfing scores as measured by the QISIS-8 can be interpreted as the true difference in the level of internal stigma of internet surfing between Chinese and Australian undergraduates.

Based on the results of the strict measurement invariance, we subsequently compared the scores of Chinese and Australian undergraduates on internal stigma of internet surfing and found that the QISIS-8 scores of the Australian undergraduates were significantly higher than those of the Chinese students. This is evidence that internal stigma of internet surfing likely exists among the Australian undergraduates, and is different than China's situation. For stigmatization, Chinese undergraduates tend to internalize their stigma of internet surfing with a perspective of conformity and a general "public stigma." Public stigma is a continuous process in which the public stigmatizes some specific groups, events or behaviors (9). "Collective-centered" individuals accept and normalize public stigma based on collective identity thinking (78). Australian undergraduates, however, stigmatize internally the internet surfing when they are unable to cope with the physical and mental damage caused by improper internet use, and this is magnified by an individualistic culture – one that emphasizes individual responsibility and selection. This stigmatization process is based on individual self-recognition and judgment after online practice and experience (79).

A recent study has pointed out that 80% of Australian youth play games online and gamble, and 1–5% of them are addicted to these kinds of activities (80). These Australian youth enjoy the convenience and excitement that the internet brings, but they are not well-equipped to deal with the psychological problems that arise therein. They do not have effective coping strategies.

In a developed country of immigrants, the youth of multi-cultural Australia have a significant prevalence of psychological distress and tendencies toward stigmatization (81). Youth with mental disorders are reluctant to seek help, and they lack relevant knowledge to adequately deal with their own problems (82–84). We also found from interviews with participants that while internet surfing can bring pleasure; it can also produce self-accusations and anxiety. Mental frustrations have emerged, leading many youths to believe that the internet is wasting their time, money, and energy. And they have no idea how to use the internet scientifically and reduce its harm to their physical and mental health. This gives rise to the internal stigma of internet surfing. Australian youth definitely need to use information technology and the internet in more positive ways – green, environmentally-friendly, and sustainable ways. Hopefully, corresponding mental problems can be addressed (85).

Limitations and Future Directions

The findings of this study should be considered in light of its limitations. First, participants were predominantly recruited from the southwest of China and New South Wales in Australia. Thus, the results might not generalize to other geographic areas or cultures. Additional studies should further examine and replicate our findings in other regions in China and other Western samples (e.g., North America). Moreover, the QISIS was originally developed based on Chinese senior high school students. Future research should benefit from investigating cross-cultural invariance of the QISIS by comparing a sample of Chinese youth directly with Western samples. Finally, data collection (offline / online) and sample characteristics (e.g., sex ration, and age) were different in both groups (e.g., Chinese and Australian populations), and these differences might influence the results of invariance across the groups. Future studies should be focus on the aforementioned factors to avoid their influence on the measurement invariance and comparison of differences in cross-cultural research.

Despite these limitations, results of the current study have suggested that the revised QISIS-8 demonstrates strict measurement invariance across Sino-Australian undergraduates, as well as satisfactory internal consistency. It holds promise as a self-report instrument for the assessment of internal stigma of internet surfing among Chinese and Australian undergraduates.

DATA AVAILABILITY STATEMENT

The data supporting the conclusions of this study are available upon request to author YG (gy8620@163.com) and corresponding author RW.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Chongqing University of Arts and Sciences Institutional Review Board. The University of Newcastle Human research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YG was mainly responsible for the overall conception and design of this study, investigated the data, drafted the manuscript, and provided the final approval for the manuscript. JL contributed to the analysis and interpretation of the data, drafted the manuscript and provided the final approval for the manuscript. J-cH helped to carry out the investigation of the data. RW contributed to the investigation of the data, and revised the manuscript. JW also revised the manuscript and provided final approval for the manuscript. All authors contributed to the article and approved the submitted version.

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Anxiety, Depression, and Stress Are Associated With Internet Gaming Disorder During COVID-19: Fear of Missing Out as a Mediator

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Background: Many teenagers suffered negative emotional states, especially anxiety and depression, during the COVID-19 outbreak, and most teenagers choose Internet games to cope with negative emotion. Previous evidence indicated that fear of missing out is related with anxiety and depression in teenagers with Internet gaming disorder, but it is unclear how fear of missing out influences depression, anxiety, or stress.

Methods: Based on an I-PACE model, using Depression, Anxiety, Stress Scale (DASS-21), Fear of Missing Out Scale, and Internet Gaming Addiction Scale, and 324 middle school students as participants, this study explored the mediating effect of fear of missing out on depression, anxiety, or stress and Internet gaming disorder.

Results: The results showed that depression and stress are significantly related to Internet gaming disorder through the partial mediating of fear of missing out. Anxiety is not significantly related to Internet gaming disorder through the full mediating of fear of missing out, and anxiety and stress have a greater predictive effect on Internet gaming disorder through fear of missing out. Results also demonstrated that students who play Honor of Kings or Player Unknown's Battlegrounds have more risk to develop Internet gaming disorder.

Conclusions: The results indicated that fear of missing out as a mediator regulates the relationship among depression, anxiety, and stress and Internet game disorder. Specifically, under the mediation of fear of missing out, teenagers with anxiety are more likely to develop Internet gaming disorder, while teenagers with depression or stress might be prone to other types of Internet use disorders.

Keywords: depression, anxiety, stress, fear of missing out, internet gaming disorder, teenagers

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INTRODUCTION

The outbreak of COVID-19 has had negative influences on the living state and mental health of teenagers. For the prevention and control of the epidemic, social interaction was forced to transfer online from offline (1), and it induced some negative emotions such as anxiety, depression, and stress (2, 3). To relieve negative emotion, most teenagers choose Internet games to cope. In May 2020, *Research Report on the Internet Usage of Minors in China in 2019* released by CNNIC showed

that 61.0% of netizens under 18 years old often play Internet games. Listening to music and playing games are the most important entertainment activities for adolescents (4). Adolescents are in a "storm period" of emotional development due to their immature mind and lack of ability for emotional regulation (5). At the same time, adolescents find it easier to relieve negative emotion and obtain satisfaction via the Internet when they are facing troubles in their daily life, and with the undeveloped self-control ability, they are a highly susceptible group for Internet gaming disorder (6).

Internet gaming disorder is classified both in the DSM-5 and ICD-11, defined by an individual who partakes in continuous or repeated gaming (whether online or offline), manifested through impaired control of the game, increased emphasis on the game, and continuous or upgraded gaming regardless of negative consequences (7). Previous evidence showed that anxiety and depression are related to Internet gaming disorder (8–12). It is possible that individuals with depression or anxiety are more likely to socialize on online platforms to meet their psychological needs (13–15). So, the individuals with severe depression and individuals with general anxiety are more likely to overuse smartphones or Internet games (16). Based on previous evidence, the current study proposed that anxiety, depression, and stress are related to Internet gaming disorder (Hypothesis 1). Meanwhile, previous studies also found that demographic variables like age and gender are related to Internet gaming disorder or other problematic use disorders (17, 18). This study explored the relationship among depression, anxiety, stress, and Internet gaming disorder by controlling demographic variables.

Meta-analysis indicated that depression or anxiety is not the only factor influencing Internet gaming disorder; there are other factors between anxiety, depression, stress, and Internet gaming disorder (17, 19). One study focused on adults with Internet gaming disorder and found that individuals with Internet gaming disorder had lower resilience, higher perceived stress, and higher levels of depression. A survey of 812 participants found that the Fear of Missing Out mediated social anxiety and Internet gaming disorder (19). During the period of quarantine, most people got information through the Internet (1), while the flood of information online caused anxiety and caused people to develop a fear of missing out on the information (20).

Fear of Missing Out (FoMO) refers to a pervasive apprehension that others might be having rewarding experiences from which one is absent, characterized by the desire to stay continually connected with what others are doing (20). Studies about FoMO suggested that FoMO involves an adverse negative emotional state, and individuals with high anxiety or depression are more likely to experience FoMO (21, 22). Other studies found that FoMO is associated with higher levels of Internet gaming disorder severity (23, 24), and FoMO mediated relations between depression and Internet gaming disorder severity (16). As we can see in the study by Elhai's team (18), FoMO significantly mediated relations between anxiety and both smartphone use frequency and problematic smartphone use severity, but did not account for relations between depression and smartphone use or problematic smartphone use (18). And although previous studies focused on the mediating effect of FoMO, most of them explored the links between FoMO and Internet gaming disorder in Western culture (19, 25). It is therefore unclear whether FoMO has the same mediating effect in a Chinese context. Additionally, most studies on FoMO explored the level of participants' FoMO through the scale established by Przybylski et al., however, the FoMO Scale from Przybylski et al. was developed from the Western context, and needs to verified in the context of China.

Brand's team (26, 27) proposed an interaction of Person-Affect-Cognition-Execution (I-PACE) model to explain the development of addictive behaviors. I-PACE model believes that different core characteristics have different cognitive biases to the environment, which will affect the first choice of behavior and develop into specific addictive behaviors (26, 27). Though previous research showed that there are mediating factors (like FoMO) between anxiety, depression, stress, and Internet gaming disorder (17, 19), few studies distinguished the relationship among the relationships in anxiety, depression, and Internet gaming disorder, and few studies explored the influence mechanism of the first choice of behaviors. Therefore, this study aims to explore whether the difference exists in the relationship between depression, anxiety, or stress and Internet gaming disorder, and to explore how fear of missing out influences depression, anxiety, or stress.

To explore how FoMO influences the relationship between depression, anxiety, or stress and Internet gaming disorder severity (the mechanism of the first choice of behaviors) and to verify whether the FoMO scale is valid in the context of China, this study used the I-PACE model to explore the mechanism between them. The I-PACE model indicated that addictive behaviors are the consequence of interactions between the core characteristics of a person and several moderating and mediating variables, which may be dynamic and develop over time as a consequence of engagement in specific behaviors (26, 27). So FoMO, as a cognitive factor, is a mediating factor in personal variables and problematic use (26, 27). Specifically, the psychopathological factors (like anxiety, depression, and stress) are mediated by FoMO to affect behavioral decision-making, forming the different addiction behaviors (26, 27). The current study proposed that FoMO is significantly related to anxiety, depression, stress, and Internet gaming disorder (Hypothesis 2), and FoMO mediates the relationship among anxiety, depression, stress, and Internet gaming disorder (Hypothesis 3). The relationship of all variables is shown in **Figure 1**.

METHODS

Participants and Procedure

Due to the restriction of mobile phone use in teenagers, participants were randomly recruited from a middle school in Tianjin through convenience sampling in 2021. Specifically, the psychology teacher issued the questionnaires in class and 400 adolescents completed the questionnaire; 324 of them are valid questionnaires. Among the 324 participants, there were 163 boys (50.3%) and 161 girls (49.7%), age range from 12 to 15 years ($M \pm SD = 13.07 \pm 0.76$). To explore the distribution of the data, we used the Q-Q graphical method in the SPSS tool to analyze and found that the participants

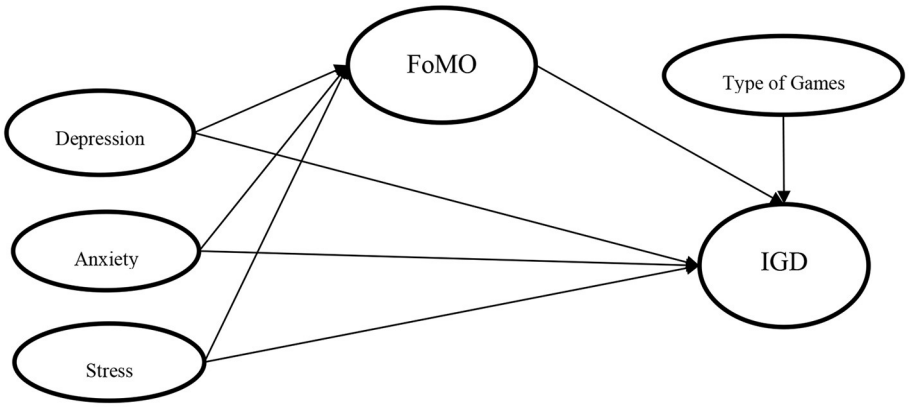

FIGURE 1 | Relation diagram of various variables. FoMO, fear of missing out; IGD, Internet Gaming Disorder.

distribution was normal, and subsequent data analysis could be carried out. All the participants volunteered for the study and all the participants and their parents signed their informed consent. Emotional or psychological support was provided when participants wanted it. Ethics approval was given from the Ethics Committee of Tianjin Normal University. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Measures

The Depression Anxiety Stress Scale-21 (DASS-21)

In this study, the Chinese version of DASS-21 (28) was used to evaluate the level of anxiety, depression, and stress of the participants. It is a 3-point self-evaluation scale and requires participants to score each item based on their own feelings in the past week (0 = completely inconsistent, 3 = completely in line). The scale consists of three subscales: depression, anxiety, and stress. The higher the score, the higher the level of anxiety, depression, and stress. Previous studies have indicated that DASS-21 has good reliability and validity. In the current study, the Cronbach's α of the depression subscales, anxiety subscales, and stress subscales were 0.87, 0.84, and 0.86.

Internet Gaming Disorder Scale

This study uses the Internet gaming disorder scale developed by Cui (29). Cui developed the Internet gaming disorder scale based on DSM-4 and the eight criteria for Internet disorder from Young (29), which consists of 10 items, each with two options of "yes" and "no." Answering "yes" gets 1 point, while answering "no" gets 0 points. Those with a total score of 7 or >7 are considered as having Internet gaming disorder. The scale is a standard-referenced test prepared by the Angoff method and has good empirical validity (29). We revised the scale based on DSM-5. In order to validate the scale, we issued 300 questionnaires to a middle school in Tianjin through convenient sampling in 2021 and collected 253 valid questionnaires before the formal study. The results of confirmatory factor analysis using AMOS showed that $\chi^2/df = 2.85$, NFI = 0.88, CFI = 0.90, TLI = 0.87, RMSEA = 0.08. In the current formal study, the Cronbach's α of the Internet gaming disorder scale was 0.75.

Fear of Missing Out Scale

In this study, the single-dimensional FoMO scale developed by Przybylski et al. (20) was used to assess the FoMO level of participants. It has 10 items and Likert 5-point scoring (1 = completely non-conforming, 5 = completely conforming) scale. The higher the score, the higher the FoMO level. The initial internal consistency coefficient of this scale is α = 0.87 (19). In order to validate the scale in the context of China, we revised the scale into Chinese by translating it from English to Chinese and back to English again. And then we issued 250 questionnaires to a middle school in Tianjin through convenience sampling in 2020 and collected 203 valid questionnaires before the formal study. The results of confirmatory factor analysis using AMOS showed that $\chi^2/df = 2.41$, NFI = 0.91, CFI = 0.94, IFI = 0.86, RMSEA = 0.08. It means that the scale has a good validity in the context of China. In this formal study, the Cronbach's α of the scale was 0.84.

Statistical Analyses

The data were analyzed through SPSS 22.0 for descriptive and correlation analysis, using One-way ANOVA to test the demographic differences of each variable, and used model 4 in the PROCESS 3.3 plug-in to analyze the mediating effect of the model. The scores of each scale are standardized and then further calculated.

RESULTS

The General Characteristics of Adolescents' Internet Gaming Disorder

Descriptive statistics and difference tests showed (**Table 1**) that there are significant gender differences in Internet gaming disorder, but no significant gender differences in depression, anxiety, stress, and FoMO, The scores of Internet gaming

TABLE 1 | Descriptive statistics (M ± SD) and Difference tests of each variable.

Demographic variable		Stress	Anxiety	Depression	FoMO	IGD
Gender	Male	0.62 ± 0.67	0.57 ± 0.64	0.37 ± 0.55	2.11 ± 0.79	0.22 ± 0.21
	Female	0.76 ± 0.72	0.66 ± 0.67	0.49 ± 0.64	2.25 ± 0.86	0.14 ± 0.18
	t	**1.84**	**1.27**	**1.81**	**1.43**	**−3.58*****
Age	12	0.73 ± 0.66	0.64 ± 0.65	0.38 ± 0.49	2.31 ± 0.89	0.17 ± 0.22
	13	0.66 ± 0.69	0.57 ± 0.62	0.42 ± 0.58	2.17 ± 0.78	0.18 ± 0.20
	14	0.69 ± 0.76	0.65 ± 0.72	0.49 ± 0.67	2.03 ± 0.84	0.19 ± 0.19
	15	0.81 ± 0.71	0.94 ± 0.83	0.61 ± 0.85	2.51 ± 0.82	0.26 ± 0.22
	F	**0.24**	**1.22**	**0.70**	**1.97**	**0.71**
Grade	7 Grade	0.62 ± 0.60	0.53 ± 0.56	0.35 ± 0.48	2.13 ± 0.78	0.17 ± 0.20
	8 Grade	0.78 ± 0.81	0.74 ± 0.76	0.55 ± 0.71	2.25 ± 0.88	0.19 ± 0.20
	t	**−2.05***	**−2.88*****	**−3.04*****	**−1.25**	**−0.61**
Game duration (week)	<5 h	0.62 ± 0.68	0.56 ± 0.61	0.37 ± 0.51	2.12 ± 0.79	0.14 ± 0.18
	5–10 h	0.78 ± 0.64	0.71 ± 0.64	0.47 ± 0.61	2.21 ± 0.81	0.30 ± 0.19
	>10 h	1.22 ± 0.70	1.04 ± 0.90	0.95 ± 0.87	2.74 ± 1.13	0.41 ± 0.24
	F	**7.08*****	**5.12****	**8.63*****	**4.65****	**32.11*****
Type of games	Honor of Kings	0.67 ± 0.65	0.62 ± 0.64	0.44 ± 0.61	2.14 ± 0.87	0.22 ± 0.22
	PUBG	0.74 ± 0.75	0.57 ± 0.65	0.43 ± 0.55	2.09 ± 0.84	0.21 ± 0.22
	Single games	0.71 ± 0.71	0.65 ± 0.69	0.45 ± 0.61	2.22 ± 0.77	0.16 ± 0.18
	Don't play	0.45 ± 0.60	0.51 ± 0.57	0.34 ± 0.62	2.31 ± 0.88	0.06 ± 0.13
	F	**1.07**	**0.45**	**0.22**	**0.66**	**5.83*****

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; FoMO, fear of missing out; IGD, Internet Gaming Disorder; PUBG, Player Unknown's Battlegrounds. Bold values indicate the results of difference tests.

disorder in males are significantly higher than in females. There is no significant age difference in depression, anxiety, stress, FoMO, and Internet gaming disorder. There are significant grade differences in depression, anxiety, and stress, but no differences in FoMO and Internet gaming disorder. The score of depression, anxiety, and stress in 8th grade students are significantly higher than in 7th grade students. In terms of the duration of playing a game, there are significant differences in depression, anxiety, stress, FoMO, and Internet gaming disorder. The scores of depression, anxiety, stress, FoMO, and Internet gaming disorder of adolescents with long game duration are significantly higher than adolescents with short game duration. There are no significant differences of type of games in depression, anxiety, stress, and FoMO, but there is significant difference in Internet gaming disorder. The scores of Internet gaming disorder in students who played Honor of Kings or Player Unknown's Battlegrounds are significantly higher than students who played single-player games or do not play.

Correlation Analysis Results

The Correlation Analysis is shown in **Table 2**. The results showed that there is a positive correlation among depression, anxiety, stress, FoMO, and Internet gaming disorder after adjusting for gender, age, grade, game duration, and type of games. Like the data shows in **Table 2**, FoMO was moderately correlated with stress, anxiety, and depression scores. So, we estimated Pearson correlations and found that the correlation coefficient of FoMO and stress is 0.58 ($p < 0.001$), the correlation coefficient of FoMO and anxiety is 0.56 ($p < 0.001$), and the correlation coefficient of FoMO and depression is 0.51 ($p < 0.001$). FoMO was just mildly correlated with IGD, with the correlation coefficient of FoMO and IGD being 0.27 ($p < 0.001$).

TABLE 2 | Correlation Analysis of each variable.

		1	2	3	4	5
1	FoMO	1				
2	IGD	0.27***	1			
3	Stress	0.58***	0.26***	1		
4	Anxiety	0.56***	0.26***	0.80***	1	
5	Depression	0.51***	0.26***	0.77***	0.76***	1

$^{***}p < 0.001$; FoMO, fear of missing out; IGD, Internet Gaming Disorder.

The Mediator of FoMO on Internet Gaming Disorder Under Different Negative Emotions

In order to test the mediating effect of FoMO in depression, anxiety, stress, and Internet gaming disorder, we standardized the data and adjusted for gender, age, grade, game duration, and type of game, using the SPSS data analysis of model 4 in PROCESS. The results showed (**Table 3**) depression, anxiety, and stress are significantly positively related to FoMO ($\beta = 0.53$, $p < 0.001$, $\beta = 0.58$, $p < 0.001$, $\beta = 0.59$, $p < 0.001$). After introducing FoMO as a mediating variable into the equation, it was found that depression and stress are still significantly positive predictive of Internet gaming disorder ($\beta = 0.16$, $p < 0.05$, $\beta = 0.14$, p

TABLE 3 | Path Analysis.

	β	*SE*	*95% CI*
Direct path (Direct effects)			
Depression → IGD	0.15	0.06	[0.04, 0.28]
Anxiety → IGD	0.13	0.06	[−0.001, 0.25]
Stress → IGD	0.14	0.07	[0.01, 0.27]
Path through FoMO (Indirect effects)			
Depression → FoMO → IGD	0.09	0.04	[0.02, 0.16]
Anxiety → FoMO → IGD	0.10	0.04	[0.03, 0.18]
Stress → FoMO → IGD	0.10	0.04	[0.02, 0.19]

FoMO, fear of missing out; IGD, Internet Gaming Disorder.

< 0.05), but anxiety is not a significantly positive predictor of Internet gaming disorder ($\beta = 0.13, p > 0.05$). Meanwhile, FoMO as a mediating variable is also significantly positively related to Internet gaming disorder ($\beta = 0.17, p < 0.01, \beta = 0.18, p < 0.01, \beta = 0.17, p < 0.01$).

The mediating effect test found that depression, anxiety, and stress are significantly related to Internet gaming disorder through the partial mediating factor of FoMO (*ab* = 0.09, *Boot SE* = 0.04, *95% CI* is [0.02, 0.16], *ab* = 0.10, *Boot SE* = 0.04, *95% CI* is [0.03, 0.18], *ab* = 0.10, *Boot SE* = 0.04, *95% CI* is [0.02, 0.19]), the relative effect of depression, anxiety, and stress are, respectively, 35.45%, 44.95%, and 41.90%. And the mediator relationship of all variables is shown in **Figure 2**.

DISCUSSION

This study investigated the relationship of depression, anxiety, stress, and Internet gaming disorder, and explored the role of FoMO in the relationship between depression, anxiety, stress, and Internet gaming disorder. The current study focuses on Chinese teenagers to explore whether there is a difference between the settings of China and the West, and to explore the validity of FoMO scales in cultural adaptability.

This study found that depression, anxiety, and stress are significantly positively correlated to Internet gaming disorder, and FoMO is significantly relevant to anxiety, depression, stress, and Internet gaming disorder, supporting H1 and H2, which is consistent with previous research. Previous studies found that individuals with higher levels of depression, anxiety, and stress are more likely to develop an Internet games disorder (16, 19, 30). A possible reason is that Internet games are a way for individuals to escape from reality. And they can receive sequential rewarding experience during game playing, and increase their craving for Internet games. Therefore, individuals with higher levels of depression, anxiety, and stress are more willing to spend time playing Internet games. Previous studies also found that FoMO has a positive relationship with anxiety and depression severity (18) and Internet gaming disorder (22, 23). One interesting result is that the relationship between FoMO and IGD in this study ($r = 0.27$) is higher than in previous studies ($r = 0.12$) (24), which may be induced by different FoMO scales used in two studies. Although the FoMO scale in this study has a good validity and reliability, and most previous studies on FoMO were conducted in a Western culture setting, FoMO may have different external performances in different contexts, so the results are different.

This study also found that when FoMO acts as a mediating factor, there is still a significant relationship among depression, stress, and Internet gaming disorder, but there is no significant relationship between anxiety and Internet gaming disorder. It means that FoMO acts as a part mediator among depression, stress, and Internet gaming disorder, and acts as a full mediator between anxiety and Internet gaming disorder, supporting H3. Specifically, anxiety, stress, and depression symptoms will increase the level of FoMO (18), and higher FoMO is more likely to result in impulsive behaviors and spending more time playing Internet games (24), Meanwhile, higher FoMO in anxiety symptoms leads to more risk to develop to Internet gaming disorder. The current study found that different types of games have different predictive effects on Internet gaming disorder, as the results showed that the scores of Internet gaming disorder of students who played Honor of Kings or Player Unknown's Battlegrounds are significantly higher than students who played single-player games. A possible reason is that FoMO is a kind of anxiety symptom caused by fear of missing out on the rewarding experience of others (20), while Honor of Kings or Player Unknown's Battlegrounds may provide more opportunities to interact with others and provide more opportunities for continuous rewards. Therefore, anxious individuals with higher FoMO will be more at risk for Internet gaming disorder. According to the I-PACE model, FoMO might create an attention bias in that people are worried about missing reward experiences or other information (26, 27), Internet games might meet the needs of individuals with fear of missing rewards or information and obtain the corresponding psychological satisfaction, so that they develop into Internet gaming disorder.

More interestingly, the results of this study indicated that anxiety and stress have a greater predictive effect on Internet gaming disorder through the mediating relationship of FoMO (44.95%, 41.90%) than depression (33.45%). A possible reason is that depressed individuals pay more attention to themselves and are unwilling to have too much contact with the real world. Though Internet games may make depressed individuals satisfied through socializing or rewarding experiences, other Internet activities (e.g., social networking or online shopping) may also have the opportunity to allow depressed individuals to escape from real world interaction. According to the I-PACE model, the external stimulus provides individuals with clues to rewarding experiences, which can promote cravings for information related to Internet activities, thereby forming Internet addiction (26, 27). As the results of this study found, individuals with different emotional states may develop different cognition or affection bias to Internet activities, and then develop into different Internet addiction. This finding provides the basis for future research on the impact of FoMO on different types of Internet addiction, and provides evidence for the I-PACE model to explain the

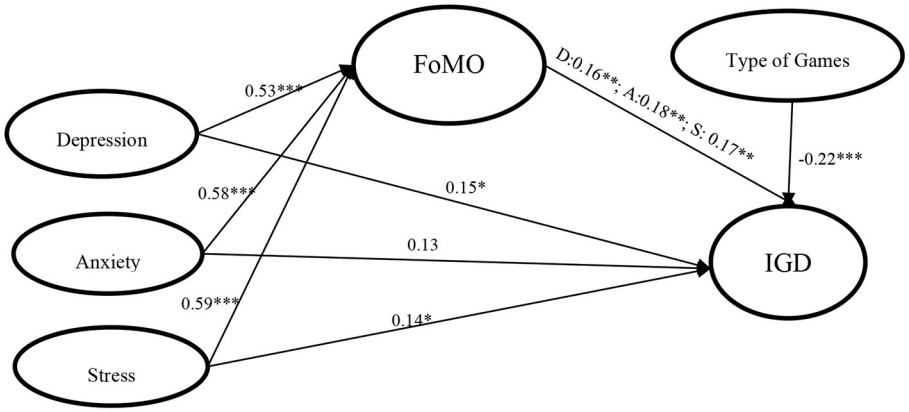

FIGURE 2 | The mediating role of FoMO in the various dimensions of negative emotion and internet gaming disorder. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; FoMO, fear of missing out; IGD, Internet Gaming Disorder.

mechanism of first choice of behaviors to develop specific addictive behaviors.

LIMITATIONS

It cannot be denied that this study has some limitations. Firstly, this study used Chinese students only; it may cause a lower external validity. Future researchers should consider more participants from different culture settings. Secondly, the cross-sectional method cannot reveal the causal relationship among depression, anxiety, stress, FoMO, and Internet gaming disorder. Future researchers may explore it through other methods. Thirdly, the study did not consider the mechanism changes in the brain. Future research can explore the different mechanisms of the brain of FoMO individuals, to validate the interpretation of the I-PACE model in specific types of Internet addiction.

CONCLUSION

In sum, this study found that the FoMO scale has a good validity in the context of China, and depression and stress are significantly related to Internet gaming disorder through the partial mediating factor of FoMO. Anxiety is not significantly related to Internet gaming disorder through the fully mediating factor of FoMO. Specifically, under the mediation of fear of missing out, teenagers with anxiety are more likely to develop Internet gaming disorder, while teenagers with depression or stress might be prone to other types of Internet use disorders.

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 Ethics Committee of Tianjin Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

YW and LZ were responsible for the analysis and interpretation of data, drafted the first version of the manuscript, and critically revised the manuscript. BL collected the data for this study. YW, LZ, and PZ provided critical revisions of the manuscript for important intellectual content and approved the final manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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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.2022.827519/full#supplementary-material

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The Professional Identity and Career Attitude of Chinese Medical Students During the COVID-19 Pandemic: A Cross-Sectional Survey in China

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Background: Although professional identity is a strong predictor of career choice, only a few studies have reported on medical students' career attitude during a public health emergency. This study investigates the changes in medical students' professional identity and career attitude during the COVID-19 pandemic, evaluates their mental health and social support system under stress, and explores the relationship between their career attitude and other factors.

Methods: An online survey of 6,226 Chinese medical students was conducted to collect information on demographics, professional identity, and career attitude. The collected data were assessed using the Patient Health Questionnaire, the Generalized Anxiety Disorder Scale, and the Social Support Rating Scale.

Results: The results revealed that most (80.8%) of the participants did not change their career attitude and the professional identity of most participants strengthened, and they preferred to participate on the frontline during the COVID-19 pandemic. The prevalence of depression and anxiety among medical students was 22.86% and 35.43%. Low social support, depressive symptoms, male gender, and higher grades were factors that negatively affected career attitude.

Conclusions: After the outbreak of the pandemic, it was necessary to conduct diversified professional identity research to support medical students, especially those with low social support and depressive symptoms.

Keywords: professional identity, career attitude, COVID-19 pandemic, China, medical students, health emergency

BACKGROUND

COVID-19 is considered a global pandemic and has been raging since March 11, 2020 (1), seriously threatening the health of people worldwide. In many countries, there was a serious shortage of medical workers because of the increased demand for professionals to help; consequently, retired doctors were recalled, and medical students were sent to help in the fight against the pandemic. In

China, more than 42,600 medical workers went to the most seriously affected areas to help (2). In this sudden public health crisis, doctors renewed their sense of value and honor in the profession. Medical students are a major component of medical reserve forces and must also participate in ensuring the health and safety of the population (3). Therefore, it is important to assess their professional identity and psychological state during the pandemic.

Under stressful situations, individuals have different emotional, cognitive, and behavioral responses. An individual's cognitive evaluation also affects their stress responses (4). The COVID-19 pandemic has had profound mental health consequences for many people (5), especially college students (6). A previous study indicated that medical University students experienced poor mental states during the COVID-19 outbreak (7).

One's professional identity is an individual's professional self-concept based on their beliefs, values, motives, attributes, and experiences (8) and is derived from and perceived in terms of the role that individuals assume in their work. Professional identity is a factor affecting job satisfaction (9). It is an important part of nurturing professionalism among medical students (10, 11) and is related to how strongly individuals identify with their careers. Some scholars also pay attention to the formation and factors that influence medical students' professional identity (12–15). For physicians-in-training, preliminary data suggest that good virtues in medical practice are associated with a strong sense of professional identity (16). Further, career attitude refers to the tendency of medical students to pursue the medical profession in the future; It depends upon different interlinked factors (17) and formed by a matching of perceptions of specialty characteristics with personal needs (18), such as expected salary, intellectual satisfaction, workload, experience during the medical schools, the student values and professional attitude, and so on. Professional identity is an important predictor of continuing to do the job (9). Previous studies have also shown that students' career attitude would be affected by their mental health state (19), depressive symptoms were considered predictors for professional exhaustion which would affected career attitude (20).

Recently, the professional identities of medical students have gradually studied. During the COVID-19 pandemic, some scholars paid attention to the career attitudes (21, 22) and willing to volunteer (23) in medical students; medical students are motivated by a sense of purpose or duty, altruism, perception of good performance and values of professionalism. Previous studies also have focused on the tense physician-patient relationship and violent injuries in China, which may have affected medical students' professional identity (24). To the best of our knowledge, the professional identity and career attitude of medical students in China during the COVID-19 pandemic have yet to be investigated. Therefore, this study has attempted to investigate the changes in medical students' professional identity and career attitude during the COVID-19 pandemic, evaluate their mental health and social support system under stress, and explore the relationship between their career attitude and correlated factors.

METHODS

Participants

We used an online survey to conduct a cross-sectional study on the professional identity and mental health of medical students from February 11 to 19, 2020. All data were collected online via a self-reported questionnaire using the Wenjuanxing platform (https://www.wjx.cn/). Participants were recruited with a snowball sampling method through wechat and social media in the form of Wenjuanxing. Participants were encouraged to forward the link to other relevant respondents. Prior to filling the questionnaire, participants were informed that they had the rights to withdraw their consents at any time, and that all information would be kept anonymous and confidential throughout the study. Inclusion criteria were full-time medical University students, including undergraduate from grade 1 to grade 5, living in mainland China, $\geq$18 years of age. A total of 6,318 participants took part in the survey. After excluding incomplete questionnaires and those that were completed in $<$3 min, 6,226 participants from 31 provinces and autonomous regions were included in the analysis.

Approval for the study was obtained from the Ethics Committee of Beijing HuiLongGuan Hospital. All participants provided informed consent online to participate in the study.

The demographic section was designed by the research team to collect the general characteristics of medical students, including gender, age, grade, hometown, and 2019-nCoV exposure (2019-nCoV exposure means being diagnosed with COVID-19 or having a history of close contact).

Assessment of Professional Identity

The questionnaire was designed to evaluate six factors (professional cognition, professional emotion, professional commitment, professional behavior, professional achievement, and professional value) of professional identity after consulting the relevant literature (25). One item was selected from each of the six dimensions of medical students' professional identity scale (25), and a simple medical students professional identity scale (see **Appendix A**) was developed to evaluate professional identity. The response for each item consists of five choices: from 1 (strongly disagree) to 5 (strongly agree). In this study, Cronbach's α was 0.857 and 0.890 before and after the pandemic, respectively.

Assessment of Career Attitude

Evaluation of career attitude was conducted by assessing medical students' attitude after the pandemic (the following question was asked: "Did your willingness to practice medicine change after the pandemic?" 1. unchanged; 2. enhanced; 3. weakened). Based on the results, we divided medical students into three groups: unchanged, enhanced, and weakened.

Assessment of Reasons of Studying Medicine

We reviewed the literatures (17, 18) and listed the reasons why medical students were willing or unwilling to continue studying medicine, the reasons were allowed multiple option.

Students choose from the seven options below: The reasons for the willingness to be a doctor include: (1) "Being a doctor is my dream." (2) "Doctors are respected." (3) "Doctors are valuable." (4) "Doctors are paid well." (5) "Doctors have rich social connections." (6) "After the outbreak, the state will provide more support to doctors." (7) "Nothing else matters." The reasons for not being willing to be a doctor include: (1) "Being a doctor is stressful." (2) "The workload of doctors is too heavy." (3) "An outbreak of infectious disease increases the risk to doctors and their families." (4) "Doctor-patient relations are strained." (5) "Doctors are poorly paid." (6) "I did not like studying medicine." (7) "I have other career options."

Assessment of Depressive Symptoms

Depressive symptoms were screened using the 9-item Patient Health Questionnaire (PHQ-9) (26). The PHQ-9 has been widely used in China, and the reliability and validity of the Chinese version of the PHQ-9 has been demonstrated (27). The PHQ-9 was scored from 0 to 27; Cronbach's α, in this case, was 0.87. A PHQ-9 score > 5 was considered indicative of depressive symptoms.

Assessment of Anxiety Symptoms

Anxiety symptoms were screened using the 7-item Generalized Anxiety Disorder Scale (GAD-7) (28). The GAD-7 has been widely used in China, and the reliability and validity of the Chinese version of the GAD-7 has been confirmed (29), with scores ranging from 0 to 21. Cronbach's α for this case was 0.92. A GAD-7 score > 5 was considered indicative of anxiety symptoms.

Assessment of Social Support

Social support was assessed using the Social Support Rating Scale (SSRS) (30), which has already been used widely in various studies in different Chinese communities and has been shown to have good validity and reliability (31) a higher score indicating more social support. Final scores were divided into three grades (high, moderate, and low).

Analysis

Data analysis was performed using SPSS statistical software (version 24.0; IBM Corp). The chi-square test was used to compare the changes in the career attitude of medical students in different demographic categories. Scores obtained from the GAD-7, PHQ-9, and SSRS for the three groups of medical students were also compared. The rank sum test was used to analyze differences in the dimensions of professional identity among the three groups of medical students before and after the pandemic outbreak. Multivariate disordered logic regression was used to analyze the factors influencing changes in career attitude. The level of significance was set at 0.05 (two-sided).

RESULTS

A total of 6,226 full-time medical undergraduates aged 18–27 years completed the questionnaires. The median age of the participants was 21 years, of which 60.1% were female. The students came from all provinces of China, except Macau, and 98.6% took the survey at home. A total of 79.0% of the respondents revealed that they would like to participate in the frontline. And 92.0% of them has no 2019-nCoV exposure.

As shown in **Table 1**, the number of participants who did not change their career attitude was 4,989 (80.1%), while enhanced career attitudes accounted for 741 (11.9%) of the respondents. Students whose career attitude was weakened totaled 496 (8.0%). There were statistical differences among students from different academic years ($P < 0.05$) and hometowns ($P < 0.05$).

We then investigated why medical students were willing and unwilling to become doctors. As shown in **Figure 1**, the top three reasons for willingness to become a doctor were: (1) "Doctors are valuable." (2) "Being a doctor is my dream." (3) "Doctors are respected." The top three reasons for not being willing to become a doctor were: (1) "Doctor-patient relations are strained." (2) "The workload of doctors is too heavy." (3) "Being a doctor is stressful." (**Figure 2**).

Table 2 includes the results that were obtained using the non-parametric Wilcoxon signed-rank test. In the enhanced group, there was no significant difference in professional achievement before and after the pandemic ($P = 0.494$); however, the difference was statistically significant for the rest of the groups. In the weakened group, there were significant differences in professional cognition, commitment, achievement, and value.

Scores (cutoff score 5) from GAD-7 and PHQ-9 tests were used to divide respondents into the "anxiety group" and the "depression group," Based on the GAD-7 and PHQ-9, the prevalence of depression and anxiety among medical students was 22.86 and 35.43%, respectively. A chi-square test showed that there were significant differences in anxiety, depression, and social support among the three groups of medical students with different career attitude (summarized in **Table 3**).

We set the dependent variable of weakened, unchanged, and enhanced groups to 0, 1, and 2, respectively, and then performed an ordered multivariate logistic regression analysis. The parallel line hypothesis test showed $P < 0.05$, which indicated that the data could not be analyzed using this method. Therefore, we conducted a disordered multivariate logistic regression analysis. The resultant chi-square value of the model was 139.49 ($P < 0.001$), which indicated its statistical significance. The pseudo-R2 of Nagelkerke was 0.031, which indicated that the model corresponded, to a certain degree, with the dependent variables (**Table 4**).

Compared to subjects in the unchanged group, students in junior academic classes of medical school were more likely to enhance their career attitudes, whereas the attitude of freshmen was 1.374 times higher than that of fifth-year students. Subjects whose family members strongly supported them in their fight against the pandemic were more likely to enhance their career attitude than those who were strongly opposed by their family members. The number of subjects who were strongly supported by their families was 2.755 times higher than those whose family members were strongly opposed (**Table 4**).

Compared to subjects in the unchanged group, males were more likely to weaken their career attitude than females, and medical students with depression were more likely to weaken their attitudes than those with high social support. Students who

TABLE 1 | The changes in career attitude among medical students with different socio-demographic characteristics ($N = 6,226$).

Variables	*n* (%)	Unchanged (*n* = 4,989)	Enhanced (*n* = 741)	Weakened (*n* = 496)	X^2	*P*
Gender					2.78	0.249
Male	2,484 (39.9)	1,969 (79.3)	289 (11.6)	226 (9.1)		
Female	3,742 (60.1)	3,020 (80.7)	452 (12.1)	270 (7.2)		
Hometown					7.299	0.026
Urban resident	2,213 (35.5)	1,763 (79.7)	248 (11.1)	202 (9.1)		
Rural resident	4,013 (64.5)	3,226 (80.4)	493 (12.3)	494 (12.3)		
Grade					19.335	0.013
1st year	1,875 (30.1)	1,494 (79.7)	243 (13.0)	138 (7.3)		
2nd year	819 (13.2)	638 (77.9)	110 (13.4)	71 (8.7)		
3rd year	784 (12.6)	605 (77.2)	104 (13.3)	75 (9.6)		
4th year	1,331 (21.4)	1,083 (81.4)	150 (11.3)	98 (7.4)		
5th year	1,417 (22.7)	1,169 (82.5)	134 (9.5)	114 (8.0)		
2019-nCoV exposure					0.564	0.754
No	5,727 (92.0)	4,594 (80.2)	681 (11.9)	452 (7.9)		
Yes	499 (0.8)	395 (79.2)	60 (12.0)	44 (8.8)		

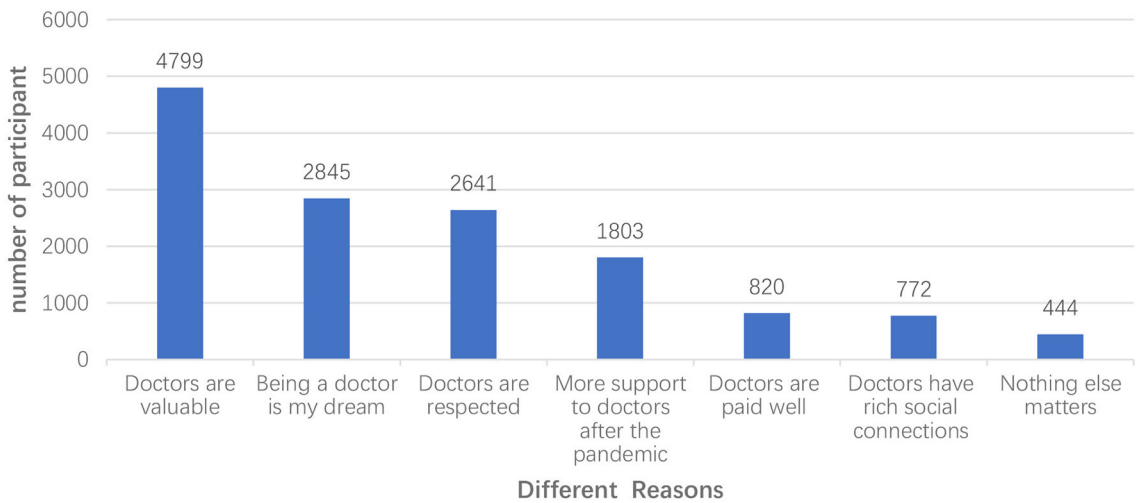

FIGURE 1 | Reasons of willingness to be doctor.

lived in cities were 1.248 times less likely to practice medicine than those living in rural areas. The results are summarized in **Table 5**.

DISCUSSION

The career attitude formed by a matching of perceptions of specialty characteristics with personal needs (18) and the characteristics of students such as age, gender, geography and study year (17). In this study, there were statistical differences among students from different academic years and hometowns. Previous studies have shown that the professional identity of medical students decreases over time (32, 33). At the time of our survey, medical students were staying in their home towns on winter vacation. And medical students from urban resident or rural resident are different, this could be explained by imbalances between economy, culture, and different publicity efforts relating to pandemic prevention knowledge between urban and rural areas (21).

In this study, most (80.8%) of the participants did not change their career attitude, and 741 (11.9%) of the total respondents enhanced their career attitude. This shows that the majority of medical students have a strong desire to become doctors, indicating that they have a strong professional identity. Professional identity is an important factor in the development of medical education and practice, and the transformation of medical students' professional identity is at the core of medical education (11). Those who possess a strong professional identity

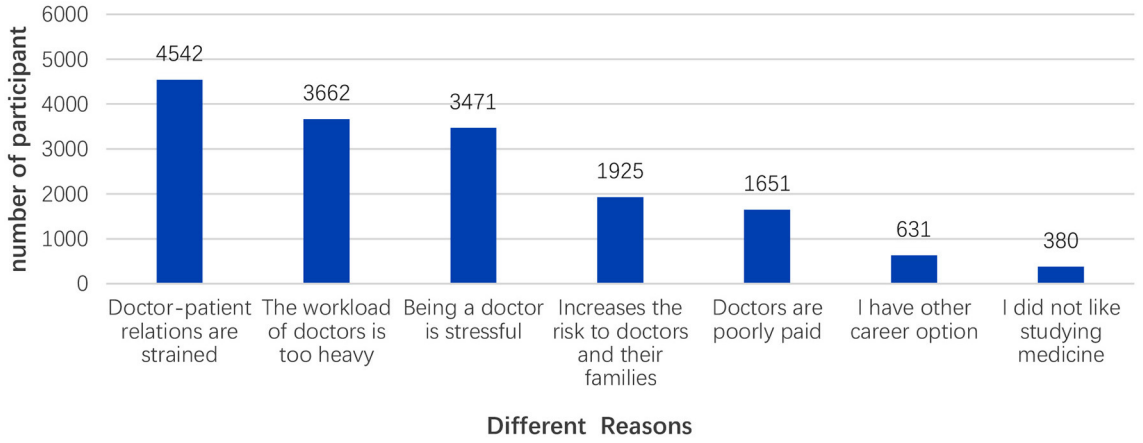

FIGURE 2 | Reasons of unwillingness to be doctor.

TABLE 2 | The professional identity among medical students with different career attitudes before and after the pandemic ($N = 6,226$).

Variables		Career attitude		
		Unchanged	Enhanced	Weakened
Professional cognition	Z	−13.911	−8.026	−2.5
	P	0.000	0.000	0.012
Professional emotion	Z	−6.276	−6.633	−1.333
	P	0.000	0.000	0.182
Professional commitment	Z	−3.260	−7.994	−4.926
	P	0.000	0.000	0.000
Professional behavior	Z	−6.791	−7.852	−1.600
	P	0.000	0.000	0.110
Professional achievement	Z	−13.126	−0.685	−6.367
	P	0.000	0.494	0.000
Professional value	Z	−3.121	−6.598	−5.925
	P	0.002	0.000	0.000

are more likely to be connected to their line of work and find a greater sense of purpose in life through it (34). In addition, medical students' career attitudes are influenced by their cognition about, attitude toward, and evaluation of their future careers. The formation and evolution of a professional identity is a dynamic process. Before and after the pandemic, most dimensions of professional identity of medical students changed. These findings revealed that COVID-19 pandemic could affect the professional identities of medical students. This finding was similar to that of a previous study, which concluded that nursing students' professional identity was enhanced after the outbreak of SARS in Hong Kong, China (35). After the outbreak of COVID-19 pandemic, one study (36) found that about one-fifth of surveyed medical students currently believe that the COVID-19 pandemic will affect their choice of specialty. Another study found that the percentage of middle-school students who wanted to study medicine increased to 55.1%, and 29.8% of middle-school students had changed from unwilling to study medicine to willing to study medicine, which indicated that middle-school students had changed their attitude toward medical work after the outbreak of COVID-19 (37). Another study (23) showed that 48.7% of Indonesian medical students were willing to volunteer, shortage of medical personnel and sense of duty were the main reasons increasing the students' willingness to volunteer. The professionalism of medical staff during the epidemic may also have been an inspiration. Some scholars (38, 39) found that the role of models and mentors had a significant impact on the professional identity of medical students. Passi and Johnson (40) also indicated that positive role modeling by doctors effectively enhanced the transformation of a student into a doctor. In this study, 79.0% of the students were likely to engage in the "battle" against the virus. This could be regarded as their "post-traumatic growth," which suggests that exposure to critical events could lead to opportunities for growth (41). According to the survey in this study, "being a doctor is valuable," "being a doctor is my dream," and "being a doctor is respected" are the most popular reasons medical students choose to become a doctor. The sense of value and achievement of doctors is still the main reason medical students choose to become doctors.

This study also found that medical students with depression were more likely to weaken their attitude toward medicine, which might be due to a sense of uncertainty about themselves. Previous studies (42, 43) have shown that depression is one of the most common health problems among University students, especially among medical students who endured heavy financial burdens and study-induced stress (44). After the outbreak of COVID-19, 37.0% of Chinese University students experienced depressive symptoms and 24.9% experienced anxiety symptoms (37). The mental health of these medical students could be a predisposing factor for burnout during residency or postgraduate training (45). This might also affect their choice of future career.

Similarly, it was found that strong social support enhanced medical students' career attitudes. This study also established that the attitude of medical students' family members toward

TABLE 3 | Depressive symptoms, anxiety symptoms and social support among medical students with different changes in career attitude (N = 6,226).

Variables	*N* (%)	Changes of career attitude			X^2	*P*
		Unchanged	Enhanced	Weakened		
Depressive symptoms				14.747	0.001	
Yes	2,206 (35.4)	1,724 (79.0)	268 (12.1)	214 (9.7)		
No	4,020 (64.6)	3,264 (81.2)	473 (11.8)	282 (7.0)		
Anxiety symptoms				11.088	0.004	
Yes	1,423 (22.9)	1,101 (77.4)	182 (12.8)	140 (9.8)		
No	4,803 (77.1)	3,888 (80.9)	559 (11.6)	356 (7.4)		
SSRS					31.063	0.000
Low	2,151 (34.6)	1,703 (79.2)	227 (10.6)	221 (10.3)		
Medium	2,146 (34.5)	1,731 (80.7)	257 (12.0)	158 (7.4)		
High	1,929 (31.0)	1,555 (80.6)	257 (13.3)	117 (6.1)		

TABLE 4 | Multivariate disordered logic regression of the factors associated with the changes in career attitude (*N* = 6,226).

Career attitude		B	SE	Sig.	Exp (B)	95% Confidence Interval for Exp (B)	
						Lower Bound	Upper Bound
Enhanced	Intercept	−2.579	0.303	0			
	Gender						
	Male	−0.003	0.082	0.971	0.997	0.849	1.17
	Grade						
	1st year	0.318	0.115	0.006	1.374	1.096	1.722
	2nd year	0.372	0.138	0.007	1.451	1.106	1.903
	3rd year	0.371	0.141	0.008	1.450	1.100	1.910
	4th year	0.189	0.127	0.136	1.208	0.943	1.548
	Depressive						
	No	−0.132	0.085	0.120	0.876	0.742	1.035
	SSRS						
	Low	−0.165	0.103	0.109	0.848	0.694	1.037
	Medium	−0.071	0.097	0.460	0.931	0.771	1.125
	Does your family support you to fight the epidemic						
	Strong support	1.014	0.298	0.001	2.755	1.537	4.941
	General support	0.656	0.289	0.023	1.927	1.093	3.399
	Neutrality	0.615	0.284	0.031	1.850	1.059	3.231
	Opposed	0.345	0.307	0.261	1.412	0.774	2.578
	Hometown						
	Urban resident	−0.105	0.084	0.210	0.900	0.763	1.061

Women, 5th year, people with depressive symptoms, high level of SSRS, family strongly opposed you to fight against the epidemic and rural resident were selected as the reference group.

fighting the pandemic also affected students' attitudes toward medical practice. Generally speaking, people with high social support had better resources; they received more support and help coping with their working environment and were more likely to solve problems and difficulties. As a resource available to individuals, social support played an intermediary role in coping with stress, and those with good social support could cope better with it (46). The availability of social support reduced the odds of mental distress for those who experienced it (47). Degree of social support was found to be negatively correlated with anxiety and depression among residents (44). In the current COVID-19 outbreak, high social support can effectively reduce anxiety and improve self-efficacy and sleep quality in COVID-19 patients' caregivers (48). Students who lived alone or had poor relationships with their partners, classmates, or friends scored higher on the depression and anxiety scales. Thus, for medical students under stress due to the public health emergency, good social support was conducive to a positive psychological state and encouraged them to continue to engage in the medical profession.

In addition, freshmen, sophomores, juniors, and senior medical students were more likely to strengthen their career attitudes than fifth-year medical students. Previous studies have shown that the professional identity of medical students decreases over time (32, 33). Iqbal et al. (49) also indicated that higher-grade University students were more depressed and had poorer mental health. The reason might be that the higher-grade students have higher levels of stress (50), and they were affected by a heavy academic load and encountered setbacks in clinical

TABLE 5 | Multivariate disordered logic regression of the factors associated with the changes in career attitude ($N = 6,226$).

Career attitude		B	SE	Sig.	Exp (B)	95% Confidence Interval for Exp (B)	
						Lower Bound	Upper Bound
Weakened	Intercept	−2.070	0.242	0			
	Gender						
	Male	0.225	0.096	0.020	1.252	1.037	1.513
	Grade						
	1st year	−0.002	0.134	0.986	0.998	0.767	1.298
	2nd year	0.167	0.161	0.299	1.182	0.862	1.621
	3rd year	0.269	0.159	0.090	1.309	0.959	1.786
	4th year	−0.101	0.145	0.485	0.904	0.680	1.201
	Depressive						
	No	−0.249	0.099	0.012	0.780	0.642	0.947
	SSRS						
	Low	0.326	0.125	0.009	1.386	1.084	1.771
	Medium	0.103	0.129	0.424	1.108	0.861	1.426
	Does your family support you to fight the epidemic						
	Strong support	−1.116	0.277	0.000	0.328	0.190	0.564
	General support	−0.713	0.221	0.001	0.490	0.318	0.755
	Neutrality	−0.440	0.204	0.031	0.644	0.432	0.960
	Opposed	−0.008	0.220	0.970	0.992	0.644	1.527
	Hometown						
	Urban resident	0.221	0.097	0.023	1.248	1.032	1.510

Women, 5th year, people with depressive symptoms, high level of SSRS, family strongly opposed you to fight against the epidemic and rural resident were selected as the reference group.

internship. On the other hand, the lower-grade medical students had just entered medical colleges and had not yet completely started the study of clinical medicine; thus, they expected much from themselves.

Males were more likely to weaken their attitudes toward medicine. Some previous studies (32, 33, 51) concluded that females reported stronger identification than males. This might be related to the fact that males bore more social responsibilities and economic pressure (52, 53) which bring more pressure or their less seeking help and coping strategies.

The most significant advancement of this study was that it conducted the largest survey of professional identity and career attitude of medical students during the COVID-19 pandemic. Simultaneously, this study discussed the demographic factors of people with different career attitudes in depth and assessed factors related to mental health status. Further research in the field should focus on ways to improve medical students' mental health and enhance their professional identity.

However, this study has several limitations. First, the cases were recruited using snowball sampling. We could not weigh this sample to increase representativeness because statistics on national medical students were not available. Second, medical students reported their professional identity before the outbreak, and the retrospective nature of the study might have caused recall bias. Finally, although the data collection process was anonymous, online surveys could not verify the identity of respondents, and self-reporting might have been accompanied by personal biases.

CONCLUSIONS

The COVID-19 pandemic not only effected a crisis but reconstructed the professional identity of medical students. After such a crisis, some medical students' professional identity was enhanced, and they were proud of the profession they had chosen to pursue. However, as illustrated above, this was not the case for all medical students. We should pay more attention to medical students with depressive symptoms, low social support, and higher grades. The utilization of social support by medical students could be strengthened through group coaching, which is an effective method of support (54).

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 Beijing HuiLongGuan Hospital. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JXC and XJY designed the study, revised the manuscript, and wrote the final version. XJY and LG completed the design of the questionnaire. LBZ and JXC analyzed the data. SYZ, LGZ,

and MQ have contributed to data collection. SJZ participated in the revising of the manuscript. JXC received funding support for the research. All authors contributed to the final draft 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/fpsyt.2022.774467/full#supplementary-material

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Mental Health Profiles in a Sample of Moroccan High School Students: Comparison Before and During the COVID-19 Pandemic

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Background: Adolescent high school students may be particularly susceptible to suffering from the effect of isolation, physical distancing restrictions, and school closures imposed during the COVID-19 (Corona Virus Disease 2019) pandemic. Given the biological and psychological changes that occur during this period of development, adolescents' experiences of these pandemic measures could significantly threaten their mental health and cause long-term consequences.

Aim: The main objectives of the study were to determine the impact of confinement because of the COVID-19 pandemic restrictions on the psychological distress of Moroccan adolescents and identify the risk and protective factors that could influence their mental health.

Methods: The participants in this study were Moroccan high school students who were recruited at two different times—before the COVID-19 pandemic (350 students, mean age: 16.55 years; 53.71% female; data collected in 2014/2015) and after the announcement of the pandemic (457 students, mean age: 16.84; 64.1% female; data collected in 2020). Students responded to an anonymous survey that included several validated instruments, such as the Brief Symptom Inventory and the Godin-Shephard Leisure-Time Physical Activity questionary, and elicited information about the students' psychosocial environment, gender, and age. The scores on the Brief Symptom Inventory dimensions from the pre-pandemic period and during 2020 were compared. A comparison between the scores of the two genders of the 2020 sample was also carried out. In addition, binary regression analysis was performed to predict the associations between gender, frequency of physical activity, the presence of the number of negative psychosocial factors, and those dimensions of the Brief Symptom Inventory that significantly changed between the samples.

Results: Female students reported higher psychological distress than male students in both data collection periods. During the COVID-19 pandemic, students scored significantly ($p < 0.001$) higher in depression and paranoid ideation, and they scored significantly ($p = 0.01$) lower in hostility and anxiety compared with the pre-pandemic period. Female gender and the experience of physical or psychological abuse significantly

increased the risk of reporting higher scores in depression and paranoid ideation symptoms during 2020. Moderate and frequent physical activities were significantly and negatively associated with depression ($p = 0.003$ and $p = 0.004$; respectively).

Conclusions: This study confirms the stressful impact of the COVID-19 pandemic on Moroccan high school students, who reported more symptoms of depression and paranoid ideation compared with the pre-COVID-19 period. Female students reported higher psychological distress than male students did. The experience of physical /psychological abuse during the pandemic worsened mental health, while moderate/frequent physical activity improved it.

Keywords: COVID-19 pandemic, Brief Symptom Inventory (BSI), gender, psychological distress, physical and/or psychological abuse, physical activity

INTRODUCTION

Coronavirus disease of 2019 (COVID-19) has caused a public health emergency that has raised concerns internationally. On March 11, 2020, the World Health Organization (WHO) declared that the spread of COVID-19 had reached the status of a global pandemic (1). To slow the spread of the pandemic, many governments introduced measures that reduce physical contact by enforcing social distancing (2). In this context, on March 24, 2020, the Moroccan government decided to impose a national lockdown to limit the spread of the disease by closing most public establishments, preventing all social and entertainment activities outside the home, and restricting the movement of people by imposing exceptional authorization of one member of each family (3).

The confinement is a difficult psychological and social experience for most people; it requires physical and social distancing, including separation from family and friends, as well as frustration resulting from the commitment to sit at home. The government restrictions could have disastrous consequences for mental health (4, 5). In fact, mental health issues resulting from the COVID-19 outbreak are common in various subpopulations, including confirmed patients (6), frontline professionals healthcare (7), and elderly persons (8). Importantly, social distancing may increase mental health problems in adolescents, who are already more vulnerable to developing mental health problems compared with adults (1, 9, 10) because of adolescents' increased desire for autonomy and connection with peers (11).

The United Nations Sustainable Development Group (UNSDG) shows that the COVID-19 pandemic has created the biggest upheaval in education systems history, affecting nearly 1.6 billion students in more than 190 countries (12). Closings of schools and other educational institutions affected 94% of the world's student population, a proportion that has risen to as high as 99% in low- and middle-income countries (12).

Morocco, among many countries, imposed a complete closure of all schools at all educational levels (13), resulting in a general isolation of students at their homes for a period of around 4 months (from March 2020 to July 2020). As a result, face-to-face studies were replaced by distance learning, leisure activities outside the home stopped, and all organized sports and collective physical activities were prohibited. Indeed, most adolescents adopted sedentary behaviors at home; therefore, a reduction in physical activity was observed (14). Previous research has shown that decreased physical activity is associated with worsened mental health profiles (15, 16), whereas lower levels of depression are associated with more time spent engaged in physical activity, including team sports, gym exercises, and walking outdoors (17–19).

Loades et al. (20) found that social isolation and loneliness affect young people; the impact of the COVID-19 pandemic's restrictions on health is potentially significant and of particular concern regarding the mental health of children and adolescents (21). Unfortunately, social distancing measures can lead to social isolation in an abusive household, and that abuse is especially likely to be exacerbated during this time of financial/social instability, fear of infection, boredom, and frustration (22). Previous research has shown that adolescent abuse may be associated with post-traumatic stress disorder (23) and low self-esteem (24), which are strongly linked to internalized and externalized behaviors and negative effects such as depression, anxiety, hostility, somatization, and psychoticism (25). In addition, parental substance use problems may affect the mental health of children. Recent studies caried out on Moroccan and Swedish adolescents show that adolescents who have at least one parent with substance use problems (drugs and/or alcohol) reported more mental health problems (25, 26).

In addition, adolescence is often seen as a period of challenges that can lead to mental health problems (27, 28), especially that more than 50% of mental disorders in adults occur before the age of 18 (29). For example, in Morocco one in five adolescents

Abbreviations: ANX, anxiety; AUC, area under the curve; BSI, Brief Symptom Inventory; COVID-19, coronavirus disease of 2019; DEP, depression; GSI, General Severity Index; HOS, hostility; INS, interpersonal sensitivity; M, mean; MeSHe, Mental and Somatic Health without borders project; MET, metabolic equivalent; OBS, obsessive-compulsiveness; OR, odds ratio; PAP, adolescents reporting parental alcohol use problems; PAR, paranoid ideation; PDP, adolescents reporting parental drug use problems; PHA, adolescents reporting the experiences of physical abuse; PHOB, phobic anxiety; PSA, adolescents reporting the experience of psychological abuse; PSY, Psychoticism; SCL-90-R, symptom checklist revised; SD, Standard deviation; SOM, somatization; SPSS, Statistical Package for the Social Sciences; UNSDG, United Nations Sustainable Development Group.

suffers from a mental disorder; in half of these cases, the age of onset was 14 years (30, 31). According to the results of two studies carried out in Tunisia and Egypt, 18.7% of Tunisian adolescents aged 15 to 17 suffer from anxiety and 5.2% from depression (32), whereas 25.5% of Egyptian adolescents suffer from anxiety disorders (33). The prevalence of psychological distress among adolescents in sub-Saharan Africa countries is close to that found in North African ones, this prevalence was 23.0% in Tanzania (34), 24.2% among urban out-of-school adolescents in Nigeria (35), 15.7% in Zambia (36). In Tanzania, the prevalence of single psychological distress in adolescents was 20.6% while that of multiple psychological distress was 10.3% (37).

However, to date, very few studies in Morocco and African countries have focused on adolescent mental health during the COVID-19 pandemic. Since the mental health of today's adolescents determines the stability and security of tomorrow's society, it is essential to consider the psychological well-being of children and adolescents during crises. This consideration is particularly vital because young people are more likely to experience the long-term consequences of problems related to their mental health profile (38).

There is a scarcity of studies focused on adolescent mental health during the COVID-19 pandemic in Morocco. Moreover, previous studies (25, 26) conducted as part of the project to which this study belongs "Mental and Somatic Health without borders" (MeSHe) project (39) have shown an association between negative psychosocial factors, such as parental alcohol or drug use problems and experiences of physical or psychological abuse, and adolescent mental health profiles. Therefore, the present study aims to examine how the mental health of Moroccan adolescents has changed during the COVID-19 pandemic, to determine the impact of the negative psychosocial factors mentioned above on mental health profiles, and to determine the effect of physical activity, which is assumed to be a protective factor.

METHOD

Study Population

This study was carried out within the framework of the "Mental and Somatic Health without borders" (MeSHe) project (39). The MeSHe survey, founded by the project leader and co-author (NK), focuses on somatic and mental health profiles coupled with substance use and aggressive antisocial behaviors in adolescents in an international context.

The participants in the present study were Moroccan high school students recruited in two different periods:

- 2014/15, before the COVID-19 pandemic
- 2020, during the COVID-19 pandemic

The 2014/15 Sample

A detailed description of this population can be read in the study by Zouini et al. (25). Briefly, using convenience sampling, 375 high school students (170 boys and 205 girls) were selected from classes of four high schools located in different areas in Tetouan, Morocco, during the academic year of 2014/15 and participated in this study. The high schools had a total of 97 10th, 11th and 12th grade classes. Two classes from each grade and from each school were conveniently selected to participate in the study. In these 24 classes, there were 876 students of which 375 (43%) completed the survey. The age range of the participants was 15–19 [mean (M) = 16.56, standard deviation (SD) = 1.04] years.

The 2020 Sample

From September 2020 to February 2021, 616 students aged 15–19 years completed the MeSHe survey from Morocco. During the pandemic, contact with high school students was made in part via social media (Facebook and Instagram) and via high schools by sharing the online questionnaire link with high school principals who in turn share it with students using the website or official pages of the establishment, and groups of classes created on WhatsApp. A substantial proportion (81.84%) of the data originated from Tetouan city.

In the data files for the two different samples, students not reporting their gender or reporting genders other than male or female, those who had more than 5% missing data concerning the measure of mental health [Brief Symptom Inventory (BSI); see below], and those who gave no answer on negative psychosocial factors or leisure-time physical activity were excluded. The final samples for which data were analyzed comprised 350 students (162 boys, 188 girls) with a mean age of 16.55 (SD = 0.96) from the 2014/15 data file and 457 high school students (164 boys, 293 girls) with a mean age of 16.84 (SD = 1.22) from the 2020 data file.

Measures

The MeSHe project (39) assesses information from high school students by means of a standardized, self-reported anonymous survey (the MeSHe survey). Alongside background information, such as age, gender, and the presence of negative psychosocial factors [parental alcohol use problems (PAP), parental drug use problems (PDP), experiences of physical abuse (PHA), experiences of psychological abuse (PSA)], the MeSHe survey consists of validated questionnaires in which young people rate their mental and physical health; aggressive, antisocial, and self-harm behaviors; and substance use habits, as well as answering questions related to their physical activity and personality. This study focuses on the responses considering students' mental health (captured by the BSI), physical activity (measured by the Godin–Shephard Leisure-Time Physical Activity Questionnaire) and the existence of any negative psychosocial factors reported by the adolescents.

The BSI is a brief form of the Symptom Checklist Revised (SCL-90-R), a self-reporting inventory developed to measure respondents' degree of psychological distress (40). The BSI has been translated into several languages, including Arabic (41). The responding adolescents rated the general influence of each item during the past year on their wellbeing.

The BSI contains 53 items, each of which is rated on a 5-point Likert scale ranging from 0 ("not at all") to 4 ("extremely"). Nine primary symptom dimensions of distress are assessed in the BSI—namely, somatization (SOM), obsessive-compulsiveness (OBS), interpersonal sensitivity (INS), depression (DEP), anxiety (ANX), hostility (HOS), phobic anxiety (PHOB), paranoid

ideation (PAR), and psychoticism (PSY). In addition to the nine symptom dimensions, three global indices of distress—the Global Severity Index (GSI), Positive Symptom Distress Index, and Positive Symptom Total—can be calculated (40). In this study, only the GSI, an indicator of the current overall level of distress, was calculated. Here, the validated Arabic (Syrian) version of the BSI (41) was used, with acceptable (0.67) to good (0.88) internal reliability in all the primary symptom dimensions.

The Godin–Shephard Leisure-Time Physical Activity Questionnaire (42) is a self-rated instrument that measures usual leisure-time physical activity during no specific timeframe. The subject simply estimates a usual 7-day period. We calculated the total leisure-time activity score in metabolic equivalents (METs). The reported weekly frequencies of strenuous, moderate, and mild activities are multiplied by nine (strenuous), five (moderate), or three (mild) to calculate the health contribution score using the following formula: (frequency of strenuous physical activity * 9 METs) + (frequency of moderate physical activity * 5 METs) + (frequency of mild physical activity * 3 METs) (42). The health contribution score is subdivided into three categories as follows: ≥24 units (∼14 kcal/kg/week or more), active (having substantial health benefit); 14–23 units (between 7 and 13.9 kcal/kg/ week), moderately active (some health benefit); and less than 14 units (less than 7 kcal/kg/week or more), insufficiently active (low health benefits) (43). This inventory was validated by Godin and Shephard (42) in an adult population showing significant correlations between points assessed and actual percentage of body fat, and maximal aerobic power, and it has also been validated in the adolescent population (44) and was equally reliable in girls and boys indicating that it may be useful for comparing physical activity levels between groups and examining changes in activity levels of groups over time (44).

Ethical Considerations

The MeSHe survey was designed in accordance with the Helsinki Declaration (45). The use of the survey in Morocco was approved by the Regional Directorate of the Ministry of National Education in Tetouan (with registration number 85) and by the Faculty of Science, University Abdelmalek Essaadi, during the period leading up to the announcement of the COVID-19 pandemic. The directorate is responsible for managing and directing all matters concerning students from primary to high school education in Tetouan province. The survey was voluntary and anonymous, and it required written consent from the respondent. For online data collection after the announcement of the COVID-19 pandemic, online informed consent was obtained from all subjects.

Statistical Analyses

The IBM™ Statistical Package for the Social Sciences (SPSS) version 26 software program was used to analyze the data. The independent *t*-test was used to compare the BSI scores of male and female students and those of the 2014/15 and 2020 samples. The strength of the statistically significant comparison was evaluated using Cohen's d effect size with the following d values: 0.2 represents a "small" effect, 0.5 a "medium" effect, and 0.8 a "large" effect (46).

We replaced the missing values in the BSI items with the means by gender if a respondent had <5% missing data (under three items). Otherwise, the response was eliminated.

The method of classification by clusters was used to transform each of the continuous variables "Paranoid Ideation score" and "Depression score" into two clusters characterized by a good quality of cohesion and separation, with average silhouettes of classification 0.7 and 0.6, respectively:

- PAR score:
  - ➢ Cluster 1 (31.5%): Group 1: low levels of PAR symptoms (group mean =0.69);
  - ➢ Cluster 2 (68.5%): Group 2: high levels of PAR symptoms (group mean =2.32).
- DEP score:
  - ➢ Cluster 1 (48.4%): Group 1: low levels of DEP symptoms (group mean=0.71);
  - ➢ Cluster 2 (51.6%): Group 2: high levels of DEP symptoms (group mean =2.29).

Two nominal variables were then created. In addition, binary regression analysis was used to predict the association between gender, the frequency of physical activity, the presence of any negative psychosocial factors—specifically, PDP, PAP, PHA, PSA—and the fact of scoring highly in DEP and PAR symptoms on the BSI.

The choice of these factors involved in the regression model is based on the results of two previous studies carried out on Moroccan population (25, 47), one of these two studies is realized within the framework of the same project (MeSHe project) from which the 2014/15 sample was taken. This last study showed that negative psychosocial factors impact the mental health profile of adolescents while the other study shows that physical activity has a positive effect on psychological health.

All the analyses were two-tailed, and the significance level was defined as $p < 0.05$.

RESULTS

Mental Health of Moroccan High School Students During the COVID-19 Pandemic

Table 1 summarizes the mean values for each of the nine primary symptom dimensions of the BSI and the GSI in the Moroccan student sample from 2020. Generally, the responding Moroccan female students reported higher psychological distress when compared with male students. The female students scored significantly higher on all primary symptom dimensions except for the "HOS" dimension, where no significant difference could be measured between the genders, the scores of SOM, OBS, PSY, DEP, INS, PAR differed between the two groups with a small effect size, whereas those of PHOB and ANX differed with a moderate effect size. The generally higher psychological distress level in the female students is also reflected in their significantly higher GSI

TABLE 1 | Self-reported psychiatric problems during the COVID-19 pandemic ($N = 457$).

BSI subscales	Moroccan adolescents M (SD)	Male ($n = 164$) M (SD)	Female ($n = 293$) M (SD)	*t*-Test				Cohen's d
				t	*p*	Mean difference	(95%) CI	
SOM	1.26 (0.87)	1.02 (0.76)	1.39 (0.9)	4.55	<0.01	0.36	(0.21; 0.52)	0.42
OBS	1.76 (0.88)	1.56 (0.86)	1.88 (0.87)	3.69	<0.01	0.31	(0.15; 0.48)	0.35
PSY	1.29 (0.94)	1.16 (0.84)	1.37 (0.96)	2.42	0.02	0.22	(0.04; 0.39)	0.23
DEP	1.52 (0.96)	1.37 (0.93)	1.60 (0.97)	2.48	0.01	0.23	(0.05; 0.41)	0.24
INS	1.55 (0.93)	1.36 (0.88)	1.66 (0.95)	3.3	<0.01	0.30	(0.12; 0.47)	0.32
HOS	1.11 (0.89)	1.06 (0.80)	1.15 (0.94)	1.12	0.27	0.09	(−0.07;0.26)	0.10
PHOB	1.23 (0.89)	0.91 (0.74)	1.40 (0.92)	6.28	<0.01	0.5	(0.34; 0.65)	0.56
ANX	1.39 (0.95)	1.06 (0.81)	1.58 (0.98)	6.19	<0.01	0.53	(0.36; 0.69)	0.55
PAR	1.80 (0.96)	1.62 (0.96)	1.90 (0.94)	3.06	<0.01	0.28	(0.10; 0.46)	0.3
GSI	1.43 (0.78)	1.23 (0.71)	1.54 (0.80)	4.32	<0.01	0.31	(0.17; 0.46)	0.4

SOM, somatization; OBS, obsessive-compulsiveness; INS, interpersonal sensitivity; DEP, depression; ANX, anxiety; HOS, hostility; PHOB, phobic anxiety; PAR, paranoid ideation; PSY, psychoticism; GSI, Global Severity Index; CI, confidence interval; COVID-19, coronavirus disease of 2019; SD, standard deviation.

scores, the GSI score differed between male and female students with a small effect size (**Table 1**).

Comparison of Moroccan High School Students' Mental Health Before and Under the COVID-19 Pandemic

Students from the 2020 data collection sample scored significantly higher in the DEP and PAR ($p < 0.001$) primary domains of BSI than those from the 2014/15 data collection sample, and the scores of these two domains differed between the two groups with a small effect size. However, students during the COVID-19 pandemic scored significantly lower in the HOS and ANX ($p = 0.01$) primary dimensions of BSI compared with the report from 2014/15, and the scores for these dimensions differed between the two groups with a negligible effect size (**Table 2**).

Male students from the 2020 data collection sample scored significantly higher in the DEP, PAR, and INS ($p < 0.001$, $p = 0.01$ and $p = 0.03$, respectively) primary domains of BSI than those from the 2014/15 data collection sample, and the scores of these three domains differed between the two groups with a small effect size. However, during the COVID-19 pandemic, male students scored significantly lower in the ANX ($p = 0.03$) primary dimension of BSI than was reported in 2014/15, and the scores in this dimension differed between the two groups, with a small effect size (**Table 3**).

Female students from the 2020 data collection sample scored significantly higher in the DEP and PAR ($p = 0.01$ and $p < 0.001$, respectively) primary domains of BSI than did those in the 2014/15 data collection sample, and the scores of these three domains differed between the two groups with a small effect size. However, female students during the COVID-19 pandemic scored significantly lower in the ANX and HOS ($p < 0.01$ and $p = 0.01$; respectively) primary dimensions of BSI compared with the report from 2014/15, and the scores of these two dimensions differed between the two groups with a small effect size (**Table 4**).

Risk and Protective Factors of the Significantly Increased Psychological Domains

The overall model rates for the two proposed models in binary logistic regression were very good: 66.6 and 71% for DEP and PAR symptoms, respectively. Being female significantly increased ($p = 0.03$) the risk of reporting higher scores in both the DEP and PAR primary symptom domains of BSI to almost twice the level associated with being male (**Tables 5**, **6**). Reporting any negative psychosocial events, especially the experience of physical or psychological abuse, significantly increased a subject's risk [odds ratio (OR) = 2.25, $p = 0.004$ and OR = 3.28, $p < 0.001$, respectively] of belonging to Group 2 of the DEP clusters, which was characterized by higher scores for depression symptoms (**Table 5**). Reporting psychological abuse also significantly increased the risk [odds ratio (OR) = 4.25, $p < 0.001$] of belonging to Group 2 of the PAR clusters, which was characterized by higher scores for symptoms of paranoid ideation (**Table 6**).

The binary logistic regression results show that the frequency of physical activity is significantly ($p = 0.002$) negatively associated with high scores in the DEP primary domain of the BSI (**Table 5**). In fact, we found that moderate or frequent exercise was associated with a much more significant decrease in the risk of belonging to Group 2 of the DEP clusters ($p = 0.003$ and $p = 0.004$, respectively) than was the absence or scarcity of physical activity.

DISCUSSION

Mental Health of Moroccan High School Students During the COVID-19 Pandemic

Our results show that female students reported significantly more symptoms on all the BSI primary domains, except for HOS, compared with male students. This finding is in accordance with the results of other studies carried out before the appearance of the COVID-19 pandemic (25, 26, 48, 49) and even with those

TABLE 2 | Comparison of self-reported psychiatric problems between the 2020 ($N = 457$) and the 2014/15 samples ($N = 350$).

	Before the COVID-19 pandemic	During the COVID-19 pandemic	*t*-Test				Cohen's *d*
			t	*p*	Mean difference	CI (95%)	
SOM	1.26	1.26	−0.05	0.96	0.03	(−0.12; 0.12)	0
OBS	1.72	1.76	0.75	0.46	0.03	(−0.07; 0.17)	0.05
PSY	1.37	1.29	−1.22	0.22	−0.10	(−0.20; 0.05)	−0.09
DEP	1.22	1.52	4.61	<0.01	0.31	(0.17; 0.43)	0.32
INS	1.50	1.55	0.83	0.41	0.04	(−0.08; 0.18)	0.06
HOS	1.28	1.11	−2.74	0.01	−0.18	(−0.28; −0.05)	−0.19
PHOB	1.18	1.23	0.83	0.41	0.06	(−0.07; 0.17)	0.06
ANX	1.55	1.39	−2.51	0.01	−0.18	(−0.29; −0.04)	−0.18
PAR	1.47	1.80	5.31	<0.01	0.32	(0.21; 0.46)	0.36
GSI	1.39	1.43	0.64	0.52	0.05	(−0.07; 0.14)	0.05

SOM, somatization; OBS, obsessive-compulsiveness; INS, interpersonal sensitivity; DEP, depression; ANX, anxiety; HOS, hostility; PHOB, phobic anxiety; PAR, paranoid ideation; PSY, psychoticism; GSI, Global Severity Index; CI, confidence interval; COVID-19, coronavirus disease of 2019; SD, standard deviation.

TABLE 3 | Comparison of male students' mental health before and during the COVID-19 pandemic.

	Before the COVID-19 pandemic	During the COVID-19 pandemic	*t*-Test				Cohen's *d*
			t	*p*	Mean difference	CI (95%)	
SOM	0.99	1.02	0.40	0.69	0.03	(−0.13; 0.20)	0.04
OBS	1.52	1.56	0.49	0.63	0.05	(−0.14; 0.23)	0.05
PSY	1.26	1.16	−1.13	0.26	−0.10	(−0.28; 0.08)	−0.11
DEP	1.05	1.37	3.33	<0.01	0.32	(0.13; 0.51)	0.34
INS	1.16	1.36	2.12	0.03	0.20	(0.01; 0.39)	0.22
HOS	1.17	1.06	−1.32	0.19	−0.11	(−0.28; −0.05)	−0.13
PHOB	0.97	0.91	−0.71	0.48	−0.06	(−0.23; 0.11)	−0.07
ANX	1.24	1.06	−2.15	0.03	−0.18	(−0.35; −0.02)	−0.20
PAR	1.37	1.62	2.57	0.01	0.25	(0.06; 0.45)	0.28
GSI	1.19	1.23	0.41	0.68	0.03	(−0.12; 0.18)	0.04

SOM, somatization; OBS, obsessive-compulsiveness; PSY, psychoticism; DEP, depression; INS, interpersonal sensitivity; HOS, hostility; PHOB, phobic anxiety; ANX, anxiety; PAR, Paranoid ideation; GSI, Global Severity Index; COVID-19, coronavirus disease of 2019; CI, confidence interval.

TABLE 4 | Comparison of female students' mental health before and during the COVID-19 pandemic.

	Before the COVID-19 pandemic	During the COVID-19 pandemic	*t*-Test				Cohen's *d*
			t	*p*	Mean difference	CI (95%)	
SOM	1.49	1.39	−1.30	0.19	−0.11	(−0.27; 0.05)	−0.12
OBS	1.89	1.88	−0.18	0.85	−0.01	(−0.17; 0.14)	−0.02
PSY	1.47	1.37	−1.12	0.26	−0.10	(−0.27; 0.07)	−0.11
DEP	1.36	1.60	2.71	0.01	0.24	(0.07; 0.42)	0.26
INS	1.79	1.66	−1.48	0.14	−0.13	(−0.30; −0.04)	−0.14
HOS	1.37	1.15	−2.74	0.01	−0.22	(−0.39; −0.06)	−0.26
PHOB	1.35	1.40	0.61	0.54	0.05	(−0.11; 0.21)	0.06
ANX	1.82	1.58	−2.84	<0.01	−0.24	(−0.41; −0.07)	−0.26
PAR	1.56	1.90	4.27	<0.01	0.35	(0.19; 0.51)	0.38
GSI	1.56	1.54	−0.36	0.71	−0.02	(−0.15; 0.11)	−0.03

SOM, somatization; OBS, obsessive-compulsiveness; PSY, psychoticism; DEP, depression; INS, interpersonal sensitivity; HOS, hostility; PHOB, phobic anxiety; ANX, anxiety; PAR, paranoid ideation; GSI, Global Severity Index; COVID-19, coronavirus disease of 2019; CI, confidence interval.

TABLE 5 | Association among gender, negative psychosocial factors, the frequency of physical activity, and reported higher levels of DEP symptoms assessed by logistic regression [fit measures for the model: overall model test rate (66.6%) and pseudo r-squared (0.22)].

Logistic regression						AUC
	B	*p*	OR	95% CI for OR		
				Lower	Upper	
Gender: girls	0.51	0.03	1.66	1.04	2.65	0.46
Comparison group: boys						
PAP: yes	0.20	0.71	1.22	0.43	3.51	0.51
Comparison group: no						
PDP: yes	0.17	0.68	1.18	0.54	2.58	0.52
Comparison group: no						
PHA: yes	0.81	<0.01	2.25	1.29	3.91	0.61
Comparison group: no						
PSA: yes	1.19	<0.01	3.28	2.00	5.37	0.65
Comparison group: no						
Frequency of physical activity		<0.01				0.38
Comparison group: Never/rarely						
Sometimes	−0.69	<0.01	0.50	0.31	0.80	
Often	−0.90	<0.01	0.40	0.22	0.75	

PAP, adolescents reporting parental alcohol use problems; PDP, adolescents reporting parental drug use problems; PHA, adolescents reporting experiences of physical abuse; PSA, adolescents reporting experience of psychological abuse; CI, confidence interval; OR, odds ratio; AUC, area under the curve; P, probability level; B, the unstandardized regression weight.

TABLE 6 | Association among gender, negative psychosocial factors, the frequency of physical activity, and reported higher levels of PAR symptoms assessed by logistic regression [fit measures for the model: overall model test rate (71%) and pseudo r-squared (0.18)].

Logistic regression						AUC
	B	*p*	OR	95% CI for OR		
				Lower	Upper	
Gender: girls	0.52	0.03	1.69	1.04	2.74	0.45
Comparison group: boys						
PAP: yes	1.32	0.10	3.73	0.77	18.07	0.52
Comparison group: no						
PDP: yes	0.53	0.28	1.69	0.66	4.34	0.54
Comparison group: no						
PHA: yes	0.49	0.13	1.63	0.86	3.09	0.59
Comparison group: no						
PSA: yes	1.45	<0.01	4.25	2.31	7.82	0.65
Comparison group: no						
Frequency of physical activity		0.29				0.42
Comparison group: Never/rarely						
Sometimes	−0.27	0.30	0.77	0.46	1.26	
Often	−0.49	0.13	0.61	0.33	1.15	

PAP, adolescents reporting parental alcohol use problems; PDP, adolescents reporting parental drug use problems; PHA, adolescents reporting experiences of physical abuse; PSA, adolescents reporting experiences of psychological abuse; CI, confidence interval; OR, odds ratio; AUC, area under the curve; P, probability level; B, the unstandardized regression weight.

performed during the COVID-19 pandemic (50–53), which all confirm that mental health problems have a feminine trend associated with the fact that girls more often experienced negative aspects of social interactions, performance and responsibility (54), higher level to react to stressful life events (24), low self-esteem rate (55) in comparison to boys, in addition to hormonal, biological and developmental differences between the two genders (56–59).

The increased distress level in female high school students generally could be associated with differences between girls and boys from a hormonal perspective; Albert (56) found that hormonal changes in girls, especially during puberty, can be a trigger for depression, and thus, mental health problems. In addition to hormonal differences, biological and developmental differences may also be implicated. During adolescence, the amygdala and hippocampal volume changes differ according to gender; the amygdala volume increases significantly only in boys, whereas the hippocampal volume increases significantly only in girls (57). These cerebral areas have also been associated with such disorders as depression and anxiety; therefore, the differences found at the developmental scale may be associated with the distinct gender differences in mental health profile (58, 59).

Girls and boys do not react to stressful life events in the same way. Girls experience higher levels of episodic stress and are more responsive to these stressors, which increases their likelihood of having a high level of psychological distress compared with boys (54, 60–63). Previous studies have shown that girls exposed to a stressful event, such as stress-related school, an experience of physical or psychological abuse, parental substance use problems, parental depression, family dysfunction, and negative parenting behaviors, report more psychological distress compared with boys exposed to the same conditions (25, 26, 60, 61, 64).

Comparison of the Mental Health Profile of Moroccan Adolescents Before and During the COVID-19 Pandemic

During social distancing, students' daily life was disrupted, and the students were isolated from their friends and routine; moreover, they were concerned about changes in local pandemic status, which could be associated with negative psychological effects, including increased stress, hostility, and anxiety (4, 65–67), especially since the crucial resources to cope with this stressful situation, such as the availability of social support, were largely absent or impaired. However, comparing the 2014/15 and the 2020 samples, we found a significant decrease in ANX in the 2020 male sample and ANX and HOS in the 2020 female sample. This result may be associated with the use of coping strategies on the part of the students in our 2020 sample to fight against their new stressors related to the COVID-19 pandemic. It is known that people use various coping methods in crisis or disaster situations (68). Kar et al. (69) suggest that "hoping for the best" is the most common way to cope, followed by "keeping busy." Dealing with the problems faced, could also involve

religious faith, trying to share feelings and to communicate with others (69).

The first indications suggest that the pandemic has changed the way media are used (70). The increase in media consumption, or consumption of specific types of content, can be seen as a positive coping strategy to decrease hostility and to cope with the stress and anxiety experienced during the initial period of social distancing (71–75). Students' use of a coping strategy, such as accessing media, can play an important role in problem-oriented or emotional adaptation, such that students can use the media as a way to keep in touch with friends and family; a source of social support (76); a tool for entertainment, monitoring the local situation, or gathering information on other pandemics; or even a way to distance themselves from the current situation, providing humor and insight. These last forms are particularly interesting because they can be considered a positive aspect of coping that helps students to believe that they have more control over the situation; as a result, they may develop fewer hostile reactions to the stressful situation (74). In addition, these last positive aspects are also positively linked to psychological wellbeing by the absence of negative affect as an indicator of subjective wellbeing, the absence of psychological symptoms as an indicator of mental health, and fulfillment as an indicator of psychological functioning in different areas of life (70).

The decrease in anxiety could also be related to the period of distribution of the questionnaires, which coincided with the passage from full to partial confinement (September 2020 to February 2021); therefore, a reduction of social distancing measures and a transition to a new study program (50% face to face and 50% distance learning) occurred during this period. This return of students to a normal life, even partially, could decrease their anxiety levels (76).

Our results show that Moroccan high school students (males and females) reported more symptoms coupled to depression and paranoid ideation during the COVID-19 pandemic compared with the before-COVID-19 period. This increase in depression symptoms reported by students from the 2020 sample could be associated with a higher likelihood of perceiving deteriorations induced by the COVID-19 pandemic in different areas of daily life, including conflict with family members; loneliness; and worry about their studies, relationships with peers, and health (20, 77–81). Indeed, Magson et al. (77) found that increased conflict with fathers was associated with more depressive symptoms; this conflict may reflect a developmental gap in the inherent desire of adolescents to connect with their peers and seek greater autonomy from their parents (82). In addition to family conflicts, increased depression symptoms may also be linked to loneliness. In fact, Loades et al. (20) found a clear association between loneliness and mental health problems in children and adolescents—specifically, depression problems; especially, the duration of loneliness appears to be a predictor of future mental health problems up to 9 years later.

Moroccan high school students belonging to the 2020 sample reported a high level of paranoid ideation symptoms compared with students from the 2014/15 sample. This increase in the inability to trust most people, feeling that others are not giving the respondent credit for their accomplishments, feeling that others will take advantage of the respondent if given the opportunity, and feeling that others are watching or talking about the respondent, in addition to the perception that others are responsible for most of the problems the respondent experiences, could be associated with physical and verbal victimization, low self-esteem and self-efficacy, interpersonal concerns, social withdrawal personality traits, and parent–child conflict (83–85). Moreover, stress is associated with self-esteem in multiple ways. Stressful events affect self-esteem, and self-esteem affects how people respond to and cope with stress (86). Stressful life events reinforce avoidant and ambivalent behaviors, as well as insecurity. As a result, the adolescents exposed to stressors, such as those related to the COVID-19 pandemic, may have low self-esteem (63, 87) and start to exhibit symptoms of paranoid ideation (88–90). Thus, the deterioration of family or parent–child relationships during the period of COVID-19 may also be related to the increase of paranoid ideation symptoms (91, 92), especially as the COVID-19 situation is considered a stressful situation for parents, who have been obliged to support their children while working from home, while at the same time, social support for parents has been lacking because of social isolation; all these factors could be responsible for an increase in parent–child conflict (10, 93–95), and consequently, enhance the chance to develop psychiatric disorders among the children (96, 97).

Our results show a significant increase in interpersonal sensitivity symptoms in males during COVID-19 compared to male adolescents from the 2014/15 sample. Given the conservative nature of Moroccan society, Moroccan males have more freedom to leave their homes than do females; consequently, males may exhibit higher interpersonal sensitivity. In fact, a study carried out by Sfendla and Hadrya (47) on a sample of the Moroccan population showed that people allowed to leave their homes are at greater risk of contracting the virus; this group exhibited high interpersonal sensitivity, which may be due to the uncertainties associated with the pandemic. In addition, quarantine conditions during the COVID-19 period cultivated a new belief in people concerning their vulnerability to harm and the fact that proximity to others is a direct threat (98); thus, some students have reported feeling that people were hostile and did not like them (99), which will gradually replace their old worldview of interpersonal relationships (100).

Risk and Protective Factors During the COVID-19 Pandemic

Female gender is a predictor factor of depression and paranoid ideation problems. Being a girl tripled the risk of reporting increased levels of depression and paranoid ideation during the COVID-19 pandemic in Morocco. Similar results have been found by previous studies carried out before the announcement of the COVID-19 pandemic in Moroccan, Swedish, and Israeli adolescent samples (25, 26, 101); these results reinforce the conclusion that Moroccan adolescents already reported the worst mental health profile before the COVID-19 pandemic, represented by their higher depression and paranoid ideation scores compared with adolescents from other countries and

confirm the feminine trait of mental health problems, as discussed above.

According to the regression model results, reporting psychological abuse during the pandemic, significantly increased the risk of reporting high levels of paranoid ideation and depression symptoms (by factors of four and three, respectively), and reporting physical abuse during the pandemic also doubled the risk of reporting high levels of depression symptoms. Physical or psychological abuse is also associated with a high level of psychological distress, as found by previous research carried out among Moroccan and Swedish high school students (30, 40). Similar to our findings, Moroccan and Swedish studies found that the high school students who reported an experience of physical or psychological abuse scored significantly higher for depression and paranoid ideation symptoms, as well as other symptoms of psychological distress, such as phobic anxiety, somatization, obsessive-compulsiveness, anxiety, psychoticism, and interpersonal sensitivity.

The experience of abuse can cause a cascade of negative consequences across multiple functional domains for children and adolescents (102–104). The experience of abuse has been linked to increased psychological distress (26, 40, 104–106) and to long-term mental health consequences, such as low self-esteem, substance abuse (107), post-traumatic stress disorder (108), suicidal behaviors and depression (24, 25, 42, 109, 110), obsessive-compulsiveness, attention deficit hyperactivity and oppositional defiant problems (111), personality disorders (112), emotional unresponsiveness, and neuroticism (113).

No association was found between parental substance use problems and depression/paranoid ideation symptoms during the COVID-19 pandemic among Moroccan adolescents; in contrast, a recent study showed that Swedish adolescents who reported parental substance use problems scored significantly higher in the PSY, PAR, DEP, and ANX dimensions of the BSI (26). In addition to the Islamic religion, which prohibits the consumption of drugs and alcohol, this non-association between parental substance use problems and the mental health problems diagnosed during the COVID-19 pandemic in the Moroccan adolescent sample can be related to the traffic restrictions required during the COVID-19 pandemic period, which contributed to reducing access to these substances, and therefore, the decrease in their consumption by parents. Consequently, there was reduced reporting of parental substance use problems from children.

A significant association between physical activity frequency and depression symptoms was found. Moderate or frequent physical activity for high school students in the 2020 sample significantly decreased their risk of reporting higher levels of depression symptoms. This result is consistent with recent publications that have studied the association of physical activity and depressive symptoms on adolescents (114–116).

During confinement, physical activity can be done at home using a variety of exercises that are safe, simple, and easy to perform. Such forms of exercise can include, but are not limited to, strengthening exercises, balance and control activities, stretching exercises, or a combination of them. Examples of home exercise include walking around the house, lifting and carrying groceries, alternating leg lunges, climbing stairs, and doing traditional strength exercises (117). In addition, adolescents may be more motivated to exercise by making exercise a family activity, using virtual classes or online videos, and creating fitness challenges. Such methods could help maintain physical function and prevent the occurrence of several mental health disorders during this critical period (117).

Recent studies have found a positive effect of physical activity on adolescent mental health, mainly on depressive symptoms, and these positive effects are linked to biological and psychosocial pathways (118, 119). The biological mechanism suggests that physical activity has a variety of interrelated changes that take place in the brain to produce a protective environment against depression; therefore, physical activity improves mental health through changes in the structural and functional levels of the brain (120, 121). Improved mental health through moderate or frequent physical activity can also be linked to the secretion of serotonin (122, 123) and endorphin (124), in relation to their antidepressant and analgesic effects, respectively. physical activity also has an impact on the regulation of cortisol (125), which reduces physiological responsiveness to stress.

Strengths and Limitations

There are several limitations to our study that should be mentioned. Non-probability sampling, the time lag between the two samples collected before COVID-19 (2014/15) and during COVID-19 (2020), and the absence of criteria other than age for the inclusion of students during the COVID-19 period (unlike the pre-COVID period, during which high school location, high school class, and specialty programs were also considered) were limiting points in the present study. In addition, the MeSHe project has a cross-sectional conception; therefore, no conclusion about causal associations can be drawn from the data collected. In the present study, data collection was mostly limited to high schools in the city of Tetouan and its surrounding regions in northern Morocco; the results should only be generalized with caution. Although the data were collected through online self-report questionnaires, the use of self-reporting has well-known limitations—namely, self-report questionnaires depend on the respondents' ability and willingness to remember and respond honestly; thus, responses can be skewed through social desirability and recall biases (126). However, despite the constraint of availability and access to the internet for some adolescents belonging to the lower socioeconomic class, online questionnaires were the only method to assess the mental health profile of adolescents during COVID-19 isolation. Regarding the gender distribution of our study population, it should be noted that there were more female students than male ones responding to the survey in the two periods of data collection (2014/15 and 2020) this can be explained by the fact that generally girls are more likely to participate than boys in surveys (127–129). It is important to note that the survey uses previously validated instruments for data evaluation, which is one of the strengths of our study.

CONCLUSION

The results of the present study reinforce previous findings on the stressful impact of the COVID-19 pandemic on Moroccan high school students. Moroccan high school students reported more symptoms of depression and paranoid ideation during the COVID-19 pandemic than they did during the pre-COVID-19 period. Female gender and negative psychosocial factors, such as the experience of physical or psychological abuse, have a significant negative impact on depression and paranoid ideation problems. The study also presents new evidence on the protective effect of moderate/frequent physical activity on disorders involving depressive and paranoid ideation symptom. Our findings have implications for several areas of intervention. First, the creation of specific centers on listening and educational guidance that work in cooperation with a specialized staff, such as psychological counselors, should be encouraged at the level of high schools to guarantee the assessment of students' mental health problems and to allow communication with their parents in a timely manner to set up an adequate effective intervention. In addition, in cooperation with teachers and psychological counselors, health authorities should identify groups at risk for early psychological intervention. Adolescent girls should also receive more attention, as they are the most affected by the repercussions of the COVID-19 pandemic. Finally, we highlight the necessity of promoting physical activity as an important preventive strategy for maintaining adolescent mental health.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Regional Directorate of the Ministry of National Education in Tetouan (Registration Number 85). Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AM: data collection, data analysis, drafting, and revision of the manuscript. BZ: contribution to statistical analyses, responsibility for the content of the results, and critical revision of the drafted manuscript. NK: design and direction of the Mental and Somatic Health without borders (MeSHe) project, supervision of data collection, data interpretation, and critical revision of the manuscript. MS: supervision of data collection, critically important intellectual feedback on the interpretation of the results, revision of the manuscript, and monitoring of manuscript progress and revisions. All authors read and approved the final manuscript.

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CASE REPORT
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Case Report: COVID-19 Pandemic Exacerbates Eating Disorder by Social and Intrafamilial Isolation

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The coronavirus disease-2019 (COVID-19) pandemic has increased the stress levels of children and their parents and diagnoses of eating disorders (EDs), irritable bowel syndrome, migraines, tension headaches, orthostatic dysregulation, and/or school refusal has increased among children. We present a case of a nine-year old girl, which rapidly worsened due to stress and isolation related to the COVID-19 pandemic. The patient's father noted her rapid weight loss due to poor oral intake. While she had already stopped gaining weight before the pandemic, her weight rapidly decreased to 22 kg during the pandemic. We diagnosed her with an ED and administrated nasogastric tube feeding. We postulated that not only social isolation, but also the disruption in her relationship with her parents, due to the pandemic, contributed to her ED. During a family meeting, she revealed that she felt more anxious during the pandemic. After the meeting, her parents rescheduled their jobs so that the family can have dinner together every night. The patient started eating sufficiently and weighed 31.8 kg at the one-year follow-up. The proportion of children with ED increased during the pandemic; their symptoms worsened because they felt lonely due to social and intrafamilial isolation. While parents have themselves experienced more stress during the pandemic, children, including those with ED, have experienced increased stress related directly to the pandemic, as well as indirectly from their parents. Pediatricians should consider the impact of stress on children, especially from social and intrafamilial isolation, both during and after the pandemic.

Keywords: COVID-19, feeding and eating disorders, intrafamilial isolation, stress, weight loss

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INTRODUCTION

During the coronavirus disease-2019 (COVID-19) pandemic, children and their parents experienced high levels of psychological stress, even if they were not infected with the coronavirus (1, 2). The proportion of children with eating disorders (ED) increased during the pandemic due to social isolation and closure of schools, resulting in disruption of protective factors, such as extra-curricular activities, school routine, and peer relationships (3). In Japan, even during the pandemic, there are families in which both parents must work daily; therefore, in many cases, the children stay at home alone when schools are closed. This causes a disruption of familial relationships, leading to increased ED in children. We present a patient with an ED that was rapidly exacerbated due to stress and environmental change during the pandemic; the patient experienced marked improvement in both intrafamilial relationship and symptoms after a family meeting.

CASE PRESENTATION

A 9-year-old girl was brought to the hospital by her father because of poor oral intake and rapid weight loss within a few months along with significant irritability during the day. Her family included her parents, a 6-year-old sister, and a 2-year-old brother. She had no history of disease which affected her feeding. There was no other identifiable cause of weight loss, such as unavailability of food at home or lack of interest in eating. She was neither involved in excessive exercise nor exposed to social media. She attended after-school English and piano classes, and also attended the Kumon Math Program classes 4 days a week. She weighed 22 kg, with a body mass index of 12.0 kg/m^2. She presented with bradycardia (heart rate: 40 beats per minute) and hypotension (82/56 mm Hg). Her skin was dry, and the capillary refill time was 3 secs, indicating dehydration. Blood tests revealed low levels of blood sugar (49 mg/dL), pre-albumin (10.1 mg/dL), transferrin (148 mg/dL), alkaline phosphatase (215 U/L), insulin-like growth factor-1 (17 ng/dL), and free triiodothyronine (1.3 pg/mL), which resulted from chronic poor oral intake. The patient was admitted to manage her health problems and to improve her eating habits.

We plotted her growth curve and found that she had stopped gaining weight 15 months earlier. Furthermore, when schools were closed due to the COVID-19 pandemic, she lost approximately 6 kg of weight rapidly in the next 3 months (**Figure 1**). The child scored 16 (below cut-off of 18) on the Eating Attitudes Test 26, although questions on social pressure to eat were highly scored. She exhibited no preoccupation for thinness or excessive physical activity. Thus, she was diagnosed with avoidant/restrictive food intake disorder, according to the criteria of Diagnostic and Statistical Manual of Mental Disorders.

After admission, intravenous hydration (30 ml/day of Solita-T3®, Otsuka, Japan) for 2 weeks and oral nutritional supplements (250 ml/day of Meibalance®, Meiji, Japan, or 500 ml/day of Ensure®, Abbott, Japan) for 1 week, both of which were not enough for her to gain her weight, were administered. However, her weight decreased to 21 kg because she was not eating. Nasogastric tube feeding was required temporarily. A family meeting was organized to help her express her feelings, needs, and wants. During the meeting, she shared that she felt anxious whenever her mother left the house for work, and that her anxiety increased during the pandemic. However, she tried to be patient and was not willing to tell her parents about it for a long time. After the meeting, she felt better, and her parents rescheduled their working hours to improve her health. The patient started eating sufficiently and her weight increased gradually. She was discharged after 2 months of admission. We carefully followed up by checking her body weight and assessing her relationship with her parents. She weighed 31.8 kg at the one-year follow-up visit. The patient and her parents provided informed assent, and this case report was approved by the appropriate ethics review board.

DISCUSSION

Our patient had an ED for over 1 year before the pandemic. Her growth stopped when her mother resumed work after her younger brother turned one, and she started after-school activities, such as English classes, piano lessons, and the Kumon Math Program classes. She probably endured the shallow relationship with her parents and maintained her self-esteem by studying hard. However, when the government declared a state of emergency in Japan, she could not continue with school and after-school activities. Following this, her ED rapidly exacerbated. She had to stay at home and take care of her 6-year-old sister when her parents left for work daily. In addition, her parents complained about each other and argued in front of her. Her parents had to work hard and stay out of home every day during the pandemic, and they could not take off time to take care of her when she was lacking appetite and showing other signs of her disorder. Furthermore, her schoolteachers did not notice her weight loss when school reopened because her home teacher was changed at the beginning of the school year. Her ED rapidly worsened due to stress caused by the social and intrafamilial isolation as well as the many complaints and arguments between her parents. Therefore, we can say that multiple factors are involved in the exacerbation of ED in children during the pandemic.

One of the causes of ED in children is increased stress in children and their parents. According to a study, parents' stress increased from even before the pandemic to May 2020 (at the peak of mandatory staying at home) and remained elevated above pre-COVID-19 values in September 2020 (children's return to school) (1). Parents suffered from a shortage of relaxation time, difficulty in child rearing, increased partner aggression, and an increased sense of unfairness during the pandemic (2). These two studies have no data on ED in children; however, the authors suggest that children (including those with EDs) experienced stress directly due to the COVID-19 pandemic and indirectly due to their parents. In this case, the children, including our patient, were left alone at home as the parents had to go to work every day and needed to be careful to prevent coronavirus infection at their workplaces. The mother also complained about unfair division of labor to the father during the pandemic. All these factors increased the stress of the children and the parents which led to the worsening of symptoms of ED in the patient. Furthermore, the number of patients with EDs that were under 16 years of age, who required admission due to worsening symptoms, increased during the pandemic (3). We noticed that the number of new outpatient cases (under 16 years of age) who presented to our department with ED, irritable bowel syndrome, migraines, tension headaches, orthostatic dysregulation, and/or school refusal, which could be caused by stress, increased in 2020; conversely, the total number of new outpatient cases of different diseases, particularly infectious diseases (which accounted for most outpatient cases before the pandemic), markedly decreased in the same age group (**Figure 2**). This marked decrease in the number of new

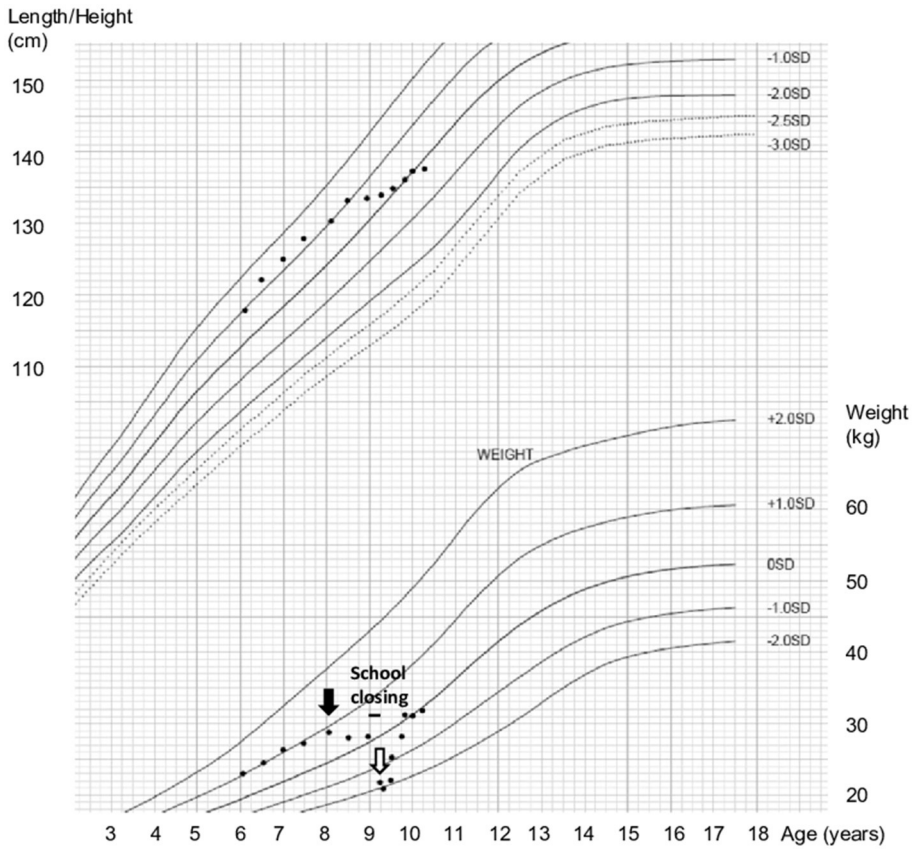

FIGURE 1 | Growth stopped before the COVID-2019 pandemic and weight loss began during the pandemic. Growth stopped a year and 3 months before admission (black arrow). School had been closed for over 3 months (black bar). She was admitted due to rapid weight loss (white arrow).

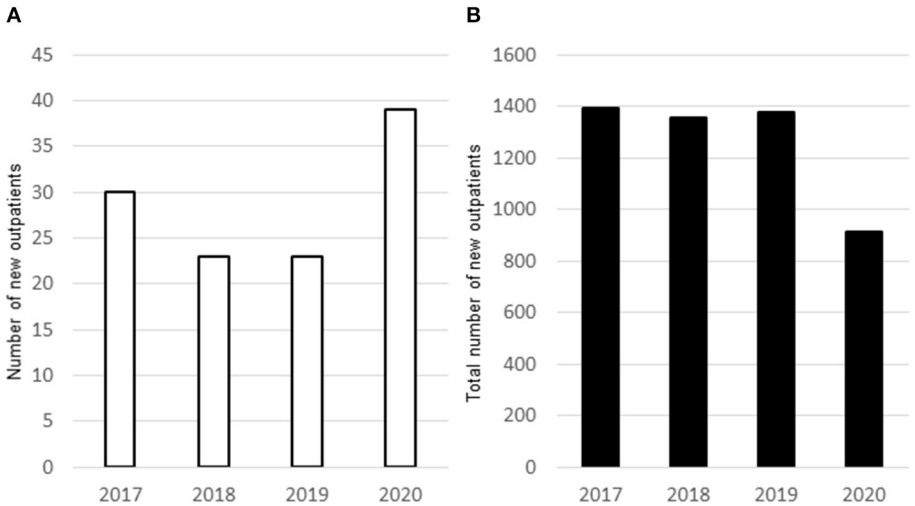

FIGURE 2 | In 2020 with the COVID-2019 pandemic, there was an increase in newly diagnosed outpatients (age >16 years) with eating disorders, irritable bowel syndrome, migraine, tension headache, orthostatic dysregulation, and/or school refusal, **(A)**. The number of new outpatients (age >16 years) decreased in at Saiseikai Kyoto Hospital **(B)**.

infectious disease cases could be explained by improvement in hygiene methods and practices during and after the COVID-19 pandemic.

In this case, the family meeting helped to improve the patient's symptoms. She obviously did not spend enough time with her parents during the pandemic; therefore, we can say that intrafamilial isolation had a greater effect on her ED than social isolation. We suggested that her parents should reschedule their work and have dinners together every day. This is a simple but particularly important strategy for patients with ED, especially cases with intrafamilial isolation. Family meal session has been recently used as a strategy for ED (4). Having dinner with family is a natural thing, but pediatricians are frequently consulted by patients with ED, who feel lonely because they do not have dinner with their parents. Therefore, physicians should ascertain whether patients with ED have enough time with their family during the pandemic.

If the parents can reschedule their work, family meetings may be particularly effective for children who do not spend much time with their parents, and therefore feel lonely. Flexible working results in improved employee mental health (5). Parents with mental health problems may indirectly affect ED symptoms in pediatric patients (6). In our case, we asked the patient's mother's employer to reduce her work hours to make time for family dinners. The workload reduction probably improved the mother's mental health and resulted in successful family meetings.

There are some limitations to the findings of this report. The family meeting may not have been the only cause for the patient's recovery. We regularly checked the relationship between her and her family after the meeting, but the feeding and weight gain may have resulted from self-recovery or our sustained attention over time.

The World Health Organization and the Japanese government have suggested that people should adjust to the "new normal" even after the pandemic (7, 8); therefore, children and adults may remain under stress for the next few years. Therefore, pediatricians should be aware that children may be experiencing great stress, especially from social and intrafamilial isolation, during and after the pandemic.

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 Saiseikai Kyoto Hospital. 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

YK was the patient's main healthcare provider, drafted the initial manuscript, reviewed, and revised the manuscript. KK and SG assisted with clinical treatment and reviewed and revised the manuscript. All authors have read and approved the final manuscript.

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The Moderating Role of Lifestyle on Insomnia in Home Quarantine College Students During the COVID-19 Epidemic

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There has been sufficient evidence for the relationship between lifestyle and insomnia in the general population, but for individuals who already suffer from insomnia, it is not clear whether a healthy lifestyle can also pose similar benefits. The present study investigated the roles of different aspects of lifestyle in the development of individual insomnia by tracking insomnia symptoms of college students during the COVID-19 lock-down. Two surveys were conducted on 65,200 college students in the process of home isolation in Guangdong Province of China, at the pandemic outbreak period (T1) and the initial remission period (T2), respectively. Given the objectives of the present study, a total of 1,702 college students with clinical insomnia from T1 were selected as subjects. Insomnia symptoms were assessed using the Youth Self Rating Insomnia Scale (YSIS), while demographic information, epidemic exposure, and lifestyle were all measured by self-developed questionnaire, through network survey. The 1,702 college students (mean age ± standard deviation, 20.06 ± 1.46, range 16–25; 71.9% females) with insomnia symptoms were divided into three trajectory groups: recovery group, remission group, and chronic insomnia group according to their insomnia scores in T2 phase. The results showed that there was no significant difference in demographic backgrounds or epidemic exposure among the three groups, however, there were significant differences in food intake, exercise, and Internet use. The regression results further showed that both the recovery group and the remission group adopted more regular food intake than the chronic group. The recovery group exhibited better daily exercise habits than both the remission group and the chronic group. The duration of Internet use was significantly shorter for the recovery group than for the chronic group. These findings indicate a strong relationship between the lifestyle and the recovery of insomnia for college students isolated at home during the epidemic period. Significance of the different aspects of lifestyle on the recovery of insomnia are discussed.

Keywords: insomnia, lifestyle, college student, the COVID-19 epidemic, food intake

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INTRODUCTION

Previous studies indicated that college students were prone to sleep disruption (1–5). A meta-analysis among college students reported the pooled mean prevalence of insomnia of 18.5% (9.4–38.2%) (6), which was higher than that in general population in Italy (7.4%) (7), as well as that among the general population in China (9.2%) (8). A recent study on Norwegian college students found a substantial increase in sleep problems from 2010 (22.6%) to 2018 (30.5%) (5). Given the already high prevalence, such upward trend is a concern needing to be addressed.

Insomnia exerts non-negligible adverse effects on individual's daily life. It is reported that insomnia not only impairs physical and mental functions and reduces work productivity, but could also cause mental problems, such as anxiety and depression, and even suicide (9–15). The primary aim of the present study was therefore to find the factors associated with the recovery from insomnia in college students.

Lifestyle has received increasing attention in medicine in recent years (16). Lifestyle changes can be beneficial for preventing, treating, and even reversing the progression of chronic diseases by addressing their underlying causes (17). Emerging evidence have revealed relationships between different aspects of lifestyle and insomnia, such as food intake (18, 19), exercise (20–22), and Internet use (23, 24).

The relationship between food intake and sleep has been an important research question. First of all, from the perspective of nutritional intake, dietary tryptophan can directly affect sleep quality (25). More importantly, there is emerging evidence that the food intake regularity with regards to amount is correlated with sleep disturbance. For example, overeating, especially binge eating disorder, is associated with insomnia symptoms. Individuals with binge eating disorder reported more severe insomnia symptoms than individuals without a history of binge eating disorder (19, 26). It is also demonstrated in a four-year follow-up study that excess food intake induced poor sleep quality (27). On the other hand, there are also findings which support the hypothesis that the food intake regularity with regards to time is correlated with sleep disturbance. In a cross-sectional study, the timing of meals during COVID-19 home isolation was associated with sleep disturbances (28). Adults with insomnia had more nighttime eating habits than those without insomnia (29). An individual's nighttime eating habits may lead to delays in their biorhythms, which in turn may delay sleep phases (30). On the basis of the existing studies, the current study focused on whether the regularity of food intake could help regulate sleep patterns in individuals with insomnia.

Exercise is often thought to promote sleep and reduce insomnia symptoms and is recommended as a non-pharmacological treatment in insomnia treatment guidelines (20, 31). However, empirical findings have not always been consistent. In terms of intervention for insomnia and related symptoms, most RCT studies have shown that specific form and patterns of exercise, especially aerobic exercise and exercising at regular intervals, can promote better sleep quality and thus alleviate symptoms of insomnia (32–35). These studies are usually designed with a blank control group (i.e., no training task was employed for the control group), achieving moderate or higher effect sizes. However, when individuals who completed health education was employed for the control group, no gain of exercise was found, or only very limited positive effect (36). Thus, the relationship between exercise and insomnia symptoms will be further explored in the current study in a longitudinal investigation.

China is reported to have the largest number of Internet users in the world, with an estimation of 883 million Internet users in 2019, which is estimated to surge to 1.14 billion by 2025 (37). Having become an important part of daily life, Internet use is bound to have an important and long-term impact on users' mindsets and behaviors. Cross-sectional investigation on the use of Internet and related electronic products found that excessive or even addictive Internet use were associated with mental and psychological problems, including sleep problems such as insomnia (38, 39). A few longitudinal studies have examined the causal relationship between the two. An 8-month follow-up survey of Chinese vocational school students reported that excessive Internet use was a contributor to insomnia (40). At present, most studies focus on sleep problems and insomnia from the perspective of Internet addiction and problematic Internet use. The relationship between non-excessive Internet use and insomnia remains unclear. In the case of home quarantine during the outbreak of COVID-19, the Internet was predominantly the only way for individuals to connect with the outside world, which may have a different meaning for an individual's sleep than what it used to have.

Present Study

The outbreak of COVID-19 is a serious public health crisis with extensive psychological and behavioral consequences. During the SARS outbreak in 2003, the proportion of people who reported insomnia increased significantly (41, 42). In the wake of the COVID-19 outbreak, studies have reported rates of insomnia ranging from 7.3 to 37.6% (43–47), greater than the pre-pandemic worldwide insomnia prevalence, estimated before the pandemic between 3.9 and 22% (48). An Italian study that compared insomnia symptoms among 240 college students with both gender and age controlled, before and after the pandemic, found that college students experienced more severe insomnia symptoms during the quarantine period than before the pandemic (49). In China, in order to combat the pandemic more effectively, home quarantine was implemented, which reduced the influence from the outside world. It was demonstrated that irregular lifestyle in food intake, exercise, and Internet use in home quarantine individuals during the epidemic placed great pressure on physical and mental health (50–54). Studies have found significant changes in eating habits during the pandemic, and some individuals may increase their food intake to alleviate negative emotions (50). Similarly, physical exercise habits are difficult to maintain during home isolation (51). Maintaining good exercise habits improves mental health (52), and more exercise reduces the incidence of insomnia (53). A study finds that students showed more changes in their routine behaviors than non-students after the outbreak, and insomnia scores increased more than that of non-students (54); Many

studies have reported increased time spent using Internet and related electronic devices under isolation and outdoor activity restrictions (55, 56), and a strong relationship was found between bedtime use of electronic devices and sleep problems (57, 58). On other hand, the maintenance of a healthy life style was shown to reduce the adversity of physical problems and maintaining physical and mental health (59, 60). Taken together, behavior management with an aim to maintain the stability of different aspects of lifestyle might be of great clinical values.

The present study thus aimed to explore the factors that are protective against insomnia from the perspective of lifestyle. We hypothesized that a healthy lifestyle would be beneficial for overcoming insomnia among college students who were isolated at home. Most of the existing studies use cross-sectional design, which limited their capacity to explore the temporal role of lifestyle in the prognosis of insomnia. Therefore, the current study was designed to examine the relationship between lifestyle and insomnia from the perspective of the dynamic evolution of sleep problems.

MATERIALS AND METHODS

Samples and Design

This study was part of a school-based cohort study. The baseline and follow-up of this study were conducted from February 3 to February 10, 2020 (shortly after the pandemic outbreak, T1), and from March 24th to April 3rd, 2020 (before the pandemic over when the epidemic began to remiss, T2), respectively. A total of 65,200 undergraduate students under home quarantine in Guangdong Province, China, completed both self-report surveys. Details of sample characteristics in both surveys were described elsewhere (61, 62).

A general questionnaire was designed to collect information on socio-demographics, exposure with COVID-19 epidemic, psychosocial factors and lifestyle. Surveys were conducted through the network platform ("http://www.togx.cn/step_50.html"). The investigation was approved by the Human Research Ethics Committees of South China Normal University (Ethics_No._SCNU-PSY-2020-01-001). All participants were given electronic informed consent before starting the online survey. Participations in this study were entirely voluntary and were informed that they could quit the experiment at any time.

Measures

Socio-demographic variables including gender, age, numbers of children in family, living in a rural area or urban area, were collected by dichotomous or ordinal questions at baseline (T1).

Three items were developed to assess individual exposure to COVID-19 (1) infected cases with COVID-19 in the community or village (0 = No, 1 = Yes); (2) relatives or acquaintances being contracted with COVID-19 (1 = Nobody, 2 = Do not know, 3 = Confirmed or Suspected); (3) Pandemic severity in the living province (1 = Mild, 2 = Moderate/ Severe). The severity of the province in the epidemic exposure was derived from the T1 measurement. A combination of two measurements (T1 and T2) was used to assess the extent of community outbreaks and relatives or acquaintances infections.

Lifestyle was measured from three aspects: food intake, daily exercise, and Internet use in T2. The survey question about food intake regularity was: *"In the past two weeks, have you been eating three meals a day regularly on aspects of time and amount?"* The subjects were asked to respond on a four-point scale (0 = Never, 1 = Seldom, 2 = Sometimes, 3 = Always). Daily exercise question was: *"In the past two weeks, how much time did you spend on average exercising every day?"* Answers were also recorded on a four-point scale (0 = Never, 1 = <30 min, 2 = Between 30 and 60 min, 3 = More than 60 min). The question about Internet use was: *"In the past two weeks, how much time did you use the Internet every day?"* Answers were recorded on a three-point scale (0 = ≤2 h, 1 = Between 3 and 5 h, 2 = More than 5 h).

Insomnia was evaluated using the Youth Self Rating Insomnia Scale (YSIS), which is a self-rating insomnia scale for Chinese adolescents (63), with an internal consistency reliability coefficient of 0.80, and a retest reliability coefficient of 2 weeks of 0.82. In the present sample, Cronbach's α for the total score were 0.89 and 0.90, respectively, at two time points. The YSIS has 8 items and evaluates 3 aspects: (1) Insomnia symptoms; (2) Self-awareness of sleep quality; (3) The effect of insomnia on daily function. Answers were scored on a 5-point Likert scale, with a total score of 40. Higher scores implied more severe insomnia. The cutoffs of the insomnia score were as follows: Normal, <22; Mild insomnia, 22–25; Moderate insomnia/probable clinical insomnia, 26-29; Severe insomnia/clinical insomnia, ≥30. Moderate insomnia and severe insomnia were pooled together, and categorized as clinic insomnia.

Statistical Analysis

All analyses were conducted with SPSS 22.0 for Windows in this study (IBM SPSS Statistics). Socio-demographic variables were first calculated descriptively. 1,702 subjects who reached probable clinical level of insomnia level at T1 were divided into recovery group (<22), remission group (22–25) and chronic group (≥26), according to the trajectory of insomnia severity as measured by YSIS between T1 and T2. Chi-square tests were performed for between-group differences in categorical variables such as demography, pandemic exposure, and living habits, and T-test or ANOVA for continuous variables. Moreover, multiple logistic regression was conducted to examine the predictive factors associated with insomnia trajectory membership. Age, insomnia score at T1 was treated as continuous, while other predictors were treated as categorical. Outcomes of two-sided tests with P-value < 0.05 were regarded as being statistically significant.

RESULTS

Demographic Characteristics, the COVID-19 Exposure, and Psychosocial Measurements by Insomnia Status

In the outbreak period, the incidence of insomnia symptoms in college students isolated at home was 8.6%, and the incidence of clinical insomnia reached 2.6%. There were significant

TABLE 1 | Demographics and the COVID-19 exposure of the total sample.

Variable	No insomnia (*n* = 59584)	Mild insomnia (*n* = 3914)	Clinic insomnia (*n* = 1702)	F/χ^2	*P*
Gender					
Male	18,936 (31.8%)	1,118 (28.6%)	479 (28.1%)	27.15	0.000
Female	40,648 (68.2%)	2,796 (71.4%)	1,223 (71.9%)		
Age (*M, sd*)	20.09 (1.49)	20.11 (1.49)	20.06 (1.46)	0.64	0.527
No. of children in the family					
1	11,954 (20.1)	841 (21.5%)	405 (23.8%)	17.68	0.000
≥2	47,630 (79.9)	3,073 (78.5%)	1,297 (76.2%)		
Location					
Rural	24,468 (41.1%)	1,325 (33.9%)	521 (30.6%)	152.09	0.000
Urban	35,116 (58.9%)	2,589 (66.1%)	1,181 (69.4%)		
Severity in the living province					
Mild	5,108 (8.6%)	288 (7.4%)	135 (7.9%)	7.95	0.019
Moderate/ Severe	54,476 (91.4%)	3,626 (92.6%)	1,567 (92.1%)		
Infection in community or village					
No	53,852 (90.4%)	3,378 (86.3%)	1,403 (82.4%)	153.65	0.000
Yes	5,732 (9.6%)	536 (13.7%)	299 (17.6%)		
Infection in relative or acquaintances					
No	33,194 (55.7%)	1,689 (43.2%)	687 (40.4%)	390.96	0.000
Do not know	25,046 (42.0%)	2,095 (53.5%)	933 (54.8%)		
Confirmed or suspected	1,344 (2.3%)	130 (3.3%)	82 (4.8%)		

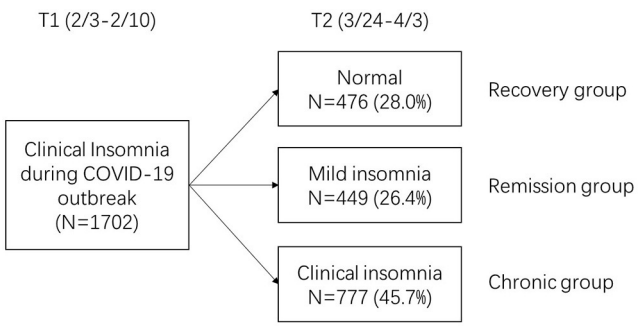

FIGURE 1 | Trajectories of insomnia symptoms between two time points after the COVID-19 epidemic.

differences among the three groups in epidemic exposure and demographic characteristics except for age (see **Table 1**).

The Trend of Insomnia and the Difference of Lifestyle in Each Group

For 1,702 college students who fell into the insomnia group on the first test, there was a significant difference in their insomnia scores between T1 and T2 [29.02 ± 3.028 vs. 24.76 ± 6.486, t (1,701) = −27.299; P <0.001; Cohen's d = 0.84], that is, the insomnia symptom of college students remitted significantly as a whole in the remission period than that in the outbreak period of COVID-19.

According to the classification of insomnia trajectories, by the time of the follow-up, 28% of the students recovered to normal sleep state (without insomnia), constituting of the recovery group; 26.4% of the students showed initial reduction in symptoms, with scores of T2 measures indicating mild insomnia (remission group). 45.7% of college students continued to show moderate to severe insomnia, namely chronic group (see **Figure 1**).

As seen in **Table 2**, Chi-square analysis results showed that there was no significant difference in demographic backgrounds among recovery group, remission group and chronic group, including gender, one-child status and family residence. In the investigation of pandemic exposure, there was no significant difference among the three groups in terms of the severity of the pandemic in the province where they lived, the infection situation in the community or village where they lived, and the infection situation of the close friends and relatives.

The result of ANOVA showed that there were significant differences in insomnia scores between the three groups at T1 [$F_{(2,1,699)}$ = 39.01; P <0.0001; η_p^2 = 0.044]. Tukey *post-hoc* test indicated that the effect was mainly driven by the difference between the chronic group and recovery group (P <0.0001), also by the difference between the chronic group and remission group (P <0.0001) (see **Figure 2**). There were also significant differences among the three groups in food intake, exercise and Internet use.

Significant between-group differences were found for participants with different insomnia trajectories on the three aspect of lifestyles (see **Figure 3**). In terms of food intake regularity, distribution patterns of eating regularity measures across the three groups of subjects were different. More specifically, the food intake distribution (from *"Never"* to

TABLE 2 | Demographics, the COVID-19 exposure, lifestyle, and insomnia in recovery group, remission group and chronic group.

Variable	Recovery (*n* = 476)	Remission (*n* = 449)	Chronic (*n* = 777)	F/χ^2	*P*
Gender					
Female	339 (71.2%)	330 (73.5%)	554 (71.3%)	0.819	0.664
Male	137 (28.8%)	119 (26.5%)	223 (28.7%)		
Age (*M, sd*)	20.07 (1.401)	20.15 (1.479)	20.01 (1.49)	1.392	0.249
No. of children in the family					
1	105 (22.1%)	105 (23.4%)	195 (25.1%)	1.564	0.458
≥2	371 (77.9%)	344 (76.6%)	582 (74.9%)		
Location					
Rural	146 (30.7%)	142 (31.6%)	233 (30.0%)	0.360	0.835
Urban	544 (69.3%)	307 (68.4%)	544 (70.0%)		
Severity in the living province					
Mild	41 (8.6%)	37 (8.2%)	57 (7.3%)	0.740	0.691
Moderate/ Severe	435 (91.45)	412 (91.8%)	720 (92.7%)		
Infection in community or village					
No	398 (83.6%)	378 (84.2%)	627 (80.7%)	3.028	0.220
Yes	78 (16.4%)	71 (15.8%)	150 (19.3%)		
Infection in relative or acquaintances					
No	213 (44.7%)	183 (40.8%)	291 (37.5%)	8.751	0.068
Do not know	236 (49.6%)	247 (55.0%)	450 (57.9%)		
Confirmed or suspected	27 (5.7%)	19 (4.2%)	36 (4.6%)		
Eating regularly					
Never	16 (3.4%)	19 (4.2%)	83 (10.7%)	131.661	0.000
seldom	39 (8.2%)	41 (9.1%)	160 (20.6%)		
Sometimes	117 (24.6%)	151 (33.6%)	254 (32.7%)		
Always	304 (63.9%)	238 (53.0%)	280 (36.0%)		
Exercise					
Never	64 (13.4%)	81 (18.0%)	180 (23.2%)	39.169	0.000
<30 min	254 (53.4%)	249 (55.5%)	439 (56.5%)		
30–60 min	113 (23.7%)	96 (21.4%)	126 (16.2%)		
>60 min	45 (9.5%)	23 (5.1%)	32 (4.1%)		
Internet use					
≤2 h	30 (6.3%)	19 (4.2%)	29 (3.7%)	30.366	0.000
3–5 h	95 (20.0%)	87 (19.4%)	86 (11.1%)		
>5 h	351 (73.7%)	343 (76.4%)	662 (85.2%)		
YSIS (T1)	28.30 (2.61)	28.61 (2.80)	29.70 (3,24)	39.01	0.000

Note: Severity in the living province, measured at T1; Infection in community or village, NO = answer "NO" both at T1 and T2, YES = answer "YES" at least once at T1 and T2; Infection in relative of acquaintances, NO = answer "NO" both at T1 and T2, Do not know = answer "Do not know" both at T1 and T2, Confirmed or suspected = answer "Confirmed or suspected" at least once at T1 and T2; YSIS (T1) = insomnia score at T1.

"*Always*") of the recovery group was most inclined to be regular, the remission group was second, and the chronic group was the worst. For daily exercise, more than half of the subjects in all three groups chose *"Less than 30 minutes"*. In terms of the differences between the groups, a higher percentage of people in the recovery group exercised for more than 30 min, and fewer did not exercise, while the chronic group showed the opposite pattern. In terms of Internet use time, the majority of subjects in all three groups chose *"More than 5 hours"*, more than 70%. Specifically, the proportion of people in the recovery group was the lowest, and the proportion of people in the chronic group was the largest.

Logistic Regression of the Influence of Lifestyle on the Trajectory of Insomnia

Multivariate regression analysis was conducted to investigate the relationship between the changes in insomnia symptoms of the three groups of subjects, and food intake, exercise habits, and Internet use, controlling for the effects of epidemic exposure, demographic variables, and baseline insomnia level (see **Table 3**). Taking the recovery group as reference, multivariate logistic regression analyses were conducted. College students who chose *"Do not know"* as an answer to the infection in relative or acquaintances (OR for *"Do not know"* vs. *"Nobody"* being 1.33, 95% CI 1.03–1.71, $P = 0.03$), showed more severe symptoms

of insomnia at T1 (OR 1.17, 95% CI 1.12–1.22, $P < 0.001$) and more Internet use (at T2) (OR for > 5 h vs. ≤ 2 h = 2.05, 95% CI 1.16–3.61, $P = 0.01$), with higher likelihood of developing chronic insomnia. In addition, individuals who reported less regular eating habits (OR for Sometimes vs. Never = 0.55, 95% CI 0.30–1.00, $P = 0.05$; OR for Always vs. Never = 0.25, 95% CI 0.14–0.45, $P < 0.001$) and had less time for exercise (OR for 30–60 min vs. Never = 0.65, 95% CI 0.43–0.98, $P = 0.04$; OR for > 60 min vs. Never = 0.35, 95% CI 0.20–0.62, $P < 0.001$) had a higher risk of chronic insomnia (see **Table 3**). Taking the recovery group as reference, college students in remission group reported less time for exercises (OR for > 60 min vs. Never = 0.43, 95% CI 0.23–0.79, $P < 0.01$). Taking the chronic group as reference, individuals with lower insomnia scores at T1 (OR 0.89, 95% CI 0.86–0.93, $P < 0.001$) and kept more regular eating habits (OR for Sometimes vs. Never = 2.28, 95% CI 1.30–3.99, $P < 0.0001$; OR for Always vs. Never = 3.09, 95% CI 1.78–5.36, $P < 0.001$) had a higher likelihood of insomnia remission.

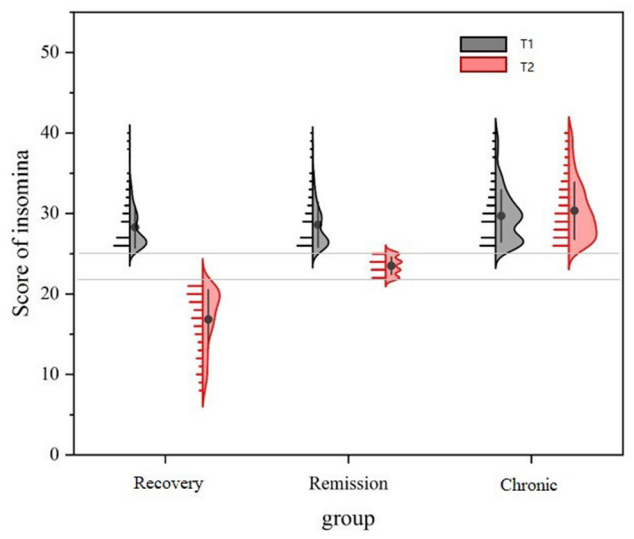

FIGURE 2 | Scores of insomnia symptoms in recovery group, remission group and chronic group at T1 and T2.

DISCUSSION

In the total sample of the present study, 1,702 students reached the level of clinical insomnia (2.6%). Two months after the outbreak of the pandemic, it was found that the statuses of college students who had clinical insomnia varied: some fully recovered and no longer had insomnia (recovery group, 28%), some showed reduction in symptoms back to mild insomnia (remission group, 26.4%), and nearly a half continued to suffer from probable clinical insomnia (chronic group, 45.7%). Significant between-group differences were found on three aspects of lifestyle: food intake, Internet use, and daily exercise. Further regression analysis showed that lifestyle was a predictor of insomnia change, when the effects of epidemic and other demographic variables were controlled for.

First of all, we found that regular food intake was an important factor that buffers the development of insomnia symptoms, i.e., the remission and recovery groups maintained higher food intake regularity than those with chronic insomnia. The two basic activities of food intake and sleep are rhythmical (18, 64). Regular food intake in terms of time and amount may help better stabilize daily biological rhythms, and develop good sleep hygiene habits to improve the symptoms of insomnia. Existing studies have also found that regular food intake helps avoid circadian clock disorders and reduce metabolic disorders (65). The current study provided evidence for that the regularity of food intake and sleep, which are two basic activities, may have a certain coupling effect. The level of lifestyle regularity was closely associated with the recovery process of insomnia, that is,

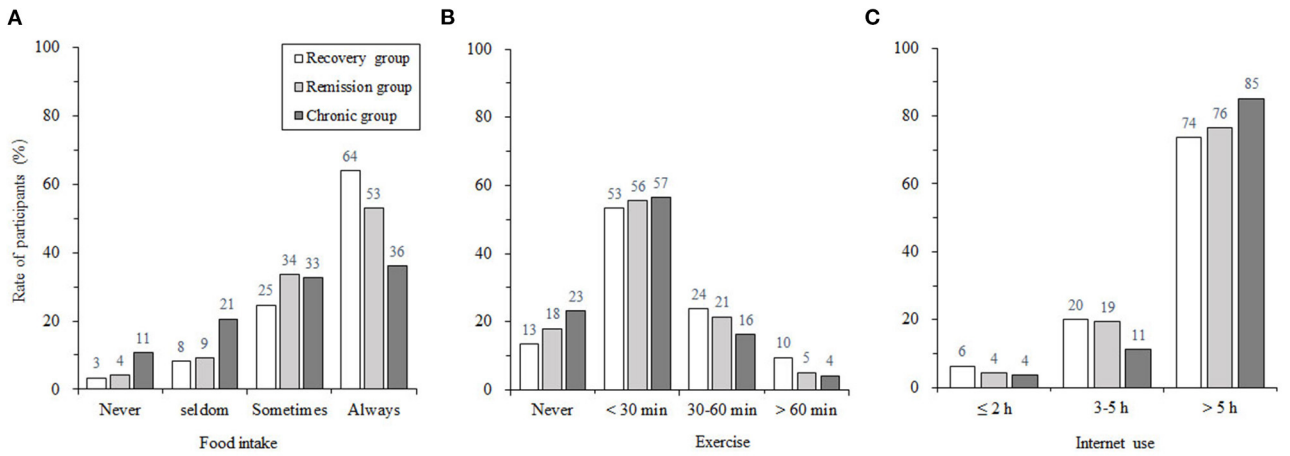

FIGURE 3 | The proportion of participants in the aspect of food intake regularity **(A)**, exercise duration **(B)**, and the Internet use duration **(C)** for recovery group, remission group, and chronic group.

TABLE 3 | Multivariate logistic regression of predictors on insomnia trajectories.

Variable	Remis vs. recovery	chronic vs. recovery	Remis vs. chronic
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender			
Male	1	1	
Female	1.11 (0.82–1.49)	0.97 (0.74–1.28)	1.14 (0.87–1.50)
Age	1.04 (0.95–1.14)	0.98 (0.90–1.06)	1.07 (0.98–1.16)
No. of children in the family			
1	1	1	
≥2	0.90 (0.65–1.25)	0.77 (0.57–1.05)	1.17 (0.86–1.16)
Location			
Rural	1	1	
Urban	1.00 (0.74–1.35)	1.03 (0.78–1.36)	0.97 (0.74–1.28)
Severity in the living province			
Mild	1	1	
Moderate/ Severe	1.00 (0.74–1.35)	1.230 (0.77–1.95)	0.81 (0.51–1.29)
Infection in community or village			
Yes	1	1	
No	1.12 (0.77–1.61)	1.02 (0.73–1.42)	1.09 (0.79–1.52)
Infection in relative or acquaintances			
No	1	1	
Do not know	1.20 (0.91–1.57)	**1.33 (1.03–1.71)** *	0.90 (0.70–1.16)
Confirmed or suspected	0.81 (0.43–1.53)	0.76 (0.42–1.35)	1.07 (0.58–1.98)
Eating regularly			
Never	1	1	
Seldom	1.00 (0.44–2.25)	1.03 (0.53–2.00)	0.97 (0.52–1.18)
Sometimes	1.25 (0.60–2.58)	**0.55 (0.30–1.00)**†	**2.28 (1.30–3.99)** **
Always	0.76 (0.38–1.55)	**0.25 (0.14–0.45)** ***	**3.09 (1.78–5.36)** ***
Exercise			
Never	1	1	
<30 min	0.79 (0.54–1.15)	0.76 (0.54–1.08)	1.04 (0.75–1.43)
30–60 min	0.74 (0.47–1.15)	**0.65 (0.43–0.98)** *	1.13 (0.76–1.69)
>60 min	**0.43 (0.23–0.79)** **	**0.35 (0.20–0.62)** ***	1.23 (0.66–2.30)
Internet use			
≤2 h	1	1	
3–5 h	1.49 (0.78–2.87)	1.11 (0.59–2.09)	1.34 (0.68–2.65)
>5 h	1.54 (0.84–2.81)	**2.05 (1.16–3.61)** *	0.75 (0.41–1.40)
YSIS (T1)	1.04 (0.99–1.10)	**1.17 (1.12–1.22)** ***	**0.89 (0.86–0.93)** ***

*Note: OR, odds ratio, CI, confidence interval, Data are given as odds ratio (95% confidence interval). Bolded values indicate the significant predictors. Remis = Remission. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $0.05 < p < 0.1$.*

individuals with more regular lifestyle exhibited greater degree of recovery from insomnia.

In addition, we found that a lack of daily exercise was a risk factor for individuals to develop chronic insomnia or not be able to recover fully, compared with those in the recovery group. According to the WHO, 2.5 h of exercise per week (0.5 h a day multiplied by 5 days) is enough to provide a significant health boost (66). Results of randomized controlled trials (RCT) using exercise up to this dose (2.5 h in total per week) also suggested that regular exercise can help reduce the insomnia symptoms (32–35). This may be because regular exercise can help individuals break the vicious cycle of insomnia (20). The result of the present study further suggested that a longer period of exercise seems to have more benefits, especially more than 60 min of daily exercise, may promote reduction in insomnia, with the hope to recover to normal sleep level. This was similar to the findings of a longitudinal study of college students, which also suggested that 60 min or more of moderate physical activity could help maintain physical and mental health during the pandemic (51). In the case of home isolation during the pandemic, the amount of physical and mental activity, such as daily life, work, and study, is greatly reduced. Thus, students may need even more exercise to maintain the balance between energy intake and expenditure.

The current study found that prolonged Internet use was quite prevalent among Chinese college students from Guangdong province during the COVID-19 epidemic. More than 79.7% of students with insomnia symptoms use the Internet for more than 5 h per day, in another words, prolonged Internet use has been linked to insomnia, which is consistent with a number of studies on Internet overuse, and the overuse or poor use of related electronic products (67–70). The present study also found that more than 5 h of Internet use is a risk factor for chronic insomnia, it has to do with a longitudinal design for mobile excessive use of relation with insomnia results consistent, namely insomnia may be the result of excessive use of network rather than a cause (40). Similarly, two longitudinal studies in Italy found a strong association between smartphone use and insomnia, with increased use of electronic devices within 2 h of bedtime exacerbating insomnia symptoms, and reduced use time improving insomnia symptoms (57, 58). Prolonged use of interactive electronic products may not only cause hyper arousal and interferes with healthy sleep initiation, buy also make deep sleep more difficult (71, 72). Prolonged Internet use and bright lights on screens at night suppress melatonin secretion, forcing circadian rhythms out of whack disrupt the regulation of biological sleep/wake rhythms (67, 69, 73).

It is important to note that the current study did not find a predictive role for Internet use in remission vs. recovery, or persistent insomnia vs. remission. This suggested that Internet use may not be as sensitive as exercise and food intake in the prognosis of insomnia. It is worth noting that this study only investigated the time of Internet use in a day as a whole, without specific time points, which may inevitably limit the sensitivity of the prediction of Internet use duration, considering a strong relationship between the changes of evening exposure to electronic devices and the time course of sleep problems, which have been consistently reported (57, 58). Food intake and exercise, while both being sensitive in predicting the prognosis of insomnia, play different roles. Regular food intake was relevant to a fundamental change in the direction from insomnia to normal sleep. Eating behaviors and sleep behaviors are synchronized that are essentially regulated by interactions between circadian clocks and hormones, and this network of interactions has a

strong effect on behavior. This means that these two behaviors are in a multi-layered network system, and changing one factor may affect the whole network. So, maintaining a stable food intake rhythm may provide a way to stabilize circadian rhythms (64, 65). Thus, maintaining stable food intake behavior can help restore the circadian rhythm of the master biological clock, so as to improve insomnia symptoms. In contrast, the effect of daily exercise on the recovery of insomnia are primarily on the magnitude of improvement. Various mechanisms have been proposed to explain how exercise may render sleep benefits. It is postulated that exercise increases energy expenditure and body temperature in a manner that facilitates sleep for recuperation of the body (74–76). In general, it is important to maintain a healthy lifestyle during quarantine in order to help the recovery of insomnia.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The current study was conducted in the context of epidemic home isolation, during which the influence of other external factors on insomnia symptoms was reduced, so it was more conducive to explore the influence of daily lifestyle on insomnia. The setting of quarantines helps control for some variables while also being distinctive to everyday situation. Thus, it should be cautious in extrapolating to the relationship between lifestyle and the development of insomnia in general. More importantly, the development of insomnia and lifestyle were both obtained through self-report observations in the current study, without manipulation of the variable. Therefore, the current study can't rule out the possibility of the opposite relationship, i.e., the improvement in insomnia may leads to a more regular lifestyle, or that it could work both ways. Rigorous RCT experiment is needed to explore the impact of lifestyle on the improvement of insomnia.

Sleep measures was not taken by objective measurements, such as the recognized gold standard PSG (Polysomnography). There were also limitations in the evaluation of lifestyle. Only general surveys were conducted on the three lifestyles, and standardized questionnaires were not employed. Lifestyle details were thus not available, such as the time of the meal, the structure of food intake, and the type of exercise. Future research can conduct a detailed investigation of lifestyle from different aspects, which may be more conducive to the understanding of the relationship between lifestyle and insomnia development, and provide operational guidance for insomnia rehabilitation.

CONCLUSION

The regularity of lifestyle is closely related to the recovery of insomnia in home quarantine college students during the COVID-19 epidemic. The food intake regularity in the lifestyle plays the more basic role than exercise, and to some extent, acts as the premise of other aspects of the lifestyle.

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 Committees of South China Normal University (Ethics_No._SCNU-PSY-2020-01-001). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FF and JZhao: conceptualization. FF and JZhan: methodology. JZhan and LM: formal analysis and writing—original draft preparation. JZhan, ZM, and DW: investigation. JZhan, LM, and HC: data curation. JZhan, JZhao, and FF: writing—review and editing. All authors contributed to the article and approved the submitted version.

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Impacts of Stress Response and Negative Emotion on Mental Health of College Students During the COVID-19 Outbreak

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Object: In this study, we aimed to explore the influences of stress responses and negative emotion on mental health of college students during the initial COVID-19 outbreak in China.

Methods: A nationally representative sample of 1,351 college students, aged 18–23 years, took part in an online survey during the COVID-19 outbreak. The ANOVA, correlation coefficients, structural equation modeling (path analysis), and other statistical analysis methods were used for data analysis.

Results: (1) The Chinese college students' epidemic panic and cognitive evaluation were found to be moderate (3.73 ± 0.74, 3.76 ± 0.62), while their defensive response was higher (4.61 ± 0.55). Their mental health during the COVID-19 outbreak was found to be good (3.75 ± 0.76). (2) The quality of their mental health was significantly and negatively associated with epidemic panic, and the quality of their mental health was significantly and positively associated with defensive response. (3) The quality of their mental health was significantly and negatively associated with negative emotion. (4) College students' epidemic panic and defensive response to the COVID-19 had a directly predictive effect on their mental health.

Conclusion: College students' negative emotion played a partial mediating role in the relationship between epidemic panic and mental health. College students' negative emotion played a complete mediating role in the relationship between cognitive appraisal and mental health.

Keywords: COVID-19, epidemic stress response, negative emotion, mental health, epidemic panic

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INTRODUCTION

The COVID-19 pandemic was officially recognized as one of the greatest "public health emergencies in the world" by the WHO on January 31, 2020, and it reached pandemic status throughout the world on March 11, 2020. As of November 15, 2021, more than 254 million people had been infected worldwide, with a death toll exceeding 5.11 million according to the WHO. In

addition, the COVID-19 pandemic has caused panic, anxiety, and depression among those affected by it. This series of chain reactions triggered by this negative emotion will further exacerbate the damage of the COVID-19 pandemic. The academic community has conducted empirical research on college students' stress, negative emotion, and mental health in previous major infectious disease outbreaks, for example, the SARS epidemic, which first broke out in China in 2003. Researchers explored the relationship between stress response, negative emotion, and mental health of the people during the SARS pandemic, which consistently found that there were significant correlations between people's stress, negative emotion, and mental health (1–3). The H1N1 pandemic, which first broke out in Mexico in 2009, quickly spread all over the world. Researchers explored the relationship between stress response, negative emotion, and mental health of the people during the H1N1 pandemic, which also found that there were significant correlations between people's stress, negative emotion, and mental health (4–8).

During the outbreak of COVID-19 in China, an investigation used the big data analysis method based on Sina Weibo and found that the public had increased negative emotion such as anxiety after January 20, 2020, in Wuhan, China. After the "city closure" on January 23, people were in a state of high stress response and negative emotion in the short term (9). A large-scale online survey on February 13–16, 2020, in China, which used self-rating anxiety scale (SAS) and self-rating depression scale (SDS), found that people's anxiety and depression were slightly higher than the norm (but not clinically significant), and there was no significant difference between people in Hubei province and other regions (10). This result confirmed the findings of Tong (11) on anxiety and depression among college students in the SARS epidemic, who found that the SAS and the depression scale (CESD) did not distinguish college students' difference of emotional responses between the epidemic core region and other regions. However, Wen et al. conducted a survey, which used the SAS from January 24 to February 8, 2020, and found that the anxiety level of the people in the core region was significantly higher than that of the people in other regions. On the one hand, this difference may be difficult to accurately measure the mental health of the affected people using a single self-rating scale of anxiety and depression. On the other hand, the mental health problems may be more directly related to their stress response and negative emotion. Most of the above relevant studies only measured the level of anxiety or depression (12).

According to the stress coping theory (13, 14), the external event of "city closure" or mandatory quarantine could be seen as a stressor that initiates stress response (e.g., defensive behavior and cognitive appraisal). Such appraisal might result in negative emotions (e.g., worry about the COVID-19) and thereby endanger mental health. Therefore, this study attempts to construct a relationship model between college students' stress response to the COVID-19, negative emotion, and mental health (**Figure 1**). When facing the outbreak of COVID-19, college students will have different kinds and degrees of stress responses, as shown in **Figure 1**. On the one hand, college students' stress response may have a direct impact on their mental health.

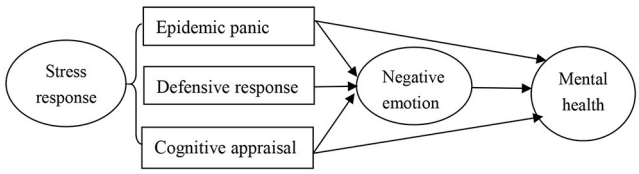

FIGURE 1 | Relationship model between stress response, negative emotion, and mental health.

On the other hand, college students' stress response may have an indirect impact on mental health through the mediating role of negative emotion. The primary objective of this study was to investigate the associations between stress response, negative emotion, and mental health status among college students during the initial phase of the COVID-19 outbreak in China.

METHODS

Participants and Design

An anonymous cross-sectional survey was conducted from February 1 to 10 (the 8–17 days after Chinese New Year and during winter vacation for college students), 2020, by using online questionnaires. A snowball sampling strategy was adopted, and 1,351 valid samples were collected. There were 306 college students in Hubei Province, 413 college students in Anhui, Henan, and Jiangxi around Hubei Province, and 632 college students in other provinces far away from the epidemic, such as Guangxi, Guangdong, Heilongjiang, Zhejiang, and Beijing. There are 927 female college students and 424 male college students. The average age of the subjects was 21.75 ± 9.81 years. The inclusion criterion was that the subjects needed to be full-time college students. The exclusion criteria included the following: (a) self-reported COVID-19 diagnosis ($n = 5$) and (b) failure to pass the internal consistency checks ($n = 23$). It was specified on the questionnaire that the return of the completed questionnaire implied that informed consent had been given. Ethical approval was obtained from the ethics committee of the corresponding author's affiliated university.

Measures

General Health Questionnaire

The General Health Questionnaire (GHQ-12) was composed of 12 items, which had good reliability and validity (15–17). The Likert 5-point scoring was used. The data of 675 participants were used to conduct a confirmatory factor analysis. The chi-square value = 47.59, DF = 31, $p = 0.06$, chi-square value/DF = 1.54, GFI = 0.99, AGFI = 0.97, NFI = 0.99, IFI = 1.00, CFI = 1.00, RMSEA = 0.03. The Cronbach's α coefficient of the GHQ-12 was 0.86.

Stress Response Questionnaire

The questionnaire was developed by Tong (11) and had a total of 13 items, which were divided into three dimensions: cognitive appraisal, epidemic panic, and defensive response to

the epidemic. The SARS in each item was replaced by COVID-19 in this study. Confirmatory factor analysis of the stress response questionnaire showed that the chi-square value = 58.67, DF = 38, $p = 0.06$, chi-square value/DF = 1.54, GFI = 0.99, AGFI = 0.97, NFI = 0.97, IFI = 0.99, CFI = 0.99, and RMSEA = 0.03. The Cronbach's α coefficient of cognitive appraisal subscale was 0.79; the Cronbach's α coefficient of epidemic panic subscale was 0.82; the Cronbach's α coefficient of defensive response subscale was 0.83; and the Cronbach's α coefficient of the entire questionnaire was 0.81.

Negative Emotion Self-Assessment Questionnaire

Referring to the PANAS scale (18, 19), six specific emotions were used to investigate the emotional feelings of college students when facing the COVID-19 epidemic. The six negative emotions are "tension, worry, panic, anger, sadness, and anxiety." We used Likert-style five-point scoring. Firstly, the data of 676 subjects were used to conduct exploratory factor analysis. One factor with a feature root >1 was extracted, and the total interpretation rate was 70.49%. Then, confirmation factor analysis was performed on the data of the remaining 675 subjects and found that the chi-square value = 55.15, DF = 17, $p = 0.06$, chi-square value/DF = 2.76, GFI = 0.98, AGFI = 0.96, NFI = 0.97, IFI = 0.98, CFI = 0.99, and RMSEA = 0.05. The Cronbach's α coefficient is 0.91.

Statistical Analysis

The ANOVA was used to test the significance of between-group differences. Pearson correlations were used to test the associations between mental health and its related influencing factors. A structural equation model (path analysis) with full information likelihood estimation was used to test the hypothesized mediation model for mental health. Tests for the direct, indirect, and total effects were based on 2,000 bootstrapped samples. Effect estimates and bias-corrected 95% confidence intervals (CI) were derived. The indices of good fit included the root mean square error of approximation (RMSEA) <0.06 and comparative fit index (CFI) >0.95. Analyses were conducted using SPSS 22.0 and AMOS 22.0. A two-sided p below 0.05 was considered statistically significant.

RESULTS

Stress Response and Mental Health of College Students Facing COVID-19

Firstly, the results of stress responses and mental health of college students when facing the outbreak of COVID-19 were as shown in **Table 1**. The level of defensive response of college students was found to be higher. The levels of both epidemic panic and cognitive appraisal were found to be moderate. The level of mental health of college students was found to be good.

Secondly, an ANOVA was conducted on the stress response and mental health of college students in different regions. The results showed that there were significant regional differences in college students' epidemic panic [$F_{(2, 1,348)} = 27.70$, $p < 0.001$, $\eta_p^2 = 0.04$]. College students in Hubei province felt higher levels of epidemic panic ($M = 3.97$, $SD = 0.75$) than did college students in non-adjacent provinces ($M = 3.75$, $SD = 0.71$) ($p < 0.001$). College students in non-adjacent provinces felt higher levels of epidemic panic than did college students in neighboring provinces ($M = 3.55$, $SD = 0.73$) ($p < 0.001$). There were significant regional differences in college students' defensive response [$F_{(2, 1,348)} = 3.41$, $p < 0.05$, $\eta_p^2 = 0.01$]. College students in Hubei province had more defensive responses ($M = 4.70$, $SD = 0.58$) than college students in both non-adjacent provinces ($M = 4.60$, $SD = 0.52$) and adjacent provinces ($M = 4.58$, $SD = 0.57$) ($p < 0.05$). There were significant regional differences in college students' cognitive appraisal [$F_{(2, 1,348)} = 22.57$, $p < 0.001$, $\eta_p^2 = 0.03$]. College students in Hubei province had higher cognitive appraisal ($M = 3.98$, $SD = 0.62$) than college students in non-adjacent provinces ($M = 3.75$, $SD = 0.61$) ($p < 0.001$). College students in non-adjacent provinces had higher cognitive appraisal than college students in adjacent provinces ($M = 3.65$, $SD = 0.59$) ($p < 0.05$). However, the results showed that there was no significant regional difference in college students' mental health ($p > 0.05$).

TABLE 1 | Stress response and mental health of college students when facing COVID-19.

	Epidemic panic	Defensive response	Cognitive appraisal	Mental health
M ± *SD*	3.73 ± 0.74	4.61 ± 0.55	3.76 ± 0.62	3.75 ± 0.76

TABLE 2 | Correlation between stress response, negative emotion, and mental health.

	1	2	3	4	5
1. Epidemic panic	1				
2. Defensive response	0.22***	1			
3. Cognitive appraisal	0.67***	0.31***	1		
4. Negative emotion	0.52***	0.13***	0.47***	1	
5. Mental health	−0.25***	0.09***	−0.05	−0.44***	1

***$p < 0.001$.

Relationship Between Stress Response, Negative Emotion, and Mental Health

Firstly, we tested the correlations between college students' stress responses, negative emotion, and mental health (**Table 2**). The results showed that there was a significant negative correlation between college students' mental health and epidemic panic. There was a significant positive correlation between college students' mental health and defensive response. There was a significant negative correlation between college students' mental health and negative emotion.

Secondly, we used a structural equation model (path analysis) to construct the relationship model between epidemic stress

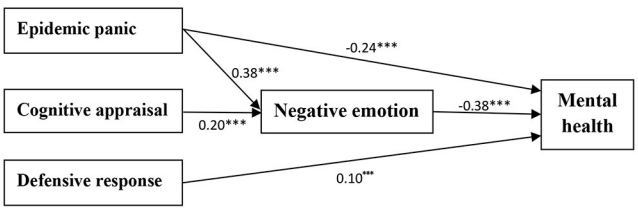

FIGURE 2 | Relationship between epidemic stress response, negative emotion, and mental health. ***$p < 0.001$.

response, negative emotion, and mental health of college students (**Figure 2**). The chi-square value = 3.43, DF = 3, $p = 0.33$, chi-square value/DF = 1.14, GFI = 1.00, AGFI = 0.99, NFI = 1.00, IFI = 1.00, CFI = 1.00, RMSEA = 0.01. On the one hand, college students' epidemic panic and defensive response had a directly predictive effect on the mental health. On the other hand, negative emotion not only played a partial mediating role in the relationship between epidemic panic and mental health but also played a complete mediating role in the relationship between cognitive appraisal and mental health.

DISCUSSION

Generally speaking, we found that Chinese college students' stress response and mental health were relatively mild when facing the outbreak of COVID-19. This might be the case because both Chinese spring festival and winter vacation played a double-buffering role during the COVID-19 epidemic in China. The further testing of college students' stress response and mental health from different regions found that, compared with college students in other provinces, college students in Hubei province who were in the epidemic core area had bigger stress responses and worse mental health. The results were consistent with the results of Wen et al. (20), which found that the perceived risk and anxiety level of people in Hubei province were significantly higher than those of other regions. In addition, this might be the case because of the control characteristics of the COVID-19 epidemic in China. The regional characteristics of the COVID-19 outbreak were very obvious, which belong to a single-core area, namely, Hubei province and Wuhan city. Therefore, most college students' stress response is obviously lower than those in Hubei province and Wuhan city. This difference was also in line with the "ripple effect." The ripple effect means that the closer to the core area of the crisis the people are, the higher their risk perception and negative emotion, and the greater the impact they feel (21). However, the result was not fully consistent with the ripple effect. We found that college students far away from Hubei province and Wuhan city had bigger stress responses to COVID-19 than those in neighboring provinces. This might be the case because the effectiveness and control of epidemic prevention were very good. Except for Hubei province, the severity of the COVID-19 epidemic in other provinces was similar and safe.

In addition, we found that there was a significant correlation between college students' stress responses, negative emotion, and mental health. That is to say, college students' stress responses had a significantly predictive effect on negative emotion and mental health. The result was consistent with previous studies, which also found that the stress response to SARS and the worry about SARS significantly predicted the level of anxiety and depression of college students (3, 11). When facing COVID-19, college students' epidemic panic and defensive response had a directly predictive effect on the level of mental health, in which the predictive effect of epidemic panic is negative, while the predictive effect of defensive response is positive. It was easy to understand that college students' epidemic panic was not conducive to the maintenance of their mental health, while college students' self-protective defense response was helpful to the maintenance of their mental health.

The results further revealed that college students' negative emotion played a mediating role in the relationship between stress response and mental health. The result was consistent with the prior research, which showed that, during the initial COVID-19 outbreak in China, Chinese college students' emotional distress played a partial mediating role in the relationship between infection risk and mental health (22). This result was partially consistent with a related study, which found that fear of COVID-19 played a mediating role in the relationship between family cohesion and stress consequences (23). In particular, college students' negative emotion played a partial mediating role in the relationship between epidemic panic and mental health. College students' negative emotion played a complete mediating role in the relationship between cognitive appraisal and mental health. This showed that the different relationship between different dimensions of stress response, negative emotion, and mental health.

LIMITATIONS AND FUTURE RESEARCH

Our survey belongs to the domain of quantitative research and lacks qualitative analysis. In addition, our results draw on cross-sectional data using a structural equation model; although we recruited a large sample, this design cannot be used to draw conclusions about causal relationships. Future research will require the use of a longitudinal survey.

CONCLUSION

College students' epidemic panic and defensive response to COVID-19 had a directly predictive effect on their mental health. College students' negative emotion played a partial mediating role in the relationship between epidemic panic and mental health. College students' negative emotion played a complete mediating role in the relationship between cognitive appraisal and mental health.

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 Committee, School of Educational Sciences, Nanning Normal University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FX conceived and designed the review. LH and FX wrote the manuscript. Both authors contributed to the article and approved the submitted version.

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Somatic Symptoms, Anxiety, and Depression Among College Students in the Czech Republic and Slovakia: A Cross-Sectional Study

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Studying in college can be a challenging time for many students, which can affect their mental health. In addition to academic pressure and stressful tasks, another aggravating factor in student life is the ongoing coronavirus disease 2019 (COVID-19) pandemic. The aim of the study was to examine the prevalence of anxiety, depression, and somatic symptoms in Czech and Slovak college students during the COVID-19 pandemic and to evaluate possible socio-demographic determinants of mental health problems. A total of 3,099 respondents participated in this cross-sectional study (Czech Republic: 1,422, Slovakia: 1,677). The analyzes included the Patient Health Questionnaire for somatic symptoms (PHQ-15), the Generalized Anxiety Disorder instrument (GAD-7), and the Patient Health Questionnaire for depression (PHQ-9). Socio-demographic factors were gender, age, family structure, marital status, form of study, degree of study, year of study, field of study, distance between home and college, residence, and housing during the semester. Among Czech students, prevalence of somatic complaints, anxiety and depression was 72.2, 40.3, and 52%, respectively. Among Slovak students, prevalence of somatic complaints, anxiety and depression was 69.5, 34.6, and 47%, respectively. During the COVID-19 pandemic, the most severe mental health problems were identified in a non-negligible part of the sample (Czech Republic: PHQ-15 = 10.1%, GAD-7 = 4.9%, PHQ-9 = 3.4%; Slovakia: PHQ-15 = 7.4%, GAD-7 = 3.5%, PHQ-9 = 2.7%). Regarding the differences between the analyzed countries, a significantly higher score in somatic symptoms, anxiety, and depression was identified in the Czech Republic. Significant differences in mental disorders were found in most socio-demographic characteristics. The main results of the logistic regression analysis revealed that risk factors for mental health disorders in Czech and Slovak students were female gender, younger age, third degree of study, and study of Informatics, Mathematics, Information and Communication Technologies (ICT). Especially in the case of these high-risk groups of students, public policies should consider a response to impending problems. The findings are an appeal for a proactive approach to improving the mental health of

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students and for the implementation of effective prevention programs, which are more than necessary in the Czech and Slovak college environment.

Keywords: mental health, disorder, prevalence, socio-demographic determinants, COVID-19, PHQ-15, GAD-7, PHQ-9

INTRODUCTION

College students are an important element of society in every country, as they are the future driving force, but also consumers of social and health services. Therefore, it is necessary to pay attention to their healthy development, not only physical but also mental. Poor mental health can prevent them from reaching their potential. The period of college study is characterized by various social, psychological, academic, and lifestyle risk factors that can lead students to experience mental health problems such as anxiety and depression (1). Previous literature has addressed many difficulties in student life, however, the most frequent are academic pressure to succeed, balancing priorities, fear of failure, critical incidents, economic and social problems, bad relationships, or post-graduation plans (1–4).

The ongoing coronavirus disease 2019 (COVID-19) pandemic appears to be another challenging phenomenon for college students (5–10). With the onset of the pandemic, hitherto unknown conditions arose in their lives. In order to reduce the spread of COVID-19, strict measures and interventions were implemented around the world (11). Students had to face sudden changes, physical distancing, but also concerns about their health and the health of their loved ones (12). In addition, students experienced distance education and considerable changes in their study habits, with an evident problem being an impairment in concentration and learning abilities (13). All of these COVID-19-related stressors could lead to multiple consequences that can have a psychological impact on them (14). In this context, frustration caused by loss of daily routine, study disruption, loneliness and estrangement, emotional agony and distress, or uncertainty about both the present and future are strong signals of difficult COVID-19 times for students (15, 16). All of this can mean a huge psychological burden for young people, which has many consequences in their lives (17). In the first place, it is poor academic performance (13, 18), but also dropout (19), low quality of life (20), or suicidal thoughts (21, 22) which are characteristic of college students with poor mental health. It is also well-known that depression is associated with the use of addictive substances among students (23, 24). For instance, problematic drinking is common in depressed students (25, 26). In terms of anxiety, similar consequences can be considered. The higher the anxiety, the higher the nicotine dependence among college students (27). Evidence also shows that students with higher anxiety tend to have lower adherence to sleep hygiene behaviors and experience poorer sleep quality which, in turn, negatively affects their academic engagement (28). In other words, students' anxiety has a negative effect on their academic motivation (29). It is also possible to point out the somatic complaints that can occur in college students, not only during the COVID-19 pandemic (30, 31). Somatic complaints are serious concomitant symptoms of poor mental health and should not be overlooked in research. It is considered a somatic response to mental discomfort, or potentially representative of mental health concerns (32).

All of the above-mentioned findings underline the fact that college students are considered a risk group for the psychosocial long-term consequences of the pandemic (30). For these reasons, the attention of academics and professionals should be focused on young people and the determinants of their poor mental health.

Evidence from one Slovak university clearly shows a 2-fold increase in the prevalence of moderate to severe symptoms of anxiety and depression when comparing the pandemic period in late 2020 and the pre-pandemic period in 2018, with factors such as age, loneliness, having close person infected, perceived stress, and low resilience playing an important role (33, 34). Similar results were found in Czech nationwide cross-sectional surveys conducted during the first and second waves of the COVID-19 pandemic. Thus, the prevalence of anxiety almost doubled between 2017 and 2020, and the prevalence of major depression tripled (35). According to the authors of this Czech study, strong concerns about health or economic consequences of COVID-19 were associated with an increased likelihood of having a mental disorder (35). In the Czech Republic, mental health declined sharply during the first wave and showed no improvement during the second wave of the pandemic (36). These valuable findings indicated that mental health problems pose a serious threat across both populations and the situation has worsened since the onset of the pandemic. At the same time, these findings confirmed the critical situation in both countries during the COVID-19 pandemic; therefore, increased attention needs to be paid to the factors associated with poor psychological outcomes. These studies were the main motivation for the authors of the presented study.

Previous studies have mapped the situation and compared pre-pandemic and pandemic periods in the Czech Republic and Slovakia, however, the socio-demographic background of poor mental health has remained unclear. In this critical situation, it is important to know the main determinants of mental health problems in order to identify vulnerable groups and detect emerging disorders in a timely manner. The presented study provides an in-depth examination of the issue, specifically, a more detailed insight into the socio-demographic factors associated with somatic symptoms, anxiety, and depression during the early COVID-19 pandemic.

Theoretically, this study contributes to the knowledge of young people's mental health. Simultaneously, this study helps professionals and public policy makers better understand the issue and develop more effective strategies to improve the mental health of young people. This problem has long been neglected and overlooked in practice in the Czech Republic and Slovakia,

and therefore the study can be a valuable platform for a proactive approach with evidence-based interventions.

MATERIALS AND METHODS

The main aim of the study was to examine the prevalence of anxiety, depression, and somatic symptoms in Czech and Slovak college students during the COVID-19 pandemic and to evaluate possible socio-demographic determinants of these mental health problems.

Data Collection and Respondents

The research included primary data collected in the first half of 2020, thus during the first wave of the COVID-19 pandemic in the Czech Republic and Slovakia. Data collection took place in two phases. In the first phase, an online questionnaire was distributed to Czech and Slovak students in their maternal language, mainly throughout emails addressed to academic authorities (deans, vice-deans), academic staff, and members of the university student council. In addition, the questionnaire was shared on social networks, while organic and paid propagations were applied. In the second phase, emails requesting the sharing of the questionnaire with students were addressed to teachers and lecturers of individual universities and individual fields of study. This step was chosen to help collect data in the planned structure of the research sample.

In general, the ambition was to collect data in accordance with the structure of the surveyed populations in both countries. The properties of the sample were based on two main criteria. The first criterion was an adequate representation of colleges, while the research covered 80% of all Czech and Slovak colleges and universities. The second criterion was an adequate proportion of study fields and a minimum of 30 observations in each study field.

A data cleaning process was performed prior to the analyzes. In this regard, 179 respondents were excluded on the basis of their negative answer to the control questionnaire item (a positive answer was needed to claim that one million has 6 zeros, and a numerical expression was also provided). Subsequently, 27 respondents were excluded on the basis of a system error identified in recording their responses (incomplete data). Finally, 87 respondents (foreign students) were excluded on the basis of their nationality, as the research was focused exclusively on domestic students. A total of 3,099 respondents [Czech Republic (CZ) = 1,422; Slovakia (SK) = 1,677] were included in the final research sample. At this point, it should be noted that in several cases of identification variables, obvious errors were identified (e.g., 1,000 as year of birth). These individual responses were removed and considered as missing data in the used analyzes. The socio-demographic profile of the sample is shown in **Table 1**.

The first degree of study represents a bachelor's study, which is followed by a master's (or engineering) study as the second degree, and the last third degree represents a doctoral study. The combination of the first and second degree represents a specific form that is characteristic of fields of study, such as medical fields.

Measures

The research focused on anxiety, depression, and somatic symptoms, which were measured by three screening instruments selected from a study conducted by Kroenke et al. (37). Specifically, somatic symptoms were measured using the Patient Health Questionnaire for somatic complaints (PHQ-15), anxiety was measured using the Generalized Anxiety Disorder instrument (GAD-7), and depressive symptoms were identified using the Patient Health Questionnaire for depression (PHQ-9). The PHQ-15 items offered the following possible answers: not bothered−0, bothered a little−1, bothered a lot−2. The answers to the GAD-7 and PHQ-9 items were as follows: not at all−0, several days−1, more than half the days−2, nearly every day−3. For all the measures, the total score was the sum of the answers coded as above. In this way, the somatic symptoms (PHQ-15) and anxiety (GAD-7) scores ranged as follows: 0–4 none, 5–9 mild, 10–14 moderate, 15 and higher scores indicated severe somatic symptoms/anxiety. The depression score (PHQ-9) could be in the following intervals: 0–4 none, 5–9 mild, 10–14 moderate, 15–19 moderately severe, 20 and higher scores indicated severe depression. Thus, the higher the total score, the more serious the mental problem.

Statistical Analysis

The analytical processing was carried out in three main steps, which were frequency analysis, descriptive analysis and regression analysis. The analyzes were carried out separately for the Czech Republic and separately for Slovakia in order to point out the specificities of these two countries, which share a common history. Frequency analysis was used to point out the prevalence of mental problems in the analyzed population on the basis of its division into individual intervals according to the above-mentioned severity of selected mental disorders. Descriptive analysis of selected mental health indicators was performed in a secondary classification according to the socio-demographic characteristics that are the focus of this study. The central tendency measures (mean, median) were used to identify gross scores in the analyzed data. The Mann-Whitney U test was used to assess differences between two categories, and the Kruskal-Wallis H test was used to assess differences between three or more categories. To their results, η^2 was also calculated for a better comparison of the effect size of the identifying socio-demographic characteristics. According to Cohen (38), the results can be seen as follows: small effect size ($\eta^2 = 0.01$), medium effect size ($\eta^2 = 0.06$), and large effect size ($\eta^2 = 0.14$). The main analysis was devoted to the application of multiple logistic regression with a binary dependent variable.

$$\ln\left(\frac{p}{1-p}\right) = \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik}, (-\infty, \infty) \quad (1)$$

where p is the success probability.

The dependent variables, namely somatic symptoms (PHQ-15), anxiety (GAD-7), and depression (PHQ-9) were adjusted to the dichotomous form (0—no mental health problem, 1—mild and higher severity of a mental health problem). For the purpose of this regression analysis, some socio-demographic characteristics were also adjusted into a dichotomous form.

TABLE 1 | Socio-demographic profile of the sample.

	Variable	*n*	%	% Without missing
Gender	Male	955	30.8	30.8
	Female	2,144	69.2	69.2
Age	≤20	399	12.9	12.9
	21–25	2,130	68.7	68.8
	26–30	314	10.1	10.1
	≥31	251	8.1	8.1
	Missing	5	0.2	–
Family structure	Complete family (mother and father)	2,379	76.8	76.8
	Incomplete (mother only)	199	6.4	6.4
	Incomplete (father only)	44	1.4	1.4
	Divorced parents (living with mother)	421	13.6	13.6
	Divorced parents (living with father)	44	1.4	1.4
	Living only with siblings	3	0.1	0.1
	Orphan	9	0.3	0.3
Marital status	Single	2,826	91.2	91.2
	Married	234	7.6	7.6
	Divorced	37	1.2	1.2
	Widowed	2	0.1	0.1
Degree of study	1st degree	1,798	58.0	58.0
	2nd degree	808	26.1	26.1
	Combined 1st and 2nd degree	91	2.9	2.9
	3rd degree	402	13.0	13.0
Year of study	1st	1,082	34.9	34.9
	2nd	953	30.8	30.8
	3rd	611	19.7	19.7
	4th	199	6.4	6.4
	5th	212	6.8	6.8
	6th	42	1.4	1.4
Form of study	Full-time	2,591	83.6	83.6
	Part-time	508	16.4	16.4
Field of study	Education	357	11.5	11.5
	Humanities & Arts	179	5.8	5.8
	Social, Economic & Legal Sciences	1,336	43.1	43.1
	Natural Science	123	4.0	4.0
	Design, Technology, Production & Communications	257	8.3	8.3
	Agricultural & Veterinary Sciences	120	3.9	3.9
	Health Service	234	7.6	7.6
	Services (tourism, sports, security, transport, logistics)	309	10.0	10.0
	Informatics, Mathematics, ICT	184	5.9	5.9
Distance between home and college	≤20.0 kilometers	861	27.8	27.9
	20.1–50.0 kilometers	675	21.8	21.9
	50.1–100.0 kilometers	773	24.9	25.0
	≥100.1 kilometers	779	25.1	25.2
	Missing	11	0.4	-
Residence	Village	1,280	41.3	41.3
	City with up to 10,000 inhabitants	452	14.6	14.6
	City of 10,001–100,000 inhabitants	984	31.8	31.8
	City of 100,001–1,000,000 inhabitants	288	9.3	9.3
	City with over 1,000,001 inhabitants	95	3.1	3.1
Housing during the semester	Dormitory	945	30.5	30.5
	Sublet	426	13.7	13.7
	With family acquaintances	270	8.7	8.7
	With a friend	70	2.3	2.3
	At home	1,388	44.8	44.8

n, frequency.

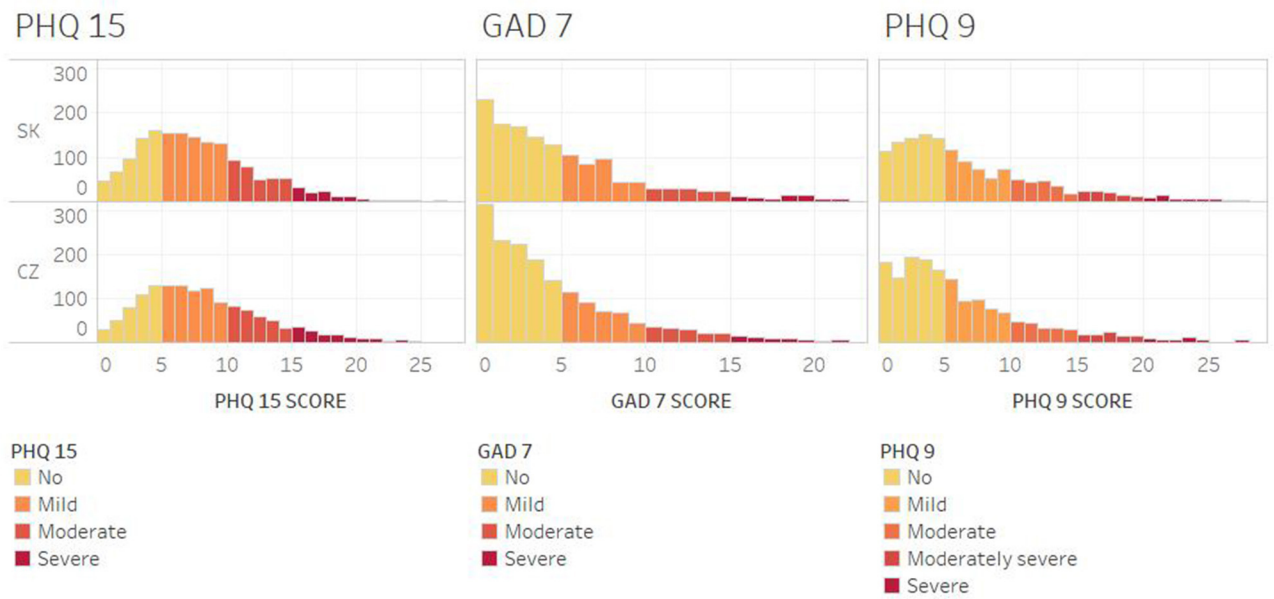

FIGURE 1 | Distribution of PHQ-15, GAD-7 and PHQ-9 scores in the Czech Republic and Slovakia.

Statistical processing was performed using SPSS Statistic v. 26 (IBM, Inc., Armonk, NY, US) and visualization was performed using Tableau v. 2021.4 (Tableau Software, LLC, Seattle, WA, US).

RESULTS

In the Results section, the main findings of the research are divided into two subsections according to the applied analysis. The first subsection is devoted to the results of descriptive and frequency analyzes, which provide a first look at the data as well as the prevalence of mental health disorders among students. The second subsection is devoted to the results of the used logistic regression models, which offer an insight into the socio-demographic factors associated with somatic symptoms, anxiety, and depression during the early COVID-19 pandemic.

Descriptive and Frequency Analyzes

Figure 1 shows the distribution of selected mental health problems among Czech and Slovak college students. Overall, students reported the most positive outcomes in anxiety (GAD-7) and, conversely, the least positive outcomes were observed in somatic symptoms (PHQ-15). Similar distributions of selected mental disorders were observed in both countries. Although not obvious in terms of distribution, the results of the Mann-Whitney U test revealed significant differences in all mental disorders (GAD-7: $U = 1106963.0$, p-value $= 0.001$; PHQ-9: $U = 1113829.5$, p-value $= 0.002$; PHQ-15: $U = 1134734.5$, p-value $= 0.020$). Regarding anxiety, a significantly higher GAD-7 score was identified in the Czech Republic (CZ: mean $= 4.71 \pm 4.6$, median $= 3$; SK: mean $= 4.15 \pm 4.26$, median $= 7$). Students from the Czech Republic also reported a significantly higher score in the two remaining mental disorders, that is depression (PHQ-9 CZ: mean $= 6.34 \pm 5.5$, median $= 5$; SK: mean $= 5.30 \pm 5.30$, median $= 4$) and somatic symptoms (PHQ-15 CZ: mean $= 7.77 \pm 4.8$, median $= 7$; SK: mean $= 7.32 \pm 4.6$, median $= 7$). On this basis, it was justified in further analyzes to compare the socio-demographic groups of the population also in the classification of countries.

In the Czech sample, severe somatic symptoms were found in 10.1% of students, severe anxiety in 4.9%, and severe depression in 3.4%. In general, mild and higher rates of mental health problems were identified in 72.2% of students with somatic complaints, 40.3% of students with anxiety, and 52% of students with depression. In the Slovak sample, 7.4% of students reported severe somatic symptoms, 3.5% of students experienced severe anxiety, and 2.7% of students reported severe depression. At the same time, mild and higher rates of mental health problems were found in 69.5% of students with somatic complaints, 34.6% of students with anxiety, and 47% of students with depression.

Table 2 presents the proportion of the most serious rates of mental health problems reported by Czech and Slovak respondents classified according to socio-demographic characteristics. Higher proportion values were observed in several cases; however, COVID-19-related stressors could be reflected in these findings. A more detailed look at the results of the frequency analysis and difference tests is provided in **Supplementary Tables 1–9**.

Supplementary Tables 1–3 show the results for somatic symptoms (PHQ-15) in the classification of selected socio-demographic characteristics of students. In addition to higher rates of somatic complaints, several significant differences in the obtained scores were observed. In both countries, there were significant differences between the gender categories, with higher mean scores for females, and between the age categories, with

TABLE 2 | Proportion of severe mental health problems (PHQ-15, GAD-7, PHQ-9) in the classification of selected socio-demographic characteristics—frequency (percentage ratio).

Variable	Category	PHQ-15, *n* (%)		GAD-7, *n* (%)		PHQ-9, *n* (%)	
		CZ	SK	CZ	SK	CZ	SK
Gender	Male	10 (2.9)	14 (2.3)	6 (1.7)	21 (3.5)	3 (0.9)	19 (3.1)
	Female	134 (12.5)	110 (10.3)	64 (6)	38 (3.5)	46 (4.3)	27 (2.5)
Age	≤20	26 (13.5)	10 (4.9)	19 (9.8)	8 (3.9)	17 (8.8)	5 (2.4)
	21–25	95 (10.7)	98 (7.9)	37 (4.2)	42 (3.4)	28 (3.1)	33 (2.7)
	26–30	14 (8.2)	8 (5.6)	11 (6.4)	5 (3.5)	5 (2.9)	5 (3.5)
	≥31.00	9 (5.4)	8 (9.4)	3 (1.8)	3 (3.5)	3 (1.8)	3 (3.5)
Family structure	Complete family	97 (9.5)	100 (7.4)	56 (5.5)	44 (3.2)	36 (3.5)	30 (2.2)
	Incomplete (mother only)	8 (8.7)	8 (7.5)	2 (2.2)	8 (7.5)	3 (3.3)	5 (4.7)
	Incomplete (father only)	2 (8.7)	1 (4.8)	1 (4.3)	2 (9.5)	2 (8.7)	1 (4.8)
	Divorced parents (with mother)	33 (12.9)	14 (8.4)	11 (4.3)	5 (3)	9 (3.5)	9 (5.4)
	Divorced parents (with father)	4 (14.8)	1 (5.9)	0	0	0	0
	Living with siblings, orphan	0	0	0	0	0	1 (14.3)
Marital status	Single	134 (10.7)	118 (7.5)	67 (5.3)	56 (3.6)	47 (3.8)	41 (2.6)
	Married	8 (5.9)	5 (5.1)	2 (1.5)	2 (2)	1 (0.7)	5 (5.1)
	Divorced, widowed	2 (5.9)	1 (20)	1 (2.9)	1 (20)	1 (2.9)	0
Form of study	Full-time	110 (10.6)	115 (7.4)	56 (5.4)	54 (3.5)	41 (3.9)	42 (2.7)
	Part-time	34 (8.9)	9 (7.1)	14 (3.7)	5 (3.9)	8 (2.1)	4 (3.1)
Degree of study	1st degree	68 (10.3)	90 (7.9)	27 (4.1)	42 (3.7)	21 (3.2)	33 (2.9)
	2nd degree	34 (8.9)	23 (5.4)	18 (4.7)	11 (2.6)	8 (2.1)	9 (2.1)
	Combined 1st and 2nd degree	9 (18)	5 (12.2)	7 (14)	3 (7.3)	5 (10)	0
	3rd degree	33 (9.9)	6 (8.8)	18 (5.4)	3 (4.4)	15 (4.5)	4 (5.9)
Year of study	1st	43 (9.1)	45 (7.4)	26 (5.5)	22 (3.6)	21 (4.5)	17 (2.8)
	2nd	43 (9.9)	47 (9.1)	18 (4.1)	16 (3.1)	13 (3)	11 (2.1)
	3rd	48 (15.1)	25 (8.5)	17 (5.3)	14 (4.8)	9 (2.8)	13 (4.4)
	4th	2 (2.1)	2 (1.9)	4 (4.2)	3 (2.9)	2 (2.1)	2 (1.9)
	5th	7 (9.6)	5 (3.6)	5 (6.8)	3 (2.2)	3 (4.1)	2 (1.4)
	6th	1 (3.3)	0	0	1 (8.3)	1 (3.3)	1 (8.3)
Field of study	Education	37 (13.4)	10 (12.5)	18 (6.5)	5 (6.3)	16 (5.8)	6 (7.5)
	Humanities & Arts	8 (7.9)	11 (14.1)	5 (5)	3 (3.8)	2 (2)	4 (5.1)
	Social, Economic & Legal Sciences	60 (9)	38 (5.7)	24 (3.6)	17 (2.5)	14 (2.1)	13 (1.9)
	Natural Science	2 (4)	1 (1.4)	0	2 (2.7)	0	2 (2.7)
	Design, Technology, Production & Communications	5 (5.4)	8 (4.9)	3 (3.2)	9 (5.5)	3 (3.2)	8 (4.9)
	Agricultural & Veterinary Sciences	16 (23.9)	5 (9.4)	14 (20.9)	1 (1.9)	8 (11.9)	1 (1.9)
	Health Service	11 (20.4)	22 (12.2)	4 (7.4)	9 (5)	4 (7.4)	2 (1.1)
	Services (tourism, sports, security, transport, logistics)	3 (4.3)	18 (7.5)	2 (2.9)	6 (2.5)	0	5 (2.1)
	Informatics, Mathematics, ICT	2 (4.3)	11 (8)	0	7 (5.1)	2 (4.3)	5 (3.6)
Distance between home and college	≤20.0	48 (10.4)	25 (6.3)	28 (6.1)	20 (5)	20 (4.3)	13 (3.3)
	20.1–50.0	30 (9.4)	17 (4.8)	13 (4.1)	11 (3.1)	9 (2.8)	8 (2.2)
	50.1–100.0	39 (11.2)	32 (7.5)	13 (3.7)	13 (3.1)	10 (2.9)	12 (2.8)
	≥100.1	27 (9.2)	49 (10.1)	16 (5.4)	14 (2.9)	10 (3.4)	12 (2.5)
Residence	Village	39 (8.5)	58 (7)	19 (4.2)	30 (3.6)	13 (2.8)	15 (1.8)
	City (up to 10,000)	19 (7.5)	12 (6.1)	14 (5.5)	7 (3.5)	7 (2.8)	8 (4)
	City (10,001–100,000	58 (12.6)	40 (7.6)	25 (5.4)	16 (3)	21 (4.6)	19 (3.6)
	City (100,001–1,000,000)	15 (8.9)	12 (10.1)	8 (4.7)	5 (4.2)	3 (1.8)	3 (2.5)
	City (over 1,000,001)	13 (15.7)	2 (16.7)	4 (4.8)	1 (8.3)	5 (6)	1 (8.3)
Housing during the semester	Dormitory	26 (10.7)	55 (7.8)	16 (6.6)	18 (2.6)	6 (2.5)	19 (2.7)
	Sublet	28 (9.8)	22 (15.8)	15 (5.2)	9 (6.5)	13 (4.5)	7 (5)
	With family acquaintances	24 (11.9)	6 (8.8)	10 (5)	4 (5.9)	9 (4.5)	4 (5.9)
	With a friend	6 (15)	3 (10)	4 (10)	1 (3.3)	4 (10)	1 (3.3)
	At home	60 (9.2)	38 (5.1)	25 (3.8)	27 (3.7)	17 (2.6)	15 (2)

PHQ-15, Patient Health Questionnaire for somatic symptoms; GAD-7, Generalized Anxiety Disorder instrument; PHQ-9, Patient Health Questionnaire for depression; n, frequency of severe mental problems; CZ, Czech Republic; SK, Slovakia.

younger students reporting higher rates of somatic complaints than older students. With a focus on marital status, differences were confirmed at the significance level of $\alpha < 0.001$ in the Czech Republic and at the level of $\alpha < 0.05$ in Slovakia. In terms of the study specifics, both countries showed significant differences between the forms of study, while full-time students were characterized by higher mean scores compared to part-time students. Significant differences were also evident between the fields of study in both countries. In this context, it should be noted that the highest mean score was found for Agricultural & Veterinary Sciences (mean = 10.03) in the Czech Republic. On the contrary, the study of Design, Technology, Production & Communications was characterized by the lowest PHQ-15 score in both countries (mean: CZ = 5.53; SK = 5.90). Significant differences were also identified between the years of the study, but only in Slovakia. In both countries, it was possible to observe significant differences between students' housing during the semester, while students who lived at home during the semester also reported the least somatic complaints (mean: CZ = 7.57; SK = 7.09).

Supplementary Tables 4–6 provide the results for anxiety (GAD-7) in the classification of selected socio-demographic characteristics of students. Again, the difference analysis revealed the most obvious differences in anxiety between the gender categories and between the age categories. Based on the descriptive analysis, female students and younger students acquired higher mean GAD-7 scores in both countries. Significant differences were also identified between the categories of marital status in both countries, with higher mean scores for single students. For the study specifics, the highest score was observed in Czech students with a combined first and second degree (mean = 5.7). However, no significant difference in anxiety was found between the study degrees. On the other hand, both countries showed significant differences between the forms of study, with full-time students reporting higher rates of anxiety than part-time students. In the Czech Republic, there were significant differences between the years of study, as well as between the fields of study. In this context, the highest score was identified in respondents studying Agricultural & Veterinary Sciences (CZ mean = 7.28). Focusing on the years of study, Czech third-year and fifth-year students reported the highest rates of anxiety compared to other years (mean: 3rd = 5.55, 5th = 5.0). In general, it can be stated that no significant differences in anxiety were confirmed between the individual categories of residence. All categories showed approximately similar scores ranging from 2 to 4. A cautious difference at the significance level of $\alpha < 0.1$ was observed for housing during the semester only in Slovakia.

Supplementary Tables 7–9 present the results for depression (PHQ-9) in the classification of selected socio-demographic characteristics of students. As in previous mental disorders, significant differences between the age categories and between the categories of marital status were fully confirmed in both countries. Based on the mean values, it can be noted that younger students suffered from depression more than older students, but also single students reported significantly more depression compared to older students. Gender differences were significant only in the Czech Republic, and female students reported a higher score of depression than male students. In terms of the specifics of the study, significant differences between the forms of study and between the fields of study were confirmed in both countries. In this regard, full-time students acquired higher depression scores than part-time students. Czech respondents studying Agricultural & Veterinary Sciences reported the highest PHQ-9 score (mean = 9.84) compared to others, while respondents studying Design, Technology, Production & Communications reported the lowest mean score (mean = 5.31). In Slovakia, the highest mean score was found in Humanities & Arts (mean = 7.01; median = 5.5), but the median value was higher in the case of Agricultural & Veterinary Sciences (mean = 6.77; median = 6). The lowest mean score was observed in Social, Economic & Legal Sciences (mean = 5.28). Subsequently, significant differences between the degrees of study and between the years of study were revealed only in the Czech Republic. Higher mean scores were evident among Czech students of a combined first and second degree, and among Czech third-year and fifth-year students. In both countries, it was possible to confirm significant differences between students' housing during the semester. Czech students living in dormitories showed the highest depression score (mean = 7.23), while the lowest score was identified for students living at home (mean = 5.9). In Slovakia, students who lived with family acquaintances (mean = 6.63) and in sublet (mean = 6.73) during the semester had the highest depression scores. Similar to the Czech Republic, the lowest depression score was found for students living at home (mean = 5.34). Last but not least, significant differences were found between the distances from home to college in Slovakia, with the highest mean score observed in students traveling more than 100 kilometers (mean = 6.15).

In terms of effect size (η^2), it can be stated that the highest rates were found in the gender categories for somatic symptoms (PHQ-15), and these rates could be attributed to a medium effect size (η^2: CZ = 0.108; SK = 0.122). The effect sizes for anxiety (GAD-7) and depression (PHQ-9) were clearly lower, while small effect sizes could be confirmed.

Logistic Regression Analyzes

This subsection presents the results of the used logistic regression models, the purpose of which was to reveal possible socio-demographic determinants of somatic symptoms, anxiety, and depression among Czech and Slovak college students. As mentioned in the methodology, the dependent variables, namely somatic symptoms (PHQ-15), anxiety (GAD-7), and depression (PHQ-9), were first adjusted to a dichotomous form as follows: 0—no mental health problem, 1—mild and higher severity of a mental health problem. As there were a small number of observations in several socio-demographic categories, some characteristics of students were adjusted to a dichotomous scale (i.e., several categories were merged). This step was to improve the understanding of the results.

Table 3 shows all possible socio-demographic explanatory variables considered in terms of somatic symptoms. It was possible to observe several significant relationships. Being a female increased the probability of somatic symptoms during the early COVID-19 pandemic in both countries. The results

revealed that Czech female students were 4.3 times more likely and Slovak female students were 4.23 times more likely to suffer from somatic symptoms. Among Czech students, somatic symptoms were more common in younger individuals, as they had a higher probability of somatic complaints. Specifically, Czech students aged ≤25 years (categories: ≤20 and 21–25) were more likely to have somatic symptoms than students aged 31 years and over. No significant relationship in terms of age was observed in the Slovak sample. Significant relationships were also found in characteristics related to family status. In this regard, Czech students from an incomplete family were 60% more likely to experience somatic symptoms than Czech students from a complete family, while the other variables remained constant. In terms of the specifics of the study, significant relationships were confirmed in terms of degree of study, years of study, as well as fields of study. Based on the results, it can be concluded that first- and second-degree students were less likely to be somatic than third-degree students only in Slovakia. Focusing on academic years, Czech and Slovak third-year students were approximately 1.5 times more likely to suffer from somatic complaints compared to first-year students. Czech students of Humanities & Arts [odds ratio = 0.4; 95% Confidence Interval (CI) = 0.2–0.78], Social, Economic & Legal Sciences (odds ratio = 0.4; 95% CI = 0.24–0.68), Natural Science (odds ratio = 0.43; 95% CI = 0.19–0.98), and Design, Technology, Production & Communications (odds ratio = 0.36; 95% CI = 0.2–0.66) were less likely to have somatic complaints compared to students of Informatics, Mathematics, Information and Communication Technologies (ICT). In Slovakia, only students of Services (tourism, sports, security, transport, logistics) had a significantly lower probability of somatic symptoms than students of Informatics, Mathematics, ICT. In the category of residence, the results revealed a significant relationship only in the Czech Republic. In this case, students from cities were less likely to be somatic than students from villages (odds ratio = 0.68; 95% CI = 0.52–0.91).

Table 4 presents the results of the logistic regression analysis, taking into account all possible socio-demographic explanatory variables in terms of anxiety. The most obvious relationships were found in the categories of gender and degree of study. Anxiety was more common among female students than among male students. Czech females were 1.94 times more prone to anxiety compared to males, while Slovak females had a chance to suffer from anxiety 1.36 times higher than males. With a focus on age, the youngest Czech students aged <20 years were 2 times more likely to be anxious than the oldest students aged 31 years and over. In Slovakia, no significant relationship was found at a significance level of $\alpha < 0.05$. In terms of family status, it can be stated that Czech students from an incomplete family had a 1.3 higher probability of anxiety than students from a complete family. Significant relationships were also observed in the specifics of the study. Czech first- and second-degree students as well as Slovak students of lower than third degree (1st, 2nd, combined) had significantly lower probability of anxiety disorder than doctoral students (third-degree). In the category of the years of study, Slovak fifth-year students were identified with a significantly lower probability of anxiety compared to first-year students (odds ratio = 0.59; 95% CI = 0.35–0.97). In contrast, Czech third-year students were 1.74 times more likely to suffer from anxiety than freshmen. In the category of the study fields, there were several significant relationships with a negative β coefficient. Based on these results, it was possible to conclude that Czech students of Humanities & Arts (odds ratio = 0.4; 95% CI = 0.22–0.73), Social, Economic & Legal Sciences (odds ratio = 0.47; 95% CI = 0.3–0.75), Design, Technology, Production & Communications (odds ratio = 0.34; 95% CI = 0.18–0.62), and Services (odds ratio = 0.47; 95% CI = 0.24–0.91) were identified as significantly less likely to be anxious compared to students of Informatics, Mathematics, ICT. Similar results were observed among Slovak students. Thus, students of Social, Economic & Legal Sciences (odds ratio = 0.57; 95% CI = 0.39–0.84), Natural Science (odds ratio = 0.38; 95% CI = 0.2–0.72), and Services (odds ratio = 0.58; 95% CI = 0.38–0.9) were less likely to have anxiety than students of Informatics, Mathematics, ICT. In terms of the categories related to students' residence, no significant relationship was found.

Table 5 shows the results of the logistic regression model with all possible socio-demographic explanatory variables considered in terms of depression. With a focus on gender, Czech female students were 1.53 times more likely to be depressed than male students. However, this was not the case in Slovakia, as no significant relationship was found. Focusing on age, it was possible to confirm that younger students had a higher chance of depression than older students. Compared to the oldest students aged 31 years and over, Czech students aged ≤20 years were 3.51 times more likely to suffer from depression, while students aged 21–25 years were 2.36 times more prone to depression. In Slovakia, a significant relationship was found only in the youngest category. In this case, Slovak students aged ≤20 years were 2.42 more likely to have depression than students aged ≥31 years. Czech students from an incomplete family were 1.45 times more likely to suffer from depression than students from a complete family. Slovak single students (odds ratio = 1.92; 95% CI = 1.12–3.27) were more likely to be depressed than students with a different marital status (married/divorced/widowed). Regarding the study specifics, Czech students of the first degree were identified with a significantly lower probability of depression compared to students of the third degree (odds ratio = 0.75; 95% CI = 0.57–0.99). At the same time, Slovak students of lower than third degree (1st, 2nd, combined) were less likely to be depressed than doctoral (third-degree) students. Among Czech students, third-year students were more likely to suffer from depression than first-year students. In terms of fields of study, several significant relationships were found in both countries. In these cases, a negative β coefficient indicated a lower probability of depression in students of individual fields of study compared to students of Informatics, Mathematics, ICT. In the Czech Republic, they were students of Humanities & Arts; Social, Economic & Legal Sciences; Natural Science; Design, Technology, Production & Communications; as well as Services. In Slovakia, they were students of Social, Economic & Legal Sciences; Natural Science; Design, Technology, Production & Communications; Health Services; and Services. In the distance category, Slovak students who traveled 50.1–100 kilometers from

TABLE 3 | Logistic regression analysis with somatic symptoms (PHQ-15) as a dependent variable.

PHQ-15	Czech Republic (Nagelkerke $R^2 = 0.383$)		Slovakia (Nagelkerke $R^2 = 0.327$)	
	β (SE) Sig	AOR (95% CI)	β (SE) Sig	AOR (95% CI)
Gender (reference category: male)				
Female	**1.459 (0.147)**†	4.3 (3.22–5.74)	**1.442 (0.126)**†	4.23 (3.3–5.41)
Age (reference category: ≥31)				
≤20	**0.852 (0.366)****	2.35 (1.14–4.81)	0.699 (0.418)*	2.01 (0.89–4.56)
21–25	**0.624 (0.301)****	1.87 (1.03–3.37)	0.603 (0.375)	1.83 (0.88–3.82)
26–30	0.375 (0.292)	1.46 (0.82–2.58)	0.36 (0.358)	1.43 (0.71–2.89)
Family structure (reference category: complete)				
Incomplete	**0.476 (0.149)*****	1.61 (1.2–2.15)	0.164 (0.149)	1.18 (0.88–1.58)
Marital status (reference category: not single (married/divorced/widowed)				
Single	0.085 (0.266)	1.09 (0.65–1.83)	0.305 (0.293)	1.36 (0.76–2.41)
Form of study (reference category: part-time)				
Full-time	0.004 (0.207)	1 (0.67–1.51)	−0.051 (0.284)	0.95 (0.54–1.66)
Degree of study (reference category: 3rd degree)				
1st degree	−0.027 (0.162)	0.97 (0.71–1.34)	**−0.638 (0.267)****	0.53 (0.31–0.89)
2nd degree	0.213 (0.184)	1.24 (0.86–1.77)	**−0.686 (0.284)****	0.5 (0.29–0.88)
Combined 1st and 2nd	0.026 (0.417)	1.03 (0.45–2.33)	−0.466 (0.482)	0.63 (0.24–1.62)
Year of study (reference category: 1st)				
2nd	0.04 (0.165)	1.04 (0.75–1.44)	0.051 (0.154)	1.05 (0.78–1.42)
3rd	**0.388 (0.194)****	1.47 (1.01–2.16)	**0.403 (0.186)****	1.5 (1.04–2.15)
4th	0.405 (0.286)	1.5 (0.86–2.63)	−0.146 (0.265)	0.86 (0.51–1.45)
5th	0.085 (0.312)	1.09 (0.59–2.01)	−0.19 (0.251)	0.83 (0.51–1.35)
6th	−0.656 (0.431)	0.52 (0.22–1.21)	0.217 (0.698)	1.24 (0.32–4.87)
Field of study (reference category: Informatics, Mathematics, ICT)				
Education	−0.311 (0.302)	0.73 (0.41–1.32)	−0.054 (0.337)	0.95 (0.49–1.84)
Humanities & Arts	**−0.919 (0.343)*****	0.4 (0.2–0.78)	0.29 (0.368)	1.34 (0.65–2.75)
Social, Economic & Legal Sciences	**−0.906 (0.265)**†	0.4 (0.24–0.68)	−0.378 (0.209)*	0.68 (0.45–1.03)
Natural Science	**−0.838 (0.418)****	0.43 (0.19–0.98)	−0.261 (0.328)	0.77 (0.4–1.46)
Design, Technology, Production & Communications	**−1.023 (0.31)**†	0.36 (0.2–0.66)	−0.322 (0.245)	0.72 (0.45–1.17)
Agricultural & Veterinary Sciences	0.023 (0.461)	1.02 (0.41–2.53)	0.656 (0.446)	1.93 (0.8–4.62)
Health Service	−0.329 (0.424)	0.72 (0.31–1.65)	−0.157 (0.278)	0.85 (0.5–1.47)
Services (tourism, sports, security, transport, logistics)	−0.56 (0.373)	0.57 (0.27–1.19)	**−0.469 (0.235)****	0.63 (0.39–0.99)
Distance between home and college (reference category: ≥100.1)				
≤20.0	0.024 (0.19)	1.02 (0.71–1.49)	−0.103 (0.187)	0.9 (0.63–1.3)
20.1–50.0	−0.036 (0.197)	0.96 (0.66–1.42)	0.098 (0.187)	1.1 (0.76–1.59)
50.1–100.0	−0.016 (0.191)	0.98 (0.68–1.43)	−0.048 (0.155)	0.95 (0.7–1.29)
Residence (reference category: Village)				
City	**−0.38 (0.144)*****	0.68 (0.52–0.91)	0.054 (0.117)	1.06 (0.84–1.33)
Housing during the semester (reference category: Home)				
Away from home	0.028 (0.148)	1.03 (0.77–1.37)	−0.05 (0.152)	0.95 (0.71–1.28)

AOR, adjusted odds ratio (AOR = e^{β}); 95% CI, 95% confidence interval.
**p-value < 0.1.*
***p-value < 0.05.*
****p-value < 0.01.*
†*p-value < 0.001.*
Significant results are highlighted in bold.

TABLE 4 | Logistic regression analysis with anxiety (GAD-7) as a dependent variable.

GAD-7	Czech Republic (Nagelkerke $R^2 = 0.134$)		Slovakia (Nagelkerke $R^2 = 0.169$)	
	β (SE) Sig	AOR (95% CI)	β (SE) Sig	AOR (95% CI)
Gender (reference category: male)				
Female	**0.665 (0.145)**†	1.94 (1.46–2.58)	**0.304 (0.123)****	1.36 (1.06–1.72)
Age (reference category: ≥31)				
≤20	**0.695 (0.327)****	2 (1.06–3.81)	0.68 (0.409)*	1.97 (0.88–4.4)
21–25	0.32 (0.279)	1.38 (0.8–2.38)	0.721 (0.372)*	2.06 (0.99–4.26)
26–30	−0.005 (0.274)	0.99 (0.58–1.7)	0.569 (0.35)	1.77 (0.89–3.51)
Family structure (reference category: complete)				
Incomplete	**0.266 (0.125)****	1.3 (1.02–1.67)	0.091 (0.135)	1.09 (0.84–1.43)
Marital status (reference category: not single (married/divorced/widowed)				
Single	0.062 (0.245)	1.06 (0.66–1.72)	0.246 (0.285)	1.28 (0.73–2.24)
Form of study (reference category: part-time)				
Full-time	−0.127 (0.183)	0.88 (0.62–1.26)	−0.403 (0.265)	0.67 (0.4–1.12)
Degree of study (reference category: 3rd degree)				
1st degree	**−0.72 (0.143)**†	0.49 (0.37–0.64)	**−1.012 (0.242)**†	0.36 (0.23–0.58)
2nd degree	**−0.367 (0.161)****	0.69 (0.51–0.95)	**−0.882 (0.258)**†	0.41 (0.25–0.69)
Combined 1st and 2nd	−0.633 (0.331)*	0.53 (0.28–1.02)	**−1.147 (0.427)*****	0.32 (0.14–0.73)
Year of study (reference category: 1st)				
2nd	−0.074 (0.148)	0.93 (0.69–1.24)	0.024 (0.142)	1.02 (0.78–1.35)
3rd	**0.552 (0.168)*****	1.74 (1.25–2.42)	0.233 (0.164)	1.26 (0.91–1.74)
4th	−0.331 (0.256)	0.72 (0.43–1.19)	−0.212 (0.253)	0.81 (0.49–1.33)
5th	0.045 (0.278)	1.05 (0.61–1.8)	**−0.535 (0.257)****	0.59 (0.35–0.97)
6th	−0.533 (0.434)	0.59 (0.25–1.37)	0.002 (0.671)	1 (0.27–3.74)
Field of study (reference category: Informatics, Mathematics, ICT)				
Education	−0.423 (0.259)	0.65 (0.39–1.09)	0.268 (0.298)	1.31 (0.73–2.34)
Humanities & Arts	**−0.918 (0.307)*****	0.4 (0.22–0.73)	−0.255 (0.298)	0.78 (0.43–1.39)
Social, Economic & Legal Sciences	**−0.755 (0.235)*****	0.47 (0.3–0.75)	**−0.558 (0.197)*****	0.57 (0.39–0.84)
Natural Science	−0.561 (0.368)	0.57 (0.28–1.17)	**−0.974 (0.328)*****	0.38 (0.2–0.72)
Design, Technology, Production & Communications	**−1.09 (0.308)**†	0.34 (0.18–0.62)	−0.212 (0.237)	0.81 (0.51–1.29)
Agricultural & Veterinary Sciences	−0.461 (0.349)	0.63 (0.32–1.25)	−0.228 (0.333)	0.8 (0.41–1.53)
Health Service	−0.151 (0.355)	0.86 (0.43–1.73)	−0.221 (0.243)	0.8 (0.5–1.29)
Services (tourism, sports, security, transport, logistics)	**−0.762 (0.34)****	0.47 (0.24–0.91)	**−0.539 (0.222)****	0.58 (0.38–0.9)
Distance between home and college (reference category: ≥100.1)				
≤20.0	−0.152 (0.165)	0.86 (0.62–1.19)	−0.102 (0.173)	0.9 (0.64–1.27)
20.1–50.0	−0.029 (0.172)	0.97 (0.69–1.36)	0.004 (0.17)	1 (0.72–1.4)
50.1–100.0	−0.201 (0.165)	0.82 (0.59–1.13)	−0.116 (0.142)	0.89 (0.67–1.18)
Residence (reference category: Village)				
City	−0.084 (0.123)	0.92 (0.72–1.17)	−0.168 (0.107)	0.84 (0.68–1.04)
Housing during the semester (reference category: Home)				
Away from home	−0.042 (0.13)	0.96 (0.74–1.24)	0.15 (0.14)	1.16 (0.88–1.53)

AOR, adjusted odds ratio (AOR = e^{β}); 95% CI, 95% confidence interval.
**p-value < 0.1.*
***p-value < 0.05.*
****p-value < 0.01.*
†p-value < 0.001.
Significant results are highlighted in bold.

TABLE 5 | Logistic regression analysis with depression (PHQ-9) as a dependent variable.

PHQ-9	Czech Republic (Nagelkerke $R^2 = 0.079$)		Slovakia (Nagelkerke $R^2 = 0.060$)	
	β (SE) Sig	AOR (95% CI)	β (SE) Sig	AOR (95% CI)
Gender (reference category: male)				
Female	**0.427 (0.136)*** **	1.53 (1.17–2)	0.185 (0.115)	1.2 (0.96–1.51)
Age (reference category: ≥31)				
≤20	**1.256 (0.324)**† **	3.51 (1.86–6.62)	**0.885 (0.388)** **	2.42 (1.13–5.18)
21–25	**0.86 (0.274)*** **	2.36 (1.38–4.05)	0.65 (0.351)*	1.92 (0.96–3.81)
26–30	0.475 (0.267)*	1.61 (0.95–2.71)	0.269 (0.335)	1.31 (0.68–2.52)
Family structure (reference category: complete)				
Incomplete	**0.37 (0.124)*** **	1.45 (1.14–1.84)	0.021 (0.129)	1.02 (0.79–1.32)
Marital status (reference category: not single (married/divorced/widowed)				
Single	−0.276 (0.241)	0.76 (0.47–1.22)	**0.65 (0.273)** **	1.92 (1.12–3.27)
Form of study (reference category: part-time)				
Full-time	−0.021 (0.178)	0.98 (0.69–1.39)	−0.147 (0.258)	0.86 (0.52–1.43)
Degree of study (reference category: 3rd degree)				
1st degree	**−0.288 (0.141)** **	0.75 (0.57–0.99)	**−0.754 (0.242)*** **	0.47 (0.29–0.76)
2nd degree	−0.251 (0.158)	0.78 (0.57–1.06)	**−0.792 (0.257)*** **	0.45 (0.27–0.75)
Combined 1st and 2nd	−0.019 (0.341)	0.98 (0.5–1.91)	**−1.158 (0.415)*** **	0.31 (0.14–0.71)
Year of study (reference category: 1st)				
2nd	−0.148 (0.144)	0.86 (0.65–1.14)	−0.046 (0.136)	0.96 (0.73–1.25)
3rd	**0.4 (0.166)** **	1.49 (1.08–2.06)	0.281 (0.16)*	1.33 (0.97–1.81)
4th	−0.075 (0.24)	0.93 (0.58–1.48)	−0.053 (0.239)	0.95 (0.59–1.52)
5th	0.136 (0.271)	1.15 (0.67–1.95)	−0.104 (0.231)	0.9 (0.57–1.42)
6th	−0.007 (0.401)	0.99 (0.45–2.18)	−0.328 (0.667)	0.72 (0.2–2.66)
Field of study (reference category: Informatics, Mathematics, ICT)				
Education	−0.492 (0.257)*	0.61 (0.37–1.01)	−0.165 (0.298)	0.85 (0.47–1.52)
Humanities & Arts	**−1.108 (0.302)**†	0.33 (0.18–0.6)	−0.13 (0.297)	0.88 (0.49–1.57)
Social, Economic & Legal Sciences	**−0.751 (0.232)*** **	0.47 (0.3–0.74)	**−0.788 (0.195)**†	0.45 (0.31–0.67)
Natural Science	**−0.854 (0.363)** **	0.43 (0.21–0.87)	**−0.659 (0.295)** **	0.52 (0.29–0.92)
Design, Technology, Production & Communications	**−0.72 (0.285)** **	0.49 (0.28–0.85)	**−0.462 (0.234)** **	0.63 (0.4–1)
Agricultural & Veterinary Sciences	−0.355 (0.354)	0.7 (0.35–1.4)	−0.315 (0.333)	0.73 (0.38–1.4)
Health Service	−0.209 (0.36)	0.81 (0.4–1.64)	**−0.562 (0.242)** **	0.57 (0.35–0.92)
Services (tourism, sports, security, transport, logistics)	**−0.656 (0.328)** **	0.52 (0.27–0.99)	**−0.831 (0.218)**†	0.44 (0.28–0.67)
Distance between home and college (reference category: ≥100.1)				
≤20.0	−0.167 (0.162)	0.85 (0.62–1.16)	0.029 (0.166)	1.03 (0.74–1.42)
20.1–50.0	−0.067 (0.169)	0.94 (0.67–1.3)	0.03 (0.164)	1.03 (0.75–1.42)
50.1–100.0	−0.042 (0.162)	0.96 (0.7–1.32)	**−0.289 (0.137)** **	0.75 (0.57–0.98)
Residence (reference category: Village)				
City	0.071 (0.121)	1.07 (0.85–1.36)	0.076 (0.103)	1.08 (0.88–1.32)
Housing during the semester (reference category: Home)				
Away from home	0.011 (0.127)	1.01 (0.79–1.3)	0.078 (0.133)	1.08 (0.83–1.4)

AOR, adjusted odds ratio (AOR = e^{β}); 95% CI, 95% confidence interval.
**p-value < 0.1.*
***p-value < 0.05.*
****p-value < 0.01.*
†p-value < 0.001.
Significant results are highlighted in bold.

home to college were 0.75 less likely to be depressed than students traveling more than 100 kilometers.

DISCUSSION

Prevalence and Differences in Mental Health Problems

Among Czech students, prevalence of somatic complaints, anxiety and depression was 72.2, 40.3, and 52%, respectively. The most severe mental health problems were found in 10.1% of students with somatic symptoms, in 4.9% of students with anxiety, and in 3.4% of students with depression. Among Slovak students, prevalence of somatic complaints, anxiety and depression was 69.5, 34.6, and 47%, respectively. The highest severity was found in 7.4% of students with somatic symptoms, in 3.5% of students with anxiety, and in 2.7% of students with depression. Hajduk et al. (33) found a higher prevalence of depression and anxiety among Slovak students, but their research took place in December 2020, i.e., during the second wave, when the situation was more critical. In both their studies, Slovak students reported more depression than anxiety (33, 34), which corresponds to the results of the presented study. A very similar prevalence of mental health problems such as anxiety and depression was found among college students from Saudi Arabia (39) and South Korea (40), while students from Brazil showed a higher prevalence of both depression and anxiety (41). In comparison with the results of this study, Duan et al. (42) revealed a higher prevalence of depression but a lower prevalence of anxiety among Chinese college students. Portuguese and Lithuanian students reported a similar prevalence of anxiety but a lower prevalence of depression (43, 44). A slightly lower prevalence of mental disorders was found in a study involving Poland, Slovenia, Ukraine, Russia Germany, Turkey, Israel, and Colombia (9). Thus, the prevalence of mental disorders was similar to other countries (45).

Regarding the differences between the analyzed countries, a significantly higher score in somatic symptoms, anxiety, and depression was identified in the Czech Republic. Significant differences in the obtained scores were also observed in several individual cases, separately for the Czech Republic and Slovakia. Among others, the most obvious differences in mental disorders were found between the gender categories and between the age categories. In this context, it can be stated that female students suffer from mental health problems more than male students, but also younger students reported more mental health problems than older students. There were also other significant differences, especially between the categories of marital status, the categories of study form, the categories of study field, and the categories of housing during the semester.

Gender Factor

The main findings showed that female gender can be considered as one of the risk factors associated with an increased probability of somatic complaints and anxiety in both countries, and depression in the Czech Republic. This is in line with other studies focusing on students' mental health (9, 14, 39, 46–49). It is a well-known fact that females are more prone to mental disorders and report more mental health problems compared to their male counterparts (50). This can be explained by a lower threshold for perceiving mental impairment in males (51). In addition, the causes of mental problems are more prevalent in females; therefore, females are more likely to develop risk factors for mental disorders than males as early as adolescence (32, 52–54). This can result in more frequent emotional outlets in females (51), but also more frequent symptomatology associated with pain, fatigue, digestive problems, psychomotor agitation, and others (55). All this indicates that females feel and experience difficulties more internally, while biological factors also play an important role (56).

Age Factor

It was also found that Czech students aged 25 years and under were more likely to have somatic symptoms and depression compared to students aged 31 years and over. At the same time, Czech students aged 20 years and under were more likely to be anxious than students aged 31 years and over. In Slovakia, younger age was found to be a significant factor only in the case of depression. In more detail, Slovak students aged 20 years and under were more likely to suffer from depression than the oldest students (aged 31 years and over). These results agree with the general knowledge that younger people are a vulnerable population group in terms of poor mental health, as evidenced by many authors (39, 46, 57–60). On the other hand, there is also confrontational evidence that older age can be a risk factor in some cases (14). A Hungarian study showed that the younger age of college students can be considered an explanatory variable of favorable mental wellbeing during the COVID-19 isolation (61). Thus, inconsistencies can be observed across studies in different countries. However, the fact remains that special attention should be paid to younger people and their mental health in public policies.

Family Factor

The fact that college students from an incomplete family more often suffered from mental health problems, such as somatic symptoms, anxiety, and depression, was proven only in the Czech Republic. Despite the fact that this fact did not manifest itself in Slovakia, it is possible to agree with O'Farrell et al. (62), who also found that being from a single-parent family was independently associated with a high depression score. Moreover, a recent study confirmed that being from an incomplete family was associated with a higher lifetime prevalence of major depressive disorder (63). Thus, a family structure is an important determinant of students' mental health not only during the COVID-19 pandemic (64, 65). It is well-known that the family has an irreplaceable place in students' lives, while the presence of both parents is an essential aspect of cohesion, stability and support (66). Gray et al. (67) also emphasized that students reporting sufficient time spent with family members and highest level of love and connectedness, as well as those living in a two-parent family, were happiest. This underlines the importance of the role of parents in students' lives.

This study revealed that being a single student increases the chance of depression only among Slovak students. In other words, single Slovak students were more likely to

be depressed than students of a different marital status (married/divorced/widowed). A similar finding was presented by AlHadi and Alhuwaydi (39), who considered a single status to be a main risk factor for anxiety and depression. However, there are also conflicting findings that suggest that married students may be at greater risk of mental discomfort (14, 58). In this study, no significant relationships were confirmed in terms Czech students, as well as mental disorders such as anxiety and somatic complaints. Therefore, this should also be further examined in terms of having a partner.

Study Specifics

This study did not show that form of study can be considered a determinant of mental discomfort among Czech and Slovak college students. Thus, Czech and Slovak full-time students were not more prone to mental problems compared to part-time students. These findings are inconsistent with those of Stallman (49). According to some authors, full-time students were more negatively impacted by the COVID-19 pandemic, which was reflected in their emotional life (68, 69). On the other hand, Esmaeelzadeh et al. (70) found that part-time students were at higher risk of depression and anxiety than full-time. The form of study did not prove to be significant in the presented research and this fact may reflect the conditions of higher education in the Czech Republic and Slovakia. In any case, these discrepancies with other studies can be followed up with further research.

The findings of this study indicated that Slovak students of lower than third degree (1st, 2nd, combined) had significantly lower probability of anxiety and depression than doctoral (third-degree) students. At the same time, Slovak first- and second-degree students were less likely to be somatic than third-degree students. Among Czech students, first-degree students were less likely to have anxiety and depression and second-degree students were less likely to have anxiety compared to third-degree students. These findings indicate that doctoral students can be considered a risk group (31). The truth is that the degree of study should not be underestimated when examining students' mental health. In this regard, Aristovnik et al. (68) examined the issue from a global perspective and emphasized that first-degree students were generally affected more by the COVID-19 pandemic in terms of their emotional life. Ochnik et al. (9) also revealed that study degree can be a predictor of mental health. In their study focusing on nine countries, it was found that the first degree of study is a risk factor for depression. It is clear that the presented study provided different findings than international and global studies.

With a focus on the years of study, it was found that Czech third-year students were more likely to be anxious, depressed and somatic than first-year students. Slovak third-year students were also more likely to have somatic complaints, but fifth-year students were less likely to have anxiety compared to first-year students. Other studies have also shown that academic years play an important role in students' mental health. In this regard, AlJhani et al. (14) confirmed that first-year students from Saudi Arabia had higher levels of anxiety and stress. Al Saadi et al. (71) found that anxiety was less likely in fifth-and sixth-year compared to second-year students. In other studies, similar findings were revealed in terms of depression, anxiety and stress in other studies (72, 73). Accordingly, it can be agreed that the year of study is one of the main predictors of mental health (4, 47), although the findings may be different, as shown in this study.

The results revealed that the study of Informatics, Mathematics, ICT can be considered a risk factor for mental problems such as somatic symptoms, anxiety and depression in Czech and Slovak students. In other words, the results showed a lower probability of mental problems in students of study fields other than Informatics, Mathematics, ICT. In terms of comparison with other studies, Lipson et al. (74) confirmed that students of Humanities & Art and Design were more likely to have mental health problems. In a study conducted by Odriozola-González et al. (73), students of Humanities & Arts and Social Sciences & Law reported higher scores related to anxiety, depression, and stress with respect to students of Engineering & Architecture. However, their findings are inconsistent with those of Posselt and Lipson (75). It is evident that the field of study should be considered in the mental health of students, as each field is characterized by a different level of difficulty, which may be more pronounced during the COVID-19 pandemic. Academic demands are many times the most obvious aspect of the field of study.

In terms of other characteristics analyzed in this study, the distance between home and college was significant only in Slovak one case, specifically in depression.

Residence Specifics

Housing during the semester did not appear to be an important determinant of mental problems among Czech and Slovak students. On the other hand, it is possible to point out the findings of Thériault et al. (76), which showed that students living on campus had higher self-efficacy, especially on the subscale of psychological wellbeing, followed by students living off campus with their parents. Students living off campus without their parents had the lowest scores. One significant relationship was also found in the category of residence. In this context, Czech students from cities were less likely to have somatic symptoms than students from villages. Yang et al. (77) also confirmed that rural students had more mental health problems than urban students. At the same time, Zhang et al. (78) pointed to the fact that urban students have significantly higher self-esteem scores than their rural counterparts, but no statistically significant difference in depression was observed between urban and rural students. In contrast, Ochnik et al. (9) analyzed nine countries, including the Czech Republic, and revealed that living in town is a risk factor for depression.

Implications for Public Health

The level of mental disorders among Czech and Slovak college students was high during the early pandemic. Therefore, the study highlights the importance of monitoring the mental health of college students, communicating problems and developing effective prevention programs. Czech and Slovak colleges should pay increased attention to the mental health of their students and, together with experts and government officials, create mental health policies for successful prevention, early detection and

effective treatment of students' mental health problems. In this context, interventions aimed at students' mental health literacy and stigma reduction are necessary (79, 80). Student-centered programs and measures should focus on developing positive coping skills and reducing negative coping behaviors (57, 81).

In addition, barriers to seeking help from mental health professionals should be carefully identified and removed in order to support students' efforts to seek help and to provide timely psychological services with respect to the ongoing pandemic. This study encourages the apparent need for accessible and full-time psychological services in Czech and Slovak colleges to deliver psychological interventions to vulnerable students. College counseling centers play an important role in this regard and have great potential to provide students with professional assistance in improving their mental health (82). Also, electronic counseling centers, digital help-seeking tools and Internet-based interventions have unique features that can make them a key source of support for young people's mental health in modern times, as they are more available and less stressful (83, 84). These tools can provide valuable information, promotional images and videos, online lectures with experts aimed at recognizing the importance of good mental health for young people.

In view of the presented finding, students' individual characteristics such as gender, age, degree of study and field of study should be of great importance when developing mental health programs in the Czech Republic and Slovakia. In this context, female students, younger students, third-degree students, and students of Informatics, Mathematics, ICT were most at risk of mental disorders in both countries. These vulnerable groups of students need special attention and targeted interventions. Nevertheless, the supportive educational interventions should be focused on the college environment as a whole. Family structure and year of study should not be overlooked when developing effective strategies to improve students' mental health. Mental health policies need to focus on health promotion and preventive measures, as the demand for them increases even more during the COVID-19 pandemic. There are many ways to improve students' mental health and achieve their potential in a society, in which education for an active and healthy lifestyle, social and family support, as well as professional adequate help for students with mental health problems are irreplaceable (85). In the case of mental disorders, it is also necessary to be vigilant in terms of substance use (86, 87).

Strengths, Limitations, and Future Direction

The study has many strengths such as in-depth insight into the problem through many socio-demographic factors, sample size, direct comparison of the Czech Republic and Slovakia, but also coverage of two European countries where insufficient attention was paid to the issue. However, the study did not avoid limitations. Possible limitations include the fact that there was some risk of skewing the results due to non-random sampling. However, the selection of the research sample (quota sampling) was the most suitable alternative in the given conditions of the COVID-19 pandemic. Random selection could not be performed. Nevertheless, this limitation need not be considered disruptive to the results and value of knowledge. Another limitation may be the different measures related to COVID-19 applied in both countries, which may have affected Czech and Slovak students in different ways. Future research ambitions will focus on comparing the results of the pandemic period with the post-pandemic period.

CONCLUSIONS

Good mental health of students should be a priority for college representatives, society, professionals and policy makers, not only during the pandemic period. The study enriches the knowledge base about students' mental health in the Czech Republic and Slovakia. Thus, the main aim of the study was to examine the prevalence of anxiety, depression, and somatic symptoms in Czech and Slovak college students during the COVID-19 pandemic and to evaluate possible socio-demographic determinants of these mental health problems. The results revealed a high prevalence of mental disorders among Czech and Slovak college students and identified vulnerable groups of students, who require a special attention. In this context, female gender, younger age, third-degree (doctoral) study, and study of Informatics, Mathematics, ICT were associated with a higher probability of mental health problems during the early COVID-19 pandemic in both countries. In addition, strategies and interventions aimed at improving students' mental health should also take into account family structure, degree of study, and year of study. The findings of the study can help in efforts to improve students' mental health and implement effective prevention programs, which are more than necessary in both countries.

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 research was approved by the Ethics Committee of the General University Hospital in Prague as individual research (Ref. 915/20 S–IV). The study was conducted according to the guidelines of the Declaration of Helsinki. The respondents provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

BG: conceptualization, writing—original draft preparation, writing—review and editing, visualization, supervision, project administration, and funding acquisition. VI: conceptualization, methodology, investigation, resources, writing—original draft preparation, writing—review and editing, visualization, and supervision. MR: conceptualization, methodology, software, data curation, formal analysis, investigation, writing—original draft preparation, and writing—review and editing. TM:

resources, writing—original draft preparation, writing—review and editing, visualization, supervision, project administration, and funding acquisition. MM: conceptualization, investigation, writing—original draft preparation, writing—review and editing, supervision, project administration, and funding acquisition. All authors contributed to manuscript revision, read, 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/fpubh.2022.859107/full#supplementary-material

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Impact of Online Courses on University Student Visual Attention During the COVID-19 Pandemic

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Background: Under the threat of COVID-19, many universities offer online courses to avoid student gatherings, which prevent teachers from collecting responses and optimizing courses. This work collected eye movement data to analyze attention allocation and proposed instruction for improving the courses.

Methods: Subjects were recruited to watch three online courses. Meanwhile, their eye movement data were collected through Dikablis Glasses. Mayer's multimedia cognitive theory was adopted to discriminate the pivotal components of online course, and the Mann–Whitney relevance analysis demonstrated that different representations of courses affected the viewers' attention differently.

Results: Three subjects watched three different types of political courses. Course 1, which combined text and explanation, attracted the most attention. Course 2 was shown to be less attractive than course 1 and better than course 3, but the subjects were distracted by the animations in course 2. Course 3, which did not use any technique to present learning content, attracts the least attention from the subjects. A correlation analysis shows that course 1 and course 3 have similar results compared with course 2.

Conclusion: Online courses have become a norm during the COVID-19 pandemic. Improving the quality of online courses can effectively reduce the impact of the epidemic on teaching. These experiment results suggest that text + commentary in the design of online courses can effectively attract the attention of the listeners and achieve better learning results. Attention gradually rises in the early stage and then falls after reaching a peak. At this time, the proper introduction of animation can effectively reverse the attention curve, while individual text or commentary results in quickly losing the listener's attention.

Keywords: COVID-19, attention bias, eye movement, university student, cognitive theory

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INTRODUCTION

After the sudden outbreak of the COVID-19 epidemic in early 2020, almost all stages of educational institutions decided to support online courses for students in response to the shutdown of campuses (1–3). Over 22.59 million university students and 1.67 million teachers participated in online courses (4). However, there are flaws in online learning,

FIGURE 1 | Schematic of the visual attention experiment.

such as delay in responses, lack of a sense of community and feelings of isolation, and undermined teaching quality (5–7). Traditional methods, which were used to estimate the quality and efficiency of offline courses, encountered limitations in online courses (8–10). It is also difficult for teachers to receive responses from students directly and optimize their course structures (11–14). Brown and Krzic (15) compared three different methods of teaching and taught using videos, laboratory manuals, and assignments, and combining synchronous and asynchronous and virtual laboratories were fundamental and the critical first step in transitioning to online teaching and learning. Tang et al. (16) used Fuzzy Comprehensive Evaluation-Analytic Hierarchy Process (FCE-AHP) to quantitatively evaluate the quality of online courses and divided the evaluation criteria into four major indicators and 14 s-level indicators. Hou et al. (17) created a way to investigate students' perception of online courses in terms of teaching presence, cognitive presence, and online modality. Chick et al. (18) proposed several innovative solutions, including the flipped classroom model, online practice questions, and teleconferencing in place of in-person lecture to bridge the educational gap for surgical residents during this unprecedented circumstance. Zhang and Liu (19) investigated the college students' attitude toward online courses in shaping their psychological distress during the COVID-19 epidemic. Yu-Fong Chang et al. (20) provided a questionnaire-based online survey to analyze the difference in learning effectiveness between a physical classroom and online class learning for dental students. Zhang and Wei (21) analyzed the positive and negative effects of online teaching mode on the effectiveness of moral education function of ideological and political courses in colleges and universities by literature research, questionnaire survey, and interview. They suggested that cultivating teachers, improving the information technology level, and expanding the Internet coverage were necessary methods. Bao (22) proposed five principles of high-impact teaching practice to effectively deliver large-scale online education.

The cognitive load theory and the cognitive theory of multimedia learning were proposed as instruction for many researchers in educational video design (23–25). Well-designed online courses influenced and promoted the students' depth of learning (26). Iorio-Morin et al. (27) identified four workflows to improve the effectiveness of using a video in medical education based on the cognitive theory of multimedia learning. Liu et al. (28) proposed four modes of video to test whether this theory applied in English-as-a-second-language (ESL) students. Luzón and Letón's results suggested that appropriate animation promoted selecting information, building representation models, and making sense (29).

FIGURE 2 | Dikablis Glasses.

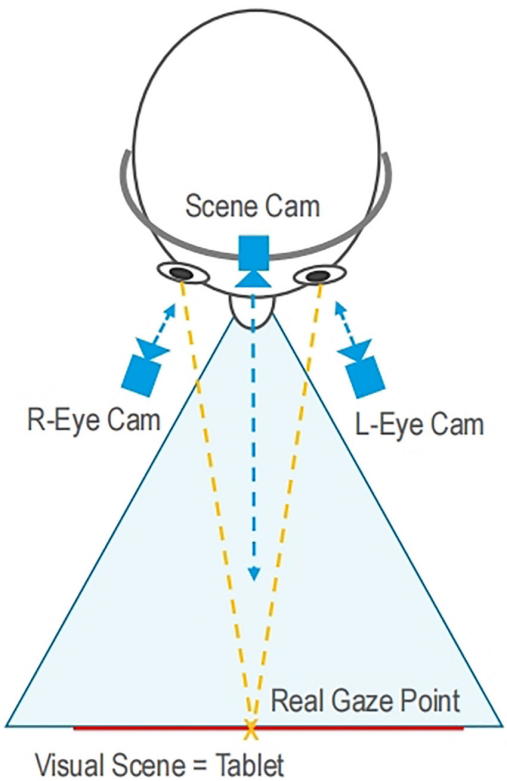

FIGURE 3 | Schematic of eye movement tracking.

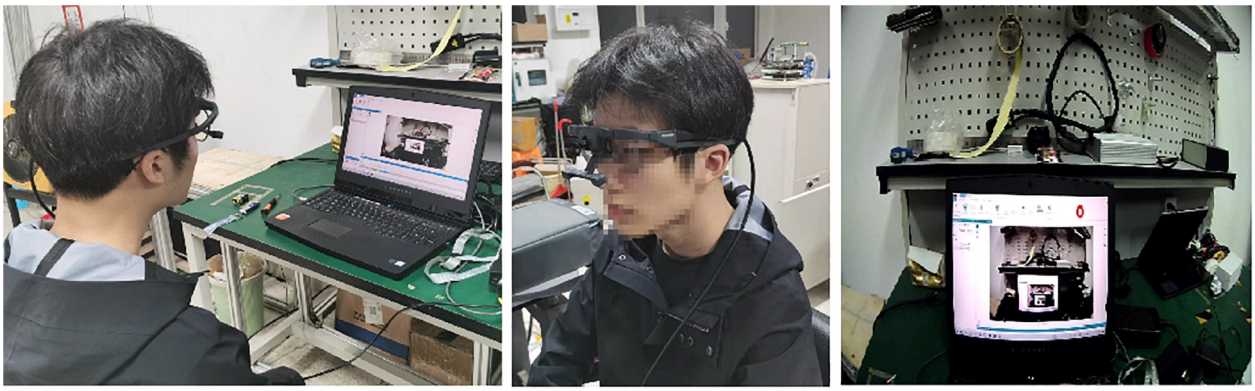

FIGURE 4 | Collection of the subject's eye movement data.

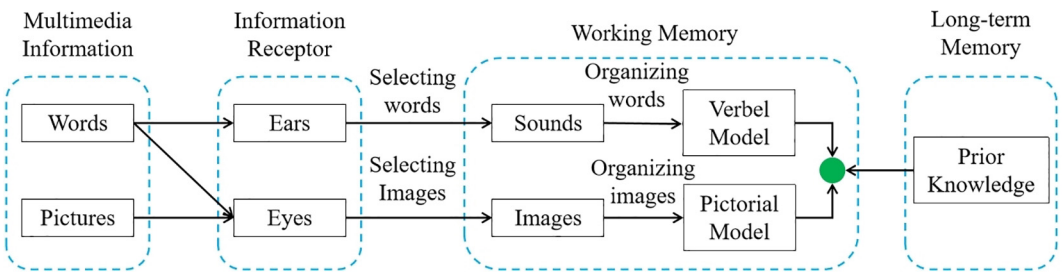

FIGURE 5 | Schematic of multimedia cognitive theory.

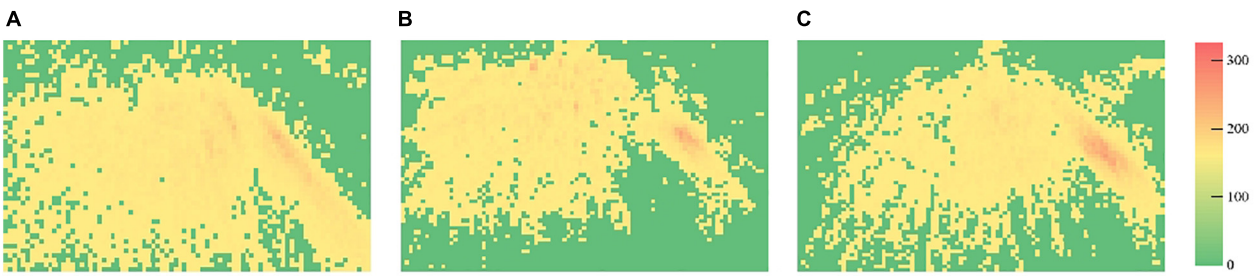

FIGURE 6 | Heat maps of course 1 (**A**, heat map of subject 1; **B**, heat map of subject 2; and **C**, heat map of subject 3).

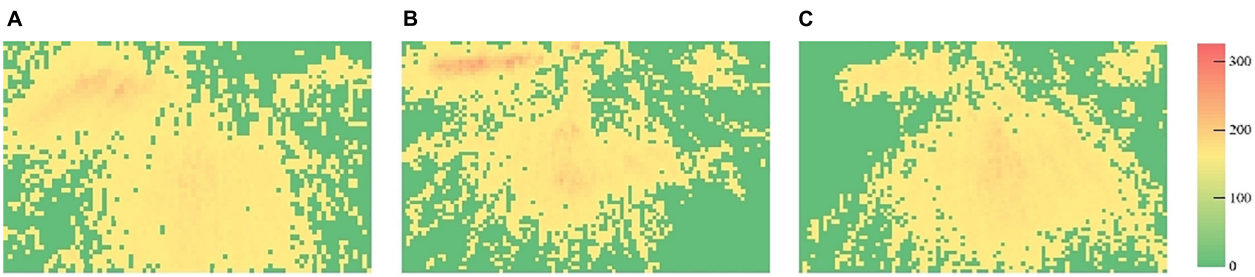

FIGURE 7 | Heat maps of course 2 (**A**, heat map of subject 1; **B**, heat map of subject 2; and **C**, heat map of subject 3).

MATERIALS AND METHODS

Experiment Design

Three subjects were recruited to participate in this experiment. They were required to watch three political videos which lasted 5 min each, and they had 1 min to rest between two courses. The schematic of the experiment is shown in **Figure 1**. The online courses can be divided into three types. Course 1 had set the text to the left of screen, and teacher stood to the right. Course 2 used subtitles to replace text at the bottom of the screen and added some transition animations to switch shots. In course 3, the teacher sat in the middle of the screen without any subtitle or animation.

Eye Movement Tracking System

Dikablis Glasses system (Ergoneer, Germany) was used to collect eye movement data, which is shown in **Figure 2**. The full image measurement frequency of the system is 50 Hz. The horizontal viewing angle ranges from 50° to 115°, and the vertical viewing angle ranges from 50° to 115°. As shown in **Figure 3**, scene camera received the images of the subjects' visual scene. The right and left eye cameras caught the position of the pupils and calculated real gaze position.

All subjects sat in front of the computer and wear eye trackers. The eye track system needed to be calibrated firstly. The gaze point was indicated by a red dot on the screen during calibration. The subject watched the online courses after adapting to the track

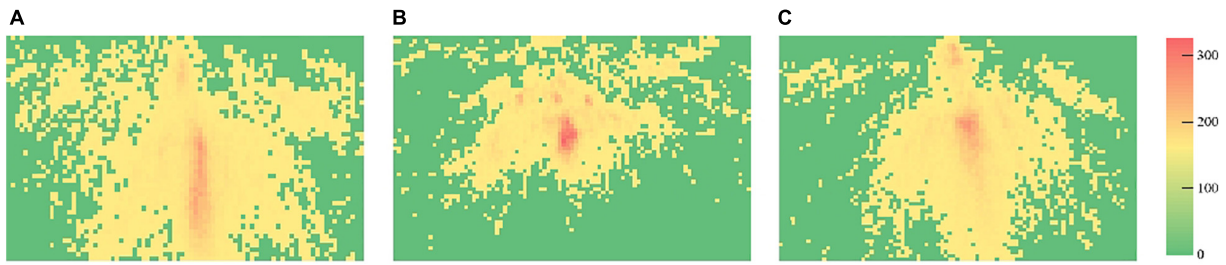

FIGURE 8 | Heat maps of course 3 (**A**, heat map of subject 1; **B**, heat map of subject 2; and **C**, heat map of subject 3).

FIGURE 9 | Frame of videos (**A**, course 1; **B**, course 2; and **C**, course 3).

TABLE 1 | Comparison of attention ratio.

	Course 1 (%)	Course 2 (%)	Course 3 (%)
Subject 1	62.60	71.75	65.24
Subject 2	72.63	74.36	68.54
Subject 3	98.15	87.23	91.56
Average	77.79	77.78	75.11

glass, and the tracker system tracked and recorded the change of the subject's gaze point in the field of vision in real time. The experiment process is shown in **Figure 4**.

Mayer's Multimedia Cognitive Theory

Mayer's multimedia learning theory is shown in **Figure 5**, which distinguishes multimedia information from visual information and auditory information from the perspective of sensory channels. People's processing of the presented information relies on two channels: one is the visual channel, and the other is the auditory channel. Multimedia materials are divided into text and pictures. The information of text materials is received by the ears and the eyes, and the picture information is received by the eyes. The two channels respectively identify and classify information, accept the appropriate type of information for processing, and integrate learning with prior knowledge in long-term memory.

Correlation Analysis Method

Mann–Whitney's U-test is a non-parametric procedure in comparing two independent sample distributions (30). This method is more robust than T-test and can be applied to continuous data. It is especially useful when the normality assumption is not met (31).

There are two groups of independent continuous random variables $X = \{x_1, x_2, ..., x_n\}$ and $Y = \{y_1, y_2, ..., y_m\}$. The mean of variables are μ_X and μ_Y. The total size of variables is $m+n$. Suppose that X and Y are identical. The distributions of the two variables have similar shapes. To test whether there is a significant difference between μ_X and μ_Y, the null hypothesis and the alternative hypothesis can be described as follows:

$$H_0 : \mu_X = \mu_Y \tag{1}$$

$$H_1 : \mu_X \neq \mu_Y \tag{2}$$

Then, the statistical value of X can be calculated as follows:

$$U_X \ W_{YX} \ \sum_{i=1}^{m} (R_{i-1} - i) \tag{3}$$

where i represents the rank of rearranged X from largest to smallest and R_{i-1} represents the rank of variable $i-1$ in new samples, which mixes X and Y and rearranged them from largest to smallest. Then, the statistical value of Y can be calculated as follows:

$$U_Y = W_{XY} = \sum_{j=1}^{n} (R_{j-1} - j) \tag{4}$$

The area under the curve (AUC) is used to measure the significance of the difference between two variables. It can be described as follows:

$$\text{AUC} = \frac{U_X}{U_x + U_Y} \tag{5}$$

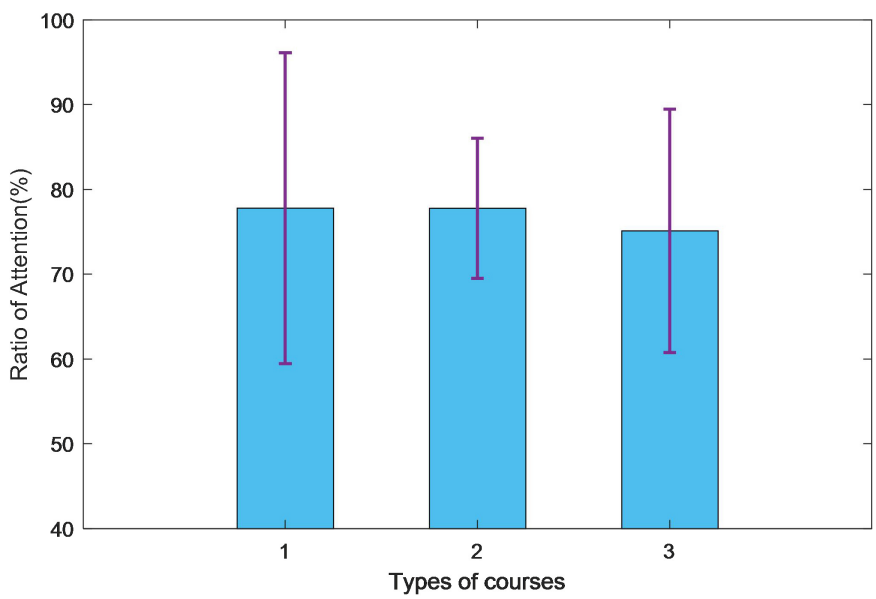

FIGURE 10 | Comparison of attention ratio.

RESULTS

Heat Maps of Visual Attention

The heat maps of courses are demonstrated in **Figures 6–8**, respectively, and the frame of the three videos is shown in **Figure 9**. The maximum value in **Figure 6** is 186, and the standard deviation is 12.69. The maximum value in **Figure 7** is 303, while the standard deviation is 14.79. The maximum value in **Figure 8** is 202, and the standard deviation is 12.53. The minimal value of the three subjects is 0. In the same course, the gaze points have similar distributions for the subjects. They focus on where the text and the teacher appeared in course 1, the gaze points of course 2 are distributed in the teacher and animation areas, and the attention at the subtitle area was less than that of the text area in course 1. The gaze points of the subjects gathered in the teacher's area. Compared with the previous courses, the heat maps of course 3 were more evenly distributed in the whole screen.

Ratio of Attention

The comparsion of attention are shown in the **Table 1** and **Figure 10**. In course 1, the average time of all subjects' eyes on the screen is 77.79%. In course 2, the average ratio on the screen is 77.78%. In course 3, it is 75.11%. The variance of the course 1 results was the largest, and the highest attention result and the lowest attention result appear in course 1. The results of course 2 have a small variance, and the distribution is relatively even. The subjects' attention is lower than in the other two courses.

The average attention curve in course 1 is shown in **Figure 11**, which is the same as the change of the human learning attention

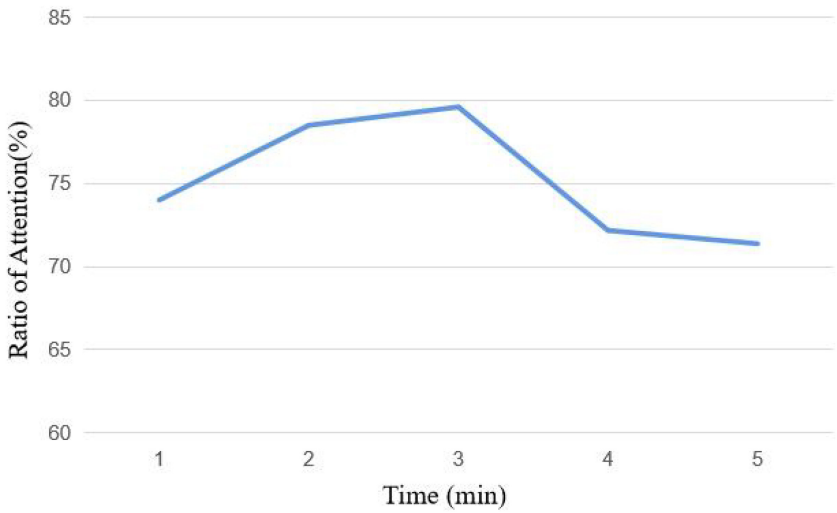

FIGURE 11 | Attention curve of course 1.

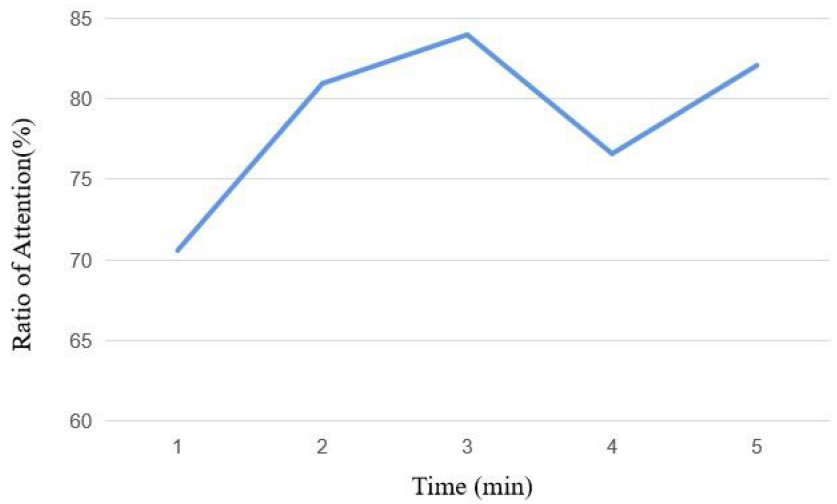

FIGURE 12 | Attention curve of course 2.

curve. Attention gradually rises in the first 3 min and then begins to fall in the last 2 min.

The average attention curve in course 2 is shown in **Figure 12**. The change of the first 4 min in course 2 is the same as the first 3 min in course 1. The attention ratio gradually rises and then falls, but it rises again at the fifth minute. The video uses animation and camera movement technology at the last 2 min to effectively attract the attention of the subjects and increase the attention time on the screen.

The average attention curve in course 3 is shown in **Figure 13**. In course 3, the attention of the subjects decreased in the second minute and then decreased again after rising. It shows that simple speech without any text can easily make listeners lose interest quickly and reduce their attention. Compared with the previous two courses, the subjects' attention in course 3 is also the lowest.

Results of Mann–Whitney Test

Mann–Whitney test is used to test two samples from continuous distributions, which have equal medians. A high *P*-value indicates that the two samples have similar distributions. The results are shown in **Figure 14**. The *P*-value of course 1 and course 2 is 0.3950. The *P*-value of course 1 and course 3 is 0.8413 and that of course 2 and course 3 is 0.1508. It shows that course 1 and course 3 have similar distributions and that course 2 is different from course 1 and course 3. Compared with course 2, the changes of attention of the subjects are more similar. It also shows that animation can improve the attention of the subjects.

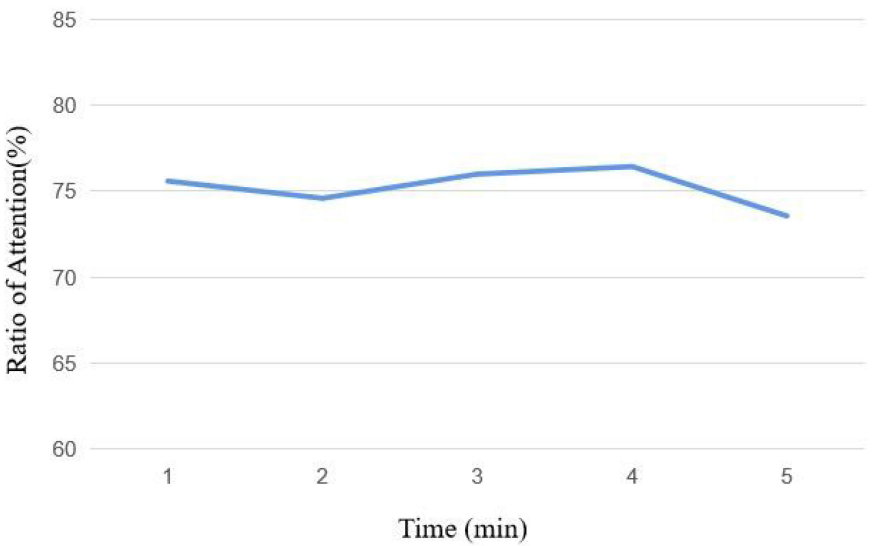

FIGURE 13 | Attention curve of course 3.

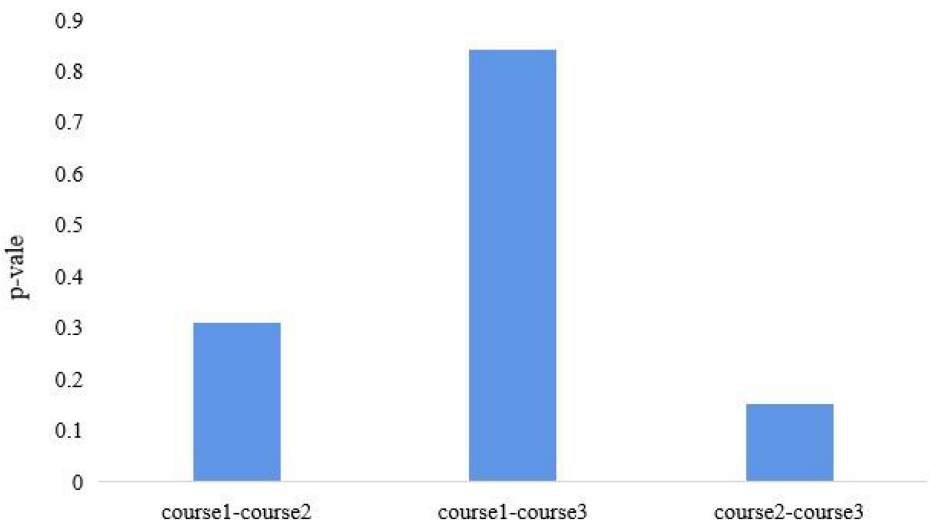

FIGURE 14 | *P*-value of courses.

CONCLUSION

Online lectures become more and more popular during the COVID-19 pandemic period, which prevents the spread of respiratory infection that is likely to happen in the traditional face-to-face teaching mode. To find out the appropriate online teaching format, this study investigated the students' visual attention during the online lecture process.

If the learning content is presented in the form of written or encoded text, then the information enters from the eyes and is processed in the visual channel, which causes the visual channel to be overloaded, while the other channel does not need to work. The experimental results show that the presentation of words in the form of text and commentary can improve the learning effect on the students.

Animation can attract students to learn and effectively increase their time spent on the screen, but it also affects the time that the subjects spend on watching subtitles. Interspersed and added animation effects during the time when their attention is failing can improve the teaching effect.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements. 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

QG designed the theoretical framework and collected the data. SL analyzed the data. Both authors wrote the manuscript.

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The Impact of the COVID-19 Pandemic on Diagnosing and Treating Attention Deficit Hyperactivity Disorder: New Challenges on Initializing and Optimizing Pharmacological Treatment

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Introduction: COVID-19 has been causing huge disruptions in mental healthcare services worldwide, including those related to ADHD. Some consequences of the pandemic, such as virtual schooling and remote work, as well as increased telemedicine, have posed new challenges for ADHD diagnosis and treatment. In this narrative review, we summarize existing COVID-19 and ADHD literature especially focusing on ADHD diagnostic during the pandemic and treatment adherence.

Methods: The databases searched were: PubMed, PsycINFO, EMBASE, Google Scholar and medRxiv. We included all English language articles and preprints that reported on medication/pharmacological treatment among the terms "ADHD" and "COVID-19" resulting in a total of 546 articles. The final search was done on Dec-23 2021. We selected fifteen articles focusing on the challenges of ADHD diagnostic during COVID-19 pandemic.

Results: Of the fifteen studies included, most were cross-sectional and perspective pieces. Most of them discussed that individuals with ADHD present risk factors that may make them more vulnerable to health negative consequences of the pandemic, which in turn may have an impact on treatment efficacy and adherence. Telemedicine is also addressed as a potential powerful instrument on monitoring ADHD treatment.

Conclusion: Despite the challenges posed by the pandemic on monitoring ADHD treatment, the available literature stressed that the current scenario also may offer new opportunities that could lead to the development of individualized treatment interventions, such as the remote monitoring of symptoms.

Keywords: attention deficit-hyperactivity disorder, treatment, COVID-19, ADHD, pharmacological treatment

INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a prevalent, impairing condition that is frequently comorbid with other psychiatric disorders and creates a substantial burden for the individual, their family, and the community (1). Positive correlations between ADHD diagnosis and unsafe school, unsafe neighborhood, and economic hardship are evident in a recent United States national research (2). Pharmacological treatment is part of the comprehensive multimodal evidence-based strategy to achieve adequate control of core ADHD symptoms and comorbid conditions, minimizing functional impairments and improving quality of life (3). Drug strategies for the treatment of ADHD are categorized into stimulants and non-stimulants. Although short-term efficacy of psychostimulants is well-established, the effectiveness of these drugs in the educational, vocational and social domains in long-term treatment remains uncertain (4, 5). Treatment selection strategy should also take into account aspects that impact medication treatment response such as age of the patient, severity of the disorder, and comorbidities (6).

COVID-19 has been causing huge disruptions in mental healthcare services worldwide (7). A significant increase of mental health complaints in the general population since the beginning of the pandemics have lead some authors to speculate that mental illness may be the next "inevitable pandemic" (8). This hypothesis seems to be especially relevant when we take together both the psychosocial effects of the pandemic and the vulnerability of psychiatric patients, including those with ADHD, as two different risk factors (9).

Recently investigators and clinicians have sought to examine the possible impact of COVID-19 pandemic on patients with ADHD (10–13). Cortese et al. suggest that the distress caused by the pandemic and the physical distancing measures may worse some of the behavioral problems already seen in patients with ADHD (14). Moreover, some consequences of the pandemic, such as virtual schooling and remote work, as well as increased telemedicine, have posed new challenges for the diagnosis and treatment of ADHD. For instance, initializing and optimizing medication treatments for ADHD has been a theme of great concern (15). Although some findings on this issue were already published, there is still a need for an in-depth investigation on the impact of the current health crisis over patients with ADHD.

In this narrative review, we summarize existing COVID-19-related literature pertinent to ADHD, with a special focus on treatment adherence, integrating recent research findings. We also provide a discussion on the potential implications of the reviewed studies for the ADHD field and provide future research directions.

This narrative review aims to identify which are the most relevant findings regarding the new challenges in diagnosing and treating patients with ADHD during the COVID-19 pandemic. We believe that the biggest challenge is to establish how to perform the best remote monitoring of patients with ADHD, ensuring good adherence to treatment. Using telemedicine more efficiently will be a crucial point in achieving good adherence to ADHD treatment.

METHODS

In this review, we use a narrative approach (16, 17). The aim is to summarize the main findings of the studies that investigate the impact of the COVID-19 pandemic on patients with ADHD and the role of ADHD as a risk factor for COVID-19. We also give a special focus on two issues: (1) diagnosing ADHD during the pandemic and; (2) the challenges that clinicians face when treating patients with ADHD during the pandemic. The following databases were searched using the terms 'ADHD and COVID-19': PubMed, PsycINFO, EMBASE, Google Scholar and medRxiv. We selected and included all English language papers and preprints resulting in a total of 546 articles. We excluded the repetitions and have selected only the ones that reported on medication/pharmacological treatment among the covered topics on the implications of COVID-19 in ADHD management. The final search was done on Dec-23 2021. We have included case reports, case–control studies, reviews, commentaries, viewpoints, perspectives, guidelines and letters to the Editor. We also searched conference abstracts for events held in 2020 and 2021, considering the rapidly evolving scope of this review.

RESULTS

A total of fifteen studies were identified and included in this narrative review. There were no randomized controlled trials on this specific topic. Most of the included studies were viewpoint/expert opinion, case–control studies and treatment guidelines. **Table 1** provides a summary of each study included in this review. We summarized the findings of these studies under the main headings described below.

The Impact of COVID-19 Pandemic on Mental Health, Sleep and Well-Being Outcomes in Patients With Attention Deficit Hyperactivity Disorder

The mental health outcome of the COVID-19 pandemic is increasingly recognized as a relevant, worldwide public health concern (27). In individuals with pre-existing neurodevelopmental disorders, such as ADHD, it has been hypothesized that the distress caused by the pandemic and physical distancing measures may lead to worsening of behavioral problems (14). In the current scenario, new priorities and challenges for diagnosing and treating individuals with ADHD have emerged.

Sibley et al. used a survey to assess the top problems reported by adolescents and young adults with ADHD during the COVID-19 pandemic (12). The most common top problems rated as more severe during the pandemic than in prior months were difficulties engaging in online learning, boredom and social isolation. Becker et al. (10) also conducted a survey study to examine the nature and impact of remote learning during the COVID-19 pandemic in adolescents with ADHD. The authors reported that fewer adolescent routines, higher negative affect, and more difficulty

TABLE 1 | Information on the included studies.

	Author(s)	Country	Journal	Study/Article type	Summary	Key findings
1	Singh et al. (18)	India	Psychiatry Research	Expert opinion/review	The authors discuss the potential negative impact of the COVID-19 pandemic on mental health of children and adolescents.	There is a need to ameliorate children and adolescents' access to mental health support services geared toward providing measures for developing healthy coping mechanisms during the current crisis.
2	Surman et al. (19)	United States	Abstract APSARD 2021	Pilot	This study explored the sensitivity of electronic patient peported outcome measures to medication effects in adults with ADHD (*n* = 91) during the pandemic.	Observation of a likely correlation between patient sensitivity and mobile ADHD symptoms while changes in treatment status were monitored.
3	Becker and Gregory (20)	United States	J Child Psychol Psychiatry	Editorial perspective	The authors discuss ways in which the pandemic may impact sleep and associated psychopathology for child and adolescents.	Youth with preexisting psychopathologies and neurodevelopmental conditions (including attention-deficit/hyperactivity disorder and autism spectrum disorder) could be especially vulnerable to disturbed sleep during this period of change and uncertainty.
4	McGrath (21)	Ireland	I J Psychol Med	Expert opinion/viewpoint	The author discusses the impact of the COVID-19 pandemic on the provision of mental health services for young people with ADHD, with a focus on a specialist ADHD service in Dublin.	Current guidelines and alternative ways of ensuring adequate service provision are discussed. Factors that should be considered when developing a telepsychiatry service for children and adolescents with ADHD are highlighted.
5	Becker et al. (10)	United States	J Adolesc Health	Survey	A survey study of remote learning practices and difficulties at the beginning of the COVID-19 pandemic in adolescents with and without ADHD (*n* = 238).	Adolescents with ADHD had fewer routines and more remote learning difficulties than adolescents without ADHD. Parents of adolescents with ADHD had less confidence in managing remote learning.
6	Non-weiler et al. (11)	United Kingdom	Children	Survey	A parent-reported study using the Strengths and Difficulties Questionnaire conducted 2nd April–2nd June 2020 (*n* = 453 children aged 4–15 years).	All groups had worse emotional symptoms than pre-COVID-19 groups, and those with attention-deficit/hyperactivity disorder showed inflated conduct problems.
7	Sibley et al. (12)	United States	J Psychiatr Res	Survey	A survey study of self and parent ratings about current and pre-pandemic top problem severity and benefits of the pandemic (*n* = 134).	There was no evidence that pandemic-related changes mitigated ADHD severity.
8	Sciberras et al. (13)	Australia	J Atten Disord	Survey	A survey study with parents (*n* = 213) of children (5–17 years) with ADHD conducted in May 2020 about physical and mental health, as well as media use during the pandemic.	COVID-19 restrictions were associated with both negative and positive impacts among children with ADHD.
9	Wyler et al. (22)	Switzerland	BMC Psychiatry	Mixed-method	This study combines a quantitative questionnaire data and qualitative data from interviews to explore ADHD patients' and therapists' experience of a specific therapy session during the COVID-19 pandemic in one of the following three treatment modalities: face to face, videoconferencing, and telephone.	Both settings, on-site with the therapist wearing a face mask and telepsychiatry, seem to be valid options to continue treatment of adults with ADHD during a situation such as the COVID-19 pandemic.
10	Cortese et al. (14)	International	Lancet Child Adolesc Health	Guidelines	A consensus statement on ADHD management during the COVID-19 pandemic published by the European ADHD Guidelines Group.	The risks and benefits of initiating or maintaining medication under the COVID-19 restrictions implemented in some countries should be carefully considered. If the use of medication is deemed desirable, strategies for remote monitoring should be implemented.

(Continued)

TABLE 1 | (Continued)

	Author(s)	Country	Journal	Study/Article type	Summary	Key findings
11	Cortese et al. (15)	International	Lancet Child Adolesc Health	Guidelines	An addendum on the previous guideline about starting ADHD medications during the pandemic.	Provides additional guidance for patients who did not have a baseline, face-to-face cardiovascular assessment before the crisis began.
12	Merzon et al. (23)	Israel	J Atten Disord	Observational	The authors examined whether ADHD constitutes a risk factor for COVID-19 infection and the role of pharmacotherapy as a protective factor using patient registered data (n = 14,022).	The risk for COVID-19-Positive was higher in untreated-ADHD subjects compared to non-ADHD subjects, while no higher risk was detected in treated ones.
13	Breaux (24)	United States	J Child Psychol Psychiatry	Observational	The authors assessed ADHD and other mental health symptoms (n = 238) shortly before the COVID-19 pandemic and in spring and summer 2020.	Adolescents with ADHD were more likely than adolescents without ADHD to experience an increase in inattentive, hyperactive/impulsive, and oppositional/defiant symptoms.
14	Altena et al. (25)	France	J Sleep Res	Review	Authors reviewed the literature on the stress-sleep link and confinement, as well as effective insomnia treatment.	Managing sleep problems as best as possible during home confinement can limit stress and possibly prevent disruptions of social relationships.
15	Breaux et al. (26)	United States	The ADHD Report	Editorial report	A report on the effects of COVID 19 pandemic on ADHD care and the use of telehealth.	Evidence suggesting the increased and far-reaching risk for individuals with ADHD during the COVID-19 pandemic.

concentrating because of COVID-19 were associated with greater remote learning difficulties.

Non-weiler et al. investigated the prevalence of emotional and behavioral problems assessed by parent reports among children and young people with ADHD between April and 2nd June 2020 (11). They found that ADHD children had worse emotional symptoms and inflated conduct problems than comparable cohorts pre-COVID-19.

It has also been postulated that quality of sleep may be profoundly impacted by COVID-19, and that children and adolescents with ADHD may be particularly vulnerable to disturbed sleep during the pandemic (20, 25). Breaux et al. examined changes in adolescent sleep before and during the COVID-19 pandemic using surveys with parents and adolescents with ADHD (24). Analysis of the survey answers showed that adolescents with ADHD did not experience an increase in night sleep duration in school days and were less likely to obtain recommended sleep duration during COVID-19 compared to non-ADHD controls. The majority of ADHD participants (83%) were already using medication to treat ADHD before the beginning of the pandemic. In his perspective piece about the impact of the pandemic on a tertiary-level specialist ADHD service in Dublin, McGrath describes many sleep problems reported by families (21). The author states: "...Sleep patterns had deteriorated for the majority of families, with sleep onset times pushed forward by approximately 3 h."

Results from a survey study showed that restrictions imposed by the pandemic may also impact children and adolescent's well-being. The authors found children and adolescents had less time spent on physical exercising, less time to engage on outdoor activities and less enjoyment in those activities while time spent on television, social media, gaming, sad/depressed mood, and loneliness were increased compared to pre-pandemic era (13).

the Impact of the COVID-19 Pandemic on Diagnosing and Treating Attention Deficit Hyperactivity Disorder: Challenges on Treatment Adherence

The implementation of a medication protocol in ADHD with periodic assessment of symptoms, real-life functional benefits and adverse effects is imperative for adjusting pharmacological treatment to optimize outcomes (6). During the COVID-19 pandemic, the EAGG released best practice recommendations suggesting individuals with ADHD should continue with medication as usual (14). However, it remains unclear whether government restrictions in different countries have prevented these recommendations from being followed by telepsychiatry.

An addendum of the EAGG recommendations was released with additional advice on starting ADHD medications during the 2019 pandemic for individuals with ADHD who did not have a pre-pandemic baseline in-person cardiovascular assessment (15). They recommended that, given the circumstances imposed by the pandemic, cardiac auscultation should not be mandatory in individuals with no risk factors for cardiac disease. The group suggested that baseline monitoring (i.e., blood pressure and heart rate measured in three separate occasions) before medication initiation can be done by a lay person supervised through remote assistance. Evidence for the effectiveness of telepsychiatry in the treatment of ADHD comes from a recent systematic review with a limited number of studies (n = 11) suggesting this modality as a viable method to provide pharmacologic treatment for children with ADHD (28). Thus, there is a strong need for studies examining the effects of remote ADHD-medication prescriptions during the COVID-19 pandemic on treatment outcomes.

Changes in medication treatment patterns during the pandemic were investigated by Sciberras et al. in a survey study

with 213 parents of children with ADHD in Australia (13). Data were gathered during a 4-week period in May 2020 when social distance measures (i.e., requiring citizens to stay at home except for essential reasons) were in place. Approximately two-thirds of the parents reported that their child was taking medication, mostly stimulants, to assist with learning, behavioral, emotional or sleep difficulties. When the parents of those children taking medication were asked specific questions about medication use in the last month, 17% reported a dosage change (majority had increased dosage), and 16% reported that their child had stopped taking a medication. Most of the stopped medications were ADHD medications (n = 24). Among the reasons informed by parents for stopping an ADHD medication were taking a break during school holidays, not requiring medication due to school closure/remote learning and stopping one ADHD medication to start another. Only 11% of parents reported difficulties in purchasing ADHD medication. Among the reasons, the two most common were: (1) medication not available on the stock and (2) difficulties on getting the prescriptions.

In his perspective article, McGrath discusses the challenges to optimizing ADHD medication for children and adolescents in face of school closures (21). He points out the difficulties to determine the effectiveness of medication without teacher feedback during medication titration. The author emphasizes the role of parental report in this process, since many parents have been working from home and then have a unique opportunity to comment on the effectiveness and impact of medication on their child's academic and social functioning.

In another survey study from Switzerland, Wyler et al. explored the perceptions of therapists and adults with ADHD about three different modalities of therapy sessions (i.e., face-to-face with the therapist wearing a face mask, *via* telephone, or videoconferencing) during the COVID-19 pandemic (22). Qualitative analysis of responses showed that patients felt that a telephone session worked well to discuss medication. Therapists reported that the limitations of a videoconferencing session were less important for sessions that focused on medication rather than psychotherapeutic work.

Despite the challenges posed by the pandemic on monitoring ADHD treatment, the current scenario also may offer new opportunities that could lead to the development of "targeted" and individualized pharmacological interventions. This issue has been considered by a recent pilot work with 90 adult patients taking stimulant therapy for ADHD (19). The study collected demographic information, medication use history and patterns, and symptoms associated with ADHD using mobile phone surveys. The researchers adopted an individualized approach to send patients medication-sensitive items of the Weiss Functional Impairment Rating Scale (WFIRS) and the Adult ADHD Self Report Scale v1.1 (ASRS) during selected time periods in the morning and evening. From these data, investigators noted sensitivity thresholds for symptom reporting by patients, as well as within-day and between-day differences in response patterns. Researchers then inferred "on" and "off" medication status based on mobile monitoring of ADHD symptoms and functional impact.

Moreover, there is now an opportunity to exploit the wider use of digital medicine innovations on monitoring patients that are using medication. This perspective is discussed by McGrath, who points to the widespread inclusion of heart rate monitors in smartphones and fitness watches as well as the possibility of inferring it from contact photoplethysmography (PPG) using cell phone cameras (21). The author argues that home-monitoring of heart rate is currently a feasible option, since most families have access to a smartphone.

Attention Deficit Hyperactivity Disorder as a Risk Factor for COVID-19 and the Role of Attention Deficit Hyperactivity Disorder's Pharmacological Treatment

It has been postulated that ADHD-related difficulties are associated with a high risk of having COVID-19 (18). To test this hypothesis, Merzon et al. (23) analyzed data from 14,022 people in Israel registered to a comprehensive database between February 1st and April 30, 2020, who underwent at least one COVID-19 test (23). The researchers reported an infection rate of 10.1% in the total sample. Analyzing the sample of individuals with a positive test result, the authors reported that these individuals were younger and had higher rates of ADHD diagnosis when compared with the sample of individuals that tested negative for COVID-19. The hypothesis of ADHD also increases the risk of severe COVID-19 infection was studied as well. The authors found that ADHD was associated with poorer outcomes in COVID-19 infection (29). In another study, people with ADHD were more vulnerable to the challenges created by the COVID-19 pandemic (30). In a report about the impact of COVID-19 on ADHD patients, the authors highlights the heterogeneity of risk among individuals with ADHD (11).

To further investigate the effect of ADHD stimulant pharmacotherapy on preventing COVID-19 infection in patients with ADHD, the authors carried out subsequent comparisons between patients treated for ADHD, patients not treated for ADHD and a control group of individuals with no ADHD diagnosis (23). Results showed that the risk for COVID-19 was higher in ADHD patients not treated. They concluded that stimulant pharmacotherapy may reduce the risk of COVID-19 infection in patients with ADHD.

DISCUSSION

In this paper, we review the current state of knowledge on the potential impact on the COVID-19 pandemic for the clinical management of ADHD. The key findings in this review are: (1) Patients with ADHD had a higher prevalence of psychiatric symptoms as a consequence of the COVID-19 pandemic. There was also a greater negative impact on learning, social life, and quality of life; (2) The risk of discontinuing the treatment of ADHD, with negative consequences for patients and families, has brought a warning to medical societies. This concern led to the creation of guidelines and strategies to maintain the correct monitoring of these patients at a distance; (3) Research findings showed a higher frequency of ADHD diagnoses in samples from COVID-19 patients. Correct treatment of ADHD was associated with a lower risk of SARS Cov 2 infection. The

main findings summarized above describe the many negative consequences associated with stopping ADHD treatment. They also point to the difficulties of evaluating and diagnosing new symptoms or comorbidities. Finally, the findings suggest the need to maintain remote monitoring, especially using telemedicine. Several studies have been published to evaluate the effectiveness of telemedicine. Positive results regarding its effectiveness, but also its limitations, have been investigated for decades (31, 32). The COVID-19 pandemic has increased the importance of telemedicine in medical practice. Telemedicine is expected to deliver timely care while minimizing exposure to protect medical practitioners and patients (33). So the use of telemedicine and virtual software offers promising potential in the fight against COVID-19 (34). A large amount of research in this area has clarified old questions, increased our knowledge and brought new challenges (35). In a recent article on the subject, the international consortium REPROGRAM provided a complete guide for the implementation of telemedicine during the COVID-19 pandemic and the relevance of its maintenance after this pandemic period (36).

The use of telemedicine for the diagnostic evaluation of patients with a clinical picture suggestive of ADHD has already been investigated. In a review on the subject, carried out before the COVID-19 pandemic, the authors indicated the effectiveness of telemedicine in the evaluation of possible new cases of ADHD. These findings are especially important for the evaluation of patients in remote areas where specialists are not present (28). However, the effectiveness of telemedicine for the follow-up of patients already diagnosed and on medication for ADHD has not been evaluated. The beginning of the COVID-19 pandemic brought the need to develop new research to evaluate the effectiveness in the follow-up of patients already diagnosed with ADHD.

Monitoring ADHD patients during the COVID-19 pandemic represents a challenge for specialists and general practitioners. The findings indicate that the discontinuation of psychotherapy and pharmacological treatment is very harmful to patients. Guidance on the best way to monitor patients remotely has been provided by several medical associations. However, we still do not have enough specific research on the effectiveness of remote monitoring of patients with ADHD. At this time, further research to investigate the role of telemedicine in the follow-up of patients with ADHD (and not just for initial diagnosis) is needed.

CONCLUSION

The COVID-19 pandemic has brought new challenges to the treatment of patients with ADHD. Initial findings showed that ADHD patients during the COVID-19 pandemic are more vulnerable to a variety of negative outcomes. These patients present greater difficulties in studies and school performance. The various findings presented in this review point to the need to adequately maintain the treatment of individuals with ADHD. Strategies for treatment adherence are even more necessary. The use of telemedicine, in particular, proved to be a very relevant measure.

Our review has limitations that need to be highlighted. The choice of narrative review instead of systematic review is the main limitation. We recognize that a systematic review would be the best choice. However, carrying out a systematic review in our study center in such a short time proved to be unfeasible. Another limitation that should be pointed out is inherent to the selection of reviewed articles. In order to focus mainly on articles on monitoring patients with ADHD in the context of the COVID-19 pandemic, we excluded articles and reviews that included samples from patients diagnosed with other mental disorders. Finally, another important limitation was the inclusion of only articles published in English during the years 2020 and 2021.

Future research should focus on conducting prospective follow-up studies of patients with ADHD and their families, using telemedicine strategies. These new studies may provide more detailed data on both short-term and long-term adherence to ADHD treatment. They will also be able to point out which changes and adaptations will be necessary for better monitoring of patients with ADHD.

AUTHOR CONTRIBUTIONS

DS defined the scope of publication interpreted data, wrote the manuscript, screened the studies, analyzed the data, provided a critical review of the manuscript, revised critically the work providing substantial input, and gave final approval of the version to be published.

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The Moderating Effect of Age on Low-Income Students' Relationships With Mentors and Their Self-Efficacy Since COVID-19

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Purposes: This study investigates the moderating effect of age on the association between relationship with mentors and self-efficacy among low-income students.

Methods: A total of 255 low-income middle and high school students participated. The PROCESS macro 3.4 for Statistical Product and Service Solutions was employed to test the moderating effect.

Results: Quality of relationship between mentors and mentees was positively associated with mentees' self-efficacy. Students' age significantly moderated the association between quality of the relationship with mentors and self-efficacy.

Discussion: It is important to expand mentorship programs for low-income students during the COVID-19 pandemic in order to foster high self-efficacy among adolescents. Recruitment of high quality mentors and additional factors that may be helpful to a good relationship between mentees and mentors, such as mentor training, mentor screening, and mentor-mentee matching, should be prioritized to improve self-efficacy among low-income students since COVID-19. Early opportunities for mentoring from high quality mentors is particularly important to increase self-efficacy among younger students such as middle school students.

Keywords: low-income students, self-efficacy, mentors, age, COVID-19

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INTRODUCTION

High self-efficacy is an important predictor of various positive outcomes among adolescents, such as increased positive thinking and affect, decreased depression, and decreased internalizing and externalizing problems (1–3). Overall, self-efficacy beliefs rise from adolescence into adulthood, but self-efficacy beliefs may decrease before again rising in adolescence, making it an important time to bolster adolescents' self-efficacy (4). One intervention that may help to bolster self-efficacy among adolescents are mentorship programs (5–7), where adolescents are paired with a trained mentor who supports the adolescent socially or academically, for example. Quality of the mentor-mentee relationship may affect adolescents' mentorship-related outcomes (6); however, some studies only examine adolescents' participation in a mentorship program, without examining

perceived quality or effectiveness. Further, an age difference may exist in the association between the quality of the mentor-mentee relationship and self-efficacy between middle school students and high school students. Thus, more research is needed on the relationship between adolescent mentees' perceived quality of their relationship with their mentor on the development of mentees' self-efficacy in the context of age.

Positive Impacts of Mentorship for Low Income Students

Across several studies, mentorship programs have found to positively affect low- income students in diverse ways (8–13). In one study, low-income students in South Korea who were satisfied with their participation in a mentorship program showed lower levels of depression than those students who were less satisfied with the program (10). The remaining studies focused primarily on academic-related outcomes. Among eighth and ninth grade students attending a school in a low-socioeconomic status (SES) community, participants in a mentor outreach program were up to 25% more likely to have a positive perception of science compared to students who did not participate in the program (13). In another study of perceived at-risk high school students in a school district where 65% of students qualified for free or reduced-price lunch, students who were randomly assigned to a school staff mentor had a higher sense of school belonging, higher perceived teacher support, and were less likely to have been disciplined at school than students who did not receive mentorship (9).

Moreover, among a student body where 85% were eligible for free lunch at school, students who reported having a natural mentor in their lives reported fewer school absences, higher expectations of school success for themselves, and a higher sense of school belonging, and these effects were intensified if the student reported a higher number of mentors in their lives (12). Additionally, researchers paired teenagers living at or below 125% of U.S. federal poverty guidelines with mentors, but they found no significant differences in self-esteem, grades, school attendance, or school disciplinary infractions; the authors posited that the lack of significant effects may be related to the relatively short median length of the mentor-mentee relationship, as well as the lack of a measure examining the quality of the mentor-mentee relationship (11). Last, at-risk middle school students paired with a school faculty or staff mentor were sent to the office significantly less often and showed improvements in attitude toward school (8). These findings suggest that, overall, participation in a mentorship program can be associated with numerous positive outcomes for low-income middle- and high-school students.

Age Differences

In a review of the literature on mentoring, the researchers noted that mentorship programs designed for adolescents rarely distinguish between the needs of older and younger adolescents (14). Such age-related differences in needs may impact the effectiveness and positive outcomes in mentorship for adolescents of different ages. For example, because social support is especially important during the transition period of early adolescence, simply having support from a mentor may be associated with particularly positive outcomes (14). Additionally, in one study of community- and school-based mentorship program, the age of the mentee was associated with the mentor's report of the quality of the mentor-mentee relationship, with mentors with middle or high school aged mentees reporting a less close or supportive relationship than those with elementary-aged mentees (15). Last, a systematic review of school-based mentoring among adolescents identified two studies that looked at age differences in their outcomes of interest (16). In the first study which analyzed a mentorship program for students aged 9–15 years, the older students had improved school attendance, but the younger students did not (17). In the second study, which examined students in grades 4 through 8, students aged <12 years had lower truancy after participating in the mentorship program than did students above age 12 (18). These contradictory findings, as well as the lack of studies looking at age differences in the outcomes of mentorship programs, demonstrate that this is a research area that warrants more attention.

Self-Efficacy During Adolescence

Findings regarding the development of self-efficacy in adolescence vary, perhaps due to differences in defining and categorizing self-efficacy (4). As teenagers develop, according to Schunk et al. (4), they "form more stable and integrated views of their capabilities, values, and attributes" (4). Some studies found that by 7th grade, adolescents' perceptions of their own competence decline before increasing as they age (4). However, while some studies have found a decline in mathematics self-efficacy in adolescence, other studies have found increases in both language and mathematics self-efficacy (4). In another study comparing the self-image and self-efficacy of adolescent girls and boys, the researchers found that girls tended to have higher academic and regulatory self-efficacy than boys, while boys had higher emotional self-efficacy (19). More research is needed in adolescent self-efficacy, particularly using more standardized measures.

Impact of Self-Efficacy on COVID-19-Related Outcomes

Research has recently emerged on the impact of self-efficacy as a buffer against negative outcomes related to the COVID-19 pandemic among adolescents and adults, underlining the importance of high self-efficacy (20). In a group of adolescents during a COVID-19-related lockdown period in Italy, positive self-efficacy predicted subjective wellbeing and positive coping, and subjective wellbeing partially mediated the relationship between self-efficacy and positive coping during the lockdown (20). In a longitudinal study of children aged 11–16, an increase in mental health symptoms during the pandemic was buffering by high self-efficacy (21). Additionally, among adults during an 8-week period of COVID-19-related confinement in France, self-efficacy remained fairly stable during this period, and greater self-efficacy was positively related to positive affect (and vice versa for negative affect), as well as positively related to work performance during this period (22). Self-efficacy also positively

predicted mental health during the COVID-19 pandemic among adults in Turkey (23).

Mentorship and Self-Efficacy

A few studies have examined the relationship between mentoring and mentees' self-efficacy among adolescents, college students and graduate students (5–7). In a sample of middle school students who participated in a 10-week after-school mentorship program, quantitative analyses did not show large changes in students' self-efficacy, but in qualitative interviews, the students expressed that they did feel greater self-efficacy than before the program (7). Additionally, among American Indian college students who participated in a paid mentorship program for 8 sessions, participants did report higher self-efficacy after participation than before (5). Last, among Hispanic graduate students who reported having a mentor during their program, mentored students had significantly higher academic self-efficacy, and 3 mentorship related variables accounted for 24% of the variance in academic self-efficacy: Having a mentor, having a faculty mentor, and effectiveness of the mentor (6). Thus, evidence suggests that participation in a mentorship program has a positive effect on mentees' self-efficacy, but more research is needed among adolescents of different ages and regarding the effect of the quality of the mentor-mentee relationship on self-efficacy.

The Current Study

Mentorship programs have been regarded as an important way to bring about high self-efficacy and positive behavioral changes among students (8–13). However, little attention has been given to students' relationships with mentors, which is a key factor to determine the quality of a mentorship program. Low-income students in particular might have experienced reduced attention from their parents or caregivers since COVID-19 because it has become more difficult to earn a living during the crisis due to economic recession (24). That is, mentors have played an important role in empowering students in low-income families since COVID-19. This study focuses on the quality of the relationship between mentees and mentors in a mentorship program rather than the quality of the mentorship program itself. Given that a good relationship with mentors can be helpful to develop self-efficacy in adolescence (7), the current study explores an association between the quality of students' relationship with mentors and self-efficacy among low-income students since COVID-19. In addition, age may influence the association as younger students (i.e., middle school students) are more open to others' advice and feedback compared to older students (i.e., high school students) who have their own thoughts and may be developing independence and an increased reliance on peers (25). Thus, this study also investigates the moderating effect of age on the association between relationship with mentors and self-efficacy among low-income students.

METHODS

Participants and Sampling

Participants in this study included a targeted, nationwide sample of middle and high school students who had engaged in a mentorship program provided by a Non-profit organization, the Korea Development Bank [KDB] Foundation. The mentorship program was only available to students from low-income families. We reached out to the 264 middle and high school students enrolled in the mentorship program to participate in our study in April 2021. Participants responded to an online survey via Google Forms. The questionnaire was first developed by the research team, and then it was reviewed by a teacher in public school and social workers. Based upon their feedback, the questionnaires were refined to minimize potential risks of the participation and to help participants clearly understand the survey questions. To access the survey, a text message including a link for the survey was distributed to potential participants. Further, both students and their caregivers received a consent form before the participation so that they were able to select whether they consented to respond to the survey. Depending on their responses, nine low-income students were not included in the final sample because either student or their caregiver(s) declined their participation. Thus, a total of 255 low-income students participated and they received a $5 gift card as a reward for participating. As the current study did not collect any private information such as name, address, and the like, this study was approved by the Institutional Review Board (#210216-2A).

Measures

Self-Efficacy

Self-efficacy in this study was measured by the General Self-Efficacy Scale (GSE) developed by Schwarzer et al. (26). This scale consists of ten items as follows: "I can always manage to solve difficult problems if I try hard enough"; "If someone opposes me, I can find the means and ways to get what I want"; "It is easy for me to stick to my aims and accomplish my goals"; "I am confident that I could deal efficiently with unexpected events"; "Thanks to my resourcefulness, I know how to handle unforeseen situations"; "I can solve most problems if I invest the necessary effort"; "I can remain calm when facing difficulties because I can rely on my coping abilities"; "When I am confronted with a problem, I can usually find several solutions"; "If I am in trouble, I can usually think of a solution"; and "I can usually handle whatever comes my way". The ten items have a four-point Likert-type scale, ranging from 1 to 4 (1 = Not at all true; 2 = Hardly true; 3 = Moderately true; 4 = Exactly true). The score of each item was summed and a higher score demonstrated higher levels of self-efficacy. The reliability and validity of this scale were checked in 23 countries, including South Korea (26). The Cronbach's α of the self-efficacy scale used in the current study was 0.90.

Relationships With Mentors

Low-income students responded to a series of questions regarding the quality of the relationship between themselves and their mentors. The relationship with mentors refers to the

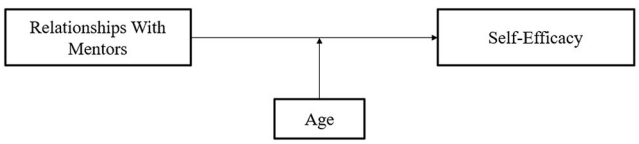

FIGURE 1 | Research framework.

closeness of the relationship between mentor and mentee and how well they are able to maintain the relationship without challenges. Five items were used to measure the quality of the relationships between mentees and mentors: "I think that my mentor values me as much as I value him or her"; "My mentor respects me"; "I found it easy to get emotionally close to my mentor"; "I found it easy to trust my mentor completely"; and "I am happy with my mentor and the relationship". Each item was rated on a five-point Likert-type scale, and response options were ranged from 1 = strongly disagree to 5 = strongly agree. A total score was calculated based on the sum of all items, and a higher score demonstrated a higher quality relationship between mentors and mentees. This scale had a Cronbach's alpha of 0.75.

Age

Asian countries use a different way to calculate age, which is different from one's international age. In these countries, a newborn is considered 1 year old at birth. Thus, to calculate participants' international age, 1 year should be deducted from the age given.

Control Variables

Gender and academic performance (e.g., letter grades of A, B, C, etc.) were controlled for in this study. Further, parents' educational attainment was included. If both their mothers and fathers had higher education, those were categorized in the parental higher education group, while others were placed in the Non-higher education group.

Analysis Strategies

The PROCESS macro 3.4 for Statistical Product and Service Solutions (SPSS) was employed to test the moderating effect of age on the association between the quality of the relationship between mentors and mentees and low-income students' self-efficacy. A bootstrap approach developed by Preacher and Hayes was applied to analyze the data, and five-thousand iterations of the bootstrapping method were conducted at the 95% confidence intervals. A research framework is shown in **Figure 1**.

RESULTS

Descriptive statistics are reported in **Table 1**. Scores of self-efficacy and quality of the relationship between mentors and mentees were 29.8 and 20.2, respectively. Respondents' average age was 17.4 years old, or an international age of 16.4 years. Almost half of the sample were girls (49.4%). Given that their average academic performance was 7.7, respondents' average letter grade was about C. 39.6% of participants had both mothers and fathers who had completed higher education.

TABLE 1 | Descriptive statistics.

Variables	% or Mean (SD)
Self-efficacy	29.83 (5.58)
Relationships with mentors	20.16 (3.44)
Age	17.36 (1.75)
Gender (girl)	49.4%
Academic performance	7.66 (3.73)
Parents' educational attainment	39.6%

TABLE 2 | Moderating effects of age on self-efficacy using SPSS process.

Variables		
(Constant)	−19.11 (18.73)	
Relationships with mentors	2.32 (0.92)	*
Gender(girl)	−1.34 (0.67)	*
Academic performance	0.28 (0.09)	**
Parents' educational attainment	1.19 (0.68)	
Moderator		
Age	2.35 (1.08)	*
Moderating effect		
Relationships with mentors*Age	−0.12 (0.05)	*

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

A moderating effect of age on the relationship between quality of relationship between mentor and mentee and participants' self-efficacy was confirmed in **Table 2**. Students' age significantly moderated the association between quality of the relationship with mentors and self-efficacy ($\beta = -0.12$, $p < 0.01$). Further, age itself was statistically related to self-efficacy ($\beta = 2.35$, $p < 0.01$). Quality of relationship between mentors and mentees was positively associated with mentees' self-efficacy ($\beta = 2.32$, $p < 0.01$). Being a boy and having greater academic performance were positively related to self-efficacy ($\beta = -1.34$, $p < 0.05$; $\beta = 0.28$, $p < 0.01$, respectively). **Figure 2** shows the moderating effect of age on the relationship among low-income students. In this study, high school students showed constant levels of self-efficacy, regardless of whether they had lower or higher scores for the quality of the relationship with their mentors (29.81 vs. 29.82). However, younger, middle school students reported a greater gap in self-efficacy between those with a lower quality of relationship with their mentor (27.91) and those with a higher quality of relationship with their mentor (31.98). In other words, high school students' self-efficacy was not influenced by the quality of the relationship with their mentor, while self-efficacy was greatly influenced by the quality of the relationship with their mentor among middle school students.

DISCUSSION

This study focuses on low-income students' self-efficacy since COVID-19. The current study's findings explored the association

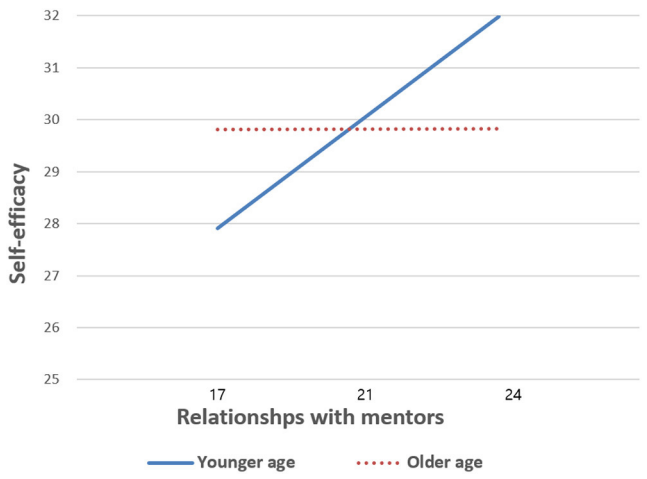

FIGURE 2 | Moderating effect of age on the association between relationships with mentors and self-efficacy among low-income students.

between the quality of the relationship between mentors and mentees and mentees' self-efficacy, and also tested the moderating effect of age on the association among middle and high school students who have grown up in low-income families. Low-income students who participated in a mentorship program and maintained a good relationship with mentors were more likely to develop higher levels of self-efficacy. In addition, there was a significant moderating effect of age on the association between the quality of the relationship between mentors and mentees and mentees' self-efficacy since COVID-19. That is, self-efficacy among younger low-income students was more greatly influenced by the quality of the relationship with their mentors.

Findings in the current study indicated that the quality of the relationship between mentors and mentees was related to self-efficacy among low-income students. This is consistent with previous studies showing that positive social relationships or social support are beneficial to increase self-efficacy among adolescents (27, 28). However, there is no evidence about the relationship among low-income students. Further, most studies have primarily considered the impact of the mentorship program in general, rather than focusing on the relationships between mentees and mentors (11, 12). Thus, this study shed a light on understanding the importance of the quality of the relationship between students and their mentors. Given that low-income students are less likely to have a chance to develop and cultivate their self-efficacy (29), perhaps due to limited resources, lower support from their caregivers and economic challenges, the relationships between mentees who come from low-income families and mentors are critical to improve self-efficacy among low-income students. Particularly, since COVID-19, low-income students might have decreased opportunities for learning and health, such as fewer after school learning programs being provided in-person, as well as fewer school meals being provided, because of the risks of spreading COVID-19 (30, 31). As a result, these students might be more isolated and disconnected from education and self-development, leading to a fear of failure and mental health problems (32). That is, they have very constrained environments to develop their self-efficacy since COVID-19. Self-efficacy might be one of the most important factors to address stresses from the pandemic situation, particularly for students who are greatly exposed to academic pressure and have had reduced opportunities to experience a variety of outdoor activities due to school closures (33). Mentorship programs have proven to help individuals to develop self-efficacy and to psychologically empower students (6–8). However, previous studies have mainly just addressed the relationship between participation in a mentorship program itself and self-efficacy or mental health (6, 7, 9, 12). Quality of mentorship is partially determined by the relationship between mentee and mentor, as the effects of mentorship are partially derived from warm feedback and advice from mentors. Despite the importance of quality of the mentor-mentee relationship, few studies focus on the relationships with mentors and self-efficacy. In particular, little is known about this association among low-income students since COVID-19.

This study found that the quality of the mentee-mentor relationship among low-income adolescents was important for self-efficacy since COVID-19. Provided that students have reduced time to communicate with teachers and friends in school in-person during parts of the COVID-19 pandemic (34), an opportunity to build a relationship with a mentor and opportunities to talk with them is beneficial to improve self-efficacy, as mentors may emotionally support students' decisions and future careers. Therefore, it is important to expand mentorship programs for low-income students during the COVID-19 pandemic in order to foster high self-efficacy among adolescents. However, rather than simply providing more mentorship programs, mentors who can create a close relationship with their mentee based on rapport-building should be recruited, as the relationship between mentees and mentors is crucial to self-efficacy. Thus, recruitment of high quality mentors and additional factors that may be helpful to a good relationship between mentees and mentors, such as mentor training, mentor screening, and mentor-mentee matching (15, 35), should be prioritized to improve self-efficacy among low-income students since COVID-19.

The current study also revealed that age moderated the association between the quality of the mentor-mentee relationship and mentees' self-efficacy. Middle school students were more likely to improve their self-efficacy if a greater quality relationship with their mentors had been maintained. On the other hand, self-efficacy of high school students in low-income families was not influenced by the quality of the relationship with their mentors. As individuals age, they may be more likely to realize their current situation and economic status and the impacts they may have on their lives (36, 37). High school students in low-income households may be more aware of the economic difficulties that may limit their daily life compared to middle school students. As a result, empowerment or support from mentors might not older children's or adolescents' self-efficacy because they already understand the potential constraints of their socioeconomic status. Self-efficacy is closely related to

confidence in one's behaviors and belief in one's abilities to accomplish tasks (38). However, high school students who already aware of their families' financial challenges might have less hope to enhance their conditions, leading to no changes in self-efficacy through mentoring. However, low-income middle school students who might be relatively less mature than high schoolers might be more strongly influenced by mentors' feedback and support. In particular, students have encountered diverse troubles among their friends and families since COVID-19, such as increased family conflict and decreased friend support (39, 40), but they may not have an adequate outlet to relieve their stresses or address issues in their lives because of social distancing. In addition, economic difficulties might negatively impact a sense of confidence among low-income middle school students and such a challenge may interrupt the development of self-efficacy. A good relationship with mentors can buffer against anti-social behaviors and serve as a guide to face challenges. For middle school students, such assistance is beneficial to improve their capability to address problems by themselves, resulting in higher levels of self-efficacy. Given the effect of age on the association between the quality of the mentor-mentee relationship and self-efficacy in this study, early opportunities for mentoring from high quality mentors is particularly important to increase self-efficacy among younger students such as middle school students. Further, low-income middle schoolers should be prioritized to receive mentorship.

This study provides new evidence about the importance of age on the association between the quality of the mentor-mentee relationship and self-efficacy among low-income students. During the coronavirus pandemic, fewer resources are available for students due to social distancing measures and economic recession (41), but when it comes to prioritizing support, low-income middle school students should be prioritized to receive mentoring based on a high-quality mentor-mentee relationship to improve their self-efficacy, which is one of the most important factors influencing achievement in one's life (42). Particularly, low-income middle school students who can increase their self-efficacy through a high-quality relationship with mentors may be more likely to succeed in their lives, perhaps leading to breaking free from poverty or low-income status in adulthood.

This study newly considers the role of age on the association between the quality of the mentor-mentee relationship and self-efficacy among low-income middle and high school students. However, interpretations should be considered in the context of limitations. First, this study was conducted in South Korea, which might have different cultural and economic environments compared to other nations. Thus, the types and numbers of mentorship programs available and characteristics of low-income students might be different from those in different countries. Second, this study only compared middle school students with high school students, so that the moderating effect of age on the association between the quality of the mentor-mentee relationship and mentees' self-efficacy is not considered elementary school students. We recommend that future studies expand the ages of participants including elementary schoolers. Third, there might be a variety of factors that influence self-efficacy. As this study included limited control variables due to limitations of the online survey method, we suggest that more variables that may affect the self-efficacy should be included in future studies. Fourth, students' academic performance is closely related to self-efficacy and another interesting story may turn up if we focus on academic performance. Thus, we recommend that future studies consider academic performance as a mediator or independent variable.

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 Institutional Review Board of Inha University approved this study (#210216-2A). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

All authors have read and agreed to the published version of the manuscript, contributed to the article, and approved the submitted version.

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Impact of Different Styles of Online Course Videos on Students' Attention During the COVID-19 Pandemic

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Background: The COVID-19 pandemic interfered with normal campus life, resulting in the need for the course to be conducted in an ideal online format. The purpose of this study is to analyze the impact of different styles of online political course videos on students' attention during the COVID-19 pandemic.

Methods: Four college students participated in this small sample study. They were required to conduct two sessions of the experiment, in which they were required to watch three different styles of course videos in each session. While watching the videos, their EEG signals were acquired. For the acquired EEG signals, the sample entropy (SampEn) features were extracted. On the other hand, Mayer's theories of multimedia technology provide guidance for teachers' online courses to enhance students' attention levels. The results of EEG signals analysis and Mayer's theories of multimedia technology were combined to compare and analyze the effects of three styles of instructional videos.

Results: Based on comparisons of the SampEn and Mayer's theories of multimedia technology analysis, the results suggest that online instruction in a style where the instructor and content appear on the screen at the same time and the instructor points out the location of the content as it is explained is more likely to elicit higher levels of students' attention.

Conclusions: During the COVID-19 pandemic, online instructional methods have an impact on students' classroom attention. It is essential for teachers to design online instructional methods based on students' classroom attention levels and some multimedia instructional techniques to improve students' learning efficiency.

Keywords: COVID-19, EEG, classroom attention, sample entropy, Mayer's theories of multimedia technology

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1. INTRODUCTION

At the end of 2019, due to the influence of the COVID-19 pandemic, mainly students study styles were changed greatly (1–3). Many schools were closed, and the students were unable to have a class as before (4). In order to solve the dilemma between epidemic prevention and teaching, schools started online courses (5, 6). Different from offline courses, students cannot face to face with teachers. How to organize the online courses and how to give the online courses in an appropriate format should be investigated (4, 7–10).

Classroom attention of students is related to the design of online teaching schemes (11). Different styles of online teaching styles can have an impact on students' attention levels (12). The attention level of students in the classroom is an important indicator to evaluate the effectiveness of teaching and learning. In addition, it is a prerequisite for students to maintain their attention in the learning process to learn effectively (13). Therefore, teachers can analyze students' classroom attention to explore more effective online teaching schemes, which can help students to improve their attention in online courses and improve their learning efficiency (14).

Attention can be monitored by physiological signals, such as electroencephalogram (EEG) signals (15). EEG signals can truly reflect the attentional state of students and can reflect the state of brain activity. Therefore, EEG signals are often used in studies to analyze attentional states. In addition, EEG acquisition devices are wearable devices, which are beneficial to be promoted and applied to detect students' classroom attention in actual teaching to assist teachers in better teaching activities (16). Entropy provides a way to quantify system regularity (17). In previous studies, Shannon entropy, dispersion entropy, multiscale entropy, approximate entropy, and sample entropy (SampEn) have been investigated as features to study the level of consciousness or attention-related EEG signals (18). In the study of Dawi et al. (19), Attention Deficit Hyperactivity Disorder patients have lower attention and smaller SampEn of EEG signals compared to normal individuals. To evaluate the level of attention in different states, Li et al. designed experiments with attentional, non-attentional and resting states, and the experimental results show that the SampEn is higher during the attentional state than that during the non-attentional state (20). Thus, previous studies have shown that the level of attention is proportional to the SampEn of EEG signals. In the study of Thomas et al. (21), EEG features based on SampEn were used to assess the attention level of participants in the game.

Online instruction relies on multimedia and an appropriate online multimedia instructional scheme which can reduce the external cognitive processing of learners and can make full use of the limited human cognitive capacity to help learners actively engage in cognitive processing (22). It is a key factor in maintaining a high attention level and enhancing learning efficiency for students during the COVID-19 pandemic. According to cognitive load theory (23) and working memory theory (24), there is a limited capacity of each channel in the human information processing system, and the cognitive resources of learners are required to be allocated during learning and problem-solving. The amount of cognitive processing that can occur in the verbal channel or the visual channel at any one time is extremely limited. Considering the characteristics of cognitive load and working memory, Mayer's theories of multimedia technology suggest how to present learners with verbal and picture information in the teaching process. Hence, two types of information will be processed in different information processing channels respectively (25). In this way, the cognitive resources of the learners are fully utilized, and thus the learners can better understand the knowledge and maintain their attention. For example, in multimedia instruction that follows the principle of temporal proximity, the picture and the narration are presented simultaneously (26). At this time, verbal processing and visual processing are carried out in separate information processing channels, which can reduce the cognitive load and facilitate learners' learning. In addition, including cues for learners on how to select and organize material can help learners reduce unnecessary extraneous cognitive processing and focus more attention on key elements, i.e., the signaling principle (27). Furthermore, according to the personalization principle (28), by using conversational voice to express verbal information in multimedia teaching, the learners can reap a better learning experience. The voice principle and the image principle as extensions of the personality principle (29, 30), using the human voice and agent to teach as if the learners are having a conversation, and both are viable ways to give learners a stronger sense of social presence.

In this work, to investigate the effects of three styles of online instructional videos on students' attention levels, we conducted the analysis based on EEG signals and Mayer's theories of multimedia technology. The framework of the study is shown in **Figure 1**. The main contributions of our work are as follows:

- In order to obtain the real attentional state of the subjects, we acquired the EEG signals of the subjects while they were performing online learning for subsequent analysis.
- To analyze the level of attention during the experiment, we calculated the SampEn of the EEG signal as an evaluation index.
- In order to analyze the three styles of online instructional videos from multiple perspectives, we combined the results of SampEn calculations and Mayer's theories of multimedia technology for discussion.

This work is organized as follows. Section 2 introduces the experimental setup and data processing methods in our work. Sections 3 and 4 represent the results and discussion of the experiment, respectively. And the conclusions are summarized in section 5.

2. MATERIALS AND METHODS

2.1. Experimental Setup

There were three instructional videos for our experiment. They were first matched with a number by random sorting. According to the sorting result, we named them as video 1, video 2, and video 3, respectively. And they were played following the numbered sequence from 1 to 3 in the experiment for all subjects. The three videos are different in styles and instructors. In video 1, the instructor and the content of the course appear simultaneously in the picture, distributed on both sides of the picture. Video 2 shows an instructor with many camera cuts. And in video 3, the instructor and the content appear alternately, and content appears in the key part. For the content, the three videos are both related to college political classes. Their knowledge points are different, but the topics and difficulties are similar.

Four healthy college students (3 males and 1 female) took part in the experiment. Their mean age was 27, ranging from

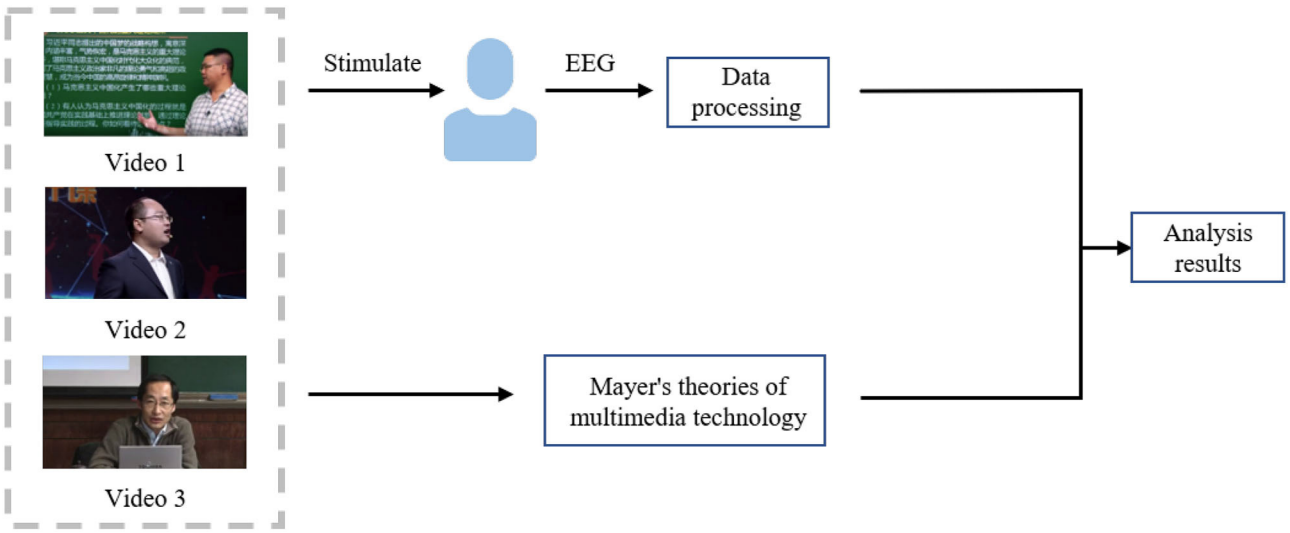

FIGURE 1 | The framework of our work.

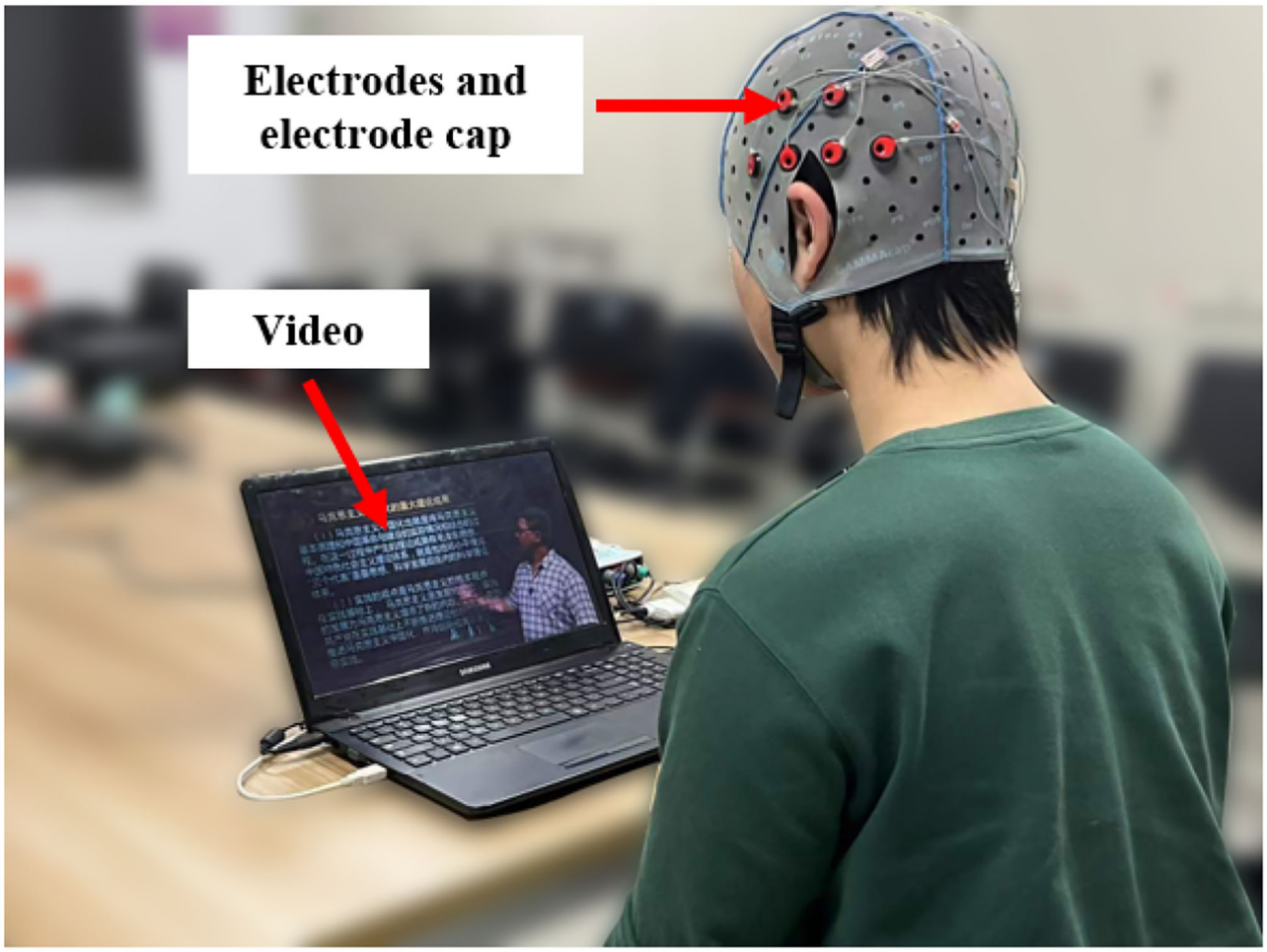

FIGURE 2 | Schematic diagram of the experimental environment.

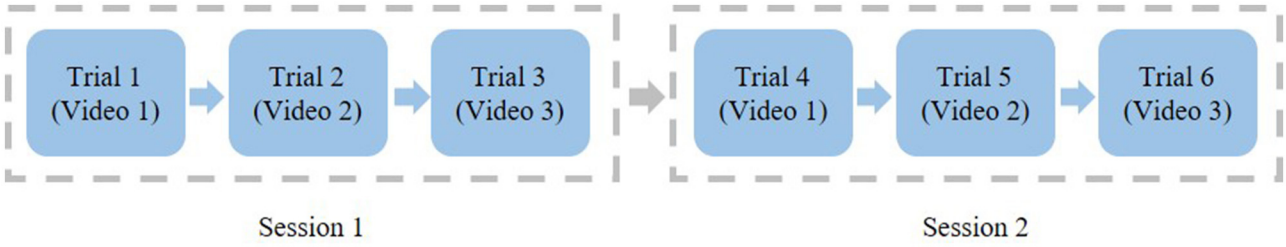

FIGURE 3 | The experimental procedure for a subject.

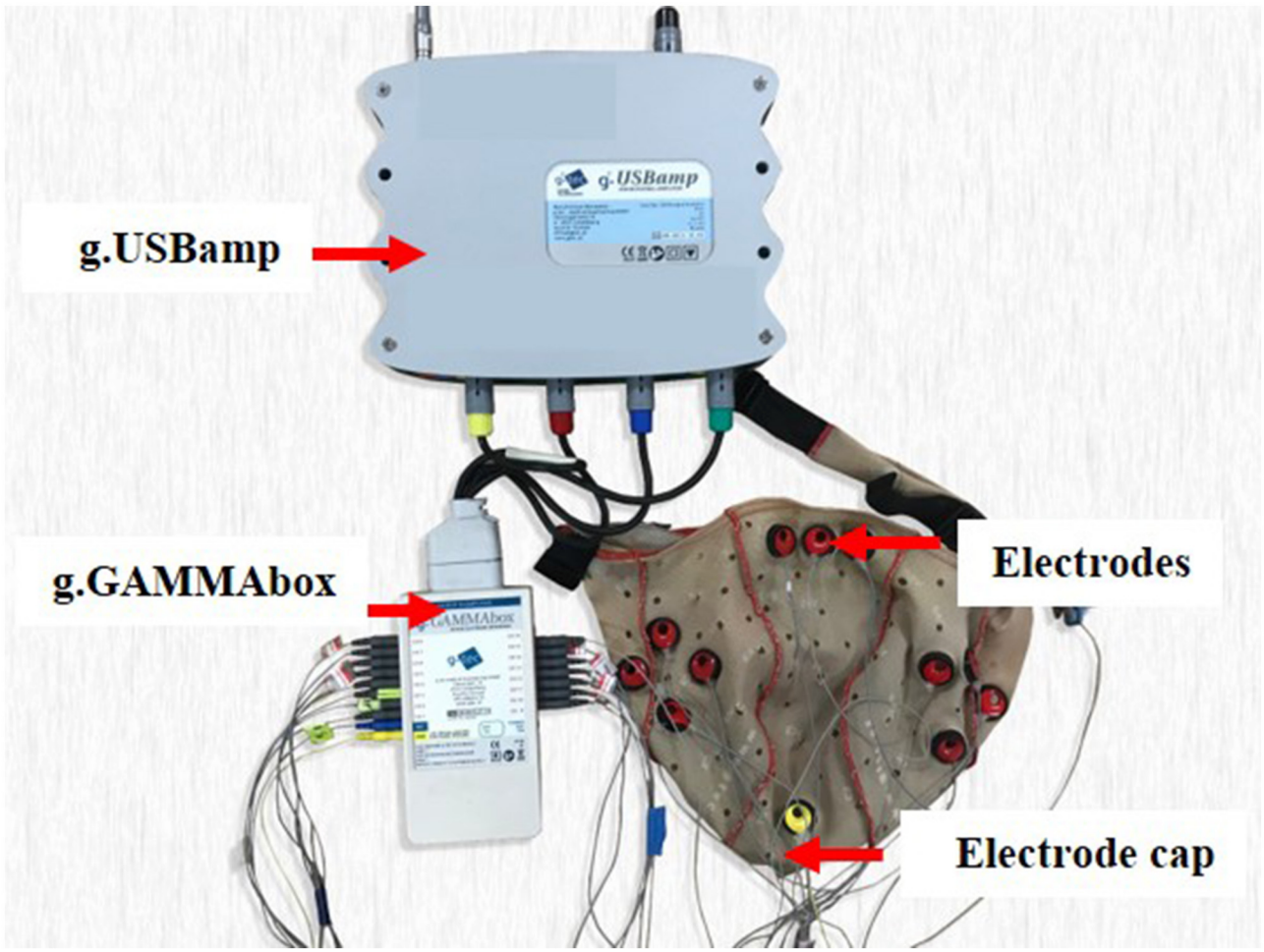

FIGURE 4 | The equipment used to acquire the EEG data.

26 to 28. **Figure 2** presents the experimental environment and the subjects were required to sit in front of the screen to watch the videos. The sound level and luminosity of the videos were appropriate for the subject that they felt comfortable with them of the video. The experiment was divided into two sessions and the experimental procedure is shown in **Figure 3**. There were three trials in a session. In one trial, the subject watched one video for approximately 5 min and their EEG signals were acquired at the same time. And each trial is separated by 1 min. The EEG signals acquisition equipment is shown in **Figure 4**. And EEG signals sampling frequency is 256 Hz. According to previous studies (31, 32) and the International 10-20 system, 12 electrodes (FT7, FT8, T7, T8, C5, C6, TP7, TP8, CP5, CP6, P7, P8) were used and their positions are shown in **Figure 5**.

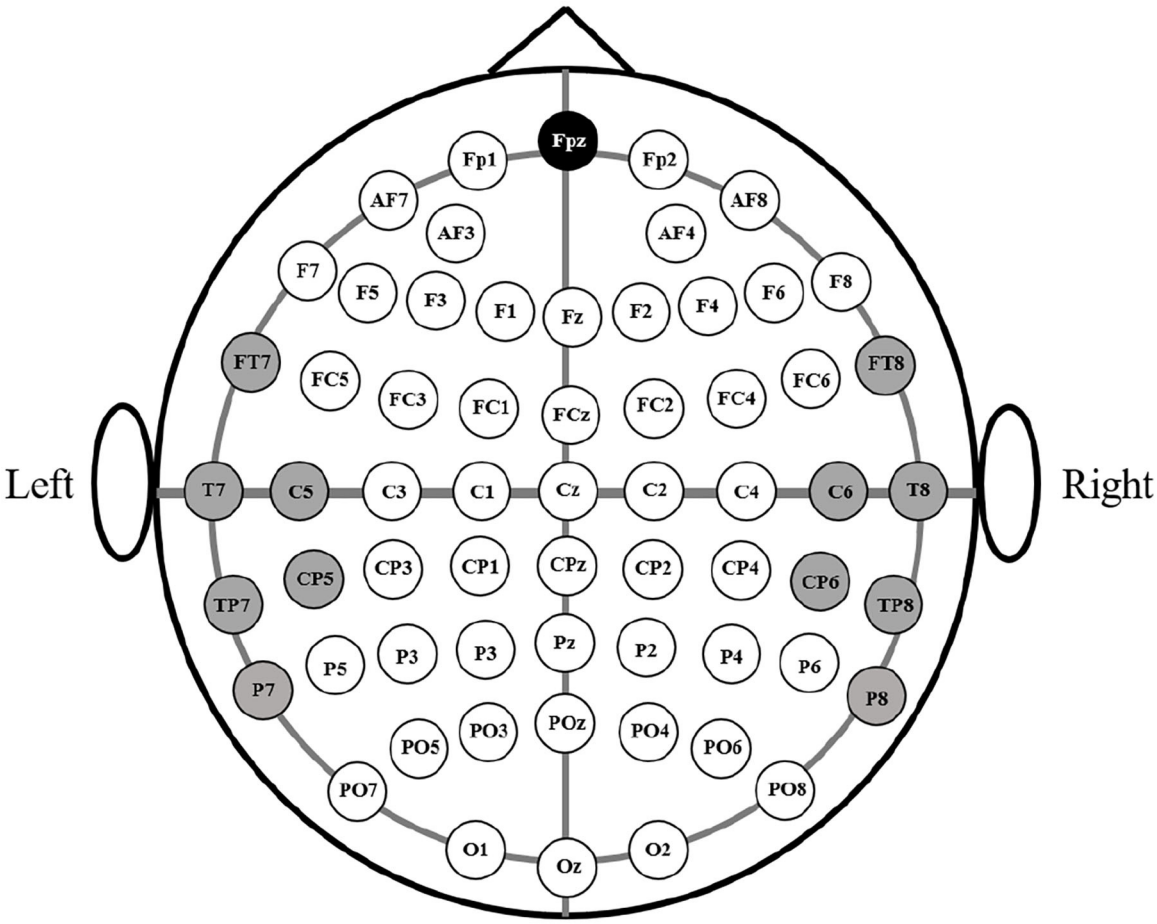

FIGURE 5 | The positions of the electrodes according to the international 10–20 system.

2.2. Data Processing

The Butterworth filter is used to filter the EEG signal to the range of 1–50 Hz to eliminate high frequency noise and improve the signal-to-noise ratio. SampEn can be used to measure the complexity of a time series (33, 34). The higher the complexity of a time series is, the higher the SampEn it has. Conversely, time series with higher self-similarity has smaller SampEn. SampEn is independent of the length of the time series. And it is noise-resistant and stable, which is suitable for deterministic and random signals. Therefore, it is suitable for the analysis of EEG signals.

To calculate SampEn, two parameters need to be specified first: run length m and tolerance window r. For a given time series $\{u(i)\}$ with N data points, e.g., EEG data with N sampling points, its SampEn can be calculated by the following steps:

Firstly, form the sequence $\{u(i)\}$ into m-dimensional vectors $X_m(1) \ldots X_m(N-m+1)$ in order. These vectors can be defined as $X_m(i) = [u(i), u(i+1), \ldots, u(i+m-1)]\,(1 \le i \le N-m+1)$, which indicate m consecutive values of u beginning from the i-th point.

Secondly, calculate the distance between the vector $X(i)$ and the rest of the vectors $X(j)$, which is defined as:

$$d\left[X_m(i), X_m(j)\right] = \max_{k=0,\ldots,m-1}\left(\left|u(i+k) - u(j+k)\right|\right) \quad (1)$$

Thirdly, count the number of $d\left[X(i), X(j)\right]$ corresponding to each $i(1 \le i \le N-m+1)$ that is less than the given threshold r, denoted as B_i. The proportion between this number and the total number of vectors is calculated according to formula (2).

$$B_i^m(r) = \frac{1}{N-m-1} B_i \quad (2)$$

And the average for all i is defined as formula (3), where $B^m(r)$ is the probability that two sequences match with m points.

$$B^m(r) = \frac{1}{N-m} \sum_{i=1}^{N-m} B_i^m(r) \quad (3)$$

Then, change the dimension to $m+1$ and calculate $B^{m+1}(r)$, which is the probability that two sequences

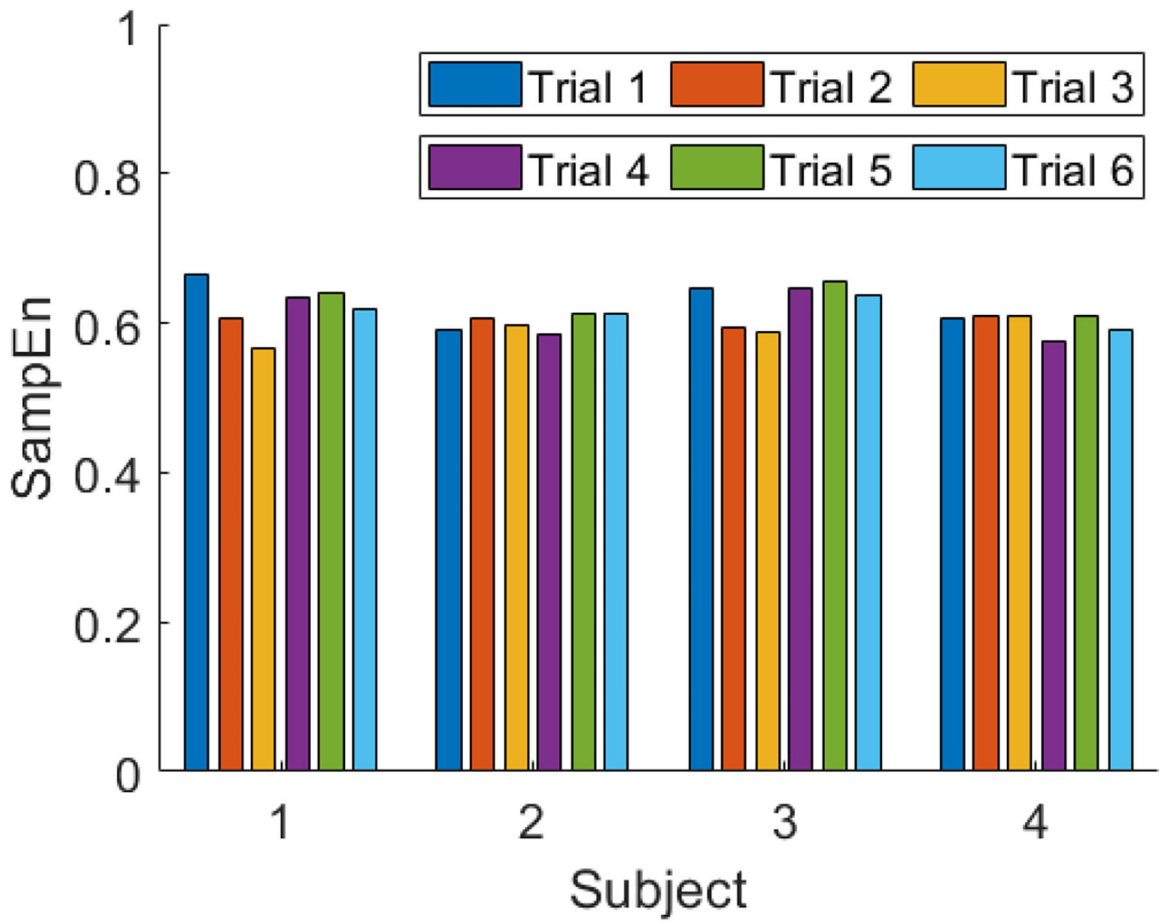

FIGURE 6 | SampEn of all trials for each subject.

match $m + 1$ points. Finally, formula (4) is used to calculate the SampEn of the sequence, denoted as H.

$$H(m, r) = \lim_{N \to \infty} \left\{ -\ln \left[B^{m+1}(r) / B^{m}(r) \right] \right\} \tag{4}$$

In this work, we set the parameters m and r to be 2 and 0.2σ, respectively, and σ is the standard deviation of the series.

2.3. Statistical Analysis

The Kruskal-Wallis test is a non-parametric test that is applied to test whether there is a statistically significant difference in the medians between three or more groups (35). It does not require the assumption that the data conform to a normal distribution. Another non-parametric test, the Mann-Whitney U test, can be used when there are only two groups of data, and it can be used to test for differences in means between data (36). In our work, we evaluated the impact of these videos on students' attention by testing whether the features were significantly different. We used the Kruskal-Wallis test to determine the significance of the difference in the effect of three videos in the same session on attention. In addition, the Mann-Whitney U test was used to determine the difference in student attention between the two sessions.

3. RESULTS

For each trial, the SampEn is calculated with non-overlapping 4s time windows. According to the results of previous studies, a higher SampEn represents a higher level of attention. In **Figure 6** and **Table 1**, it is shown that the SampEn of each trial for each subject is the mean value of the SampEn for each time window. By comparing the SampEn of each video in the two sessions, we can see that the SampEn of video 1 in session 1 is higher than that in session 2, while that of video 2 and video 3 are higher in session 2.

Figures 7, **8** show the average SampEn of the three videos in session 1 and session 2, respectively. In session 1, the SampEn

TABLE 1 | The values of SampEn for each subject.

	SampEn					
	Video 1		Video 2		Video 3	
Subject	Trial 1	Trial 4	Trial 2	Trial 5	Trial 3	Trial 6
1	0.6640	0.6328	0.6061	0.6398	0.5669	0.6189
2	0.5899	0.5863	0.6062	0.6134	0.5975	0.6123
3	0.6459	0.6469	0.5928	0.6564	0.5889	0.6368
4	0.6071	0.5758	0.6104	0.6088	0.6108	0.5906
Average	0.6268	0.6104	0.6039	0.6296	0.5910	0.6146

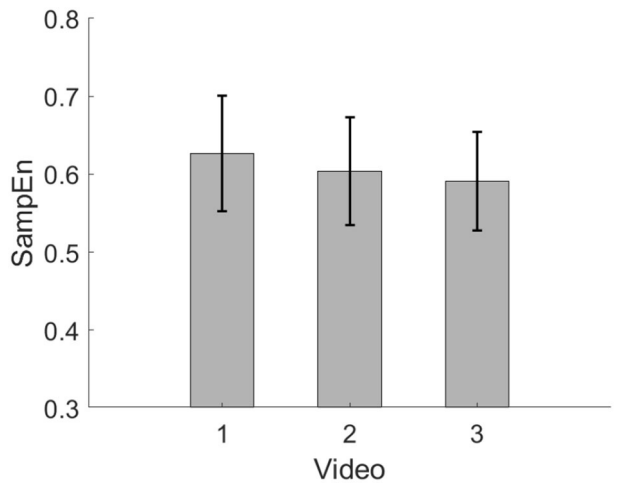

FIGURE 7 | Average SampEn of three videos in session 1.

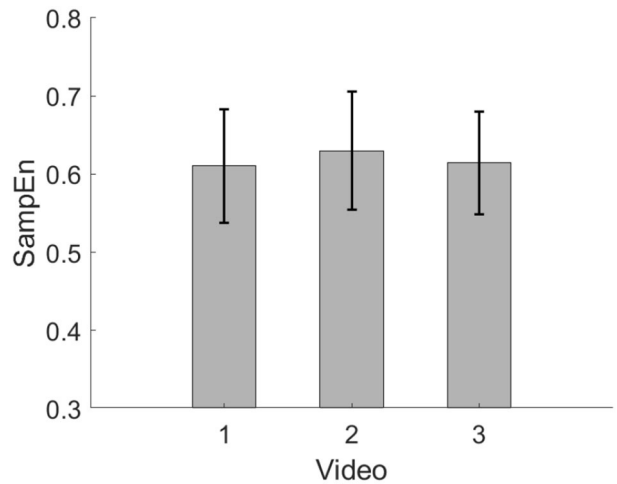

FIGURE 8 | Average SampEn of three videos in session 2.

TABLE 2 | Average SampEn for each subject.

Subject	1	2	3	4
Average SampEn	0.6214	0.6009	0.6279	0.6006

TABLE 3 | Average SampEn of three videos.

Video	1	2	3
Average SampEn	0.6186	0.6167	0.6028

of video 1 is the highest. In session 2, the SampEn of video 2 is the highest.

Table 2 presents the average of the SampEn of the EEG for all experiments for each subject. These results reflect individual variability and the effect of videos of different styles on attention. In addition, it is also reflected that there are different levels of attention for the same subject at different viewing times of the same video.

Table 3 shows the average of the SampEn of the three videos in all trials. From the results, it can be seen that video 1 stimulates higher attention levels of the subjects. In addition, video 2 and video 3 stimulate close levels of attention.

Figures 9, **10** show the trend of the average SampEn of each video for all subjects in session 1 and session 2, respectively. In session 1, video 1 is higher than the other two videos most of the time. In session 2, video 2 is higher than the other two videos most of the time. Besides, it can be seen that the SampEn decreases or fluctuates more in the middle or later stages of video viewing.

Based on the average SampEn of each video for all subjects in session 1 and session 2, we evaluated the attentional impact using two non-parametric tests. **Table 4** shows the Kruskal-Wallis test results of three trials in two sessions. The low p-values ($p < 0.05$) indicate that the difference in the impact of the three videos on students' attention was significant. Moreover, we determined the difference between the three videos in the two sessions and the Mann-Whitney U test results are presented in **Table 5**. The results illustrate that there is a significant difference in the impact of the same video on the subjects in the two sessions ($p < 0.05$).

4. DISCUSSION

Noticing that different styles of online instructional styles during the COVID-19 pandemic can have an impact on students' learning attention levels. In this work, the SampEn of EEG signals was used as an indicator of attention to assess the three styles of instructional videos, which is significant for teachers to organize and improve online teaching styles.

In terms of the mean SampEn analysis, the mean SampEn of the EEG signal corresponding to video 1 is 0.6186, which is higher than 0.6167 for video 2 and 0.6028 for video 3, i.e., video 1 is able to induce a higher level of attention. According to Mayer's theories of multimedia technology, video 1 conforms to the theory of image on the screen, i.e., adding the image of the narrator on the screen. At the same time, the narrator on the screen will point toward what is being taught with his or her hand. Such a style of instructional videos can enhance the subjects' social presence and make them feel like they are

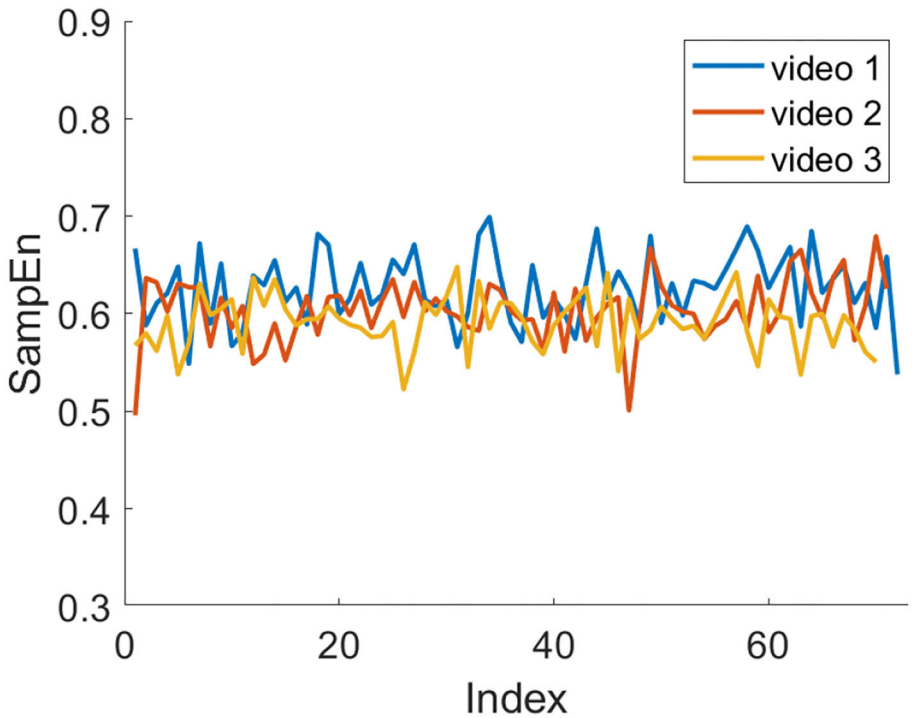

FIGURE 9 | Average SampEn of three videos in session 1 over time.

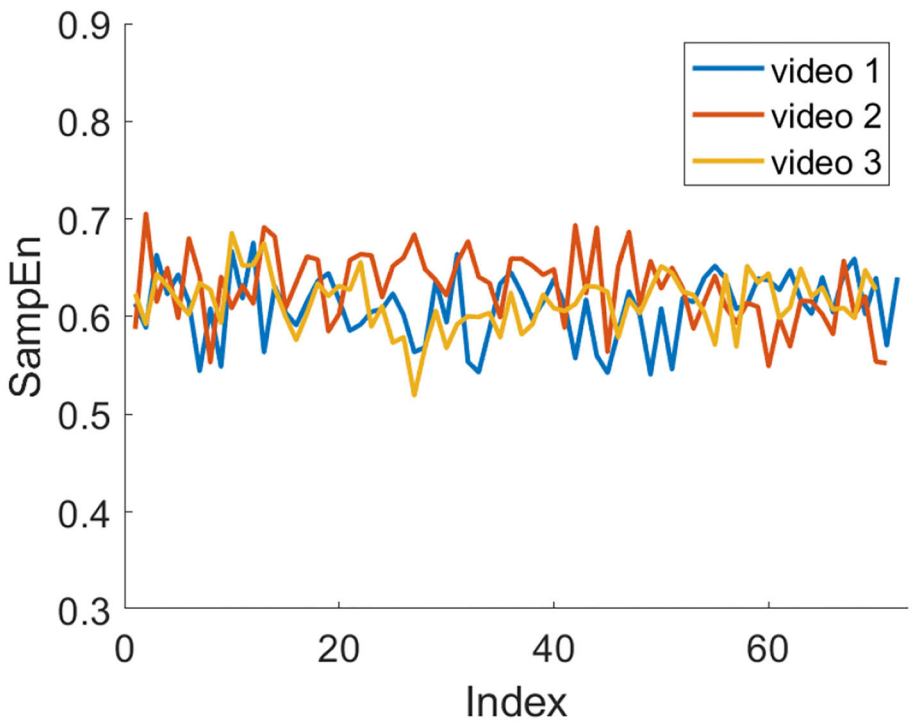

FIGURE 10 | Average SampEn of three videos in session 2 over time.

TABLE 4 | The Kruskal-Wallis test results of three trials in two sessions.

Session	1	2
p-value	9.35×10^{-9}	4.07×10^{-3}

TABLE 5 | The Mann-Whitney U test results of three videos.

Video	1	2	3
p-value	1.38×10^{-2}	3.39×10^{-5}	2.36×10^{-6}

learning from a real person, which contributes to their attention level.

Based on the comparison between the before and after the two sessions, a possible explanation is that as video 1 is easy to understand, so subjects decreased their attention to video 1 in session 2, and increased their attention to video 2 and video 3 in session 2.

In terms of the analysis of the SampEn change for each video, the SampEn fluctuated more or tended to decrease in the middle and later stages of some trials. The possible reason for this phenomenon is that as the learning time progresses, the subjects become less focused and their attention level decreases. The decline in attention is a common phenomenon in the classroom, and this experimental phenomenon is consistent with the changing pattern of attention of classroom students. Furthermore, it is an online course, and the lack of direct communication and supervision in reality, as well as the influence of the surrounding environmental factors, can affect the subject's attention. Therefore, it is a feasible way for teachers to organize online instruction by incorporating guided activity, reflection, feedback, pacing, and pre-training to build an interactive multimedia learning environment (37), which is a practical solution to improve students' attention in class and enhance the quality of online instruction. Moreover, the individual variability can be taken into account so that as many students as possible can achieve meaningful learning in the classroom.

This work is a preliminary study and still has some limitations that require further research in the future. Firstly, in our work, we selected videos with similar topics as stimuli to minimize the effect of content differences on students' attention. However, it is better to have the videos with exactly the same content. Therefore, in order to reduce the effects of other factors, it is necessary to use materials with the same content to perform future experiments. Moreover, to better analyze the impact of multiple styles of online instruction on students' classroom attention, there is a need for us to design more complete experimental paradigms in the future by adding experiments on resting, non-attentive, and attentive states. It is also to obtain labels of the data for more accurate analysis. At the same time, we need to add more subjects to provide a more comprehensive and generalized basis for online multimedia instructional design.

5. CONCLUSIONS

The COVID-19 pandemic brings negative effects to schools, and it is difficult for students to enjoy courses with teachers face to face. In this circumstance, online courses are flourishing in many schools, and students can take the courses at home during the COVID-19 pandemic. To improve the effect of online courses, this work analyzed the impact of different styles of online instructional videos on the classroom attention of the subjects. We collected the EEG signals of the subjects while watching these online course videos and calculated the SampEn of the EEG signals as a measure of attention. And video 1 has the highest average SampEn. Combined with Mayer's theories of multimedia technology, the results show that online course videos in which the instructor and the content appear on the screen at the same time and the instructor points out the location of the content while explaining it are more likely to induce higher levels of students' attention. And it is a useful basis for online multimedia instruction design in the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

QG designed the framework and acquired the data. YT acquired and analyzed the data. QG and YT wrote the manuscript. Both authors contributed to the article and approved the submitted version.

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Mental Health of COVID-19 Survivors at 6 and 12 Months Postdiagnosis: A Cohort Study

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Objective: As COVID-19 persists around the world, it is necessary to explore the long-term mental health effects in COVID-19 survivors. In this study, we investigated the mental health outcomes of survivors of COVID-19 at 6 and 12 months postdiagnosis.

Methods: Posttraumatic stress disorder (PTSD checklist for the DSM-5, PCL-5), depression (PHQ-9), anxiety (Generalized Anxiety Disorder Scale, GAD-7), resilience (Connor-Davidson Resilience Scale, CD-RISC-10), perceived social support (PSSS), personality traits (Chinese Big Five Personality Inventory-15, CBF-PI-15), and sociodemographic information were examined among 511 survivors of COVID-19 (48.1%, females; M_{age} = 56.23 years at first assessment) at 6 and 12 months postdiagnosis. The data were analyzed with Wilcoxon signed rank tests and multivariable logistic regression models.

Results: The prevalence of anxiety, depression, and posttraumatic stress disorder (PTSD) at 6 and 12 months after diagnosis was 13.31% and 6.26%; 20.35% and 11.94%; and 13.11% and 6.07%, respectively. The risk factors for all symptoms were as follows: higher neuroticism; lower openness, extraversion, agreeableness, and resilience; greater life disruptions due to COVID-19; poorer living standards; and increased symptoms of PTSD or depression at 6 months postdiagnosis.

Conclusion: The mental health of COVID-19 survivors improved between 6 and 12 months postdiagnosis. Mental health workers should pay long-term attention to this group, especially to survivors with risk factors.

Keywords: COVID-19, hospitalized survivors, PTSD, depression, anxiety

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INTRODUCTION

As of February 15, 2022, the global pandemic of COVID-19—an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)—has resulted in more than 410.6 million confirmed cases with more than 5.8 million deaths (1). Since December 2019, people around the world have continued to fight against this new disease for more than 2 years; however, we might have to live with COVID-19 for a long period of time.

For patients surviving COVID-19 infection, experiencing COVID-19 might cause substantial trauma (2). After being diagnosed with COVID-19, there was much mental suffering for patients

(3). Previous studies reported that 13.2–96.2%, 21.0–33.7%, and 16.4–34.72% of patients with COVID-19 exhibited posttraumatic stress disorder (PTSD), depression, and anxiety symptoms, respectively (2, 4–6). These studies were conducted within 3 months after the participants received confirmation of their COVID-19 infection, which revealed the immediate mental impact of COVID-19. Regarding the long-term effects of COVID-19 on survivors, these individuals continued a physical recovery phase after leaving the hospital (7, 8) and reported physical and psychological sequelae (9, 10). A study in Norway found that 9.5% of hospitalized patients reported PTSD symptoms at a median of 116 days after COVID-19 onset (11). A study including 251 participants in Brazil found that 81 (32.27%) had a positive screening for anxiety/depression 3 months following hospital discharge (12). A study in China found that 6 months after discharge from the hospital, 23% (367 of 1,617) of patients reported depression or anxiety (2). Another study investigating 152 patients 6 months after discharge also reported poor mental health compared to baseline conditions (13). In summary, survivors of COVID-19 continue to exhibit mental health problems after discharge. Moreover, the duration of the pandemic might have chronic effects on mental health. Thus, longitudinal assessments are essential for evaluating the long-term effects on the mental health of COVID-19 survivors, especially at periods of time longer than 6 months after discharge. We intended to explore the long-term mental health of COVID-19 survivors and compare the differences in their mental health over time.

Studies about previous pandemics, such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), might remind us about how the mental status of survivors of a pandemic changes over time (14–16). Survivors might show relatively high psychological distress during the acute phase (17). Cheng et al. reported that 35% of 425 survivors expressed having anxiety or depressive symptoms at 1 month post-SARS infection (17), and although the severity of mental distress might decrease, it remains higher than that of the general public over the long term (18, 19). Chau et al. performed a systematic review and found that the prevalence of anxiety, depression, and PTSD among SARS survivors was 19, 20, and 28%, respectively, and the outcomes within the first 6 months and beyond 6 months postdischarge were not significantly different (14). However, considering that the duration of COVID-19 is much longer than that of SARS and MERS, we suspected that the mental health recovery process for survivors of COVID-19 would be much longer than that observed for the previous two pandemics.

Moreover, previous mental health status might affect subsequent mental health outcomes (20–22). Nikèeviæ et al. reported that health anxiety might predict subsequent generalized anxiety and depressive symptoms in United States residents (20). Wu et al. found that during the COVID-19 pandemic, depression symptoms could predict subsequent anxiety in university students (22). Previous PTSD severity was shown to predict follow-up PTSD severity (23). However, no study has examined the temporal associations of mental health outcomes in survivors of COVID-19. Therefore, we explored whether previous mental health symptoms could predict subsequent symptoms.

Some risk factors for mental health outcomes after disasters have been reported in literature, such as female sex, young age, lower socioeconomic status, higher education level, marital status (married for women and unmarried for men), greater exposure to the disaster, and lack of perceived social support (2, 24). We included the above factors in our investigation and examined whether the effects of these factors impacted COVID-19 survivors in the long term. Regarding personality factors, higher resilience might be conducive to maintaining mental health (25). Liu et al. examined the associations between the Big Five personality traits and stress and reported that higher neuroticism and extraversion were associated with higher levels of stress during the pandemic (26). Nikčević et al. found that neuroticism was positively correlated with generalized anxiety and depressive symptoms in the general public during the COVID-19 pandemic (20). The Big Five personality traits might have effects on the mental health of patients. Furthermore, a previous study found that body mass index (BMI) significantly changed in hospital staff during the COVID-19 pandemic (27), and there could be similar changes in patients. Therefore, we also intended to explore the effects of the Big Five personality traits and BMI on mental health in patients in this study. Moreover, at different phases of the pandemic, the impacts of the above factors might not be the same (18), so it was necessary to examine the effects of these factors at different time points.

In the current study, we aimed to examine the long-term mental health effects of COVID-19 infection and to identify predictors, as we investigated the mental health of COVID-19 survivors at 6 and 12 months after diagnosis. These patients were treated at Wuhan Jin-Yintan Hospital, which was the earliest medical center designated for fighting COVID-19 in China (28). We adopted depression, anxiety, and PTSD symptoms as indices for mental health. We included the socioeconomic and individual factors described above; specifically, severity the level of symptoms, ICU admission, relatives with COVID-19, and the level of life disruption by COVID-19 were included in the assessment of the effects of COVID-19 infection.

MATERIALS AND METHODS

Procedures and Participants

After the COVID-19 outbreak, many patients were confirmed to be infected and accepted as inpatients in Wuhan Jin-Yintan Hospital. All 2,469 patients discharged between January 7 and May 29, 2020 were referred to Jin-Yintan Hospital for psychological and physical examinations. Our study was conducted through psychological examinations performed independently by a psychology graduate student and a nurse, who was trained by the graduate student to read the questions for participants who could not read. Additional details about the physical examination procedure are described elsewhere (7). The psychological investigations were conducted at two timepoints: T1, from July 24 to September 4, 2020, and T2, from December 16, 2020 to February 7, 2021. Informed consent was obtained

from all participants at each timepoint. An online questionnaire was administered. The participants completed the questionnaire by themselves with the guidance of two nurses. For those without a smartphone, a paper questionnaire was provided; for illiterate individuals, a nurse read the questions and choices for them and completed the questionnaire based on their answers. Finally, 945 and 1,131 participants were included at T1 and T2, respectively, and 537 participated in both investigations. Then, 26 participants were excluded, which included 25 participants who answered the questionnaires in less than 200 s and one participant whose birthdate was inaccurate. Thus, 511 participants (at T1: sex: 246 females/265 males; age: M = 56.23, SD = 12.18) were included in the analysis. The research proposal was approved by the ethics review committee of the Institute of Psychology, Chinese Academy of Sciences.

Measures

Demographic Variables

The basic demographic information included age, sex, BMI, educational level (primary school, junior high school, high school/technical secondary school, junior college/university, postgraduate, or above), living standard (low, below average, medium, or above average), and marital status (unmarried, married, divorced, remarried, or widowed). The variables related to how the participants were affected by COVID-19 were as follows: date of diagnosis, length of stay, severity level of symptoms associated with COVID-19 (none, mild, medium, or serious), ICU admission (no or yes), whether they had relatives confirmed to have COVID-19 (no or yes), and to what level their life had been disrupted by COVID-19 (none, mild, medium, and serious). The demographic variables were measured at T1.

Posttraumatic Stress Disorder

The PTSD checklist for the DSM-5 (PCL-5) was used at T1 and T2. The PCL-5 comprises 20 items that assess all DSM-5 PTSD symptoms. Each item was rated on a scale of 0–4 (0 = "none" to 4 = "severe"), and the total score could range from 0 to 80 (29). Higher scores indicated a more severe degree of PTSD, and scores above 33 indicated probable PTSD (29). The PCL-5 was shown to exhibit a strong reliability and validity (2). In the current study, Cronbach's alpha values for the scale at T1 and T2 were 0.935 and 0.961, respectively.

Depression

The Chinese version of the 9-item Patient Health Questionnaire (PHQ-9) was used to assess depression symptoms at T1 and T2. Each item describes a specific depressive symptom rated on a scale of 0–4 (0 = "not at all" to 3 = "every day"), and total scores can range from 0 to 27 (30). The PHQ-9 has been shown to be valid and reliable and to have good diagnostic utility. Scores above 9 indicate a probable depression disorder (30). In the present study, Cronbach's alpha values at T1 and T2 were 0.898 and 0.930, respectively.

Anxiety

The Generalized Anxiety Disorder Scale (GAD-7) was used to examine the severity of anxiety at T1 and T2. The items on the GAD-7 are rated on a four-point scale (0 = "not at all" to 3 = "every day"), and total scores can range from 0 to 21 (31). The GAD-7 was shown to have good reliability, validity and diagnostic utility. Scores above 9 indicate a probable anxiety disorder (31). In the present study, Cronbach's alpha values at T1 and T2 were 0.932 and 0.959, respectively.

Resilience

The abbreviated version of the Connor-Davidson Resilience Scale (CD-RISC-10) was used to assess resilience at T1 and T2. The CD-RISC-10 is a 10-item self-report scale with good psychometric properties. The items are scored on a five-point scale from 0 to 4 (0 = "none" to 4 = "always") (32). The total score can range from 12 to 84, and higher total scores indicate a higher level of resilience. In this study, Cronbach's alpha values at T1 and T2 were 0.967 and 0.982, respectively.

Perceived Social Support

The Chinese version of the perceived social support scale (PSSS) was administered at T1 and T2 to measure perceived social support from significant others, family members, and friends. The PSSS comprises 12 items rated from 1 to 7 (1 = "very strongly disagree" to 7 = "very strongly agree") (33). The total score can range from 12 to 84, and higher scores indicate higher perceived social support. The PSSS has been shown to have strong psychometric properties (34). In this investigation, Cronbach's alpha values at T1 and T2 were 0.955 and 0.967, respectively.

Big Five Personality

The Chinese Big Five Personality Inventory-15 (CBF-PI-15) was used to assess the Big Five personality traits at T2. The CBF-PI-15 is a very short version of the Chinese Big Five Personality Inventory (CBF-PI) and comprises 15 items answered on a six-point scale ranging from 1 ("disagree strongly") to 6 ("agree strongly") (35). The CBF-PI-15 has been shown to have good reliability and validity. In this investigation, Cronbach's alpha values ranged from 0.836 (agreeableness) to 0.895 (conscientiousness), with the exception of 0.304 for openness. We included the openness dimension in the analysis to maintain experimental integrity.

Data Analysis

Demographic characteristics are presented as the mean (M) and standard deviation (SD) for continuous variables (see **Table 1**) and as numbers with percentages for categorical variables (see **Table 2**). Mental health characteristics are expressed as the mean and SD. Wilcoxon signed rank tests were adopted to examine the changes in the variables between T1 and T2. Then, all the predictors were included in multivariable logistic regression models of the mental health outcomes. In particular, aspects of mental health at T1 were examined as predictors for outcomes at T2. Analyses were performed with SPSS 26.

TABLE 1 | Pearson correlation of the variables of the participants.

		Mean (*SD*)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	Age	56.23 (12.18)	1																				
2	Days between discharge and T1	151.79 (24.25)	–0.07	1																			
3	Days between discharge and T2	307.35 (22.06)	–0.04	0.88**	1																		
4	Length of stay (days)	36.01 (23.08)	0.08	–0.67**	–0.71**	1																	
5	BMI at T1	24.64 (3.40)	–0.04	0.03	0.03	–0.01	1																
6	BMI at T2	25.07 (3.41)	0.01	0.03	0.03	–0.02	0.92**	1															
7	Resilience at T1	26.06 (12.43)	0.03	0.10*	0.06	–0.05	0.01	0.02	1														
8	Resilience at T2	24.50 (12.09)	–0.11*	0.12**	0.11*	–0.07	–0.08	–0.08	0.19**	1													
9	Social support at T1	58.85 (20.30)	0	0.18**	0.18**	–.010*	–0.01	–0.02	0.54**	0.19**	1												
10	Social support at T2	60.21 (16.51)	–0.11*	0.12**	0.10*	–0.02	–0.01	–0.01	0.15**	0.51**	0.33**	1											
11	Neuroticism	9.09 (4.04)	0	–0.08	–0.08	0.04	–0.03	–0.03	–0.03	0.11*	–0.03	0.12**	1										
12	Openness	9.06 (4.60)	–0.21**	0.07	0.07	–0.04	–0.06	–0.09*	0.05	0.35**	0.07	0.48**	0.12**	1									
13	Conscientiousness	12.52 (4.1)	–0.20**	0.04	0.02	0.04	–0.07	–0.09	0.12**	0.56**	0.21**	0.69**	0.23**	0.58**	1								
14	Extraversion	10.05 (3.13)	–0.04	0.08	0.14**	–0.08	0.08	0.07	0.02	–0.17**	0.06	–0.05	–0.30**	–0.06	–0.22**	1							
15	Agreeableness	13.67 (3.96)	–0.07	0.03	–0.02	0.02	–0.02	–0.01	0.21**	0.60**	0.24**	0.68**	0.26**	0.35**	0.69**	–0.23**	1						
16	PTSD at T1	16.33 (15.24)	0.09*	–0.13**	–0.10*	0.07	0	0.01	–0.18**	–0.15**	–0.16**	–0.18**	0.27**	–0.14**	–0.08	–0.16**	–0.08	1					
17	PTSD at T2	10.99 (12.08)	0.01	–0.07	–0.07	0.07	0.04	0.03	–0.17**	–0.12**	–0.12**	–0.17**	0.30**	–0.08	–0.06	–0.16**	–0.12**	0.54**	1				
18	Depression at T1	5.73 (5.78)	0.05	–0.09*	–0.07	0.06	0.04	0.05	–0.20**	–0.12**	–0.18**	–0.16**	0.21**	–0.12**	–0.10*	–0.12**	–0.06	0.81**	0.47**	1			
19	Depression at T2	3.70 (4.78)	–0.01	–0.08	–0.07	0.06	0.03	0.02	–0.18**	–0.14**	–0.11*	–0.17**	0.27**	–0.10*	–0.09*	–0.11*	–0.13**	0.48**	0.86**	0.51**	1		
20	Anxiety at T1	3.96 (5.05)	–0.01	–0.10*	–0.07	0.03	0.03	0.04	–0.18**	–0.06	–0.18**	–0.13**	0.27**	–0.09*	–0.03	–0.16**	–0.04	0.77**	0.48**	0.77**	0.43**	1	
21	Anxiety at T2	2.60 (4.10)	–0.03	–0.08	–0.06	0.03	0.02	0.01	–0.16**	–0.13**	–0.11*	–0.19**	0.32**	–0.11**	–0.05	–0.16**	–0.13**	0.45**	0.81**	0.43**	0.87**	0.44**	1

**Correlation was significant at the 0.05 level (two-tailed).*

***Correlation was significant at the 0.01 level (two-tailed).*

T1, the first survey time point; T2, the second survey time point; BMI, body mass index. Variables measured twice are marked with T1 and T2 to distinguish the time, e.g., BMI at T2 was the BMI measured at T2. Big Five traits (11–15) were measured at T2. Other variables without marks were measured at T1.

TABLE 2 | Sociodemographic characteristics and mental health of the participants.

Characteristics		Number	PTSD at T1	PTSD at T2	Depression at T1	Depression at T2	Anxiety at T1	Anxiety at T2
Sex								
	Female	246 (48.14%)	18.87 (16.55)	11.82 (0.83)	6.40 (6.07)	3.98 (5.14)	4.93 (5.56)	2.95 (4.53)
	Male	265 (51.86%)	13.97 (13.51)	10.23 (0.68)	5.11 (5.44)	3.45 (4.41)	3.05 (4.35)	2.28 (3.63)
Education								
	Primary school	43 (8.41%)	16.47 (13.31)	12.95 (17.52)	4.95 (4.87)	3.37 (5.57)	4.19 (4.40)	3.02 (5.93)
	Junior high school	145 (28.38%)	16.68 (15.66)	10.59 (12.66)	5.47 (5.72)	3.44 (4.89)	4.08 (5.24)	2.32 (4.03)
	High school/technical secondary school	170 (33.27%)	17.21 (16.28)	10.51 (10.62)	6.59 (6.28)	3.71 (4.53)	4.45 (5.37)	2.55 (3.65)
	Junior college/university	142 (27.79%)	15.23 (14.14)	11.49 (11.34)	5.37 (5.39)	4.18 (4.80)	3.26 (4.52)	2.89 (4.11)
	Postgraduate or above	11 (2.15%)	11.82 (14.67)	9.82 (9.47)	3.73 (5.98)	2.09 (3.21)	3.00 (6.02)	1.55 (2.88)
Living standard								
	Low	63 (12.33%)	26.19 (18.76)	16.33 (13.82)	8.70 (6.59)	5.17 (5.40)	6.78 (6.13)	3.65 (3.96)
	Below average	170 (33.27%)	16.31 (15.34)	11.52 (13.64)	5.78 (6.03)	3.88 (5.15)	4.35 (5.35)	2.92 (4.67)
	Medium	250 (48.92%)	14.43 (13.50)	9.68 (10.12)	5.07 (5.19)	3.33 (4.34)	3.12 (4.33)	2.22 (3.74)
	Above average	28 (5.48%)	11.25 (11.67)	7.50 (10.51)	4.68 (5.47)	2.61 (4.09)	2.68 (3.92)	1.64 (3.35)
Marital status								
	Unmarried	21 (4.11%)	21.48 (19.94)	12.57 (10.27)	8.29 (7.96)	5.19 (4.49)	5.29 (6.56)	3.1 (3.82)
	Married	397 (77.69%)	15.71 (14.76)	10.62 (11.98)	5.48 (5.57)	3.54 (4.77)	3.80 (5.04)	2.58 (4.2)
	Divorced	33 (6.46%)	17.91 (17.50)	11.64 (14.55)	6.85 (6.63)	4.00 (4.86)	4.55 (5.43)	3.03 (4.53)
	Remarried	8 (1.57%)	13.50 (19.08)	6.38 (12.14)	5.50 (6.14)	2.38 (5.21)	3.00 (4.75)	1.63 (4.21)
	Widowed	52 (10.18%)	18.38 (14.48)	13.50 (11.72)	5.98 (5.62)	4.33 (4.81)	4.44 (4.24)	2.42 (3.16)
Order of severity								
	None	16 (3.13%)	18.69 (19.64)	13.06 (11.80)	6.13 (6.54)	3.38 (3.54)	7.06 (8.30)	2.63 (3.03)
	Mild	228 (44.62%)	14.45 (13.53)	9.36 (10.98)	4.90 (5.10)	3.03 (4.13)	3.63 (4.69)	2.17 (3.69)
	Medium	154 (30.14%)	15.68 (15.49)	10.62 (11.04)	5.82 (6.21)	3.81 (4.55)	3.86 (5.03)	2.76 (4.14)
	Serious	113 (22.11%)	20.67 (16.71)	14.50 (14.69)	7.23 (6.11)	4.97 (6.06)	4.33 (5.09)	3.25 (4.85)
ICU admission								
	No	283 (55.38%)	17.84 (16.35)	12.31 (0.76)	6.40 (6.21)	4.25 (5.18)	4.23 (5.31)	2.95 (4.38)
	Yes	228 (44.62%)	14.45 (13.53)	9.36 (0.73)	4.90 (5.10)	3.03 (4.13)	3.63 (4.69)	2.17 (3.69)
Relatives with COVID-19								
	No	268 (52.45%)	13.94 (13.36)	9.93 (12.25)	4.74 (5.07)	3.26 (4.58)	3.40 (4.62)	2.43 (4.22)
	Yes	243 (47.55%)	18.96 (16.70)	12.17 (11.79)	6.83 (6.31)	4.19 (4.95)	4.58 (5.42)	2.79 (3.97)
Life disturbed by COVID-19								
	None	72 (14.09%)	8.36 (10.36)	6.94 (12.05)	3.11 (4.46)	2.17 (4.32)	2.54 (5.03)	1.88 (3.91)
	Mild	183 (35.81%)	12.46 (11.16)	8.43 (8.61)	4.21 (4.25)	2.75 (3.47)	2.78 (3.60)	1.96 (3.42)
	Medium	137 (26.81%)	18.71 (15.47)	10.85 (10.14)	6.58 (6.12)	3.71 (4.43)	4.53 (5.28)	2.41 (3.72)
	Serious	119 (23.29%)	24.36 (18.36)	17.55 (15.71)	8.68 (6.64)	6.09 (6.13)	5.97 (5.92)	4.24 (5.08)

Data were n (%) or the mean (SD); bold indicates $p < 0.05$. ICU, intensive care unit; T1, the first survey time point; T2, the second survey time point; PTSD, posttraumatic stress disorder. Order of severity—severity level of the symptoms associated with COVID-19; relatives with COVID-19—whether the participant had relatives confirmed to have COVID-19; life disturbed by COVID-19—to what level the participant's life was disrupted by COVID-19.
Variables measured twice are marked with T1 and T2 to distinguish the time, e.g., PTSD at T2 was PTSD measured at T2.

RESULTS

Participants

On average, the patients participated in the investigation for 6 months (T1: M = 187.62 days, SD = 18.75) or 12 months (T2: M = 343.19 days, SD = 16.75) after the date of diagnosis. The sociodemographic and personality characteristics of the sample are displayed in **Tables 1**, **2**. The education levels of most of the participants were high school/technical secondary school (33.27%), followed by junior high school (28.38%) and junior college/university (27.79%); only a few participants had a primary school education (8.41%) or postgraduate education or above (2.15%). Most participants perceived that they lived at medium (48.92%) or below average (33.27%) living standards. The majority were married (77.69%) or widowed (10.18%).

COVID-19 Experience

The mean length of stay in the hospital was 36.01 days (SD = 23.08). The patients reported various levels of severity: 22.11% reported serious symptoms; 30.14% reported medium symptoms; 44.62% reported mild symptoms; and only 3.13% reported no symptoms. Approximately half (44.62%) of the patients were admitted to the ICU, and 47.55% had relatives with COVID-19. The lives of most patients were disrupted by COVID-19 (85.91%); more precisely, 35.81% had mild, 26.81% had

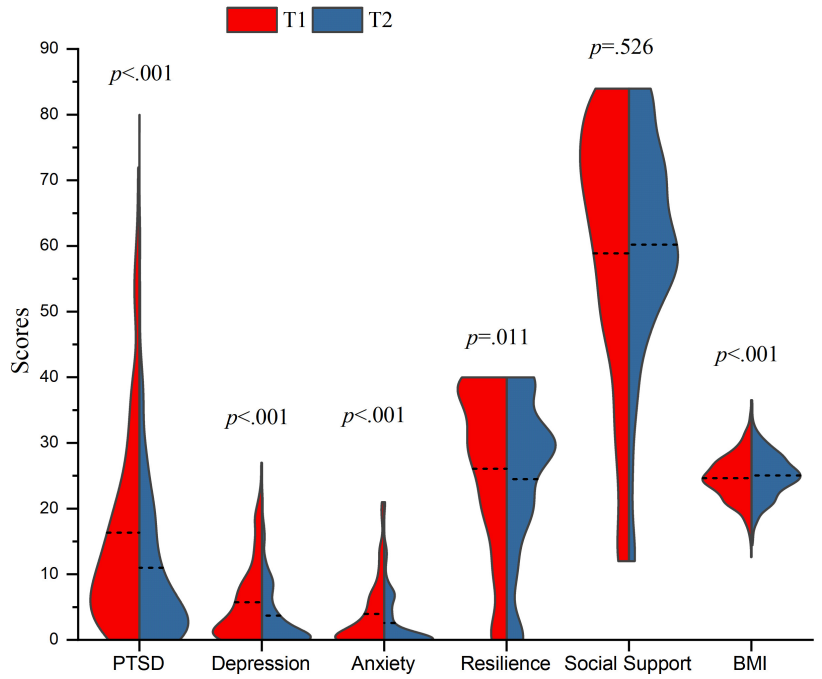

FIGURE 1 | Temporal changes of PTSD, depression, anxiety, resilience, social support, and BMI. related-samples Wilcoxon signed rank test were conducted on PTSD, depression, anxiety, resilience and social support due to the non-normality of data. The paired samples *t*-test was conducted on BMI based on the normality of data. The horizontal dash lines were used to indicate the mean value.

medium, and 23.29% had serious disruptions. These discharged patients were severely affected by COVID-19.

The Effects of Time on Mental Health and Resilience, Social Support, and Body Mass Index

As shown in **Tables 1**, **2** and **Figure 1**, at T1 and T2, 67 (13.11%) and 31 (6.07%) patients, respectively, had PTSD scores above 33; 104 (20.35%) and 61 (11.94%) had depression scores above 9; and 68 (13.31%) and 32 (6.26%) had anxiety scores above 9. The mean PTSD, depression, and anxiety scores at T1 and T2 were 16.33 (*SD* = 15.24) and 10.99 (*SD* = 12.08), 5.73 (*SD* = 5.78) and 3.70 (*SD* = 4.78), and 3.96 (*SD* = 5.05) and 2.60 (*SD* = 4.10), respectively, all of which showed significant decreases ($p < 0.001$). Interestingly, the mean BMI at T1 and T2 was 24.64 (*SD* = 3.40) and 25.07 (*SD* = 3.14), respectively, which showed a significant increase ($p < 0.001$). Moreover, the mean resilience scores (T1: $M = 26.06$, $SD = 12.43$; T2: $M = 24.50$, $SD = 12.09$) significantly changed ($p = 0.011$), while social support (T1: $M = 58.85$, $SD = 20.30$; T2: $M = 60.21$, $SD = 16.51$) did not significantly change ($p = 0.526$).

Predictors of Posttraumatic Stress Disorder, Depression, and Anxiety Symptoms at T1 and T2

The results of multivariate logistic regression for PTSD, depression, and anxiety are shown in **Table 3**. At T1, higher neuroticism and serious [odds ratio (OR) = 4.18, 95% confidence interval (CI) = 1.14–15.41, $p = 0.032$] life disruptions from COVID-19, compared to no influence, added to the probability of having PTSD symptoms. Higher openness (OR = 0.90, 95% CI = 0.83–0.97, $p = 0.005$) and a medium living standard compared to a low living standard (OR = 0.36, 95% CI = 0.15–0.85, $p = 0.020$) reduced the probability of having PTSD symptoms. Regarding depression, at T1, higher neuroticism (OR = 1.07, 95% CI = 1.00–1.15, $p = 0.048$), a high school/technical secondary school education compared to a primary school education (OR = 3.46, 95% CI = 1.24–9.66, $p = 0.018$), and medium (OR = 3.95, 95% CI = 1.40–11.13, $p = 0.009$) and serious (OR = 4.51, 95% CI = 1.56–13.05, $p = 0.005$) levels of life disruption from COVID-19, compared to no disruptions, increased the probability of depression. Higher resilience (OR = 0.96, 95% CI = 0.94–0.99, $p = 0.003$) and openness (OR = 0.92, 95% CI = 0.86–0.98, $p = 0.013$) reduced the likelihood of depression. Regarding anxiety, higher neuroticism (OR = 1.12, 95% CI = 1.03–1.22, $p = 0.008$) increased the probability of anxiety. Higher extraversion (OR = 0.89, 95% CI = 0.81–0.98, $p = 0.019$), higher openness (OR = 0.97, 95% CI = 0.95–0.99, $p = 0.002$), and medium living standards, compared to low living standards (OR = 0.25, 95% CI = 0.11–0.59, $p = 0.002$), reduced the likelihood of anxiety.

At T2, higher neuroticism (OR = 1.49, 95% CI = 1.18–1.88, $p < 0.001$) and PTSD scores at T1 (OR = 1.06, 95% CI = 1.00–1.12, $p = 0.046$) increased the probability of having PTSD symptoms; higher agreeableness (OR = 0.59,

TABLE 3 | Multivariate logistic regressions of PTSD, depression, and anxiety at T1 and T2.

Characteristics	PTSD at T1		Depression at T1		Anxiety at T1		PTSD at T2		Depression at T2		Anxiety at T2	
	p-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)
Neuroticism	**<0.001**	**1.20 (1.09, 1.33)**	**0.048**	**1.07 (1.00, 1.15)**	**0.008**	**1.12 (1.03, 1.22)**	**<0.001**	**1.49 (1.18, 1.88)**	**<0.001**	**1.30 (1.15, 1.46)**	**<0.001**	**1.49 (1.21, 1.84)**
Openness	**0.032**	**0.91 (0.83, 0.99)**	**0.013**	**0.92 (0.86, 0.98)**	**0.011**	**0.90 (0.83, 0.98)**	0.451	0.94 (0.80, 1.10)	**0.048**	**0.91 (0.82, 1.00)**	0.104	0.89 (0.78, 1.02)
Extraversion	0.074	0.89 (0.78, 1.01)	0.457	0.97 (0.88, 1.06)	**0.034**	**0.88 (0.79, 0.99)**	0.275	0.88 (0.70, 1.11)	0.154	0.90 (0.78, 1.04)	**0.023**	**0.78 (0.63, 0.97)**
Agreeableness	0.085	0.91 (0.81, 1.01)	0.979	1.00 (0.91, 1.09)	0.389	0.95 (0.86, 1.06)	**<0.001**	**0.59 (0.45, 0.77)**	**0.002**	**0.80 (0.70, 0.92)**	**0.001**	**0.69 (0.55, 0.85)**
Resilience	0.129	0.98 (0.95, 1.01)	**0.003**	**0.96 (0.94, 0.99)**	0.180	0.98 (0.95, 1.01)	0.279	1.03 (0.98, 1.09)	0.278	0.98 (0.95, 1.02)	0.212	1.04 (0.98, 1.10)
PTSD at T1	Not applicable		Not applicable		Not applicable		**0.046**	**1.06 (1.00, 1.12)**	0.696	1.01 (0.97, 1.04)	0.853	1.00 (0.96, 1.05)
Depression at T1	Not applicable		Not applicable		Not applicable		0.341	1.07 (0.93, 1.24)	**0.007**	**1.15 (1.04, 1.26)**	0.117	1.12 (0.97, 1.30)
Education												
Postgraduate or above	0.760	0.59 (0.02, 17.61)	0.532	0.39 (0.02, 7.33)	0.746	1.53 (0.12, 20.37)	–	–	–	–	–	–
Junior college/ University	0.225	2.20 (0.62, 7.84)	0.303	1.81 (0.59, 5.56)	0.769	1.21 (0.34, 4.28)	0.824	0.80 (0.11, 5.89)	0.061	4.25 (0.94, 19.23)	0.793	1.27 (0.21, 7.71)
High school/technical secondary school	0.254	1.94 (0.62, 6.02)	**0.018**	**3.46 (1.24, 9.66)**	0.303	1.79 (0.59, 5.43)	0.200	0.34 (0.07, 1.77)	0.415	1.78 (0.45, 7.14)	0.082	0.24 (0.05, 1.20)
Junior high school	0.568	1.40 (0.44, 4.44)	0.200	1.96 (0.70, 5.52)	0.316	1.75 (0.59, 5.21)	0.807	0.81 (0.15, 4.33)	0.315	2.05 (0.51, 8.27)	0.352	0.47 (0.10, 2.29)
Primary school	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Living standard												
Above-average	0.262	0.35 (0.06, 2.18)	0.647	0.73 (0.19, 2.77)	0.150	0.20 (0.02, 1.78)	0.821	0.72 (0.04, 12.69)	0.137	0.14 (0.01, 1.86)	0.625	1.93 (0.14, 26.64)
Medium	**0.020**	**0.36 (0.15, 0.85)**	**0.042**	**0.46 (0.21, 0.97)**	**0.002**	**0.25 (0.11, 0.59)**	0.094	0.26 (0.05, 1.26)	0.314	0.60 (0.22, 1.63)	0.893	0.91 (0.22, 3.70)
Below average	0.117	0.51 (0.22, 1.19)	0.106	0.54 (0.25, 1.14)	0.078	0.50 (0.23, 1.08)	0.549	1.49 (0.40, 5.53)	0.993	1.01 (0.38, 2.66)	0.525	1.52 (0.42, 5.57)
Low	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Life disturbed by COVID-19												
Serious	**0.032**	**4.18 (1.14, 15.41)**	**0.005**	**4.51 (1.56, 13.05)**	0.118	2.42 (0.80, 7.30)	0.612	1.68 (0.23, 12.45)	0.909	0.93 (0.27, 3.22)	0.398	2.37 (0.32, 17.50)
Medium	0.076	3.22 (0.89, 11.73)	**0.009**	**3.95 (1.40, 11.13)**	0.141	2.23 (0.77, 6.45)	0.463	0.44 (0.05, 4.00)	0.409	0.59 (0.16, 2.09)	0.616	0.58 (0.07, 4.83)
Mild	0.788	0.83 (0.22, 3.18)	0.778	0.86 (0.30, 2.49)	0.291	0.55 (0.18, 1.67)	0.463	0.46 (0.06, 3.70)	0.108	0.37 (0.11, 1.25)	0.900	0.89 (0.13, 5.97)
None	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

The patients with anxiety scores > 9 were considered to have a mental disorder; the patients with depression scores > 9 were considered to have a mental disorder; and the patients with PTSD scores > 33 were considered to have a mental disorder.

Bold indicates $p < 0.05$. All the predictors were included in the multivariate logistic regressions (these three predictors, PTSD at T1, depression at T1, and anxiety at T1, were only included in the models of PTSD at T2, depression at T2, and anxiety at T2); for brevity, only predictors with significant effects are presented. OR, odds ratio; Ref, reference; CI, confidence interval; PTSD, posttraumatic stress disorder; T1, the first survey time point; T2, the second survey time point. Variables measured twice are marked with T1 and T2 to distinguish the time, e.g., PTSD at T2 was PTSD measured at T2; reference category—no PTSD symptoms for the PTSD model, no depression symptoms for the depression model, and no anxiety symptoms for the anxiety model.

95% CI = 0.45–0.77, $p < 0.001$) reduced the probability of having PTSD symptoms. Regarding depression, higher neuroticism (OR = 1.30, 95% CI = 1.15–1.46, $p < 0.001$) and depression scores at T1 (OR = 1.15, 95% CI = 1.04–1.26, $p = 0.007$) increased the probability of depression; higher openness (OR = 0.91, 95% CI = 0.82–1.00, $p = 0.048$) and higher agreeableness (OR = 0.80, 95% CI = 0.70–0.92, $p = 0.002$) reduced the likelihood of depression. Regarding anxiety, higher neuroticism (OR = 1.35, 95% CI = 1.18–1.56, $p < 0.001$) increased the probability of anxiety, while higher extraversion (OR = 0.78, 95% CI = 0.63–0.97, $p = 0.023$) and higher agreeableness (OR = 0.69, 95% CI = 0.55–0.85, $p = 0.001$) reduced that probability.

DISCUSSION

This study aimed to investigate the mental health of survivors of COVID-19 in the long term as the pandemic continues to persist, examine whether the levels of depression, anxiety, and PTSD would decrease between 6 (T1) and 12 (T2) months after diagnosis and identify predictors of these mental health problems at T1 and T2. Our initial finding was that as COVID-19 continues to persist, the prevalence of anxiety, depression, and PTSD in COVID-19 survivors at 6 and 12 months after diagnosis were 13.31 and 6.26%, 20.35 and 11.94%, and 13.11 and 6.07%, respectively; all of these showed significant decreases and a trend of mental improvement. Moreover, higher neuroticism, lower openness, extraversion, agreeableness, and resilience, greater life disruptions due to COVID-19, poorer living standards and higher PTSD and depression scores at T1 were risk factors for mental health problems.

The Effects of Time on Mental and Physical Health

We found that depressive, anxiety, and PTSD symptoms of COVID-19 survivors discharged from a representative hospital treating patients with COVID-19 (Wuhan Jin-Yintan Hospital) decreased significantly between T1 and T2. This result was not consistent with a previous study on SARS (14), which reported that the prevalence of these outcomes in the first 6 months postdischarge and beyond was not significantly different. This might be because SARS lasted for only a short time (from November 2002 to July 2003) (18), while COVID-19 has continued to persist for a long time (starting in December 2019 and not yet ending) (36). Survivors remain under the threat of COVID-19 after discharge from the hospital, and thus, the recovery of their mental health might be slower. This possibility can be supported by the following evidence. First, at 1 month post-SARS, 35% of the survivors expressed having anxiety or depressive symptoms (17), which was higher than the prevalence reported by Chau et al. showing mental health recovery between the acute and postacute phases in SARS survivors. However, the prevalence of anxiety, depression, and PTSD at 6 months postdiagnosis in the current study was similar to those in the acute phase, which was 16.4, 21.0, and 13.2%, respectively (2). The long duration of COVID-19 might have prolonged the acute phase. Second, although the prevalence of anxiety, depression, and PTSD at 6 months after diagnosis in the current study was seemingly less serious than the 19, 20, and 28% prevalence rates in SARS survivors reported by Chau et al. (14), there was still a significant decline in anxiety, depression, and PTSD symptoms in COVID-19 survivors between 6 and 12 months after diagnosis. Our findings revealed that there might be different features of the prevalence and recovery process of mental health problems between COVID-19 and SARS, which still needs further study. We recommend that more attention be paid to the mental health of COVID-19 survivors over the long term, although their physical health may be protected.

We also found that resilience significantly decreased, which might be the result of the pressures associated with the ongoing pandemic (37). This can encourage mental health workers to conduct effective interventions to enhance people's resilience as the pandemic continues. Social support did not significantly vary between T1 and T2, showing the relative stability of social relationships, without much change due to COVID-19.

Interestingly, the BMI of survivors significantly increased. This might have been because the stress of COVID-19 increased the desire to eat (38). Considering that obesity is a risk factor for severe disease and mortality in people with COVID-19 infection (39), health workers should be careful not to let patients overeat.

Sociodemographic Factors Related to Mental Health Outcomes

This study found that lower education, enduring greater life disruptions due to COVID-19, and having poorer living standards were associated with increases in poor mental health outcomes. Guo et al. also reported that a low educational level was a risk factor for anxiety (40); however, the effect of education in our study was weak, which might need further study, so we do not consider it as a major predictor. Those whose lives were more seriously disrupted by COVID-19 were more likely to report PTSD and depression symptoms at 6 months postdiagnosis, which was consistent with previous studies (2), showing a dose-dependent effect. This impact could be explained by the level of trauma caused by COVID-19 (2), as those having greater life disruptions and relatives with COVID-19 might experience more psychological trauma. However, as time passed, the impact of life disruptions on mental health disappeared at T2. Living standards decreased the proportions of mental health problems only at T1, which showed the negative association between socioeconomic status and mental health (41). Those with a low socioeconomic status might have experienced greater difficulties during the COVID-19 pandemic, such as a decreased income due to quarantine and a poor living environment. Our results might illustrate that sociodemographic factors mainly have short-term effects on the mental health outcomes of COVID-19 survivors, and mental health workers should pay more attention to those who suffer more from COVID-19 and have low socioeconomic status.

Individual Factors Related to Mental Health Outcomes

Inconsistent with previous findings (2, 27), social support and BMI were not significant in the logistic regressions. Social support might mainly have an effect in the acute stage when comfort from friends and relatives could reduce the pandemic-related stress and loneliness of patients (42). An effect of BMI on mental health was not shown in the COVID-19 survivors. Further studies are needed to explore the effect of these factors in different samples and at different timepoints.

Higher resilience reduced the likelihood of depression only at T1, in line with previous reports (43, 44). However, the protective effect of resilience vanished at T2. Considering the drop in resilience between T1 and T2, a further study on the change in resilience and long-term resilience effects on mental health in COVID-19 survivors is needed.

Personality also affects mental health (20). Higher neuroticism was a risk factor for the three mental health outcomes at both T1 and T2, showing a stable long-term effect. Agreeableness had protective effects against the three mental health outcomes at T2; extraversion had protective effects against anxiety at T1 and T2; and openness had a protective effect against PTSD, depression, and anxiety at T1 and depression at T2. The results regarding the Big Five traits and mental health were in line with a previous study (20). Neuroticism was a key predictor for mental health problems, as individuals who are high in neuroticism experience a more negative affect and higher affective variability in their daily lives (45). Thus, psychological workers should pay special attention to those with high neuroticism. Nikčević et al. reported that agreeableness and extraversion played key protective roles in mental health (20), as these two traits might increase social activities, and our findings supported this idea. Furthermore, we discovered that extraversion mainly had effects on anxiety. The possible reason might have been that those who are high in extraversion increase their support seeking and decrease their support provisions when facing threats (46) and are more likely to perceive received social support (47). Further research can be done on the association of extraversion and anxiety. While agreeableness mainly had effects at 12 months postdiagnosis, this might be because those who are high in agreeableness tend to both seek and provide support (46) and might not obtain much relief in the short term.

Temporal Associations Related to Mental Health Outcomes

Consistent with previous studies (21, 23), we discovered that PTSD scores at T1 could predict PTSD symptoms at T2; depression scores at T1 could predict depression symptoms at T2, which was inconsistent with studies during the COVID-19 pandemic (20, 22); and there was no predictive effect of anxiety. COVID-19 survivors might develop PTSD symptoms after discharge, especially as the pandemic continues to persist, and they might suffer discrimination and social exclusion (48) or other negative impacts caused by the disease. Mental health workers could provide some interventions to prevent chronic PTSD symptoms and pay more attention to those individuals with PTSD symptoms. The inconsistent predictive effects of depression and anxiety may be related to several factors. First, as the pandemic was gradually controlled in China, the panic and anxiety of survivors gradually decreased, which could have reduced follow-up mental health problems. Second, anxiety might increase one's information seeking (49), which reduces uncertainty about the pandemic and self-health. Third, depression might reduce one's social and daily activities (50), causing depression symptoms to worsen. Further studies should explore the temporal associations among these mental health symptoms during the COVID-19 pandemic in larger and broader samples. Mental health workers could implement interventions for those with high levels of PTSD or depressive symptoms to prevent long-term mental health problems.

Limitations and Implications

There are some limitations of this study. First, in this study, data were obtained from self-report questionnaires; clinical diagnoses could be used in the future. Second, the sample for the current study was only from China and was not large and representative; future studies should include a more diverse sample of participants, such as patients from different countries. Third, some important factors, such as fear of reinfection (51) and pandemic prevention burnout (52), were not assessed in the current study but might have had negative effects on the mental health of the survivors of COVID-19. These factors should be assessed in future studies.

There are several important implications for psychological interventions as a result of our findings. First, we revealed that the mental health of COVID-19 survivors improved between 6 and 12 months postdiagnosis. Second, due to the much longer duration of the COVID-19 pandemic compared to previous pandemics, survivors may exhibit mental health problems in the long term, and mental health workers should continue to follow the mental health status of discharged COVID-19 patients over the long term. Third, our results indicated that at different timepoints, the predictors of mental health may vary; risk factors included higher neuroticism, increased PTSD and depression symptoms at T1, greater life disruptions caused by COVID-19, and poorer living standards, while protective factors included higher openness, extraversion, agreeableness, and resilience. Mental health workers should pay more attention to those with more risk factors and help to promote protective factors.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Review Committee of the Institute of Psychology, Chinese Academy of Sciences. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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

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Prevalence and Factors Associated With Depression and Suicidal Ideation During the COVID-19 Pandemic Among University Students in Uganda: A Cross-Sectional Study

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Background: The COVID-19 pandemic has negatively impacted psychosocial well-being and mental health of students across the world. Although students are vulnerable to depression and suicidal ideation, few studies have been conducted in Uganda. This study aimed to determine the prevalence of depression and suicidal ideation, and associated factors among undergraduate university students in Uganda.

Methods: A cross-sectional study was conducted among undergraduates [N = 540; 363 males; mean age = 23.3 (± 2.64) years] recruited from four universities using an online questionnaire that explored sociodemographic factors, depression, and other associated factors. The Patient Health Questionnaire (PHQ-9) was used to assess depression, and Item 9 was used to assess suicidal ideation in the past 2 weeks. Multivariable logistic regression analyses were performed to determine the factors associated with depression and suicidal ideation.

Results: The prevalence of moderate to severe depression was 20% (n = 108) (cut-off: 10/27 based on the PHQ-9), and the prevalence of past-2-week suicidal

ideation was 13.89% (n = 75) (cut-off: 1/3 based on the PHQ-9 Item 9). About half of the individuals who screened positive for depression had suicidal ideation. Factors associated with depression were: having relationship issues [adjusted odds ratio (aOR) = 1.79, 95% confidence interval (CI) = 1.13–2.81, p = 0.012], and having a history of sexual abuse (aOR = 2.06, 95% CI = 1.10–3.84, p = 0.023). Factors associated with reducing the risk of depression were: satisfaction with current academic performance (aOR = 0.50, 95% CI = 0.32–0.79, p = 0.003), and being in the fifth year of academic study (aOR = 0.16, 95% CI = 0.03–0.73, p = 0.018). Factors associated with suicidal ideation were: smoking cigarettes and/or marijuana (aOR = 4.83, 95% CI = 1.10–21.12, p = 0.037), and having financial tuition constraints (aOR = 1.85, 95% CI = 1.08–3.16, p = 0.024), However, satisfaction with current academic performance reduced the likelihood of suicidal ideation (aOR = 0.40, 95% CI = 0.23–0.70, p = 0.001).

Conclusion: Approximately one-fifth of undergraduate university students were moderately to severely depressed, especially those who had relationship issues and those with a history of sexual abuse. Suicidal ideation was common among smokers and those having financial tuition constraints. Therefore, it is recommended that the university authorities implement measures to provide psychological support for the students with problems concerning financial tuition constraints, relationships, and sexual abuse. Also, all students with depression should be screened for suicidality.

Keywords: depression, university students, sexual abuse, academic satisfaction, COVID-19, suicidal ideation

INTRODUCTION

Depression is a mental health disorder characterized by extreme sadness, feelings of emptiness, and/or irritable mood, accompanied by somatic and cognitive changes that significantly affect the individual's capacity to function (1). Globally, depression affects nearly 280 million people and can lead to a profound effect on all aspects of life, including a lower performance at school, poorer productivity at work, compromised relationships with family and friends, and lower ability to participate in the community (2). It was reported that Africa alone had 29.19 million cases of depression, accounting for 9% of the global depression burden (3). In Uganda, the general population prevalence was reported to be 4.6% (3). The prevalence of depression among university students in Uganda has ranged between 4.0 and 80.7% (4–7). The prevalence of depression in Uganda has been much higher among students during the coronavirus disease 2019 (COVID-19) pandemic (4) and a period characterized by marked psychological stressors and suicidality among students (8–12).

Various factors have been associated with the increased prevalence of depression among university students during the COVID-19 pandemic, including being female, precariousness, previous history of psychiatric illness, social isolation, COVID-19 illness, symptoms compatible with COVID-19, low quality of social relationships, low quality of COVID-19 information received, being a student aged 18–24 years, difficulties with paying for tuition fees prior to the pandemic, increased use of social media, internet use disorder, lack of physical activities/exercise, fear of COVID-19, poverty, and substance abuse (4, 13–16). In addition to COVID-19-related factors, several other factors have been associated with depression, including unhappy interpersonal relationships, chronic physical medical illnesses, chronic mental illnesses, low self-esteem, poor academic performance, family history of mental illness, financial constraints, insecurity at places of residence, smartphone addiction, being single, and the negative perception of the students of their learning environment (17–24). The effects of depression among students vary from mild effects such as poor academic performance (25) to very extreme events such as suicidal behaviors (9, 26–28). Previous studies have shown university students in Uganda to be at high risk of depression during the COVID-19 pandemic due to factors such as burnout, anxiety, and stress (4, 29), and such mood disorders also contribute to the increased risk of suicidal ideation (8).

Despite the introduction of peer support systems at the universities in Uganda, the prevalence of depression increased from 4.0% in 2002 to 21.5 in 2019 and 80.7% in 2020 during the first wave of the COVID-19 pandemic (4, 6, 7). This marked increase in the prevalence of depression over the years, especially during the COVID-19 pandemic, makes understanding depression among university students paramount, especially as the COVID-19 pandemic continues. Therefore, to have a better understanding of depression and suicidal ideation among students during the COVID-19 pandemic, a study among

Abbreviations: BSU, Bishop Stuart University; KIU, Kampala International University Western campus; MUST, Mbarara University of Science and Technology; KU, Kabale University; PHQ-9, Patient Health Questionnaire 9.

four universities in south-western Uganda was conducted during the second wave of the COVID-19 pandemic.

MATERIALS AND METHODS

Study Design and Settings

This was a cross-sectional survey conducted among undergraduate university students between May 2021 and September 2021 in south-western Uganda. Participants were recruited using the convenience sampling method incorporating snowball sampling with the assistance of class coordinators and faculty representatives from the four universities: Bishop Stuart University (BSU), Kampala International University—western Uganda campus (KIU), Mbarara University of Science and Technology (MUST), and Kabale University (KU). BSU is located in Mbarara City (western Uganda) with approximately 5,800 students. KIU is located 60 km from Mbarara city with approximately 17,000 students. MUST is located in Mbarara City with approximately 4,260 students. KU is located in Kabale (in extreme south-western Uganda) with approximately 3,000 students.

Inclusion and Exclusion Criteria

The study included students in KIU, BSU, KU, and MUST, aged 18 years or above during the academic year of 2019/2020, who agreed to take part in the study.

Sample Size Calculation

Using Epi Info StatCalc for Population Surveys (Version 7.2.5.0), a population size of 30,000 undergraduate university students was used to calculate the minimum sample size required to produce statistical power of 80%. The expected frequency of depression was at 21.5% among university students (medical students) before the COVID-19 pandemic (6) at an acceptable margin of error of 5% and a design effect of 1.0. The minimum calculated sample size was 257.

Study Measures and Procedure

The online survey (hosted on *Google Forms*) was pretested with Makerere University students, and then used for data collection from the four study sites. Students were recruited to participate using closed students' *WhatsApp* groups and student email addresses with a weblink to the survey. Initially, approximately 100 students from each university (including student leaders) were invited to participate (convenience sampling). They were also asked to distribute the questionnaire among their peers in the four universities (snowball sampling). The online questionnaire collected information concerning socio-demographic characteristics of the participants and assessed depression using the nine-item Patient Health Questionnaire (PHQ-9).

Basic Information of the Participants

Data were collected including participant age (years), gender (male or female), marital status (single, cohabiting, married, and separated/divorced), religion (Christian, Muslim, none), the university they were studying (BSU, KIU, MUST, KU), and type of living residence while at the university (home, hostel, rented house, university hall or other). In addition, academic information was collected, including college or faculty, the year of study, university tuition fee sponsor [private, government, non-government organization (NGO), loan scheme, or other], and whether the student was satisfied with their most recent academic grades. Using dichotomous (yes/no) questions, participants were also asked if they had difficulty paying tuition fees, relationship problems, and history of physical and/or sexual abuse. Similarly, data concerning health factors were obtained, such as a history of mental illness or chronic medical conditions (e.g., diabetes, hypertension, asthma, HIV, etc.), and a history of substance use (cigarette/marijuana smoking, alcohol drinking).

Patient Health Questionnaire

Depression symptoms were assessed using the nine-item Patient Health Questionnaire (PHQ-9). Self-reported items are rated on a four-point scale ranging from 0 to 4. Each item has a discrete response such as 0 = not at all, 1 = several days, 2 = more than half the days, and 3 = nearly every day. This instrument has been internationally accepted in screening for depressive symptoms with excellent psychometric properties (30, 31). In a Ugandan setting, the PHQ-9 has also been found to have excellent psychometric properties (32–34). At a cut-off of 10, it has high specificity (85%) and high sensitivity (88%) in detecting depression based on a meta-analysis by Levis et al. (31). The PHQ-9 has been used with university students in both Uganda (6) and south-western Uganda, therefore, its questions are culturally appropriate since the instrument had good internal reliability (35, 36). In addition, the instrument has been validated for online use (37). The PHQ-9 also categorizes depression in terms of severity. More specifically, 1–4 = minimal depression, 5–9 = mild depression, 10–14 = moderate depression, 15–19 = moderately severe depression, and 20–27 = severe depression (38). A cut-off score of 10 was used to determine whether participants had depressive symptoms or not. In addition, a score of one and above on Item 9, was used to indicate the presence of suicidal ideation in the past 2 weeks. In the present study, the Cronbach alpha was 0.85 for the PHQ-9.

Ethical Consideration

The present study was conducted in accordance with the Declaration of Helsinki 2013 and was approved by the Mbarara University of Science and Technology research ethics committee (MUSTREC #16/02-21). The Dean of Students at each of the four universities gave permission for data collection. Voluntary written informed consent was obtained from all participants.

Statistical Analysis

STATA version 16.0 was used for data analysis. Means and standard deviations were used to summarize continuous variables that were not normally distributed, while percentages and frequencies were used to summarize categorical variables. Student's *t*-tests and chi-square tests were performed to identify differences between depression and suicidal ideation, and independent study variables. Logistic regression analysis was

used to determine the variables' association with depression and suicidal ideation. Two separate logistic regressions were conducted to determine the factors associated with depression and suicidal ideation. Factors significant at bivariate logistic regression were tested for collinearity, and those with a variance inflation factor (VIF) of less than 3 were included in a back stepwise multivariate logistic regression model. A $p < 0.05$ for the significance level was considered at a 95% CI.

RESULTS

Participants

A total of 540 students were included in the final analysis. The age of the participants ranged from 18 to 40 years, with a mean of 23.3 ($SD \pm 2.64$) years. Most of the participants were male (67.22%), and the largest number of participants were from MUST (51.48%). About half of the students were satisfied with their academic performance (48.52%) and 38.15% had difficulty paying university tuition fees (**Table 1**).

Prevalence of Depression and Suicidal Ideation

Approximately 20% (95% CI: 16.71–23.63) of the students had depression based on the PHQ-9 cut-off score of 10 out of 27. The median depression symptoms score was 5 [interquartile range (IQR) = 7]. The severity of depression symptoms was: minimal (26.67%, n = 144/540), mild (37.41%, n = 202/540), moderate (13.15%, n = 71/540), moderately severe (4.63%, n = 25/540), and severe depression (2.22%, n = 12/540). However, 15.93% (n = 86/540) had no symptoms of depression (**Figure 1**).

A total of 75 students (13.89%) reported suicidal ideation based on a score of one and above on Item 9 of the PHQ-9. Moreover, 10.37% had thoughts of suicide for several days in the past 2 weeks (n = 56), 1.30% had suicidal thoughts for more than half the days in the past 2 weeks (n = 7), and 2.22% had thoughts of suicide nearly every day in the past 2 weeks (n = 12). Among individuals who scored positive for depression (at a cut-off of 10), 45.37% reported suicidal ideation (n = 49/108). However, 6.02% of individuals reporting suicidal ideation screened negative for depression (n = 26/75). There was statistically significant difference between severity of depression and having suicidal ideation ($\chi^2 = 169.14$, $p < 0.001$). Suicidal ideation was higher among students with moderately severe depression symptoms (80.00%), followed by severe depression (66.67%) (**Figure 1**).

Relationship Between Depression and Other Variables

Depression (at a cut-off of 10) was significantly higher among students who (i) had relationship difficulties than those who did not (25.55% vs. 14.29%, $\chi^2 = 10.70$, $p < 0.001$); (ii) had difficulty in paying tuition fees than those who did not (25.73% vs. 16.47%, $\chi^2 = 6.83$, $p = 0.009$); (iii) had experienced sexual abuse than those who had not (35.09% vs. 18.22%, $\chi^2 = 9.07$, $p = 0.003$); and (iv) were from humanities and social sciences, and computer sciences and information sciences than those from other faculties ($\chi^2 = 19.53$, $p = 0.012$). Depression (at a cut-off of 10) was significantly lower among (i) fifth-year university students compared to other years of study ($\chi^2 = 14.24$, $p = 0.014$), and (ii) those satisfied with their current academic performance than those who were not (13.36% vs. 26.26%, $\chi^2 = 14.03$, $p < 0.001$) (**Table 1**).

Relationship Between Suicidal Ideation and Other Variables

The mean age of individuals reporting suicidal ideation was significantly less than those without suicidality (22.61 ± 1.77 vs. 23.41 ± 2.74, t = -2.43, $p = 0.015$). Suicidal ideation was significantly higher among students who (i) smoked cigarettes and/or marijuana (36.36% vs. 13.42%, $\chi^2 = 4.74$, $p = 0.029$); (ii) had relationship difficulties (16.79% vs. 10.90%, $\chi^2 = 3.91$, $p = 0.048$); (iii) had difficulty in paying university tuition fees (18.93% vs. 10.78%, $\chi^2 = 7.08$, $p = 0.008$); and (iv) had experienced sexual abuse (22.81% vs. 12.84%, $\chi^2 = 4.24$, $p = 0.040$). Suicidal ideation was significantly lower among those satisfied with their current academic performance (8.02% vs. 19.42%, $\chi^2 = 14.68$, $p < 0.001$) (**Table 1**).

Factors Associated With Depression

Table 2 shows the results of the bivariate analysis. The likelihood of depression was reduced among those (i) in the fourth and fifth year of academic study and (ii) satisfied with their current academic performance. On the other hand, the likelihood of depression was increased among those who had (i) relationship problems, (ii) difficulty paying their university tuition fees, and (iii) a history of sexual abuse. These factors were tested for collinearity, and they all had VIFs below 3, with a mean VIF of 1.04. Consequently, they were included in the final model using the backward stepwise selection method. The model had a sensitivity of 6.64%, specificity of 98.84%, a positive predictive value of 58.33%, a negative predictive value of 80.87%, and correctly classified 80.37% of depression. The goodness-of-fit p-value was 0.632, for the included five variables (**Table 2**).

In the multivariable analysis, the factors associated with depression were having relationship problems (AOR = 1.79, 95% CI = 1.13–2.81, $p = 0.012$), and having a history of sexual abuse (AOR = 2.06, 95% CI = 1.10–3.84, $p = 0.023$). Being satisfied with current academic performance (AOR = 0.50, 95% CI = 0.32–0.79, $p = 0.003$), and being in the fifth year of academic study (AOR = 0.16, 95% CI = 0.03–0.73, $p = 0.018$) reduced the likelihood of having depression (**Table 3**).

Factors Associated With Suicidal Ideation

The likelihood of suicidal ideation was significantly lower among those (i) in the fifth year of academic study, (ii) satisfied with their current academic performance, and (iii) those who were older. On the other hand, the likelihood of suicidal ideation increased among those who had (i) difficulty paying their university tuition fees, (ii) a history of smoking cigarettes and/or marijuana, and (iii) a history of sexual abuse. These factors were tested for

TABLE 1 | Distribution of the studied factors with depression and suicidal ideation (*N* = 540).

Variable	n (%)	No depression (*n* = 432, 80%)	Depression (*n* = 108, 20%)	χ^2 (*p*-value)	No suicidal ideation (*n* = 465, 86.11%)	Suicidal ideation (*n* = 75, 13.89%)	χ^2 (*p*-value)
Age (mean ± *SD)*	23.3 (2.64)	23.38 ± 2.75	22.98 ± 2.16	1.40 (0.162)	23.41 ± 2.74	22.61 ± 1.77	–2.43 (0.015)
Sex							
Female	177 (32.78)	138 (77.79)	39 (22.03)	0.68 (0.409)	149 (84.18)	28 (15.82)	0.82 (0.365)
Male	363 (67.22)	294 (80.99)	69 (19.01)		316 (87.05)	47 (12.95)	
Current university							
BSU	59 (10.93)	47 (79.66)	12 (20.34)	0.81 (0.847)	46 (77.97)	13 (22.03)	3.96 (0.266)
KIU	127 (23.52)	102 (80.31)	25 (19.69)		112 (88.19)	15 (11.81)	
MUST	278 (51.48)	225 (80.94)	53 (19.06)		242 (87.05)	36 (12.95)	
KU	76 (14.07)	58 (76.32)	18 (23.68)		65 (85.53)	11 (14.47)	
Religion							
Christian	500 (92.59)	398 (76.60)	102 (20.40)	0.76 (0.682)	430 (86.00)	70 (14.00)	0.34 (0.844)
Muslim	35 (6.48)	30 (85.71)	5 (14.29)		31 (88.57)	4 (11.43)	
None	5 (0.93)	4 (80.00)	1 (20.00)		4 (80.00)	1 (20.00)	
Sponsor							
Government	107 (19.81)	89 (83.18)	18 (16.82)	4.33 (0.363)	97 (90.65)	10 (9.35)	5.12 (0.275)
Loan scheme	96 (17.78)	70 (72.92)	26 (27.08)		84 (87.50)	12 (12.50)	
NGO	18 (3.33)	14 (77.78)	4 (22.22)		14 (77.78)	4 (22.22)	
Private	288 (53.33)	235 (81.60)	53 (18.40)		246 (85.42)	42 (14.58)	
Others	31 (5.74)	24 (77.42)	7 (22.58)		24 (77.43)	7 (22.58)	
Area of residence							
Home	35 (6.48)	30 (85.71)	5 (14.29)	3.20 (0.525)	27 (77.14)	8 (22.86)	2.77 (0.596)
Hostel	204 (37.78)	168 (82.35)	36 (17.65)		177 (86.76)	27 (13.24)	
Rentals	250 (46.30)	192 (76.80)	58 (23.20)		216 (86.40)	34 (13.60)	
University hall	45 (8.33)	37 (82.22)	8 (17.78)		40 (88.89)	5 (11.11)	
Others	6 (1.11)	5 (83.33)	1 (16.67)		5 (83.33)	1 (16.67)	
Marital status							
Single	497 (92.04)	396 (79.68)	101 (20.32)	0.73 (0.695)	427 (85.92)	70 (14.08)	0.55 (0.758)
Co-habiting	20 (3.70)	16 (80.00)	4 (20.00)		17 (85.00)	3 (15.00)	
Married	23 (4.26)	20 (86.98)	3 (13.04)		21 (91.30)	2 (8.70)	
College/faculty							
Agriculture and environment sciences	7 (1.30)	5 (71.43)	2 (28.57)	19.53 (0.012)	6 (85.71)	1 (14.29)	19.56 (0.012)
Business and management sciences	27 (5.00)	22 (81.48)	5 (18.52)		24 (88.89)	3 (11.11)	
Computing and information science	10 (1.85)	5 (50.00)	5 (50.00)		6 (60.00)	4 (40.00)	
Education and External Studies	43 (7.96)	32 (74.42)	11 (25.58)		34 (79.07)	9 (20.93)	
Engineering, designing, art, and technology	34 (6.30)	23 (67.65)	11 (32.35)		27 (79.41)	7 (20.59)	
Health sciences/Medicine	322 (59.63)	272 (84.47)	50 (15.53)		291 (90.37)	31 (9.63)	
Humanities and social sciences	6 (1.11)	3 (50.00)	3 (50.00)		4 (66.67)	2 (33.33)	
Law	11 (2.04)	10 (90.91)	1 (9.09)		10 (90.91)	1 (9.09)	
Others	80 (14.81)	60 (75.00)	20 (25.00)		63 (78.75)	17 (21.25)	
Year of study							
First	78 (14.44)	57 (73.08)	21 (26.92)	14.24 (0.014)	64 (82.05)	14 (17.95)	10.44 (0.064)
Second	165 (30.56)	125 (75.76)	40 (24.24)		135 (81.82)	30 (18.18)	
Third	143 (26.48)	113 (79.02)	30 (20.98)		124 (86.71)	19 (13.29)	
Fourth	96 (17.78)	82 (85.42)	14 (14.58)		86 (89.58)	10 (10.42)	
Fifth	49 (9.07)	47 (95.92)	2 (4.08)		48 (97.96)	1 (2.04)	
Sixth	9 (1.67)	8 (88.89)	1 (11.11)		8 (88.89)	1 (11.11)	
Smoking cigarette/marijuana							
No	529 (97.96)	424 (80.15)	105 (19.85)	0.37 (0.542)	458 (86.58)	71 (13.42)	4.74 (0.029)
Yes	11 (2.04)	8 (72.73)	3 (27.27)		7 (63.64)	4 (36.36)	

(Continued)

TABLE 1 | (Continued)

Variable	n (%)	No depression (*n* = 432, 80%)	Depression (*n* = 108, 20%)	χ^2 (*p*-value)	No suicidal ideation (*n* = 465, 86.11%)	Suicidal ideation (*n* = 75, 13.89%)	χ^2 (*p*-value)
Drinking alcohol							
No	394 (72.96)	317 (80.46)	77 (19.54)	0.19 (0.663)	344 (87.31)	50 (12.69)	1.75 (0.186)
Yes	146 (27.04)	115 (78.77)	31 (21.23)		121 (82.88)	25 (17.12)	
Had relationship issues							
No	266 (49.26)	228 (85.71)	38 (14.29)	10.70 (0.001)	237 (89.01)	29 (10.90)	3.91 (0.048)
Yes	274 (50.74)	204 (74.45)	70 (25.55)		228 (83.21)	46 (16.79)	
Had tuition constraints							
No	334 (61.85)	279 (83.53)	55 (16.47)	6.83 (0.009)	298 (89.22)	36 (10.78)	7.08 (0.008)
Yes	206 (38.15)	153 (74.27)	53 (25.73)		167 (81.07)	39 (18.93)	
Satisfied academic performance							
No	278 (51.48)	205 (73.74)	73 (26.26)	14.03 (< 0.001)	224 (80.58)	54 (19.42)	14.68 (< 0.001)
Yes	262 (48.52)	227 (86.64)	35 (13.36)		241 (91.98)	21 (8.02)	
Been sexually abused							
No	483 (89.44)	395 (81.76)	88 (18.22)	9.07 (0.003)	421 (97.16)	62 (12.84)	4.24 (0.040)
Yes	57 (10.56)	37 (64.91)	20 (35.09)		44 (77.19)	13 (22.81)	
Been involved in physical fighting							
No	467 (86.48)	375 (80.30)	92 (19.70)	0.19 (0.660)	405 (86.72)	62 (13.28)	1,08 (0.298)
Yes	73 (13.52)	57 (78.08)	16 (21.92)		60 (82.19)	13 (17.81)	
Been managed for any mental health issues							
No	505 (93.52)	408 (80.79)	97 (19.21)	3.06 (0.080)	435 (86.14)	70 (13.86)	0.01 (0.944)
Yes	35 (6.48)	24 (68.57)	11 (31.43)		30 (85.71)	5 (14.29)	
Had a serious medical condition							
No	506 (93.70)	408 (80.63)	98 (19.37)	2.01 (0.156)	439 (86.76)	67 (13.24)	2.82 (0.093)
Yes	34 (6.30)	24 (70.59)	10 (29.41)		26 (76.47)	8 (23.53)	

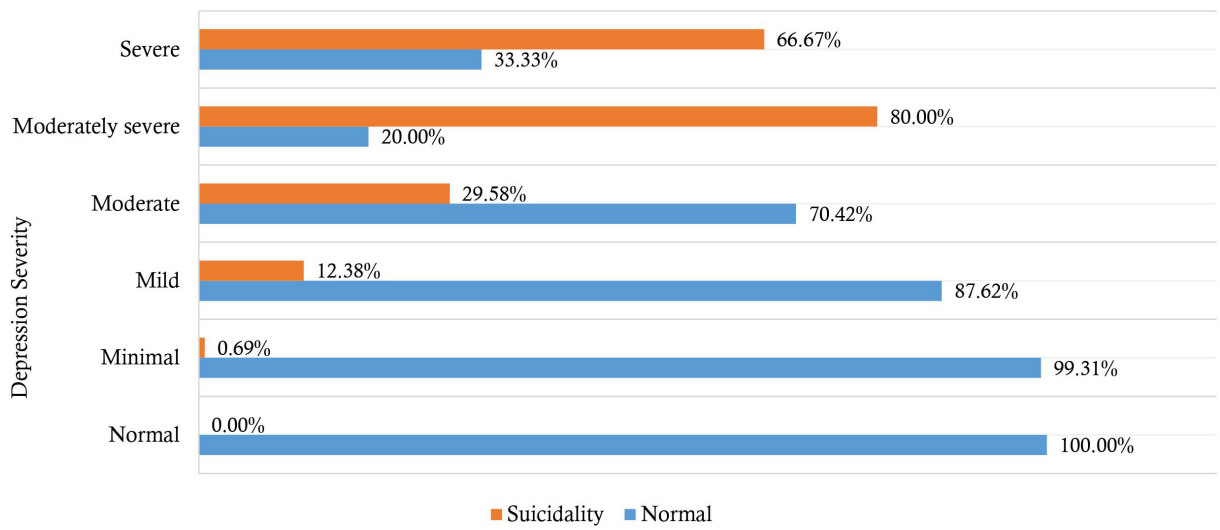

FIGURE 1 | Severity of depression and suicide ideation among Ugandan University students.

collinearity, and they all had VIFs below 3, with a mean VIF of 1.11. Consequently, they were included in the final model using the backward stepwise selection method. The model had a sensitivity of 4.00%, specificity of 100%, a positive predictive value of 100%, a negative predictive value of 86.59%, and correctly classified 86.67% of depression. The goodness-of-fit *p*-value was 0.934 for the included six variables (**Table 2**).

In the multivariable analysis, smoking cigarettes and/or marijuana (aOR = 4.83, 95% CI = 1.10–21.12, p = 0.037), and having financial tuition constraints (aOR = 1.85, 95% CI = 1.08–3.16, p = 0.024) increased the likelihood of having suicidal ideation. However, satisfaction with current academic performance reduced the likelihood of having suicidal ideation (aOR = 0.40, 95% CI = 0.23–0.70, p = 0.001) (**Table 3**).

TABLE 2 | Bivariate logistic regression analysis of factors associated with depression and suicidal ideation.

Variable	Depression		Suicidal ideation	
	Crude odds ratio (95% CI)	*p*-value	Crude odds ratio (95% CI)	*p*-value
Age	0.94 (0.86–1.03)	0.163	0.86 (0.76-0.97)	0.014
Sex				
Female	1		1	
Male	0.83 (0.53–1.29)	0.410	0.83 (0.48-1.31)	0.366
Current university				
BSU	1		1	
KIU	0.96 (0.44–2.07)	0.917	0.47 (0.21-1.07)	0.074
MUST	0.92 (0.46–1.86)	0.822	0.53 (0.26-1.07)	0.076
KU	1.22 (0.53–2.78)	0.643	0.60 (0.25-1.45)	0.257
Religion				
Christian	1		1	
Moslem	0.65 (0.25–1.72)	0.385	0.79 (0.27-2.31)	0.671
None	0.98 (0.11–8.82)	0.982	1.53 (0.17-13.94)	0.703
Sponsor				
Government	1		1	
Loan scheme	1.84 (0.93–3.62)	0.079	1.39 (0.57-3.37)	0.472
NGO	1.41 (0.42–4.79)	0.579	2.77 (0.76-10.05)	0.121
Private	1.12 (0.62–2.01)	0.716	2.83 (0.98-8.20)	0.055
Others	1.44 (0.54–3.85)	0.465	1.66 (0.80-3.43)	0.175
Area of residence				
Home	1		1	
Hostel	1.29 (0.47–3.54)	0.627	0.51 (0.21-1.25)	0.142
Rentals	1.81 (0.67–4.88)	0.240	0.53 (0.22-1.26)	0.153
University hall	1.30 (0.38–4.38)	0.675	0.42 (0.13-1.43)	0.165
Others	1.20 (0.11–12.54)	0.879	0.67 (0.07-6.65)	0.736
Marital status				
Single	1		1	
Co-habiting	0.98 (0.32–3.00)	0.972	1.08 (0.31-3.77)	0.908
Married	0.59 (0.17–2.02)	0.399	0.58 (0.13-2.53)	0.470
College/faculty				
Agriculture and environment sciences	1		1	
Business and Management sciences	0.57 (0.08–3.82)	0.561	0.75 (0.07-8.55)	0.817
Computing and information science	2.50 (0.32–19.53)	0.382	4.00 (0.34-47.11)	0.271
Education and external studies	0.86 (0.15–5.08)	0.867	1.59 (0.17-14.93)	0.686
Engineering, designing, art, and technology	1.20 (0.20 -7.16)	0.845	1.56 (0.16-15.12)	0.703
Health sciences/Medicine	0.46 (0.09–2.43)	0.361	0.64 (0.07-5.48)	0.683
Humanities and social sciences	2.50 (0.25–24.72)	0.433	3.00 (0.20-45.24)	0.427
Law	0.25 (0.02–3.47)	0.301	0.60 (0.03-11.47)	0.734
Others	0.83 (0.15–4.64)	0.835	1.62 (0.18-14.38)	0.665
Year of study				
First	1		1	
Second	0.87 (0.47–1.61)	0.653	1.01 (0.50-2.05)	0.965
Third	0.72 (0.38–1.37)	0.317	0.70 (0.33-1.49)	0.354
Fourth	0.46 (0.22–0.99)	0.046	0.53 (0.22-1.27)	0.156
Fifth	0.12 (0.03–0.52)	0.005	0.09 (0.01-0.75)	0.025
Sixth	0.34 (0.04–2.88)	0.322	0.57 (0.07-4.94)	0.611
Smoking cigarette/marijuana				
No	1		1	
Yes	1.51 (0.39–5.81)	0.545	3.69 (1.05-12.91)	0.041
Drinking alcohol				
No	1		1	
Yes	1.11 (0.69–1.77)	0.663	1.42 (0.84-2.40)	0.187
Had relationship issues				
No	1		1	
Yes	2.06 (1.33–3.19)	< 0.001	1.65 (1.00-2.72)	0.050
Had tuition constraints				
No	1		1	
Yes	1.76 (1.15–2.69)	0.009	1.93 (1.18-3.16)	0.009

(Continued)

TABLE 2 | (Continued)

Variable	Depression		Suicidal ideation	
	Crude odds ratio (95% CI)	*p*-value	Crude odds ratio (95% CI)	*p*-value
Satisfied with academic performance				
No	1		1	
Yes	0.43 (0.28–0.68)	< 0.001	0.36 (0.21-0.62)	< 0.001
Been sexually abused				
No	1		1	
Yes	2.43 (1.34–4.38)	0.003	2.01 (1.02-3.94)	0.043
Been involved in physical fighting				
No	1		1	
Yes	1.14 (0.63–2.08)	0.660	1.41 (0.73-2.73)	0.300
Been managed for any mental health issues				
No	1		1	
Yes	1.93 (0.91–4.07)	0.085	1.04 (0.39-2.76)	0.944
Had serious medical condition				
No	1		1	
Yes	1.73 (0.80–3.75)	0.161	2.02 (0.88-4.64)	0.099

DISCUSSION

In the present cross-sectional study, students from four universities in south-western Uganda during the COVID-19 pandemic were surveyed, and the prevalence of depression (at a cut-off of 10) was 20% and suicidal ideation was 13.89%. Relationship issues and a history of sexual abuse were the two factors most significantly associated with depression among students while being in the fifth year of academic study and being satisfied with current academic performance were associated with reduced depression. Smoking cigarettes and/or marijuana, and having financial tuition constraints increased the likelihood of reporting suicidal ideation. However, similar to depression, satisfaction with the current academic performance reduced the likelihood of reporting suicidal ideation.

TABLE 3 | Multivariate logistic regression analysis of factors associated with depression and suicidal ideation.

Variable	Depression		Suicidal ideation	
	Adjusted odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)	*p*-value
Age			0.88 (0.77-1.01)	0.061
Year of study				
First	1		1	
Second	0.89 (0.47–1.69)	0.721	1.29 (0.61-2.74)	0.503
Third	0.78 (0.40–1.53)	0.470	1.07 (0.47-2.44)	0.872
Fourth	0.53 (0.24–1.17)	0.116	0.88 (0.33-2.33)	0.797
Fifth	0.16 (0.03–0.73)	0.018	0.20 (0.02-1.72)	0.142
Sixth	0.36 (0.04–3.34)	0.372	1.49 (0.14-15.23)	0.737
Smoking cigarettes and/or marijuana				
No			1	
Yes			4.83 (1.10-21.12)	0.037
Had relationship issues				
No	1			
Yes	1.79 (1.13–2.81)	0.012		
Had tuition constraints				
No	1		1	
Yes	1.34 (0.85–2.11)	0.204	1.85 (1.08-3.16)	0.024
Satisfied with academic performance				
No	1		1	
Yes	0.50 (0.32–0.79)	0.003	0.40 (0.23-0.70)	0.001
Been sexually abused				
No	1		1	
Yes	2.06 (1.10–3.84)	0.023	1.47 (0.69-3.11)	0.314

During the COVID-19 pandemic, higher mental health problems have been reported among students. For instance, the prevalence of depression ranged from 46.92% to 82.4% among Bangladeshi students, as reported in a systematic review (13). Moreover, a recent meta-analysis reported a pooled prevalence of 37% depression among 436,799 students in studies published before September 20, 2020 (12). However, the depression prevalence of the present study (20%) was markedly lower than the previously reported prevalence rate of 80.7% during the first wave of the pandemic (June to July 2020) in a Ugandan study among 321 university students using the 21-item Depression, Anxiety and Stress Scale (4). The difference may be because the present study used a different instrument to screen for depression, with different sensitivities and specificities for assessing depression. In addition, Najjuka et al.'s (4) study involved all university students during the complete institutional lockdown in the first wave of the pandemic, when the levels of uncertainty about the disease were higher and there was associated higher levels of depression among students as reported by other studies (14).

The prevalence of depression in the present study was higher than that reported among non-medical undergraduate university students prior to the introduction of the peer counseling services at Makerere university, 2000–2001 at 16.2%; and medical undergraduate university students following peer counseling introduction (2002) at 4.0% (7). Despite the present study being conducted during a period when peer counseling and other psychological intervention for student mental ill-health is

well established among all Ugandan universities, the prevalence of depression reported by Ovuga et al. (7) may have been lower because the study was conducted before the COVID-19 pandemic—a period that significantly increased negative psychological effects among many students (11). However, the depression prevalence of 20% in the present study is slightly lower than 21.5% reported in a study done the year before the pandemic (May–July 2019) among 331 Makerere University medical students using the same instrument (6). The similarity between the study findings and Olum et al. (6), coupled with the significant difference from the only study assessing depression among university students during the pandemic in Uganda (4), could possibly indicate that students have adjusted to the COVID-19 situation and associated stressors, the so-called "new normal," as reported by other researchers (39). Therefore, depression may be associated with other stressors rather than being pandemic-related.

For instance, in the present study, depression among students was associated with having a history of sexual abuse, a finding similar to other studies among university students. It is also known that individuals who experience sexual abuse during childhood often experience associated depression in adulthood (40). In addition, the severity of depression can be accelerated by the abusive behaviors of the current sexual partner (17, 41). Since students in an abusive relationship have fewer protective factors against depression associated with a supportive romantic relationship, such as comfort, emotional support, and companionship (42). In addition, relationship problems cause significant psychological distress due to disappointment and unmet expectations (43).

Satisfaction with academic grades appeared to be a protective factor against depression and suicidal ideation. Good academic performance is associated with being successful in life (44); therefore, an individual feels positive about their future when their performance is good, and this may help protect them from depression. Conversely, poor academic performance has consistently been associated with depression (45). In Uganda, education is considered the "key to success" (46). Students are expected to meet extremely high expectations from their parents and society to succeed (47). Therefore, it is perhaps unsurprising that students with financial tuition constraints had an increased likelihood of reporting suicidal ideation because if they do not have the ability to fully pay for their university fees, they may lose hope for the future and experience suicidal ideation. However, it has also been reported that some students use their tuition fees to gamble, therefore, they have financial problems if they lose, leading to suicidal behaviors and suicide (48). In Uganda, law and medicine degree programs are pursued for a minimum of 5 years, and culturally these courses are associated with a successful future. Therefore, studying in the fifth-year means being near the end of the undergraduate studies for students, and the dream of future success in life is also nearing. Other researchers studying Ugandan university students have also reported the protective nature of being in the final year against depression during the COVID-19 pandemic (4). Also, by the time a student reaches the fifth year of study, they have been more likely to be exposed to all the conditions around campus and developed coping mechanisms against depression. For example, some have already coped with experiencing romantic breakups, poverty while on campus, and have gotten a peer support system through the friends they acquired over the years.

Just under half of the participants who screened positive for depression reported suicidal ideation in the past 2 weeks (45.37%). This was similar to 48.4% of individuals with major depressive disorder at a mental health facility in Ethiopia (49). The prevalence of suicidal ideation in the present study (13.89%) was lower than 22.7% from a study conducted among university students in another African country, Libya, during the COVID-19 pandemic in the months of April and May 2020 based on Item 9 of the PHQ-9 (50). This difference in prevalence rates may be due to the following reasons: (1) during the time of data collection, Libya was still experiencing a civil war which comes with multiple mental challenges, including thoughts of suicide, (ii) the study was done at a period when individuals worldwide were having higher levels of stress, anxiety, suicidal behaviors and other mental challenges (i.e., early stages of the pandemic) (51); and (iii) the sample only involved medical students who have been reported to experience higher suicidal behaviors compared to other students (52–54).

The prevalence of suicidal ideation in the past 2 weeks in the present study was also lower than 18.04% in a US study involving college students during the month of May 2020 (55). However, the prevalence was higher than 12.9 and 7.3% from studies among university students in China during February and March 2020, respectively (56, 57). Despite the studies in China being conducted earlier, the students were exposed to constant sources of stress during the pandemic, and they would have developed coping strategies to overcome stress complications such as depression and related suicidal behaviors. Smoking cigarettes and/or marijuana was associated with suicidal ideation, a finding consistent with other studies prior to the COVID-19 pandemic (58). Substance use increased during the COVID-19 pandemic and led to multiple mental challenges, including suicide (59–63). Many individuals use addictive substances to cope with stress, and marijuana, in particular, was believed by some Ugandans to treat COVID-19 symptoms (61). Some of the individuals trying to cope with stress by using psychoactive substances could have had suicidal ideation not secondary to the smoking of substances.

LIMITATIONS

The present study has a number of limitations. First, it was cross-sectional; therefore, causal relationships between the variables cannot be determined. Second, the study was conducted during the COVID-19 pandemic, which could also independently cause depression among some university students due to uncertainty about their academic progress, source of income, their jobs (for the employed participants), and worries about life. Third, another issue was that anyone who was given access to the survey web-link could respond to it; therefore, there is no guarantee that all responses were from university students only. Fourth, the study design relied on the participants' memory, which is subject

to recall bias. Fifth, this study did not access all the potential variables that could have led to an increase in depression among university students such as disruption of face-to-face teaching classes. Future research should explore these factors to better understand the factors related to depression and the pandemic to reduce such mental consequences in future pandemics. Finally, the study design did not allow for the determination of a true response rate since *WhatsApp* and emails are unable to track the number of individuals who viewed the link, especially when shared through groups.

CONCLUSION

The present study found a lower prevalence of depression among university students during the COVID-19 pandemic, similar to pre-pandemic prevalence among university students, and this was associated with having had relationship problems and a history of sexual abuse. However, being satisfied with current academic performance and studying in the fifth year appeared to be protective factors. Therefore, universities in Uganda should implement measures to provide psychological support for students with problems concerning tuition fee challenges, relationships, and past sexual abuse. These can include peer support groups and routine talks about dating and relationships to prepare the students for any outcome. In addition, finalists should be encouraged to mentor other students and teach them strategies to overcome some of the psychological stressors experienced while at university. Also, all students with depression should be screened for suicidal behaviors.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

IA, MMK, EN, MM, JK, MK, NA, IM, NW, and GR: conception and design of the study. IA, MMK, EN, MM, JK, MK, NA, RN, IM, and NW: data collection and its coordination. GR, MAM, MG, and FB: supervision. MMK and IA: formal analysis and data cleaning. IA: initial draft. IA, MMK, EN, MM, JK, RN, MK, NA, IM, SN, NW, FB, MAM, MG, and GR: review of the manuscript. MG: final editing. All authors approved the final version of the manuscript.

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Mental Health and Loneliness in University Students During the COVID-19 Pandemic in Germany: A Longitudinal Study

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The COVID-19 pandemic and its preventive measures had adverse consequences for mental health. However, knowledge of mental health trajectories across the pandemic is limited. This study investigated the mental health levels and changes among university students during the pandemic and lockdown in Germany, as well as their associated factors. We surveyed students' mental health ($N = 363$, 68% female) with the patient health questionnaire (PHQ-8) and the generalized anxiety disorder scale (GAD-7) during the first easing phase (July 2020; time 1) and the second lockdown (November 2020; time 2). Cut-off scores from the GAD-7 and PHQ-8 were used to determine clinically relevant symptoms and to define trajectory groups. Sociodemographic and pandemic-related data were assessed (e.g., coping with academic life, social contacts) as well as loneliness, stress, repetitive negative thinking, quality of life, and perceived social support. Paired *t*-test, multiple regression, and repeated-measures ANOVA were applied. Means and prevalence rates for symptoms of depression (38.8%) and anxiety (25.6%) did not differ between time 1 and time 2, and most students were asymptomatic on the PHQ-8 (44.4%) and the GAD-7 (56.3%) across the pandemic. Feelings of loneliness significantly increased from time 1 to time 2, $d = -0.30$, [−0.47, −0.13], with higher symptom levels in symptomatic groups at time 2 and greater increases in the asymptomatic groups. Levels of stress, repetitive negative thinking, quality of life, and social support did not differ during the pandemic. At time 1, loneliness and repetitive negative thinking were associated with anxiety and depressive symptoms. Anxiety and depressive symptoms were prevalent among students, and increased levels of loneliness during the pandemic were associated with elevated symptoms and differing trajectories. Further research using representative and larger samples should determine the long-term impact of the pandemic on mental health and loneliness to identify vulnerable students and offer adequate support.

Keywords: COVID-19, pandemic, depression, anxiety, loneliness, students, university

INTRODUCTION

The first wave of the coronavirus disease (COVID-19) pandemic and its lockdown measures negatively affected the mental health of many individuals (1, 2). However, specific subgroups at higher risk for mental health problems were described, including university and college students (3–7). Even before COVID-19, students were exposed to multiple stressors during the emergent adulthood adapting to social and academic life (8–11). With the COVID-19 pandemic, further potential stressors emerged due to closed universities, remote learning formats, and prolonged social distancing measures.

Studies across the globe revealed elevated symptoms of anxiety, depression, stress, and loneliness among university and college students during the pandemic (12–23). However, most of the studies applied cross-sectional designs and mental health impacts should be interpreted with caution (24). Some studies provided longitudinal data comparing the same students before and closely after the first peak of the pandemic to examine how mental health has changed. Compared with pre-pandemic levels, the majority of studies likewise showed increased symptoms of depression, anxiety, and stress (12, 25–32), but not all (33). Mixed findings were reported by Meda et al. (34) showing increased symptoms for depression but not for anxiety among students during the first lockdown in Italy compared to pre-pandemic levels, while another study among medical students in India suggested increased rates for anxiety but not for depression (35).

A few additional longitudinal studies compared different time points during the pandemic to examine how mental health has changed and revealed conflicting results. For example, studies among Chinese college students found increased anxiety and depression rates when the pandemic was under control compared with the acute phase of the pandemic, but not for self-reported stress (22, 36). Two other studies indicated decreased anxiety and depression symptoms (37), and stress levels (38) during the first lockdown compared to the pre-pandemic academic semester before increasing again in the post-lockdown period. In contrast, others reported generally high but declining anxiety and depression symptoms along with reduced daily COVID-cases and eased lockdown measures in Italy (34) and the United States (39). One recent repeated cross-sectional study with a large sample of students and non-students compared anxiety and depressive symptoms at three pandemic time points in France (40). Relative to non-students, students showed higher depressive symptoms during the first national lockdown (19% vs. 36%), comparable rates during the easing phase (21% vs. 27%), and again dramatic increases during the second lockdown (27% vs. 54%). Symptoms of anxiety were likewise more prevalent in students compared with non-students during the pandemic.

In addition to the mixed findings on mental health courses during the pandemic, it is less understood which risk and protective factors co-determine mental health levels and changes among university students during the pandemic. Previous cross-sectional data largely based on the general population suggested that increased symptoms of anxiety and depression were associated with female gender, younger age, living alone, and financial insecurities (3, 23, 41–47). In addition, these studies implied that adverse coping styles, repetitive negative thinking, boredom, pre-existing mental health conditions, and adverse childhood experiences were associated with worsened mental health, while perceived social support, having social contacts, and self-efficacy were protective for mental health.

In recent years, loneliness has consistently been linked to poorer mental health, symptoms of anxiety and depression. (e.g., (48–50). With the COVID-19 pandemic and the established social distancing measures, the link between loneliness and mental health was further emphasized (4). In fact, loneliness during the pandemic increased in the general population (51) as well as in university students compared with pre-pandemic levels (12, 29), and this increase was more prevalent in students compared with non-students (52). Moreover, loneliness was largely responsible for the exacerbated course of depressive symptoms in young adults during the pandemic (53).

Overall, knowledge is limited regarding the mental health levels of university students and trajectories after prolonged threats and stressors during the COVID-19 pandemic. Longitudinal research is warranted on how mental health changes and which stressors may be of primary concern to target prevention efforts, particularly following multiple lockdowns. In Germany, the first lockdown started in March 2020 with easing steps from May to June 2020; the second four months later in November 2020 to May 2021. Most shops, restaurants, and universities were closed and gatherings of more than five people were banned. Between the two lockdowns, restaurants and shops re-opened and contact restrictions were eased while universities remained closed. Additional measures were maintained during the easing phase such as a minimum distance of 1.5 m to others, wearing face masks in public transport, and the recommendation to reduce physical contacts whenever possible.

Using a cross-sectional and longitudinal cohort design with measures during the easing phase and the second lockdown in Germany, the current study aimed at 1) investigating the levels and changes of mental health in university students, and 2) identifying associated factors for mental health (i.e., sociodemographic, pandemic-related, and psychological variables). As registered previously (osf.io/na5b6), we expected overall worsened primary anxiety and depressive symptoms in students and worsened psychological outcomes (i.e., loneliness, stress, repetitive negative thinking, quality of life, social support) along with increasing COVID-19 cases and deaths, and re-introduced lockdown measures. To better understand how mental health changed during the pandemic, we examined trajectories based on the clinical cut-off scores for probable anxiety and depression at each time point and their associations with changes in loneliness. Moreover, we tested whether anxiety and depressive symptom levels were associated with sociodemographic variables (e.g., female gender, living alone, socioeconomic status), pandemic-related variables (e.g., coping with daily and academic life, reduced social contacts since the pandemic), and psychological variables (e.g., higher levels of loneliness, ruminative thinking, lower perceived social support, current mental disorder).

METHODS

Study Design and Participants

This cross-sectional and longitudinal online survey study was conducted according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for observational studies (54). Data was collected 2 months after the first lockdown in Germany (20 July−28 August 2020; time 1), and during the second lockdown when rates of COVID-19 infections and related deaths increased dramatically (10 November−2 December 2020; time 2). Participants older than 18 years studying in Berlin, Germany (no other inclusion or exclusion criteria) were recruited via social media, mailing lists, and the institutional website. The study was approved by the ethics committee at Freie Universität Berlin (032/2020). $N = 467$ students provided informed consent and initiated the survey via the *Questback* platform. We included $n = 363$ (77.7%) participants for the cross-sectional analyses at time 1 with complete questions regarding the primary outcomes, of which 343 (94%) completed the whole survey. $N = 254$ participants agreed to participate in the survey at time 2, of which 157 respondents completed the whole survey. Matched data at time 1 and time 2 was available for 135 respondents. This sample size entailed more than 90% power to observe a small within-effect at the 5% level (G*Power 3.1.9.2, F-test, repeated-measures ANOVA). Participants completing the survey at time 1 were entered into a raffle to receive one of ten 25 € gift cards. Psychology students from Freie Universität Berlin could receive course credits after each wave.

Measurements

Sociodemographic and Pandemic-Related Variables

The questionnaire battery at time 1 comprised data related to age, gender, family status, living situation, highest degree, field of study, students' income, and the socioeconomic status indexed by the degree and profession of the student parents (55).

To measure pandemic-specific experiences, additional items were formulated. Participants rated their perceived wellbeing and their coping abilities in daily life, in academic life, and with a potential future lockdown on a five-point Likert scale, ranging from 1 "good" to 5 "poor" (e.g., *How have you been feeling in general since the pandemic?*). Perceived wellbeing and finances compared to before the pandemic were rated on a five-point Likert scale, ranging from 1 "strongly improved" to 5 "strongly worsened" (e.g., *Has your financial situation changed since the pandemic?).* Finally, participants reported the number of days during the last 2 weeks (0–14 days) that they had social contacts and consumed alcohol, respectively (see osf.io/na5b6 for study materials used).

Primary Mental Health Outcomes

Anxiety and depression symptoms were assessed with the well-validated 7-item Generalized Anxiety Disorder Scale [GAD-7, (56, 57)] and the 8-item Patient Health Questionnaire [PHQ-8, (58)] with equivalent diagnostic accuracy compared to the PHQ-9 (59). Total scores range from 0 to 21 for the GAD-7 and from 0 to 24 for the PHQ-8. Scoring 10 or above indicates moderate-to-severe symptomatology, which typically represents clinically significant depression and anxiety (58, 60). Both instruments demonstrated excellent internal consistency in the present study (GAD-7, $\alpha = 0.87$; PHQ-8, Cronbach's $\alpha = 0.86$). Open-ended responses toward the most distressing and most positive experiences and perceived changes in academic life during the last 2 weeks were gathered to cross-validate symptoms levels, which will be presented elsewhere in detail.

Additional Psychological Variables

Outcomes assessed with reliable and valid questionnaires at the two time points were loneliness [UCLA loneliness scale, ULS-8, (61)] stress [perceived stress scale, PSS-10, items 3, 6, (62, 63)], quality of life [satisfaction with life scale, SWLS, (64, 65)], repetitive negative thinking [perseverative thinking questionnaire, (66)], and social support [brief form of perceived social support questionnaire, (67)]. Single-measure items were applied to measure feelings of boredom, presence of diagnosed mental disorder, and subjective health at time 1 (68). Associated factors with mental health at time 1 included coping strategies [active coping, positive reframing, acceptance, religion, and substance use, Brief-COPE, (69, 70)], self-efficacy [generalized self-efficacy scale; (71)], social anxiety [mini social phobia inventory, (72)], and adverse childhood experiences [ACE, (73)]. The applied scales proved acceptable to excellent internal consistency in this study (Cronbach's $\alpha = 0.72$–0.96), except for the coping subscales religion and active coping ($\alpha = 0.64, 0.69$), which were subsequently removed from further analyses.

Data Analysis

The Welch's t-test, univariate analysis of variance (ANOVA) and Chi-square test of independence were used to test differences between the cross-sectional sample and the longitudinal sample. To determine research question 1) regarding the mental health levels and changes during the pandemic, paired sample t-tests and their respective effect size estimates using Cohen's d were used to examine mean changes in variables tested at time 1 and time 2 (i.e., anxiety, depression, loneliness, stress, quality of life, social support, and repetitive negative thinking). Cohen's d of 0.2, 0.5, and 0.8 indicate a small, medium, and large effect size, respectively (74). Regarding the dependent variables anxiety and depressive symptoms, clinically relevant symptom levels at time 1 and time 2 were determined using the established cut-off score of 10 of the GAD-7 and PHQ-8 (58, 60). To adjust trajectories during the pandemic [e.g., (75)], the cut-off scores at time 1 and time 2 were used, resulting in four potential paths for anxiety and depression: 1) the asymptomatic, 2) the worsened, 3) the symptomatic, and 4) the improved trajectory. To further explore how mental health changed during the pandemic, two-way repeated measures ANOVAs with loneliness as the dependent variable were performed with the factors time and trajectory groups for depression and anxiety. Post hoc analysis using the Tukey's test (76) were applied as well as partial eta squared (η_p^2) as measures of small (0.01), medium (0.06), and large (0.14) effect sizes (74).

To examine research question 2) on factors associated with increased anxiety and depressive symptoms, we performed multiple linear regression analyses for the two primary

outcomes individually, as others have done (15, 77). The two models tested associations measured at time 1, respectively, with sociodemographic (e.g., age, gender, living situation, socioeconomic status), pandemic-related (e.g., coping with academic life since the pandemic, social contacts), and additional psychological variables (e.g., loneliness, social support, presence of current mental disorder). Associated factors for the two primary outcomes were first examined in univariate linear regression analyses and subsequently entered into a multiple linear regression model adjusting for all other tested sociodemographic, pandemic-related, and psychological factors. The statistical assumptions were tested regarding multicollinearity (i.e., tolerance and VIF factor $\leq$2). Residual and scatter plots indicated that the assumptions toward normality, linearity, and homoscedasticity were met.

Nine percent of observations at time 1 had missing values in the independent variables and were assessed with multivariate imputation by chained equations following the conditional multiple imputation approach (78). Associated factors from the regression analysis models were included in the imputation model for the dependent variable anxiety symptoms and for depressive symptoms, respectively. Twenty data sets were each imputed and subsequently pooled using Rubin's rules [(79); see (80) for an overview]. Sensitivity analyses were applied to explain any differences between the complete case analysis using list-wise deletion and the multiple imputation approach. All statistical analyses were conducted using R version 4.0.2. (81). P-values $<$ .05 indicated statistical significance.

RESULTS

Sample Characteristics

Participants at time 1 ($N = 363$) were mostly female (68%) and had a mean age of 26 years ($SD = 4.27$; **Table 1**). About half of the participants were single (49.2%), undergraduate students (46.4%), and the majority lived with others (75.2%). Most of the participants' parents (63%) had a middle economic status, while students themselves had an average income of 700–1000 Euro/month or less (67.1 %). On average, participants reported an overall very good or good health status ($M = 1.76$, $SD = 0.73$). Sixty-two participants (17.1%) self-reported a diagnosed mental disorder; most frequently named were anxiety and depressive disorders. Sociodemographic characteristics at time 1 did not differ between the cross-sectional sample and the longitudinal sample with matched data pairs, but slightly more participants with matched data had reported a mental disorder at time 1, χ^2 $(2, N = 498) = 9.63$, $p = .008$ (**Table 1**).

Pandemic-Related Responses and Changes

Wellbeing since the pandemic was overall perceived as moderate (40%) or somewhat good (27.5%) at time 1, and slightly worse or worse (61%) compared to pre-pandemic levels (**Table 2**). Students stated to cope rather well (38.3%) with their daily lives since the pandemic and that their income at time 1 did not change (52.5%) compared to pre-pandemic levels. At time 1, students slightly agreed or agreed (43.5%) to fear a potential

TABLE 1 | Sample characteristics.

	Cross-sectional sample n (%) (n = 363)	Longitudinal sample n (%) (n = 135)
Age		
mean (SD)	25.87 (4.69)	25.32 (3.83)
median	25	25
Gender [a]		
female	247 (68.0%)	100 (74.1%)
male	116 (32.0%)	35 (25.9%)
Family status		
single	179 (49.2%)	68 (50.4%)
partnership	169 (46.6%)	61 (45.2%)
other	15 (4.1%)	6 (4.4%)
having children	19 (5.2%)	6 (4.4%)
Living situation		
with others	273 (75.2%)	96 (71.1%)
alone	90 (24.8%)	39 (28.9%)
Highest degree		
High school diploma	169 (46.4%)	71 (52.6%)
Bachelor's degree	158 (43.5%)	53 (39.3%)
Master's degree	36 (9.9%)	11 (8.1%)
University in Berlin		
Freie Universität	128 (35.3%)	57 (42.2%)
Technical University	55 (15.2%)	16 (11.9%)
Humboldt University	53 (14.6%)	18 (13.3%)
Other	127 (35.0%)	44 (32.6%)
Field of study		
Social sciences	146 (40.2%)	57 (42.2%)
Humanities and arts	73 (20.1%)	26 (19.1%)
Natural sciences	43 (11.8%)	16 (11.8%
Engineering	41 (11.3%)	9 (6.6%)
Economics and politics	40 (11.0%)	16 (11.8%)
Other	4 (1.1%)	2 (1.5%)
Income (€)		
<700	101 (27.9%)	38 (28.1%)
700-1000	142 (39.2%)	57 (42.2%)
1001–1300	60 (16.5%)	18 (13.3%)
>1301–1700	60 (16.5%)	22 (16.3%)
Parents' SES		
high	65 (18.6%)	22 (16.7%)
average	220 (63.0%)	87 (65.9%)
low	64 (18.3%)	23 (17.4%)
missing *n*	13 (3.6%)	3 (2.2%)
Health status		
mean *SD*)	1.76 (0.73)	1.77 (0.67)
missing *n*	21 (5.6%)	0 (0.0%)
COVID risk group (yes)	29 (8.5 %)	11 (8.1 %)
missing *n*	21 (5.6%)	0 (0.0%)
Reported mental disorder (yes)	62 (17.1%)	31 (23.0%)
missing *n*	21 (5.6%)	0 (0.0%)

SD, standard deviation; SES, socioeconomic status.
[a] *None of the participants identified as diverse.*

TABLE 2 | COVID-19 related responses and changes during the pandemic.

Variables	Cross-sectional sample	Longitudinal sample		Paired *t* test (134)	*p* value
		Time 1	Time 2		
	Mean (SD)				
Perceived Wellbeing since COVID [a]	2.65 (0.99)	2.65 (0.96)	2.66 (0.98)	−0.06	0.950
Wellbeing since COVID *vs.* pre-COVID [a]	3.50 (1.01)	3.58 (1.00)	3.40 (1.04)	1.32	0.188
Coping with changes in daily life since COVID [a]	2.48 (0.90)	2.51 (0.93)	2.36 (0.99)	1.26	0.209
Coping with academic life since COVID [a]	2.92 (1.21)	3.01 (1.14)	2.65 (1.17)	2.41	0.017
Changed income since COVID (time 1) [a]	3.44 (0.81)	3.36 (0.76)	-		
Afraid towards potential future lockdown (time 1) [a]	3.14 (1.27)	3.13 (1.34)	-		
Coping with potential future lockdown (time 1) [a]	2.67 (1.01)	2.65 (1.04)	-		
Days/last 2 weeks with social contacts	5.26 (3.72)	4.79 (3.76)	3.17 (2.95)	3.90	<0.001
Days/last 2 weeks with social contacts *vs.* pre-COVID	2.19 (1.07)	2.04 (1.00)	1.61 (0.84)	3.99	<0.001
Days/last 2 weeks drinking alcohol	3.33 (3.14)	3.08 (3.02)	2.07 (2.29)	3.08	0.002
Days/last 2 weeks drinking alcohol *vs.* pre-COVID	2.93 (0.98)	2.87 (0.92)	2.60 (0.97)	2.42	0.017

[a] *Higher scores indicate poor or worsened outcomes using a five-point Likert scale.*

future lockdown, and at the same time, indicated they would cope rather well a second lockdown (46.3%). Students coped moderately well (30.0%) with their academic life's at time 1, which significantly improved from time 1 to time 2. The average number of days during the last 2 weeks having social contacts and drinking alcohol decreased compared to pre-pandemic levels, and decreased further from time 1 to time 2, respectively. All other ratings did not differ between the two assessments (**Table 2**).

Mental Health Levels and Trajectories During the Pandemic

Table 3 shows the results for the primary mental health outcomes depressive symptoms and anxiety symptoms for the cross-sectional and the longitudinal sample. Prevalence rates in the cross-sectional sample were 38% and 26.5% for moderate-to-severe depressive and anxiety symptoms, respectively. In the longitudinal sample, prevalence rates did not change for depressive symptoms (43% vs. 43%) and anxiety symptoms (29.6% vs. 28.1%). Between time 1 and time 2, mean scores did not significantly differ for symptoms of depression, $t(134) = -0.09$, $p = 0.924$, $d = -0.01$, 95% CI [–0.16, 0.14], and anxiety, $t(134) = -0.04$, $p = 0.968$, $d = -0.004$, 95% CI [−0.17, 0.16]. Most participants showed asymptomatic PHQ-8 trajectories from time 1 to time 2 (44.4%), followed by stable symptomatic (30.4%), worsened (12.6%), and improved depressive trajectories (12.6%). Similarly, most GAD-7 trajectories during the pandemic were asymptomatic (56.3%), followed by improved (15.5%), stable symptomatic (14.1%), or worsened trajectories (14.1%).

Regarding the additional psychological outcomes, symptoms of stress and repetitive negative thinking did not significantly differ between time 1 and time 2 (**Table 3**). In addition, perceived social support and quality of life did not differ during the course of the pandemic. However, feelings of loneliness significantly increased among students between time 1 and time 2, $t(134) = -2.63$, $p = 0.009$. The effect size for increased loneliness was small, Cohen's $d = -0.30$, 95 % CI [−0.47, −0.13]).

To further explore the increases in loneliness during the pandemic, two-way repeated-measures ANOVAs were performed with loneliness across time and between different PHQ-8 and GAD-7 trajectories. Results indicated a large and significant difference in loneliness between the PHQ-8 trajectory groups, $F(3, 131) = 11.49$, $p < 0.001$, $\eta_p^2 = 0.16$, and a medium effect of time, $F(1, 131) = 13.24$, $p < 0.001$, $\eta_p^2 = 0.03$ (**Figure 1**). In addition, there was a significant and medium interaction effect between increased loneliness during the pandemic and the PHQ-8 trajectory groups $F(3, 131) = 4.09$, $p = 0.008$, $\eta_p^2 = 0.02$. Post hoc comparisons revealed that between time 1 and time 2, loneliness significantly increased in the asymptomatic PHQ-8 trajectory group ($p = 0.002$), while increases in the symptomatic and worsened courses did not reach statistical significance. At time 2, compared to asymptomatic PHQ-8 courses loneliness was more pronounced in groups with symptomatic ($p = 0.007$) and worsened courses ($p = 0.043$), but did not differ from the improved trajectory group ($p = 0.998$). Regarding GAD-7 trajectories, effects of group and time were statistically significant and large or medium-sized, $F(3, 131) = 9.72$, $p < 0.001$, $\eta_p^2 = 0.13$; $F(3, 131) = 12.61$, $p < 0.001$, $\eta_p^2 = 0.02$ (**Figure 1**). The overall interaction between GAD-7 trajectories and loneliness was not significant ($p = 0.149$, $\eta_p^2 = 0.01$). However, loneliness significantly increased in the asymptomatic GAD-7 trajectory group ($p = 0.012$). At time 2, loneliness was more prevalent in groups with stable symptomatic compared to asymptomatic GAD-7 courses ($p = 0.014$) and did not differ from worsened or improved GAD-7 trajectories ($p = 0.548$; $p = 0.823$).

Associated Factors for Mental Health Levels and Changes

Table 4 shows the unadjusted and adjusted associations at time 1 with sociodemographic, pandemic-related and psychological variables, separately for the primary outcome of mental health

TABLE 3 | Primary outcomes and additional psychological variables during the COVID-19 pandemic.

Variables	Cross-sectional sample	Longitudinal sample		Paired *t* test (134)	*p*	Cohen's *d*	95 % CI
		Time 1	Time 2				
Depression (PHQ-8)							
Mean (*SD*)	8.12 (5.24)	8.37 (5.52)	8.43 (4.63)	−0.09	0.924	−0.01	[−0.16, 0.14]
Median (*range*)	7.00 (0–23)	8.00 (0–23)	8.00 (0–21)				
Moderate-to-severe (*N*, %)	141 (38.8%)	58 (43.0%)	58 (43.0%)				
Anxiety (GAD-7)							
Mean (*SD*)	7.15 (4.64)	7.50 (4.71)	7.52 (4.30)	−0.04	0.968	−0.004	[−0.17, 0.16]
Median (range)	6.00 (0–21)	7.00 (0–21)	7.00 (0–20)				
Moderate-to-severe (*N*, %)	93 (25.6%)	40 (29.6%)	38 (28.1%)				
Loneliness							
Mean (*SD*)	15.61 (5.51)	15.96 (5.93)	17.61 (5.04)	−2.63	0.009	−0.30	[−0.47, −0.13]
Median (range)	14 (8–30)	14 (8–29)	17 (8–28)				
Stress [a]							
Mean (*SD*)	3.91 (1.67)	4.09 (1.78)	4.42 (1.59)	−1.73	0.086	−0.20	[-0.37, −0.02]
Median (range)	4 (2–8)	4 (2–8)	4 (2–8)				
Satisfaction with life							
Mean (*SD*)	23.66 (6.58)	23.82 (6.59)	23.33 (6.17)	0.66	0.509	0.08	[−0.05, −0.21]
Median (range)	25 (5–34)	25 (6–34)	25 (5–34)				
Perceived social support							
Mean (*SD*)	19.83 (3.96)	19.96 (3.81)	19.98 (3.54)	−0.03	0.972	−0.004	[−0.14, −0.12]
Median (range)	21 (6–24)	21 (7–24)	21 (9–24)				
Repetitive negative thinking							
Mean (*SD*)	29.00 (12.59)	30.12 (12.67)	28.58 (13.10)	1.07	0.285	0.11	−0.03, −0.26]
Median (range)	29 (0–56)	30 (5–57)	29 (0–56)				

SD, standard deviation; PHQ-8, patient health questionnaire-8; GAD-7, generalized anxiety disorder-7.
[a]*Stress was measured with two items from the perceived stress scale (Cronbachs' α = 0.85).*

(depressive symptoms, anxiety symptoms). When adjusting for all other tested variables, increased depressive symptoms at time 1 were associated with worse coping abilities in daily life ($B = 0.64$; $SE = 0.29$) and worse coping with academic life since the pandemic ($B = 0.74$; $SE = 0.20$), with higher levels of loneliness ($B = 0.24$; $SE = 0.05$), social anxiety ($B = 0.20$; $SE = 0.08$), boredom ($B = 0.46$; $SE = 0.19$), and repetitive negative thinking ($B = 0.11$; $SE = 0.02$; ${}_{adj}R^2 = 52.3\%$, $p < .001$). Regarding anxiety symptoms at time 1, adjusted associations were found for living alone ($B = -0.91$; $SE = 0.44$), worse coping with academic life ($B = 0.48$; $SE = 0.18$), worse coping with a potential future lockdown ($B = 0.51$; $SE = 0.26$), loneliness ($B = 0.20$; $SE = 0.05$), and repetitive negative thinking ($B = 0.13$; $SE = 0.02$; ${}_{adj}R^2 = 59.38\%$, $p < .001$ including all variables). Sensitivity analyses with complete data applying list-wise deleted revealed similar conclusions compared to the multiple imputation approach presented for both depressive and anxiety symptoms (see **Supplementary Table 1**).

DISCUSSION

This study investigated the mental health levels and trajectories of university students during two different stages of the COVID-19 pandemic, i.e., at time 1 during the eased lockdown phase and at time 2 during the second lockdown in Germany. Contrary to the hypotheses, mean symptoms of depression and anxiety did not significantly change during the pandemic. Students most often had asymptomatic or sustained symptomatic courses of depression (56.3%, 30.4%) and anxiety (44.4%, 10.5%) during the pandemic; fewer worsened or improved between time 1 and time 2. Likewise, mean levels of stress, perceived quality of life, and social support did not change over the course of the pandemic. However, in line with the hypotheses, feelings of loneliness increased from time 1 to time 2. Higher levels of loneliness during the lockdown phase were present in participants with sustained or worsened symptom trajectories, while increases in loneliness were most prevalent in those with asymptomatic courses of depression and anxiety. Moreover, loneliness and repetitive negative thinking were associated with anxiety and depressive symptoms measured at time 1. Here, we discuss the results on mental health in the context of the COVID pandemic and its preventive measures (e.g., social distancing, closure of universities) together with further implications for students in higher education.

Findings in Context

During the eased lockdown phase in July 2020 at time 1, anxiety (GAD-7) and depression (PHQ-8) scores were more than twice as

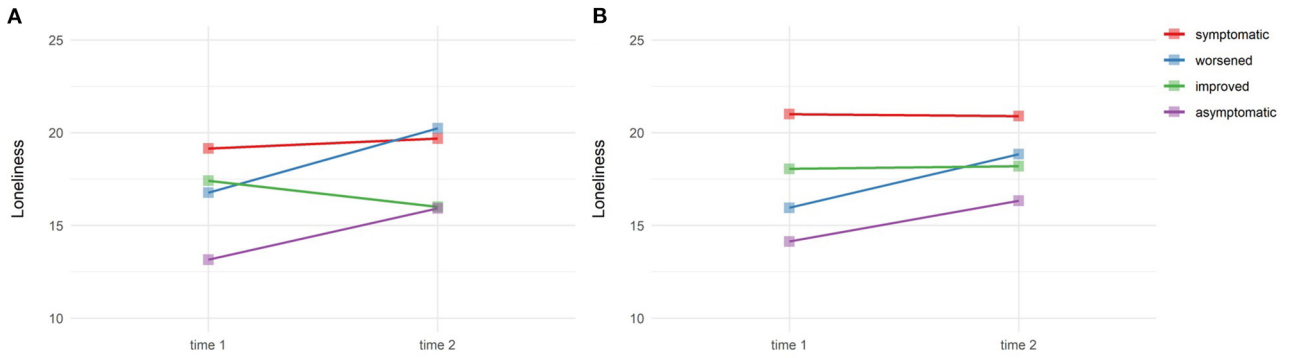

FIGURE 1 | Feelings of loneliness and trajectories of depressive symptoms **(A)** and anxiety symptoms **(B)** during the COVID-19 pandemic.

high as normative and pre-pandemic data for German university students (9, 57, 82). However, mean scores and clinically relevant rates for depressive symptoms (38.8%) in our cross-sectional sample are comparable to pandemic data of German university students assessed between June and August 2020 [37%, (13); 38.5%, 29]. Prevalence rates for anxiety symptoms at time 1 were slightly lower as reported previously during the eased lockdown phase in Germany [25.6% vs. 35.5%; (29)]. Although rates for anxiety and depressive symptoms at time 1 were slightly higher in participants with matched data at time 1 and time 2 compared to the cross-sectional sample, our results fit in with the pooled prevalence rates of anxiety and depression among students from Western countries during the pandemic [e.g., (83, 84)].

In this study, anxiety and depressive symptoms did not change during the course of the pandemic and lockdown, which contradicts our hypotheses as well as recent findings among French students with increased rates between the eased lockdown phase and the second lockdown (40). However, symptom trajectories differed during the pandemic. While most students had asymptomatic courses, approximately four of ten students had a stable symptomatic or worsened depressive course, and three out of ten faced adverse anxiety courses during the pandemic. In addition, and contrary to our hypotheses, levels did not change regarding stress, quality of life, perceived social support, and repetitive negative thinking during the pandemic, reflecting previous mixed longitudinal data [e.g., (22, 36–38)]. First, our findings indicate that most university students reported slightly worse or worse wellbeing at time 1 compared with pre-pandemic levels, which is in line with prior research [e.g., (12, 27, 28, 31). These findings generally point to decreased wellbeing during the pandemic, while symptom levels likely persisted between time 1 and time 2. However, coping with academic life improved during the pandemic, which implies that most students adapted to the remote studying formats. Second, this study was conducted at the end of the semester at time 1, and elevated symptoms levels at time 1 may also have developed partly in response to the examination phase (32). The survey at time 2 was conducted shortly after the second lockdown had started, and its long-term consequences were possibly not yet tangible.

Consistent with previous assumptions and data (4, 12, 53) but inconsistent with others (31), loneliness increased among university students during the pandemic. Loneliness particularly increased in students with asymptomatic trajectories during the pandemic, and the highest levels were present in students with symptomatic or worse trajectories. This mirrors both trajectories and symptom levels during the pandemic among the general population compared to people with pre-existing mental disorders (51). Although aligned with the established social distancing measures, social contacts decreased compared with pre-pandemic levels and further decreased during the pandemic, likely fostering loneliness in the current sample. This finding raises concerns given that loneliness is a crucial risk factor for mental health in general (48) as well as a major reason for increased helpline calls during the pandemic in Germany, and worldwide (85).

Moreover, loneliness was significantly associated with both depressive and anxiety symptoms at time 1 along with repetitive negative thinking, while adaptive coping in daily and academic life was protective for depressive symptoms, and adaptive coping with a potential future lockdown was protective for anxiety symptoms. In addition, these findings generally fit within the literature (41–47), suggesting that the way students appraise the pandemic, as well as their connections with others, may be critical in understanding the mental health during the pandemic.

The current study provides novel evidence on mental health before and during a second lockdown, identified loneliness and repetitive negative thinking as salient risk factors for mental health, and demonstrated diverging trajectories of mental health in a homogenous sample of German university students. The findings on prevalent anxiety and depressive symptoms and increased loneliness during the pandemic may foster immediate preventive actions such as psychoeducation in higher education, but also stimulate research on interventions targeting loneliness among young adults. However, the study also faces limitations. First and most importantly, the sample sizes were small and the response rate at time 2 was low (43.3 %), increasing the risk for inflated data. These numbers are comparable to other studies on university students during the pandemic [e.g., (29)], but results should be replicated with representative and larger sample sizes. Our sample consisted of participants studying at Berlin-based universities, and thus our data may not be generalized to other (student) populations. Second, the current study assessed the mental health levels and changes only twice during the pandemic, as well as the pre-pandemic well-being in

TABLE 4 | Associations with the two dependent variables depressive symptoms and anxiety symptoms at time 1 (N = 363) using simple linear (unadjusted models) and multiple linear regression analyses (adjusted models.).

	Depressive Symptoms (time 1)						Anxiety Symptoms (time 1)					
	Unadjusted model			Adjusted model [a]			Unadjusted model			Adjusted model [a]		
Independent variables	**Beta**	***SE***	***p***	**Beta**	***SE***	***p***	**Beta**	***SE***	***p***	**Beta**	***SE***	***p***
Sociodemographic data (time 1)												
Age	−0.08	0.06	0.157	−0.03	0.05	0.568	0.01	0.05	0.918	0.05	0.04	0.279
Gender (male vs.)												
female	1.15	0.58	0.052	0.14	0.44	0.743	1.32	0.52	0.011	0.29	0.40	0.463
Living situation (alone vs.)												
with others	0.45	0.64	0.478	−0.36	0.48	0.460	−0.48	0.56	0.391	−0.91	0.44	0.038
Family status (single vs.)												
partnership	−0.80	0.56	0.158	−0.32	0.44	0.472	0.08	0.50	0.877	0.15	0.40	0.705
other	−1.34	1.41	0.341	0.32	1.05	0.763	−1.85	1.25	0.138	−0.11	0.96	0.909
Parents' SES (low vs.)												
middle	0.65	0.74	0.385	0.07	0.55	0.897	0.08	0.66	0.121	−0.06	0.51	0.907
high status	0.06	0.92	0.949	0.67	0.66	0.315	−0.70	0.83	0.396	0.31	0.65	0.641
Pandemic-related variables (time 1)												
Students' income change	0.95	0.34	0.006	0.25	0.25	0.321	0.90	0.30	0.003	0.26	0.23	0.250
Coping with daily life	2.51	0.28	<0.001	0.64	0.29	0.029	2.16	0.25	<0.001	0.37	0.27	0.162
Coping with academic life	1.63	0.21	<0.001	0.74	0.20	<0.001	1.38	0.19	<0.001	0.48	0.18	0.007
Social contacts	−0.30	0.07	<0.001	−0.06	0.06	0.305	−0.30	0.06	<0.001	−0.08	0.06	0.149
Drinking alcohol	−0.06	0.09	0.515	0.07	0.08	0.341	−0.14	0.08	0.069	0.03	0.07	0.713
Coping future lockdown	1.37	0.27	<0.001	−0.05	0.28	0.863	1.56	0.23	<0.001	0.51	0.26	0.048
Anxiety future lockdown	−0.51	0.22	<0.001	0.19	0.20	0.320	−0.65	0.19	0.001	0.07	0.17	0.676
Psychological variables (time 1)												
Loneliness	0.53	0.42	<0.001	0.24	0.05	<0.001	0.45	0.38	<0.001	0.20	0.05	<0.001
Cope (positive reframing)	−1.07	0.17	<0.001	−0.18	0.15	0.254	−0.86	0.15	<0.001	−0.01	0.14	0.952
Cope (acceptance)	−0.69	0.17	<0.001	0.07	0.14	0.613	−0.81	0.15	<0.001	−0.24	0.13	0.061
Cope (substance use)	0.67	0.17	<0.001	0.22	0.14	0.128	0.23	0.15	0.136	−0.07	0.14	0.626
Social support	−0.48	0.07	<0.001	0.04	0.07	0.538	−0.42	0.06	<0.001	0.00	0.06	0.962
Self-efficacy	−0.44	0.56	<0.001	−0.03	0.05	0.579	−0.35	0.05	<0.001	0.04	0.05	0.451
Social anxiety	0.79	0.92	<0.001	0.20	0.08	0.016	0.58	0.08	<0.001	0.12	0.08	0.125
Boredom	1.77	0.23	<0.001	0.46	0.19	0.016	1.01	0.20	<0.001	−0.06	0.17	0.734
Repetitive negative thinking	0.24	0.19	<0.001	0.11	0.02	<0.001	0.21	0.02	<0.001	0.13	0.02	<0.001
Adverse childhood experiences	0.72	0.15	<0.001	0.19	0.12	0.109	0.54	0.13	<0.001	0.16	0.11	0.147
Current mental disorder (yes)	3.62	0.72	<0.001	0.80	0.56	0.154	2.82	0.65	<0.001	0.57	0.50	0.257
R^2				0.556		<0.001				0.528		<0.001
adjusted R^2				0.523		<0.001				0.493		<0.001

SES, socioeconomic status. Positive Beta values indicate a higher risk for depressive and anxiety symptoms.
[a] *Adjusted for all other variables listed in the table.*

a retrospective manner. In the absence of pre-pandemic data, the consequences of the COVID-19 pandemic in this sample should be interpreted with caution. Third, all measures were self-administered via online surveys, which potentially confounds the validity of the results. We used cut-offs from the PHQ-8 and the GAD-7 to create subgroups with differential symptom trajectories (e.g., to study transitions from uncritical to clinically relevant states), which showed good sensitivity and specificity (58, 60). However, these measures cannot replace a structural clinical interview to diagnose a depression or anxiety disorder.

CONCLUSION

Symptoms of anxiety and depression overall persisted during the COVID-19 pandemic while trajectories varied and feelings of loneliness significantly increased. Moreover, loneliness was associated with anxiety and depressive symptoms, indicating that preventing loneliness may help to maintain and promote mental health among university students. Representative studies on mental health, loneliness, and other associated factors are needed to fully identify students at high risk. Given that the COVID-19 pandemic and its preventive measures such as social distancing and remote learning continue for an indefinite period, long-term consequences for mental health are likely to occur, and universities should offer adequate support informed by the evidence to mitigate mental health problems and loneliness among university 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 Ethics Committee of the Freie Universität Berlin, Department of Education and Psychology. The participants provided their electronic informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MW, TB, and BR initiated this project and all authors contributed to designing and implementing the survey. MW analyzed the data and wrote the initial draft. All authors have reviewed and edited earlier versions and approved the final version of this manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.848645/full#supplementary-material

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Worries About COVID-19 and Adolescents' Mental Health and Life Satisfaction: The Role of Sociodemographics and Social Support

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Worries related to the COVID-19 pandemic are associated with mental health problems and reduced life satisfaction. However, the association between different types of worries about COVID-19 and adolescent mental health is unclear. Moreover, there is a lack of information about whether certain groups of adolescents are more vulnerable to the adverse effects of worries and how social support may moderate these effects. Adolescents (N = 12,686) completed a survey during the lockdown in spring 2020 in Oslo, Norway (37% response rate, 56.4% girls). The results showed that adolescent worries could be categorized into worries related to infection and those related to the general negative effects of the pandemic. Multivariate regression analyses showed that both types of worries were negatively related to positive affect and life satisfaction and positively related to depressive symptoms. Interaction analyses indicated that some associations with positive affect and depressive symptoms were stronger among adolescents with non-migrant backgrounds, higher family SES, and high reported levels of social support and physical contact during the pandemic. The findings suggest that COVID-19 worries may have negative effects on mental health and inform strategies to increase tailored psychological interventions to mitigate the effect of worry on adolescents' mental health and life satisfaction.

Keywords: worry, COVID-19, mental health, life satisfaction, adolescents

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INTRODUCTION

The SARS-CoV-2 pandemic has had a profound impact on worldwide health and economies (1). Adolescents may be particularly affected as they must not only cope with the unprecedented situation, but also with the significant transitions involved in this developmental stage (2). Moreover, adolescence is a susceptible time for developing mental health problems (3) and, thus, adolescents may be particularly vulnerable to experiencing mental health problems as a consequence of physical distancing (4) and restrictions in leisure activities (5). Therefore, knowledge about factors associated with mental health and life satisfaction is required to reduce the negative impact of COVID-19 on adolescents.

A cognitive factor that may increase vulnerability to mental health problems during the pandemic is COVID-19-related worries (6). Worry is defined as a set of maladaptive, future-oriented, repetitive, and catastrophic thoughts regarding the possibility of future negative events (7). Higher levels of COVID-19-related worries are negatively associated with adolescent mental health (8) and life satisfaction (9). The majority of studies have analyzed COVID-19 worries from an unidimensional perspective (i.e., "I worry a lot about the coronavirus-19") (10); however, a multidimensional approach may provide more detailed information about the relationship between worry and adolescents mental health. For example, Taylor et al. (11) identified different aspects of COVID-19-related worries among US adults, such as fear of infection and socio-economic consequences. Furthermore, adolescent worries may differ from adult worries. Indeed, COVID-19-related financial worries are prevalent in adults but not children (12). Correspondingly, as adolescents have a lower risk for serious health consequences from COVID-19, their worries for their own health may be lower than for adults, whereas their worries about infecting others may be higher. Recent research indicated that the most common COVID-19-related worries among adolescents are related to the impact of the restrictions on academic careers (i.e., college admissions) and health effects of an infection (i.e., self-infection and family illness) (13). Other research also identified academic worries as one type of worry related to the COVID-19 pandemic (14). However, research is still limited regarding the different content of worries and their relation to adolescent mental health.

In addition to understanding COVID-19 worries and their associations with mental health, it is vital to identify subgroups of adolescents for whom worries may have particularly detrimental effects on mental health and life satisfaction. Preliminary evidence indicated that the pandemic has greater adverse effects on mental health among girls, younger adolescents, and adolescents with migrant backgrounds and low socio-economic status (SES) (15–18). A nationwide Norwegian study also confirmed that girls, younger adolescents, and adolescents with low parental education and from poor families showed greater adverse changes during the pandemic on mental health and social relationships than older adolescents (19). However, it is unknown whether these sociodemographic characteristics moderate the association between COVID-19 worries and adolescent mental health and life satisfaction.

Perceived social support is another factor that may moderate this association. Perceived social support is positively related to mental health and life satisfaction among adolescents (20) and also reduces distress resulting from stressful events (21). Interestingly, although social contact may reduce the negative association between COVID-19 and mental health (22), more in-person contact may also increase adolescents' worries about COVID-19 infections resulting from such contact. Furthermore, adolescents' online interaction with friends was found to be related to higher levels of mental health problems during the pandemic (17). Therefore, social support and the source of social contact may moderate the relationship between worry about COVID-19 and adolescent mental health and life satisfaction.

Taken together, the current study aims to better understand the relationship between COVID-19-related worries and adolescent mental health and life satisfaction, and to distinguish the role of sociodemographic variables (gender, age, migrant background, and SES), perceived social support (support from peers and family) and type of contact (physical and online) for these associations. We hypothesize that: (1) higher levels of COVID-19-related worries are associated with poorer mental health and lower life satisfaction; (2) this association remains when controlling for gender, age, migrant background, SES, social support, and social contact; (3) the association of COVID-19-related worries with mental health and life satisfaction is stronger among girls, younger adolescents, adolescents with a migrant background and adolescents with lower family SES. Since literature on this topic is limited, we do not predict a specific direction of interactions with social support and type of contact.

METHODS

Procedure and Participants

Data were used from a large-scale population-based survey conducted between April 23 and May 8, 2020, in Oslo, the capital of Norway. At the time of assessment, all schools in Norway were closed due to the COVID-19 pandemic and students were attending digital schooling from home. The study was carried out by Norwegian Social Research (NOVA) at Oslo Metropolitan University. The school authorities in Oslo asked all public junior and senior high schools to participate in the study. Participants completed a digital questionnaire during a 30-min digital classroom session. From the eligible students, 37% ($N = 12{,}686$) participated. Previous publications have compared socio-demographic characteristic of our sample to population data about adolescents in Oslo from Statistics Norway (23). Results showed that the proportion of girls in the present sample was higher than in the population (56% vs. 50%), whereas the proportion of adolescents with migrant background was lower (30% vs. 37%). The study was anonymous and exempt from approval by the Regional Committee of Medical and Health Research Ethics. Students received written information outlining the study objectives and stating that the study was anonymous, and participation was voluntary. Parents were informed in advance about the study.

Measures

COVID-19-Related Worries

Similar to studies that analyzed COVID-19 worries from a bidimensional perspective among adults (i.e., worry about dangerousness of COVID-19 and about socio-economic impact) (11), COVID-19-related worries were conceptualized as worries related to infection (3-items: worry about own illness, infecting others, and illness of family members or friends; Cronbach's alpha = 0.73) and worries about academic and economic consequences of COVID-19 (3-items: worries about family economic situation, impact on school grades, and the country's economy; Cronbach's alpha = 0.56). Response options ranged from *not worried at all* (1) to *very worried* (4). We conducted confirmatory factor

analyses to analyze the latent structure of the items. Firstly, a one-factor solution was modeled with all items loading on one factor; however, this model did not show satisfactory fit ($\chi^2(9) = 2013.99$, $p < 0.001$; CFI = 0.85; RMSEA = 0.137; SRMR = 0.068). Following this, a two-factor solution was modeled with correlated latent factors. The three items related to worries about COVID-19 infection loaded onto one factor, whereas the remaining three items about academic and economic consequences loaded onto a second factor. This model showed satisfactory fit ($\chi^2(8) = 298.07$, $p < 0.001$; CFI = 0.98; RMSEA = 0.055; SRMR = 0.025). The two latent worry factors were positively correlated ($r = 0.52$, $p < 0.001$).

Mental Health and Life Satisfaction

Mental health was assessed with two instruments regarding positive affect and depressive symptoms. Positive affect was assessed using a 6-item scale about the frequency of positive feelings during the last seven days (e.g., "felt happy, engaged, energetic"; Cronbach's alpha = 0.87). Response options ranged from *not at all* (1) to *all the time* (5). Depressive symptoms were measured using a 6-item version of the Hopkin Symptom Checklist (24, 25). Response options ranged from *not affected* (1) to *extremely affected* (4). Internal consistency was high (Cronbach's alpha = 0.87). Life satisfaction was measured using the Cantril's ladder (26), with response options ranging from *worst possible life* (0) to *best possible life* (10).

Sociodemographics

Gender, age (i.e., school grade) and migrant background (i.e., at least one parent born abroad) were assessed by self-report. Family socio-economic status was assessed by a composite score comprising the number of books at home, level of education of parents, and four items from Family Affluence Scale II (27), which include frequency of traveling for family holidays in the previous year, number of computers and cars in the family, and the participant having an individual room at home. Higher scores indicated higher SES.

Social Support

Peer social support was measured using one item: "Do you have at least one friend who you completely trust and to whom you can reveal everything?" Response options were *yes, certainly* (4), *yes, I think,* (3) *I don't think so* (2), *I don't have anyone I would call a friend, these days* (1). Family social support was assessed using three items from a short version of the Parental Bonding Instrument (Cronbach's alpha = 0.68) (28), with higher scores indicating higher social support.

Physical and Online Contact

Physical and online contact were assessed using two questions: "How many of the previous 7 days have you been physically together with friends or a boyfriend/girlfriend?," and "How many of the previous 7 days have you been in contact with friends or a boyfriend/girlfriend via the Internet or a mobile phone?." Higher scores indicated higher levels of contact.

Data Analyses

Descriptive statistics and correlation analyses were performed. Linear regression analyses were used to examine the association between worries about COVID-19 and mental health and life satisfaction. Analyses were presented with and without controlling for covariates. Following this, moderator analyses were conducted to assess whether socio-demographic factors and social support moderated the association between COVID-19-related worries and mental health and life satisfaction. When significant moderation effects were identified, simple-slope analyses were conducted at ±1 standard deviation of the moderator means. For categorical moderators (i.e., gender and migrant background), simple slopes were run for each group. Simple-slope analyses detected at which level of the moderators (i.e., socio-demographic and social support) predictor variables (i.e., worries about COVID-19) were related to mental health and life satisfaction outcomes (29). Analyses were conducted with R (v.4.0.3), using packages *psych* (v.2.0.12) (30), *interactions* (v.1.1.3) (31), and *lavaan* (v.0.6–7) (32). A significance level of $p < 0.01$ was used.

RESULTS

Descriptive Statistics and Correlations

At the item level, adolescents worried more about infecting others ($M = 2.90$; $SD = 0.93$) and their families or friends getting infected ($M = 2.54$; $SD = 0.96$) than about being infected themselves ($M = 1.69$; $SD = 0.76$). Moreover, worries about the impact of the pandemic on their academic grades ($M = 2.39$; $SD = 0.99$) and the economy of the country ($M = 2.20$; $SD = 0.89$) were more common than worries about the family's financial situation ($M = 1.74$; $SD = 0.90$). Overall, adolescents showed a moderate level for worry about COVID-19 infection ($M = 2.38$; $SD = 0.72$) and academic and economic consequences of the pandemic ($M = 2.11$; $SD = 0.68$).

Descriptive statistics are presented in **Table 1**. Both types of worries were positively associated with being female, higher age, and migrant background, and negatively associated with family SES. Higher social support from peers was negatively related to worries about the academic and economic consequences of COVID-19, but not to worries about COVID-19 infection. Interestingly, family social support showed a small, positive relation to worries about infection, but was negatively related to worries about academic and economic consequences. Physical contact showed negative associations with both types of worry, but online contact showed a significant, albeit small, positive association only with worries about consequences.

Worry About COVID-19 Infection

Regression results for worries about infection are displayed in **Table 2**. For models including positive affect, worry about COVID-19 infection predicted negatively positive affect. The association remained significant when adjusting for covariates. Adjusted analyses also showed that being male, being younger, having a migrant background, support from peers and family, and physical contact with friends predicted higher positive affect. Models that included the interaction terms of worry

TABLE 1 | Means, standard deviations and correlations between all study variables ($N = 12{,}686$).

Variable	M	SD	Range	1	2	3	4	5	6	7	8	9	10	11	12
1. Worry infection	2.38	0.72	[1,4]												
2. Worry academic & economic	2.11	0.68	[1,4]	0.36**											
3. Positive affect	3.16	0.79	[1,5]	−0.05**	−0.25**										
4. Depressive symptoms	2.17	0.74	[1,4]	0.19**	0.39**	−0.64**									
5. Life satisfaction	6.08	2.00	[0,10]	−0.07**	−0.25**	0.60**	−0.54**								
6. Female gender, %	56.4	-	-	0.23**	0.15**	−0.15**	0.22**	−0.10**							
7. Age	3.01	1.61	[1,6]	0.05**	0.18**	−0.14**	0.18**	−0.11**	0.03**						
8. Migrant background, %	30.6	-	-	0.16**	0.18**	0.04**	−0.02*	0.03**	0.02**	−0.01					
9. Family SES	3.00	1.42	[1,5]	−0.13**	−0.18**	0.03**	−0.02*	0.02*	0.01	−0.00	−0.50**				
10. Social support peers	3.49	0.78	[1,4]	0.02*	−0.06**	0.21**	−0.15**	0.15**	0.06**	0.03**	−0.07**	0.08**			
11. Social support family	3.24	0.65	[1,4]	0.05**	−0.14**	0.37**	−0.34**	0.28**	0.04**	−0.03**	−0.07**	0.12**	0.21**		
12. Physical contact	2.43	1.13	[1,5]	−0.07**	−0.08**	0.11**	−0.05**	0.06**	−0.03**	−0.01	−0.26**	0.19**	0.21**	0.04**	
13. Online contact	4.19	1.11	[1,5]	0.03**	−0.01	0.08**	−0.00	0.04**	0.07**	0.06**	−0.10**	0.08**	0.28**	0.09**	0.28**

$^{*}p < 0.01$; $^{**}p < 0.001$.

M, mean; SD, standard deviation; Age, from grade 1 (13 years-old) to 6 (18 years-old).

TABLE 2 | Regression analyses for the association between worries about COVID-19 infection on adolescents' mental health and life satisfaction.

Model		Positive affect			Depressive symptoms			Life satisfaction		
		B	SE	*t*	B	SE	*t*	B	SE	*t*
1[a]	Worry	−0.053	0.010	−5.385**	0.191	0.010	19.745**	−0.066	0.009	−6.846**
2[b]	Worry	−0.042	0.009	−4.430**	0.171	0.009	18.428**	−0.061	0.010	−6.227**
	Female gender	−0.326	0.019	−17.437**	0.394	0.019	21.300**	−0.208	0.020	−10.666**
	Age	−0.123	0.009	−13.777**	0.153	0.009	17.342**	−0.098	0.009	−10.534**
	Migrant background	0.248	0.023	10.655**	−0.178	0.023	−7.724**	0.165	0.024	6.836**
	Family SES	0.007	0.010	0.683	0.016	0.010	1.578	0.002	0.011	0.206
	Social support peers	0.131	0.010	13.508**	−0.101	0.010	−10.524**	0.108	0.010	10.712**
	Social support family	0.348	0.009	37.783**	−0.338	0.009	−37.047**	0.260	0.010	27.061**
	Physical contact	0.089	0.010	9.194**	−0.026	0.010	−2.694*	0.052	0.010	5.096**
	Online contact	0.017	0.010	1.807	0.030	0.010	3.178*	−0.006	0.010	−0.557
3[c]	Worry × Female gender	0.003	0.020	0.134	−0.014	0.020	−0.704	−0.006	0.020	−0.292
	Worry × Age	−0.014	0.010	−1.485	0.021	0.010	2.196	0.001	0.010	0.051
	Worry × Foreign origin	0.079	0.021	3.747**	−0.098	0.021	−4.710**	0.028	0.021	1.375
	Worry × Family SES	−0.042	0.010	−4.308**	0.033	0.010	3.401*	−0.006	0.010	−0.642
	Worry × Social support peers	−0.024	0.009	−2.589	0.031	0.009	3.388*	−0.014	0.009	−1.490
	Worry × Social support family	−0.007	0.009	−0.778	0.017	0.009	1.971	−0.012	0.009	−1.353
	Worry × Physical contact	−0.032	0.010	−3.322**	0.010	0.010	1.009	−0.013	0.010	−1.407
	Worry × Online contact	−0.019	0.009	−2.029	0.021	0.009	2.266	−0.009	0.009	−1.018

*$p < 0.01$: **$p < 0.001$.
[a]*Unadjusted for covariates.*
[b]*Adjusted for all covariates.*
[c]*Adjusted for interaction main effects.*

TABLE 3 | Regression analyses for the association between worries about COVID-19's academic and economic consequences on adolescents' mental health and life satisfaction.

Model		Positive affect			Depressive symptoms			Life satisfaction		
		B	SE	*t*	B	SE	*t*	B	SE	*t*
1[a]	Worry	−0.251	0.010	−26.266**	0.390	0.009	42.875**	−0.246	0.009	−26.211**
2[b]	Worry	−0.181	0.009	−19.343**	0.319	0.009	35.376**	−0.204	0.010	−20.991**
	Female gender	−0.293	0.018	−16.111**	0.376	0.018	21.471**	−0.175	0.019	−9.303**
	Age	−0.095	0.009	−10.665**	0.108	0.009	12.556	−0.069	0.009	−7.370**
	Migrant background	0.291	0.023	12.693**	−0.226	0.022	−10.205**	0.207	0.024	8.706**
	Family SES	−0.007	0.010	−0.688	0.033	0.010	3.302**	−0.015	0.011	−1.419
	Social support peers	0.125	0.010	13.012**	−0.091	0.009	−9.833**	0.103	0.010	10.430**
	Social support family	0.325	0.009	35.501**	−0.292	0.009	−33.125**	0.232	0.010	24.469**
	Physical contact	0.087	0.010	9.058**	−0.027	0.009	−2.891*	0.050	0.010	4.995**
	Online contact	0.020	0.010	2.102	0.029	0.009	3.143*	−0.004	0.010	−0.403
3[c]	Worry × Female gender	0.006	0.020	0.316	0.025	0.019	1.332	0.007	0.019	0.374
	Worry × Age	−0.021	0.009	−2.198	0.020	0.009	2.183	−0.003	0.009	−0.268
	Worry × Foreign origin	0.019	0.020	0.945	−0.066	0.019	−3.419**	−0.026	0.020	−1.312
	Worry × Family SES	−0.024	0.010	−2.456	0.021	0.009	2.327	0.012	0.010	1.282
	Worry × Social support peers	−0.017	0.009	−1.899	0.028	0.009	3.299*	−0.018	0.009	−2.078
	Worry × Social support family	0.004	0.009	0.406	−0.007	0.008	−0.881	0.012	0.009	1.371
	Worry × Physical contact	−0.019	0.009	−1.992	0.017	0.009	1.882	0.003	0.009	0.367
	Worry × Online contact	−0.005	0.009	−0.567	0.006	0.009	0.649	0.006	0.009	0.693

*$p < 0.01$: **$p < 0.001$.
[a]*Unadjusted for covariates.*
[b]*Adjusted for all covariates.*
[c]*Adjusted for interaction main effects.*

about COVID-19 infection and moderators showed significant moderation effects by migrant background, family SES, social support from peers, and physical contact. Simple-slope analyses indicated that worry about infection predicted significantly positive affect only among those adolescents with a non-migrant background ($B = -0.09$, SE $= 0.01$, $p < 0.001$), higher family SES ($B = -0.10$, SE $= 0.01$, $p < 0.001$), more social support from peers ($B = -0.08$, SE $= 0.01$, $p < 0.001$), and more physical contact with friends ($B = -0.08$, SE $= 0.01$, $p < 0.001$), compared to adolescents with a migrant background ($B = -0.01$, SE $= 0.02$, $p = 0.60$), lower family SES ($B = -0.01$, SE $= 0.01$, $p = 0.35$), less social support from peers ($B = -0.04$, SE $= 0.01$, $p = 0.01$) and less physical contact with friends ($B = -0.01$, SE $= 0.01$, $p = 0.29$).

For models with depressive symptoms as the outcome, higher levels of worry about COVID-19 infection predicted higher levels of depressive symptoms, both with and without adjustment for covariates. Being female, being older, having a non-migrant background, having more social support from peers and family, and having less physical contact also predicted higher levels of depressive symptoms. Models with interaction terms indicated a moderation effect of migrant background, family SES, and social support from peers. Specifically, the relationship between worry about COVID-19 infection and depressive symptoms was stronger among adolescents with a non-migrant background ($B = 0.23$, SE $= 0.01$, $p < 0.001$), higher family SES ($B = 0.23$, SE $= 0.01$, $p < 0.001$), and high levels of social support from peers ($B = 0.23$, SE $= 0.01$, $p < 0.001$), compared to adolescents with a migrant background ($B = 0.14$, SE $= 0.02$, $p < 0.001$), lower family SES ($B = 0.16$, SE $= 0.01$, $p < 0.001$), and less social support from peers ($B = 0.16$, SE $= 0.01$, $p < 0.001$).

Finally, when life satisfaction was the outcome, high levels of worry about COVID-19 infection predicted low life satisfaction in models both with and without covariate adjustment. Similar to positive affect, being male, being younger, and having migrant background predicted higher levels of life satisfaction. Furthermore, social support from peers and family, and physical contact with friends predicted life satisfaction. Results from moderation analyses showed no statistically significant interaction effects for any of the potential moderators.

Worry About COVID-19's Academic and Economic Consequences

Regression models for worry about COVID-19's academic and economic consequences are presented in **Table 3**. Regarding positive affect models, worries about the academic and economic consequences were negatively related to positive affect both with and without covariates. There were similar associations between the covariates and positive affect as observed in the models with worry about COVID-19 infection. Moderation analyses did not show any significant interactions.

For models including depressive symptoms as the outcome, worries about COVID-19's academic and economic consequences predicted higher levels of depressive symptoms in both unadjusted and adjusted models. Covariates had similar associations with depressive symptoms as with worry about COVID-19 infection, but higher levels of online contact also predicted more depressive symptoms. Interaction analyses demonstrated that the relationship between worries about COVID-19's academic and economic consequences and depressive symptoms was stronger among adolescents with a non-migrant background ($B = 0.43$, SE $= 0.01$, $p < 0.001$) and with higher social support from peers ($B = 0.41$, SE $= 0.01$, $p < 0.001$), compared to adolescents with a migrant background ($B = 0.37$, SE $= 0.02$, $p < 0.001$) and lower support from peers ($B = 0.37$, SE $= 0.01$, $p < 0.001$).

For the model including life satisfaction, greater worries about COVID-19's academic and economic consequences predicted lower life satisfaction in both unadjusted and adjusted models. Covariates had similar relations to life satisfaction as in models investigating worry about COVID-19 infection. Results from moderation analyses showed no significant interaction effects.

DISCUSSION

This study analyzed the relationships between worries about the COVID-19 pandemic and adolescent mental health and life satisfaction and assessed whether these relationships were moderated by socio-demographic variables and social support. Results indicated that COVID-19 worries comprised two main dimensions: worries about COVID-19 infection and worries about COVID-19's academic and economic consequences. Findings also revealed that both types of worries predicted poor mental health (i.e., lower positive affect and higher depressive symptoms) and life satisfaction, even when controlling for covariates. Finally, our findings suggested that the relationships between worries and mental health were stronger among adolescents with non-migrant backgrounds, higher family SES, and high levels of social support or contact from peers. However, the relationships between both types of worry on life satisfaction were not moderated by any variables included in the models.

The bidimensional structure of worries about COVID-19 in adolescents, comprising worries about infection and worries about academic and economic effects, expands previous findings among US adults that the most relevant worries were the dangers of COVID-19 and the socio-economic impact of the pandemic (11). Our findings are also in line with a study with adolescents from India showing that the two most common worries were about the impact of COVID-19 on academic achievement (74% of the sample) and on health effects of an infection (41% of the sample) (13). In the present study, although adolescents reported similar, average levels of both types of worries (i.e., mean scores were around 2, on a 1–4 scale), the means varied on the item level. For example, regarding worries about infection, adolescents worried about the consequences of COVID-19 infection for others more than for themselves. Indeed, adolescents may perceive COVID-19 as less harmful for themselves than for older family members, in accordance with the lower COVID-19 morbidity and mortality among younger people (33). Moreover, adolescents were slightly

more worried about COVID-19's academic and economic impact than about the family's financial situation. As such, in line with previous studies (13, 14), our results underline the importance of addressing the impact of both school-related stress and the economic situation on adolescents' worries.

As expected, higher levels of worries about COVID-19 were negatively related to both positive affect and life satisfaction, and positively depressive symptoms. These associations were also found when accounting for covariates. These findings are in accordance with previous studies indicating that COVID-19-related worries were associated with adolescent mental health and life satisfaction (8, 9). Additionally, our results extend previous literature by demonstrating that the relationship between adolescent worries and mental health should be considered from a dimensional perspective including various worries, not only about infection but also about the academic and economic consequences of the pandemic.

This study provides novel information about factors that moderate the relationship between worries, mental health, and life satisfaction among adolescents. Contrary to our expectations, the results did not show any moderation of the relationship between worries about COVID-19 and life satisfaction. In contrast, the associations between both types of worry and mental health were stronger among adolescents with non-migrant backgrounds and higher family SES. Our results might be partially explained by the fact that adolescents with a non-migrant background and high SES families may perceive the COVID-19 pandemic restrictions as being more severe, as they may participate in organized leisure activities more often than other adolescents, and these types of activities were restricted during the pandemic (9). Another tentative explanation of our findings could be that stress and worry levels may have already been high among migrant and low SES adolescents and, thus, COVID-19 may not have changed their level of worry to the same degree as for adolescents from high SES families. Moreover, Norwegian statistics show that registered coronavirus infections were more prevalent among high socio-economic strata in the beginning of the pandemic, right before this study was conducted (34). Adolescents from high SES backgrounds may as such have had more experience of and knowledge about the adverse consequences of COVID-19 infections, which may have strengthened the association between COVID-19 worries and mental health outcomes in this group of adolescents. Future longitudinal studies that investigate the change in worries and their resulting impact on mental health during COVID-19 may help to better understand these relationships.

Regarding worries predicting levels of mental health, the association was stronger among adolescents with higher levels of social support from peers. Previous studies observed that social support mitigates the negative impacts of difficult life events (20). However, other cognitive mechanisms may explain the stronger association between worries and mental health among adolescents with more social support. For example, adolescents receiving high levels of social support may have more opportunities to engage in co-ruminative processes that maintain and increase their distress in uncertain times (35). As a result, these adolescents may share their concerns and fears related to COVID-19 to a greater degree with their peers, thus increasing the negative effect of these worries on their mental health. Interestingly, when types of social contact were analyzed, the negative association between worry about COVID-19 infection and mental health was stronger among those with higher levels of in-person contact. Indeed, it is possible that adolescents may worry about infecting others through in-person contact. These worries may change in the post-pandemic period; however, future studies should explore the longitudinal influences of in-person and online contact on adolescent mental health in order to develop better infection control strategies and, thus, reduce infection rates.

Strengths of this study include the use of a large, population-based sample of adolescents ($N = 12{,}686$) and multidimensional assessment of worries. However, the results should be interpreted in the context of some limitations. First, the cross-sectional design limits the potential to uncover causal relationships between the variables. Future studies should include longitudinal designs. Second, measures may be affected by the limitations of self-report questionnaires, such as social desirability bias, so future research would benefit from multimethod assessment. Also, the bidimensional structure of the measure of COVID-19 worries may be a result of the selection of the six items used to assess this construct in the present study. A more comprehensive instrument with a wider item selection of potential worries may have resulted in a more multifaceted measure. Third, we did not examine whether having experienced a coronavirus infection was related to COVID-19 worries and mental health outcomes, as the survey did not include items on infections. Such information would have provided valuable information about the psychological consequences of an infection and should be examined in future studies. Fourth, although confirmatory factor analyses showed adequate model fit for a two-factor solution for COVID-19 related worries, this study is the first to use this instrument to assess COVID-19 worries in adolescents. Future studies should explore if the bidimensional solution on worries stands. Fifth, the 37% rate response in this study and the underrepresentation of boys and adolescents with migrant background may to some degree influence the estimates of prevalence of COVID-19 worries and associations between COVID-19 worries and mental health outcomes. Finally, it is unclear whether the present study results are generalizable to adolescents from countries other than Norway with different welfare systems. Therefore, research examining the effects of worry about COVID-19 in other countries would be beneficial.

CONCLUSIONS

The current study enhances knowledge about the relationship between different types of worries about COVID-19 and mental health and life satisfaction among adolescents. Adolescents with higher SES and higher perceived social support levels may be more vulnerable to the association between high levels of worry about COVID-19 and poorer mental health. Future studies should monitor specific worries during the COVID-19 pandemic

to reduce the risk of the development of mental health problems related to the pandemic. In addition, this study helps to inform therapeutic and prevention strategies that aim to reduce adolescents' worries about the COVID-19 pandemic and its continuous influence on adolescent mental health and life satisfaction.

DATA AVAILABILITY STATEMENT

The data used in this study is available from the corresponding author upon reasonable request and with the permission of Norwegian Social Research (NOVA).

ETHICS STATEMENT

The study was anonymous and exempt from approval by the Regional Committee of Medical and Health Research Ethics. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

RR-C, TvS, and VU: methodology. RR-C: formal analysis. RR-C and VU: data curation. RR-C and LC-G: writing—original draft preparation. All authors contributed in conceptualization, writing—review and editing, read, and agreed to the published version of the manuscript.

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Early Adolescents' Experiences During the COVID-19 Pandemic and Changes in Their Well-Being

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Background: Early adolescence is a time of psychological and social change that can coincide with declines in mental health and well-being. This study investigated the psychological and social impacts of the COVID-19 pandemic from the perspective of students who responded to a survey in Grades 7 and 8 (ages 12–14) in British Columbia (BC), Canada. The objectives of this study were (i) to provide an overview on early adolescents' experiences and social-emotional well-being during the pandemic; and (ii) to examine whether changes in social experiences as well as feeling safe from getting COVID-19 at school were associated with changes in well-being outcomes over the course of a year.

Methods: A sample of $n = 1{,}755$ students from a large public school district self-reported on their life satisfaction, optimism, and symptoms of sadness across two time points: First, in their Grade 7 year (pre-pandemic; January to March, 2020) and then 1 year later in their Grade 8 year (during the pandemic; January to March, 2021). In Grade 8, students also reported on pandemic-specific experiences, including changes in mental health, social relationships, and activities, as well as coping strategies and positive changes since the pandemic. Data were collected online using the Middle Years Development Instrument (MDI), a population-based self-report tool that assesses children's social-emotional development and well-being in the context of their home, school, and neighborhood. Multivariable linear regression analyses were used to examine associations between pandemic-related changes in relationships and perceived safety from getting COVID-19 at school with changes in well-being outcomes.

Results: Students reported a range of experiences, with a large proportion reporting moderate concerns and impacts of the pandemic, including worries about their mental health and missing school activities. Students reported significantly lower optimism, lower life satisfaction, and higher sadness compared to the previous year. Within the sample, improvements in relationships with parents and other adults at home was associated with higher well-being during the pandemic.

Implications: Results from this study can inform decision making of policy-makers, educators, and practitioners working with youth, by providing information on students' experiences during the pandemic and identifying factors that may be protective for students' mental health during and beyond the pandemic.

Keywords: well-being, mental health, adolescent, COVID-19, survey

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INTRODUCTION

The COVID-19 pandemic has led to profound changes to the social worlds of students, including disruptions within family life, school closures, physical distancing measures within schools upon re-opening, and cancelation of most in-person social activities. These disruptions have led many researchers, physicians, and educators to raise concerns regarding the impact of the pandemic and related restrictions on students' mental health and well-being, particularly because of adolescents' sensitivity to social contexts during this developmental window (1–5). In addition to the potential of immediate mental health impacts, the pandemic may have long-term impacts on adolescents' physical, social, and emotional health due to increased stress during a period when the physiological systems that regulate and respond to stress are still developing (6). For example, social isolation is a stressor shown to be adversely associated with children's developing stress response systems (7).

The early adolescent years are a time of psychological and social change associated with the onset of many mental health problems and declines in well-being (8–10). During this time, individuals are developing a greater sense of self-awareness, awareness of others, and identity formation, as well as experiencing the onset of puberty, encountering social changes within friendship groups, and experiencing greater academic expectations and challenges (11–14). Pre-pandemic research documents the important stress-buffering effects of social relationships (15). However, in the context of the COVID-19 pandemic, it is unclear how social isolation and changes within homes and schools have affected social relationships, and how these changes, in turn, have affected students' mental health. The purpose of the current study was to investigate 12 to 14 year-old students' experiences during the pandemic after ∼4 months back at school. A core interest was examining what factors were negatively associated with students' mental health and—from a strengths-based lens—what factors were associated with resilience. This research was informed by the Positive Youth Development (PYD) framework [see (16)]. Consistent with PYD, this study takes a strengths-based perspective on child and youth development by examining assets and protective factors in several developmental contexts (e.g., school, home, community) that contribute to positive outcomes in development.

Pandemic-Related Changes in Adolescent Mental Health

Research studies worldwide have documented declines in children's and adolescents' mental health associated with the COVID-19 pandemic (1–5, 17, 18). Among adolescents ages 13 to 17, a review of COVID-19 studies including validated and designed-for-purpose self-report measures documented increases in depression, anxiety, and stress (4). In Germany, 40% of 11- to 17 year-olds reported worsened mental health due to the pandemic, 18% reported more mental health problems, and 24% reported higher anxiety (5). In Israel, a repeated-measures study conducted with 11 to 17 year-olds before and during the pandemic found adolescents were reporting increased depression, anxiety, and panic, and decreased positive emotions and life satisfaction (19). Similarly in Australia, a repeated measures study conducted with 13 to 16 year-olds found that adolescents reported increased depression and anxiety and decreased life satisfaction during the first 2 months of the pandemic compared to the previous year (20). This study found that increased conflict with parents was associated with increases in mental health problems (20). Research in Canada with early adolescents aged 10 to 12 years old using self-report items adapted from the National Institutes of Mental Health CoRonavIruS Health Impact Survey (CRISIS) found that increased stress associated with social isolation was associated with mental health problems (1). Specifically, adolescents reported increased depression (35%), anxiety (40%), irritability (45%), attention problems (46%), and hyperactivity (42%) (1).

However, these studies have also shown that the COVID-19 pandemic has not affected all adolescents in the same way. In the Canadian study using the CRISIS measure, 9% to 13% of participants reported improvements in mental health. In a national poll of 10 to 17 year-olds conducted during school closures 71% of Canadian students reported feeling bored, 54% reported missing their friends, and 41% reported feeling "quite normal" (21). In a repeated-measures study of students in grades 6 to 12 in the United States, students reported on average that their mental health improved during the first 3 months of the pandemic compared to the previous year; possible explanations for this improvement include reduced academic pressure (22). However, the authors also noted that improvements were not reported by all students. The wide ranges in mental health outcomes prompt questions regarding what changes in social experiences predict adolescents' mental health during the pandemic, and what contextual factors promote resilience during times of crisis.

Pandemic-Related Changes in Early Adolescents' Social Contexts

According to the PYD framework, thriving in adolescence is supported by the presence of developmental assets that are internal (e.g., positive values) and external (e.g., social support and activities that provide opportunities for engagement, leadership, and success) (16). Importantly, it is the interaction between individuals and their contexts that drives positive development (16). The COVID-19 pandemic has changed these developmental opportunities in several ways. For example, for some adolescents, the pandemic caused significant changes within the home environment. Families have endured enormous pressures due to the pandemic, including unemployment, financial pressure, relationship challenges, and increased caregiving and homeschooling responsibilities (2, 23, 24). Since the start of the pandemic, parents have reported more frequent negative mood and worsened mental health (2), as well as increases in negative parent-child interactions including increased conflicts and discipline (23–26). At the same time, some studies found that parents reported increases in positive interactions with children during the pandemic including increased closeness and showing love and affection, perhaps because of more time for conversations and shared activities

(23, 25–27). There are also wide socio-economic disparities among families, which impact the opportunities parents have to provide activities for their children at home, including access to online school-based activities and social networks (28). In summary, the available evidence points to a general trend toward greater stress and worse home environments during the pandemic, especially for families experiencing marginalization or disadvantages, with the caveat that this unique period may also have afforded opportunities for closer family relationships.

Another significant change occurred within the school environment. In the past year, students worldwide became more isolated due to school closures, canceled activities, and limits to social group sizes upon the return to school. Specifically in British Columbia, Canada, schools were closed mid-March 2020 with learning activities moved online (29). Schools partially re-opened in June 2020 before closing again at the end of June for summer break, and all students returned to a modified school setting in September 2020 (29). Starting from September 2020, BC schools operated under the guidelines of the Provincial Health Officer that mandated several infection prevention and exposure control measures including moving desks and implementing physical barriers to avoid close contact, staggering lunch and recess, assigning students to a specific cohort up to 60 people with whom all activities were conducted, maintaining physical distancing and hand hygiene, and limiting school gatherings such as school assemblies and extracurricular activities (30). To date, there is limited research on early adolescents' mental health in the context of schools re-opening. On the one hand, students who returned to school continued to face uncertainty, altered social routines, and potential health concerns related to virus exposure (31). On the other hand, the return to school brought greater opportunities to see friends and teachers in person and the potential to access school mental health supports. Existing research on the return to school found that most students ages 12 to 18 years old reported low levels of COVID-19-related stress (e.g., constantly thinking about COVID-19, sleep problems), however stress was higher among girls and older students (31). Other reports indicated that a higher proportion of students attending school during the pandemic reported lower well-being compared to previous academic years (32).

Protective Factors for Adolescent Mental Health

Studies that have investigated protective factors of adolescents' mental health and well-being before and during the COVID-19 pandemic provide important information. The PYD framework suggests that positive social relationships are a key foundation for promoting adolescent mental health (16). Supportive social contexts and high-quality relationships have also been identified as key components of resilience (i.e., competence in the face of adversity) and promoters of competence (i.e., when no adversity is present) (33). During the pandemic, adolescents ages 13 to 18 years-old who reported spending more time with family also reported less loneliness and depression (34). Similarly, among younger adolescents ages 9 to 11 years-old, connectedness to adults at home was associated with lower depression and anxiety during the pandemic as well as greater happiness (35). Interestingly, in this same study, connectedness to peers was not associated with mental health and well-being outcomes, which was explained as potentially resulting from the limited opportunities students had to interact with peers during the study period. In other research, students have furthermore identified potential positive impacts of the pandemic, including more time for activities they previously were too busy to pursue, increased exercise, and increased control over one's life (36). In two repeated-measures studies, social connectedness, perceived social support and consistent daily routines were also identified as protective factors for adolescent mental health during the pandemic (19, 20). Remaining gaps in research include a limited understanding of the proportion of adolescents who have maintained positive relationships during the pandemic and to what extent pandemic-related changes in relationships with adults and peers are associated with mental health and well-being in the context of returning to school.

The Current Study

The current study capitalized on a unique dataset that linked survey responses from a population cohort of students attending public school in one of the largest school districts in British Columbia, Canada, from Grade 7 (January-March 2020; just prior to province-wide restrictions due to the COVID-19 pandemic) to Grade 8 (January-March 2021; nearly 1 year into the pandemic and ∼4 months after schools re-opened). In Grade 8, students answered questions on their experiences during the pandemic, including changes in activities and social relationships, as well as their mental health and perceived safety from getting the virus at school. In this study, we addressed two research objectives: (i) to provide an overview on early adolescents' experiences and social-emotional well-being during the pandemic; (ii) to examine whether changes in social experiences as well as feeling safe from getting COVID-19 at school were associated with changes in well-being outcomes over the course of a year.

METHODS

Participants

All enrolled Grade 7 and 8 public middle school students from a large urban school district in British Columbia (BC), Canada, were invited to participate in the study at two time points. Compared to the average socio-economic characteristics of households in BC, this district has a comparable but slightly higher median household income and higher proportion of households considered low-income (37). Time 1 data were collected in Grade 7 (pre-pandemic; January-March 2020)[1] and Time 2 data were collected 1 year later in Grade 8 (∼10–12 months after the COVID-19 pandemic was first declared; January-March 2021). At both time points, all 14 middle schools of this district took part in the study. All participating students

[1] The last survey completed at Time 1 was March 6, just prior to the WHO declaring the COVID-19 pandemic [March 11, 2020 (38)] and the British Columbia Ministry of Education closing schools for two months as a public health safety measure before a partial re-opening in June (29).

in this study attended school in person at Time 1 and Time 2. In Grade 7, 2,214 students participated in the survey, representing 86% of the district's Grade 7 public school population. In Grade 8, 2,131 students participated in the survey, representing 81% of the district's Grade 8 public school population. A total of 1,755 students had linkable data across the two time points and were included in this study (49.2% girls, 50.8% boys). In the linked sample, mean age at Time 1 (Grade 7) was 13.0 years, SD = 0.12. Mean age at Time 2 (Grade 8) was 14.0 years, SD = 0.12. Overall, 56.6% of the students reported "English only" as the first language learned at home, 18.9% reported "English and another language", and 24.5% reported a language other than English as the first language learned at home. The most common first languages learned other than English were Korean (23%), Mandarin (22%), and Cantonese (9%). A comparison between children in the linked sample and those with data limited to Grade 7 found no differences with regard to age, gender, or English as a second language, but that children in the linked sample generally reported higher connectedness to adults and peer belonging than children lost to follow up.

Procedure

At both Time 1 and Time 2, data were collected using the Middle Years Development Instrument (MDI), a validated self-report measure of social and emotional competencies for children and adolescents measuring their well-being, health, and developmental assets (39, 40). All students within Grades 7 (Time 1) and 8 (Time 2) in participating schools were invited to participate, with the study team providing parents/guardians 4 weeks' notice to inquire about the study and opt their children out of participation. Schools and classroom teachers could additionally opt-out of participation. Prior to the survey, students were read an assent script and were provided the choice to do an alternative activity to the survey that would not identify their non-participation. At both time points, survey data were collected via an online survey, conducted at school during school hours[2]. At Time 2 (Grade 8), students completed an additional survey module that asked about pandemic-specific experiences, including changes in mental health, social relationships, and activities, as well as coping strategies and positive changes since the pandemic. Ethics approval for both surveys and data linkage was obtained from the University of British Columbia Research Ethics Board. Data linkage was completed at Population Data BC using children's Personal Education Number and child date of birth.

Measures

Well-Being Outcomes

Data were collected using the MDI self-report survey for children aged 9–14 (40). The MDI includes 101 items and subscales that have been previously used in developmental research with children and/or adolescents. Items were initially pilot tested in focus groups with children to ensure clarity and understanding at a Grade 4 level (40). Previous research has found the MDI to have satisfactory psychometric properties, with good internal consistency and convergent validity evidence for subscales (39, 40). The MDI has been implemented across Canada and has been validated with child and early adolescent populations internationally (42, 43). A copy of the MDI survey as well as district reports for previous Grade 7 years are available from http://earlylearning.ubc.ca/mdi/.

Children's self-reported well-being (life satisfaction, optimism) and internalizing (sadness) were measured at Time 1 and Time 2 using three subscales of the MDI (40). On each subscale, students rated their agreement with a series of statements using a 5-point Likert type response format (1 = Disagree a lot, 5 = Agree a lot). *Optimism* (3 items) was adapted from the previously validated *Optimism Resiliency Inventory Subscale* (44). In Grade 8, the mean scale score was 3.47 (standard deviation (SD) = 0.96). *Satisfaction with Life* (5 items) was measured using the *Satisfaction with Life Scale adapted for Children* (SWLS-C) (45, 46), a validated children's measure based on the *Satisfaction with Life Scale* for adults (47). In Grade 8, the mean scale score was 3.55 (SD = 1.00). *Sadness* (3 items) was adapted from the previously validated *Seattle Personality Questionnaire for Young School-Age Children* (48). In Grade 8, the mean scale score was 3.00 (SD = 1.01). Each subscale had good internal consistency, with Cronbach's alpha in Grade 8 of 0.81, 0.89, and 0.78 for optimism, life satisfaction, and sadness, respectively. These were comparable with Cronbach's alphas for optimism, life satisfaction, and sadness in Grade 7 of 0.81, 0.87, and 0.77.

Pandemic-Related Experiences

In 2021, the study team developed a subset of 18 items specifically to measure the impact of the COVID-19 pandemic and related restrictions on early adolescents. Similar to the development of the MDI, pandemic-related items were selected and adapted from existing, previously validated surveys where possible, based on their contextual and developmental relevance. Other items were developed for the purpose of this study by researchers with input from educators and students. Survey items were piloted with children and stakeholders from schools and the BC Ministry of Education and refined based on their feedback. These items are described below and provided in **Appendix A**. The following five constructs measure pandemic-specific experiences and were therefore measured only at Time 2 (January to March, 2021).

Worries About Mental Health

Students' worries about mental health were assessed using an item adapted from the National Institutes of Mental Health CRISIS questionnaire V0.3 youth self-report baseline form, "During the PAST TWO WEEKS, how worried have you been about your Mental/Emotional health being influenced by the COVID-19 pandemic?" This item was rated on a 5-point response format (1 = Not at all, 5 = Extremely) (49).

[2]Schools were closed to in-person learning in March of 2020 for most students in British Columbia (BC), with voluntary, part-time return to in-person learning open to all students in June of 2020 (29). All students were welcomed back to in-person learning in September 2020, although some families opted to keep children at home, evidenced by a 32% increase in enrolment in Distributed Learning from 2019–2020 to 2020–2021. Schools remained open throughout the 2020–2021 academic year under enhanced health and safety measures (41).

School-Based Public Health Practices and Perceived Safety From Getting COVID-19 at School

Students were given a list of common school-based public health practices, including "washing hands more frequently" and "practicing physical distancing." Students rated how easy or hard these practices were on a 5-point response format (1 = Very hard, 5 = Very easy). These items were adapted from the general population British Columbia COVID-19 SPEAK survey developed by the British Columbia Centre for Disease Control (41). Additionally, students were asked, "How often do the COVID-19 safety measures at your school make you feel safe from getting COVID-19?" Items were rated on a 4-point response format (1 = Never safe, 4 = Always safe). This item was created specifically for this study with input from stakeholders.

Changes in Relationships Due to the Pandemic

Students were asked, "From before the COVID-19 pandemic to now, have your relationships with [...] gotten better or worse?" This question was repeated for three relationship types: parents or other adults at home, teachers or other adults at school, and friends. Items were rated on a 5-point Likert type response format (1 = A lot worse, 5 = A lot better). These items were adapted from the CRISIS questionnaire V0.3 youth self-report baseline form, which originally asked participants to report how the quality of their relationships had changed due to the Coronavirus/COVID-19 crisis in the past 2 weeks, using the same rating scale.

Changes in Time Use

Students were asked, "How did the following change from before the COVID-19 pandemic to now?" Four items measured spending time with friends online, time with friends in person/face-to-face, time with family members who live in my home, and time outdoors (for example, playing sports, hiking, biking, going for walks). Students rated changes in time use on a 5-point Likert type response format (1 = Much less, 5 = Much more). These items were created specifically for this study by the research team with input from stakeholders.

Coping With Stress, Activities Missed at School, and Positive Changes Since the Pandemic

Students were asked, "What has helped you deal/cope with worries and stress related to the COVID-19 pandemic?" Students could select multiple options that applied, from a provided list. This item was adapted from a COVID-19 self-report mental health survey originally developed by the Mental Health Foundation in the United Kingdom (50). Students were also asked, "What are you missing the most at school during the COVID-19 pandemic?" and "What are some positive changes that have occurred in your life during the COVID-19 pandemic?" These items and answer options were created specifically for this study by the research team with input from stakeholders.

Gender

Student's gender was measured through school district recorded information (girls were coded as 1, boys as 2).

Analyses

Frequencies were calculated for all measures examining self-reported changes in relationships, time use, and perceived safety from getting COVID-19 at school. Paired *t*-tests were conducted to measure unadjusted changes in optimism, life satisfaction, and sadness from Grade 7 (prior to the pandemic) to Grade 8. We conducted three multivariable linear regression models, entering groups of variables in blocks, to examine associations between pandemic-related changes in relationships and perceived safety from getting COVID-19 at school with well-being outcomes (optimism, life satisfaction, and sadness), adjusted for gender, age, born in Canada (yes/no), and previously reported well-being in Grade 7. We also calculated the PRATT-index for each predictor variable in the regression model to assess each variable's relative importance (51). The PRATT-index calculates the percentage of the total variance explained in the model that is explained by each predictor variable. The formula includes each predictor's beta weight, its correlation with the outcome variable, and the total R^2 in the model [$d = (ß * rxy)/R^2$] (51). Each variable receives a score from 0 to 1, with all variables taken together accounting for 100% of the variance explained in the model. Using criteria previously established by Thomas (52), predictors are considered relatively unimportant if $d < 1/(2*p)$ where p is the total number of predictors in the model. In the full regression models within the current study, predictors with a PRATT-index score smaller than 0.06 [$d < 1/(2*8)$] explained relatively little of the variance in the model (<6% of the R^2). This was a complete case analysis. Missing data were excluded listwise in the multiple regression analyses resulting in denominators of $n = 1{,}569$ for optimism, $n = 1{,}549$ for sadness, and $n = 1{,}519$ for life satisfaction.

RESULTS

Mental Health and Perceived Safety of Getting COVID-19 at School During the Pandemic

Figure 1A presents the proportion of students who reported being worried about their mental/emotional health being influenced by the pandemic in the past 2 weeks. Nearly half of students (46%) reported feeling slightly or somewhat worried, and an additional 17% of students reported feeling very or extremely worried. When asked how much students were reading or talking about the COVID-19 pandemic (**Figure 1B**), the most frequent response (37%) was "occasionally."

At the time of data collection, school districts had put in place several safety measures to prevent the spread of COVID-19, including requiring face masks to be worn indoors, practicing physical distancing, washing hands and using hand sanitizer, canceling activities involving large groups, and requiring that students stay home when sick. Overall, the majority of students reported that it was a little easy or very easy to follow these safety protocols (**Figure 2**). The most challenging protocols to follow were practicing physical distancing and avoiding big groups. With these safety measures in place, 14% of students always felt safe from getting COVID-19 at school, 47% reported feeling safe

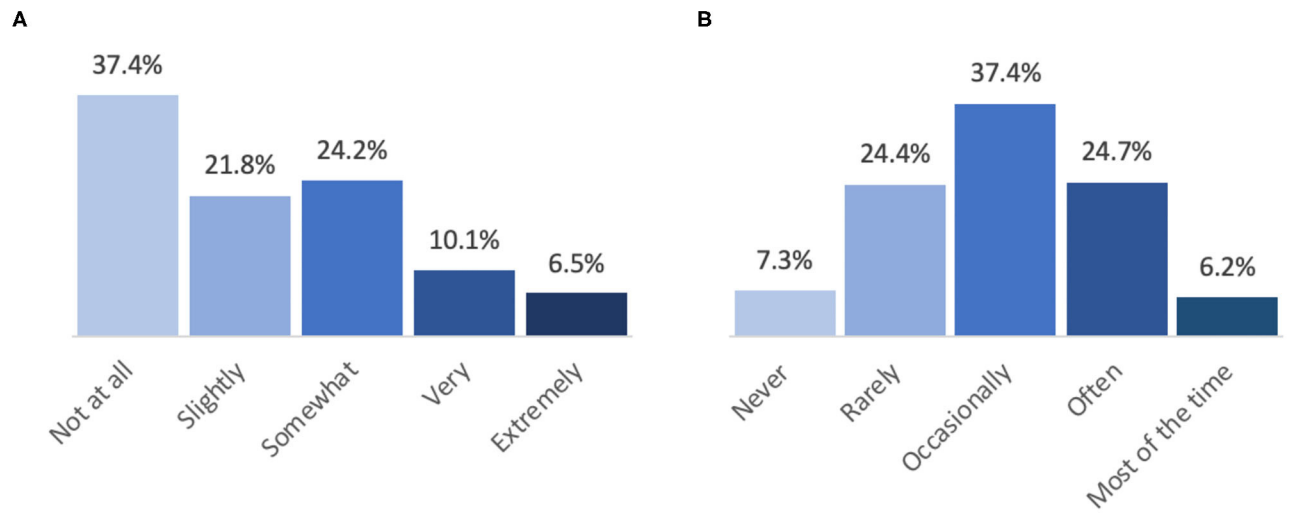

FIGURE 1 | Students' self-reported mental health and frequency of reading or talking about the COVID-19 pandemic during the past 2 weeks. **(A)** During the past 2 weeks, how worried have you been about your mental/emotional health being influenced by the COVID-19 pandemic? **(B)** How much are you reading or talking about the COVID-19 pandemic?

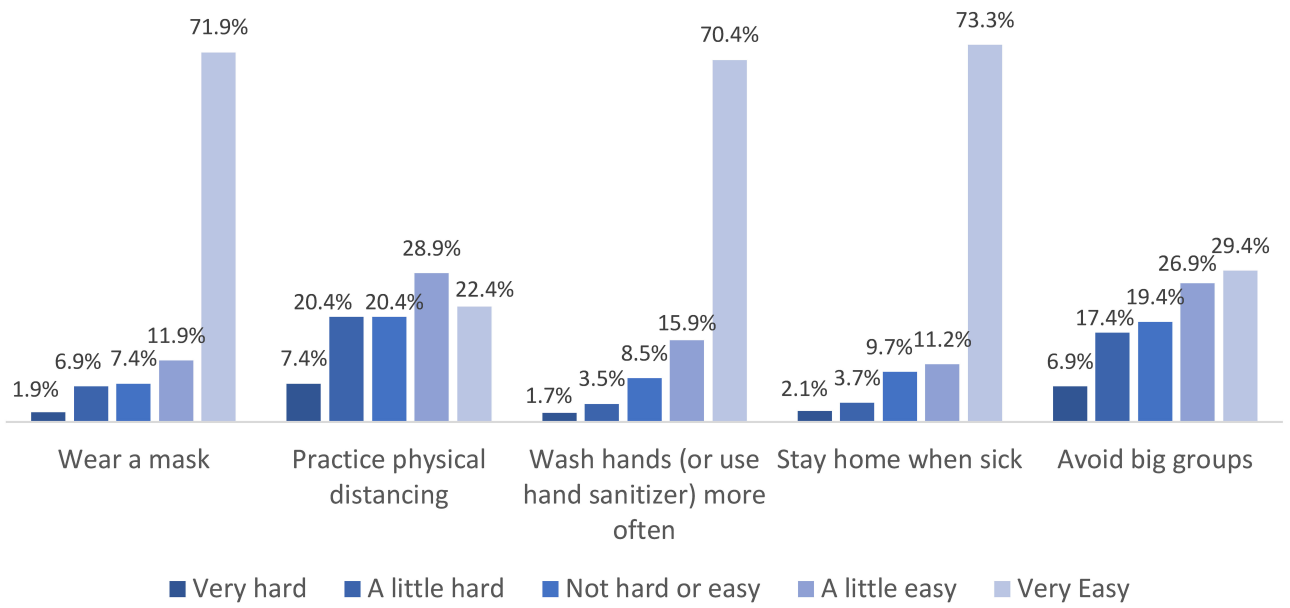

FIGURE 2 | Students' self-reported ease of practicing COVID-19 safety measures at school.

most of the time, 31% reported feeling safe some of the time, and 8% never felt safe.

Pandemic-Related Changes in Relationships

Compared to prior to the COVID-19 pandemic, the majority of students reported that their relationships with parents (or other adults at home) and teachers (or other adults at school) had stayed the same or improved (**Figure 3**). Perceived relationship improvements were even more pronounced for friendships, in which 45% of students reported that relationships with friends had gotten a little or a lot better. In contrast, 16% of students reported that their relationships with parents or other adults at home and friends had gotten a little or a lot worse, and 10% reported worsened relationships with teachers or other adults at school.

Pandemic-Related Changes in Activities and Time Use

Students reported several pandemic-related changes in their activities and time use. Compared to before the pandemic, 69% of students reported spending more or much more time with

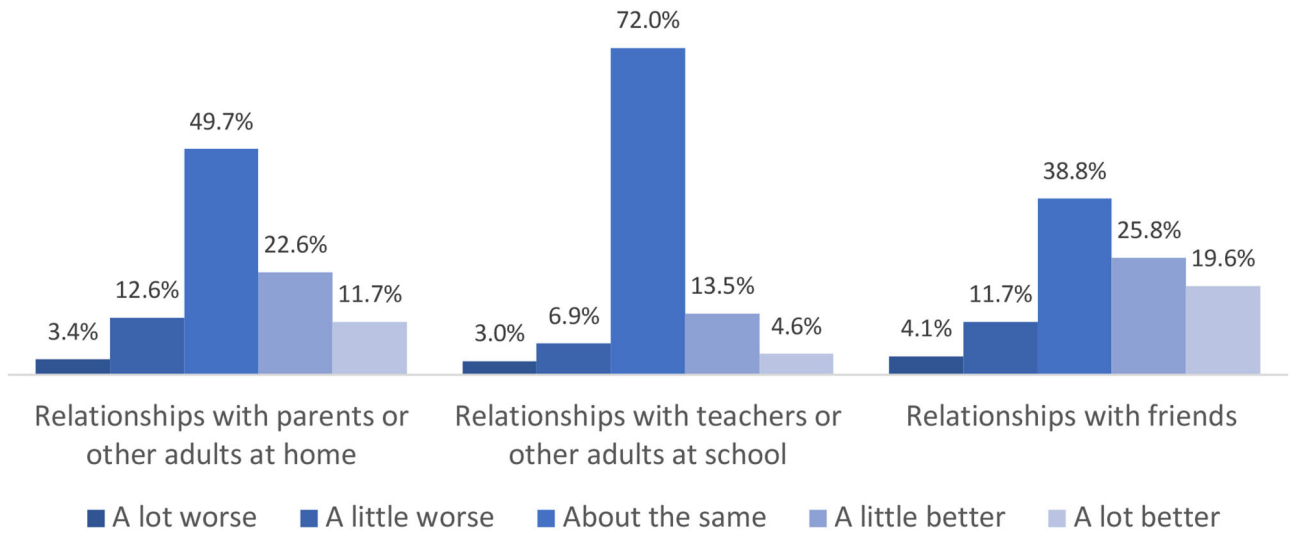

FIGURE 3 | Students' perceived changes in relationships from before the COVID-19 pandemic to now.

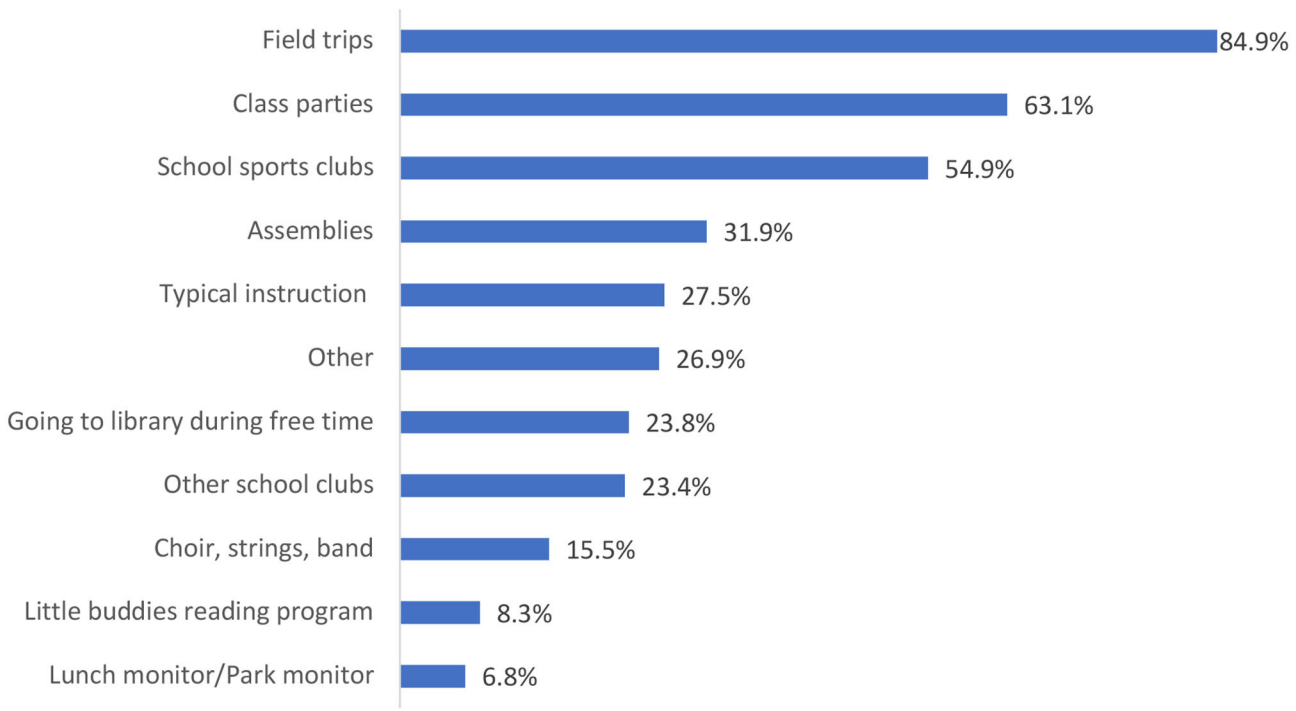

FIGURE 4 | Activities that students missed most at school during the COVID-19 pandemic.

their friends online. Seventy-two percent reported spending less or much less time with friends in person/face-to-face. In contrast, 59% of students reported spending more or much more time with family members who live in their home. Thirty-two percent of students reported spending more or much more time outdoors, whereas 35% of students reported spending less or much less time outdoors.

At the time of data collection, schools were in session but several restrictions were in place including canceled group activities, and learning within small working groups (29). When asked what students missed most at school during the COVID-19 pandemic, the most frequent response was field trips (85%), followed by class parties (63%), school sports clubs (55%), assemblies (32%), and typical instruction (28%) (**Figure 4**).

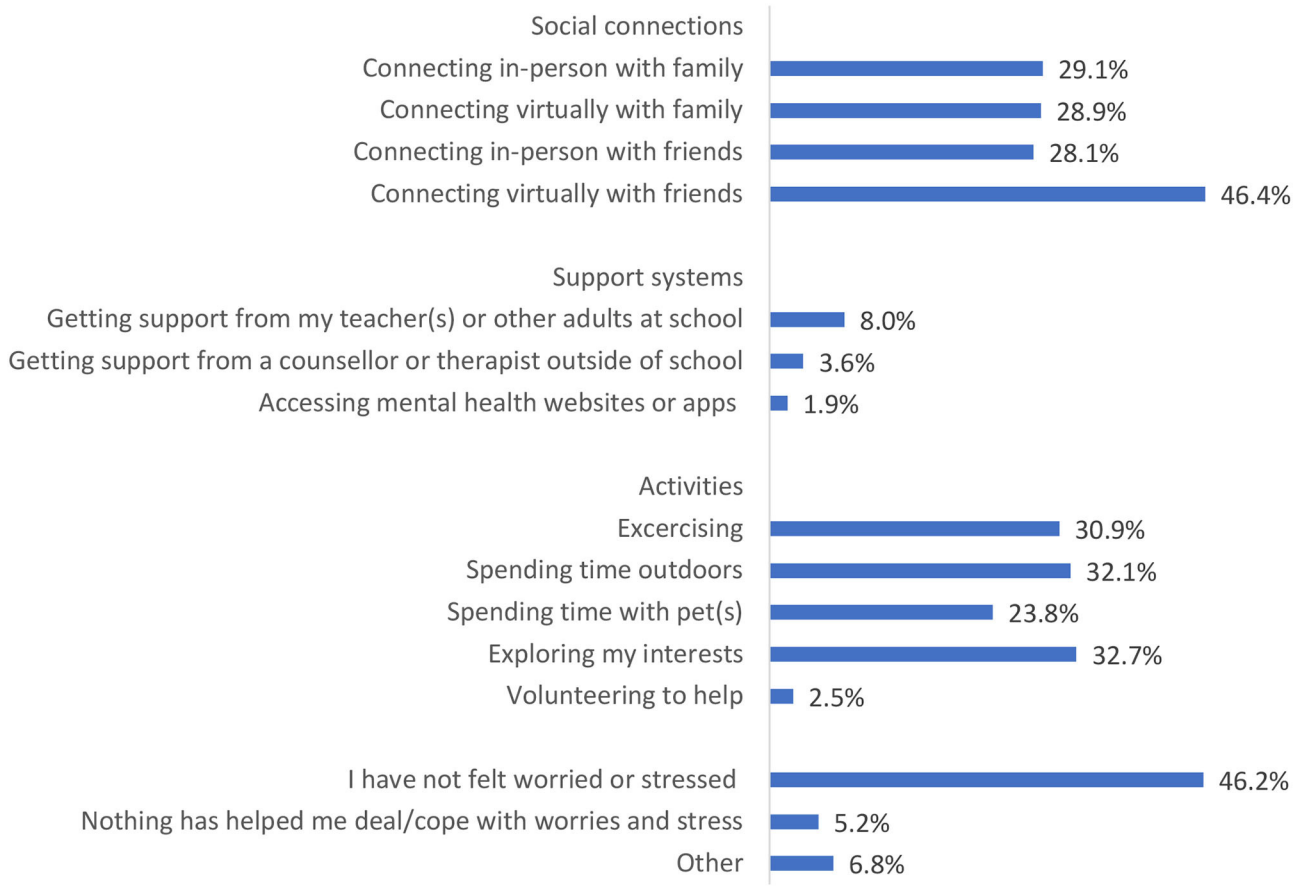

FIGURE 5 | Strategies that helped students cope with worries and stress related to the pandemic in the past 2 weeks.

Students also identified positive changes that had occurred in their lives during the pandemic, including having more time to themselves (58%), exploring other interests (44%), spending more time with family members (42%), getting more sleep (32%), spending more time with friends (30%), and helping others more (9%). However, 1 in 5 students (21%) reported that there were no positive changes.

Students were also asked what had helped them deal/cope with worries and stress related to the COVID-19 pandemic. As shown in **Figure 5**, the most frequent response was connecting virtually with friends (46%), followed by exploring their interests (33%), spending time outdoors (32%), and exercising (31%). Forty-six percent of students reported that they had not felt worried or stressed due to the pandemic, and 5% reported that nothing had helped them deal/cope with worries or stress.

Associations Between Pandemic-Related Changes and Well-Being

Overall Changes in Well-Being Compared to Before the Pandemic

Paired-samples *t*-tests identified that across all measures, self-reported well-being declined from prior to the pandemic (Grade 7) to during the pandemic (Grade 8). On average, students reported a 0.15 point decrease in mean optimism scores, $t_{(1,686)} = -6.71$, $SD_{\text{mean}} = 0.91$, Cohen's $d = 0.16$ [95% CI: 0.12,0.21], $p < 0.001$. Students reported a 0.21 point decrease in mean life satisfaction scores, $t_{(1,629)} = -10.11$, $SD_{\text{mean}} = 0.86$, Cohen's $d = 0.25$ [95% CI: 0.20,0.30], $p < 0.001$. Students' also reported 0.16 point increase in mean sadness scores, $t_{(1,669)} = 6.92$, $SD_{\text{mean}} = 0.95$, Cohen's $d = 0.17$ [95% CI: 0.12,0.22], $p < 0.001$.

Associations Between Pandemic-Related Changes and Optimism

Multivariable regression models were conducted to examine the associations between pandemic-related changes in relationships and context and early adolescents' well-being across three outcomes: optimism, life satisfaction, and sadness[3]. **Table 1** presents results from multivariable regression models examining associations between child demographics, students' reported optimism in Grade 7, and pandemic-related changes in students' relationships and feelings of safety from getting COVID-19 at

[3]Intraclass correlation coefficients (ICC) were calculated for the three outcome measures to test the proportion of variance that could be explained by clustering in the data by classroom. ICCs for each outcome were below a threshold of 0.10 [Grade 8 optimism (ICC = 0.02), Grade 8 satisfaction with life (ICC = 0.03), Grade 8 sadness (ICC = 0.02)], indicating that single level analyses were appropriate (53).

TABLE 1 | Multivariable linear regression analysis predicting optimism score at Grade 8 ($n = 1{,}569$).

		B	SE	β	95% CI	PRATT
Model 1 Adjusted $R^2 = 0.01$	Gender	0.21***	0.05	0.11	0.11, 0.30	
	Age	0.29	0.22	0.03	−0.14, 0.72	
	Born in Canada	−0.01	0.06	0.00	−0.12, 0.11	
Model 2 Adjusted $R^2 = 0.30$	Gender	0.20***	0.04	0.10	0.12, 0.27	
	Age	0.17	0.18	0.02	−0.18, 0.53	
	Born in Canada	−0.05	0.05	−0.02	−0.14, 0.05	
	Grade 7 optimism	0.56***	0.02	0.54	0.51, 0.60	
Model 3 Adjusted $R^2 = 0.37$	Gender	0.14***	0.04	0.07	0.06, 0.21	0.02
	Age	0.18	0.17	0.02	−0.16, 0.53	0.00
	Born in Canada	−0.03	0.05	−0.01	−0.12, 0.06	0.00
	Grade 7 optimism	0.48***	0.02	0.46	0.44, 0.52	0.67
	Change in home adult relationships	0.17***	0.02	0.17	0.13, 0.22	0.16
	Change in school adult relationships	0.09**	0.03	0.07	0.04, 0.15	0.04
	Change in friendships	0.05*	0.02	0.06	0.01, 0.09	0.03
	Feeling safe from getting COVID-19 at school	0.14***	0.02	0.12	0.09, 0.19	0.07

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. B, unstandardized regression coefficient; SE, standard error of B; CI, confidence interval for B; β, beta weight; standardized regression coefficient. Gender (girl = 1, boy = 2) and Born in Canada (no = 0, yes = 1).*

TABLE 2 | Multivariable linear regression analysis predicting satisfaction with life score at Grade 8 ($n = 1{,}519$).

		B	SE	β	95% CI	PRATT
Model 1 Adjusted $R^2 = 0.02$	Gender	0.28***	0.05	0.14	0.18, 0.38	
	Age	0.07	0.23	0.01	−0.37, 0.51	
	Born in Canada	0.07	0.06	0.03	−0.05, 0.20	
Model 2 Adjusted $R^2 = 0.37$	Gender	0.20***	0.04	0.10	0.12, 0.28	
	Age	0.10	0.18	0.01	−0.25, 0.45	
	Born in Canada	−0.11*	0.05	−0.05	−0.21, −0.01	
	Grade 7 satisfaction with life	0.65***	0.02	0.60	0.61, 0.69	
Model 3 Adjusted $R^2 = 0.44$	Gender	0.15***	0.04	0.08	0.07, 0.22	0.02
	Age	0.10	0.17	0.01	−0.24, 0.44	0.00
	Born in Canada	−0.08	0.05	−0.03	−0.17, 0.02	0.00
	Grade 7 satisfaction with life	0.58***	0.02	0.53	0.53, 0.62	0.72
	Change in home adult relationships	0.20***	0.02	0.19	0.16, 0.25	0.16
	Change in school adult relationships	0.10***	0.03	0.07	0.04, 0.16	0.04
	Change in friendships	0.03	0.02	0.03	−0.01, 0.07	0.01
	Feeling safe from getting COVID-19 at school	0.11***	0.02	0.09	0.06, 0.15	0.04

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. B, unstandardized regression coefficient; SE, standard error of B; CI, confidence interval for B; β, beta weight; standardized regression coefficient. Gender (girl = 1, boy = 2) and Born in Canada (no = 0, yes = 1).*

school with students' self-reported optimism in Grade 8. In the fully adjusted model with all variables entered simultaneously (model 3), higher optimism in Grade 8 was predicted by gender (boys higher optimism than girls; $B = 0.14$, 95% CI = 0.06, 0.21), higher optimism in Grade 7 ($B = 0.48$, 95% CI = 0.44, 0.52), improved relationships with adults at home ($B = 0.17$, 95% CI = 0.13, 0.22), improved relationships with adults at school ($B = 0.09$, 95% CI = 0.04, 0.15), improved relationships with friends ($B = 0.05$, 95% CI = 0.01, 0.09), and feeling safe from getting COVID-19 at school ($B = 0.14$, 95% CI = 0.09, 0.19). The Pratt Index identified three of these variables to be the most important in predicting students' Grade 8 optimism: optimism in Grade 7 (explaining 67% of the 37% total variance explained by the model), improvements in relationships with adults at home (16%), and feeling safe from getting COVID-19 at school (7%).

Associations Between Pandemic-Related Changes and Life Satisfaction

Table 2 presents results from multivariable regression models examining associations between predictor variables and students' self-reported life satisfaction in Grade 8. In the fully adjusted model, higher life satisfaction in Grade 8 was predicted by gender

TABLE 3 | Multivariable linear regression analysis predicting sadness score at Grade 8 (n = 1,549).

		B	SE	β	95% CI	PRATT
Model 1 Adjusted R^2 = 0.04	Gender	−0.40***	0.05	−0.20	−0.50, −0.30	
	Age	0.02	0.23	0.00	−0.43, 0.48	
	Born in Canada	−0.03	0.06	−0.01	−0.15, 0.09	
Model 2 Adjusted R^2 = 0.33	Gender	−0.29***	0.04	−0.15	−0.37, −0.21	
	Age	−0.01	0.20	0.00	−0.39, 0.38	
	Born in Canada	−0.04	0.05	−0.01	−0.14, 0.06	
	Grade 7 sadness	0.55***	0.02	0.54	0.51, 0.60	
Model 3 Adjusted R^2 = 0.37	Gender	−0.25***	0.04	−0.13	−0.33, −0.17	0.07
	Age	−0.01	0.19	0.00	−0.38, 0.36	0.00
	Born in Canada	−0.04	0.05	−0.02	−0.14, 0.06	0.00
	Grade 7 sadness	0.51***	0.02	0.50	0.47, 0.55	0.75
	Change in home adult relationships	−0.17***	0.02	−0.16	−0.22, −0.12	0.12
	Change in school adult relationships	0.00	0.03	0.00	−0.07, 0.06	0.00
	Change in friendships	−0.02	0.02	−0.02	−0.06, 0.02	0.01
	Feeling safe from getting COIVID-19 at school	−0.13***	0.03	−0.10	−0.18, −0.08	0.05

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. B, unstandardized regression coefficient; SE, standard error of B; CI, confidence interval for B; β, beta weight; standardized regression coefficient. Gender (girl = 1, boy = 2) and Born in Canada (no = 0, yes = 1).*

(boys higher life satisfaction than girls; B = 0.15, 95% CI = 0.07,0.22), higher life satisfaction in Grade 7 (B = 0.58, 95% CI = 0.53,0.62), improved relationships with adults at home (B = 0.20, 95% CI = 0.16,0.25), improved relationships with adults at school (B = 0.10, 95% CI = 0.04, 0.16), and feeling safe from getting COVID-19 at school (B = 0.11, 95% CI = 0.06,0.15). The Pratt Index identified two variables to be the most important in predicting students' Grade 8 life satisfaction: their life satisfaction in Grade 7 (explaining 72% of the 44% total variance explained by the model), and improvements in relationships with adults at home (16%).

Associations Between Pandemic-Related Changes and Sadness

Table 3 presents results from multivariable regression models examining associations between predictor variables and students' self-reported sadness in Grade 8. In the fully adjusted model, lower sadness in Grade 8 was predicted by gender (boys lower sadness than girls; B = −0.25, 95% CI = −0.33, −0.17), lower sadness in Grade 7 (B = 0.51, 95% CI = 0.47,0.55), improved relationships with adults at home (B = −0.17, 95% CI = −0.22, −0.12), and feeling safe from getting COVID-19 at school (B = −0.13, 95% CI = −0.18, −0.08). The Pratt Index identified three variables to be the most important in predicting students' Grade 8 sadness: gender (explaining 7% of the 37% total variance explained by the model), sadness in Grade 7 (75%), and improvements in relationships with adults at home (12%).

DISCUSSION

In this study, we sought to examine the experiences of early adolescents during the COVID-19 pandemic, and the pandemic-related factors that were associated with their well-being. Regarding our first objective, 46% of students reported feeling slightly or somewhat worried about their mental/emotional health being influenced by the pandemic in the past 2 weeks. A further 17% reported feeling very or extremely worried. In contrast, 37% of students reported feeling not at all worried about their mental health being influenced by the pandemic in the past 2 weeks. These results align with recent research in Canada that has found wide variation in 10–12 year-olds' self-reported mental health during the pandemic, with the largest proportion of respondents reporting no changes in mental health compared to before the pandemic (44–58%), and another large group (35–46%) reporting that their mental health had worsened (1). Similarly, a multi-wave study of mental health among youth ages 14–28 in Canada identified three latent profile groups that reflected their level of COVID-19-related worries (including the CRISIS measure of worries about their mental/emotional health being influenced by the pandemic). The largest group (52%) reported a moderate level of worries across the first 8 months of the pandemic; the second largest group (35%) reported a low level of worries; the smallest but still sizeable group (13%) reported a high level of worries (54).

In addition to measuring students' self-reported worries about mental health being influenced by the pandemic, we also examined changes in students' well-being and mental health from the year prior to the pandemic to nearly 1 year into the pandemic. On average, students reported significantly lower levels of optimism and life satisfaction and higher levels of sadness during the pandemic compared to the previous academic year, although the difference was small in terms of magnitude of effect sizes. This is consistent with other repeated-measures studies with adolescents 11 to 17 years-old in which participants reported increased depression, anxiety, and decreased life satisfaction during the pandemic compared to their responses before the pandemic (19, 20). It is important to note that declines in well-being commonly occur across this

age range (10) and therefore the declines in well-being in our study cannot be attributed solely to the pandemic. However, to put these findings in context, research with older adolescents (i.e., 14 to 28 year-olds) has also found declines in mental health retrospectively compared to before the pandemic, both in clinical and community samples (55). Similarly, matched comparisons between pre-pandemic and pandemic study cohorts found that 11 to 17 year-olds during the pandemic reported significantly higher levels of mental health problems and lower health-related quality of life compared to their same-age pre-pandemic controls (5). Findings from these studies support that declines in students' well-being outcomes in the current sample may have been over and above the declines commonly observed in students transitioning to grade 8.

Our second objective was to examine factors that were associated with students' mental health and resilience. A major finding of this study was that after accounting for student demographics and prior well-being levels, improvements in relationships with parents and other adults at home during the pandemic consistently emerged as one of the most important predictors of students' optimism, life satisfaction, and lower sadness. Early in the pandemic, concerns were raised about the impact of social distancing and pandemic-related stressors on adolescents' mental health and loneliness (27, 56). However, this research also suggested that spending more time together as a result of the pandemic might create opportunities for building stronger relationships within families (27, 56). Subsequent research on this topic has been mixed. For example in one study, adolescents reported no changes in family positive affect or parental warmth compared to before the pandemic (57). In another study, adolescents reported increased family conflicts and deteriorated family climate (5). As noted in these studies, family circumstances and experiences during the pandemic have varied widely (57). In the current study, 85% of students reported that their relationships with parents or adults at home had stayed the same since the pandemic or improved. Although this result is encouraging, it is important to highlight and better understand the contexts of the 15% of adolescents reporting deteriorated relationships with parents and other adults at home. Future research should closely investigate disparities in mental health and relationship impacts of the pandemic, for example through person-centered quantitative analyses and qualitative methods.

Furthermore, related to relationships with adults at home, 29% of our sample reported that spending time with family in-person and virtually had helped them deal/cope with worries and stress related to the COVID-19 pandemic. This aligns with other COVID-19 pandemic research that has identified maintaining a predictable and supportive structure at home to be an important factor in maintaining children's and adolescents' mental health in times of stress (35, 57–59). Specifically, eating meals together, creating family routines, maintaining good communication, engaging in shared activities, and creating a sense of belonging within families have been identified as resilience-building supports for children and adolescents during the pandemic (57–59).

Improvements in other relationships during the pandemic were also associated with higher well-being, although they were relatively not as important according to the Pratt Index. Specifically, relationships with teachers and other adults at school were statistically significantly associated with higher optimism and life satisfaction during the pandemic. Improved relationships with peers were also statistically significantly associated with higher optimism.

It is noteworthy that some students reported that their relationships with adults at home, at school, and with friends improved during a time when well-being generally declines. The associations between relationship improvements and higher well-being observed in this study were consistent with a stress buffering effect of positive relationships (15). These results also align with the PYD framework positing the importance of positive interactions between individuals and supportive environments (16). Feeling safe from getting COVID-19 at school was also consistently associated with higher well-being, although this variable was relatively not as important according to the Pratt Index. We also observed an effect for gender, with boys reporting higher well-being during the pandemic than girls. This finding is consistent with other research finding that girls have reported greater stress and mental health impacts of the pandemic than boys (31). Overall, the results of this study highlight the resilience-promoting role of social relationships for mental health, particularly in times of adversity or crisis.

Strengths and Limitations

This study had several strengths including the population-level sample within a large urban school district in BC. The timing of the MDI survey prior to the pandemic, and during the pandemic, furthermore provided a rare opportunity to examine longitudinal changes in early adolescents' mental health and well-being, from their own perspectives. Child self-reports are recommended for their accuracy in providing more contextualized information beyond parent measures or teacher-reported assessments that tend to rate children's behaviors more generally (5, 60–62). In this study, new items were developed and adapted specifically to capture early adolescents' lived experiences during the COVID-19 pandemic that were pilot-tested with students and stakeholders from schools and the BC Ministry of Education.

This study also has several limitations that warrant consideration. While our data captured a population sample within a large urban school district, results may not be generalizable to children living in other contexts (i.e., rural or suburban areas, regions outside of BC, Canada). Asking participants to self-assess changes in their mental health status, relationships, and time use compared to before the pandemic using single-item measures may be considered a limitation. However, it is important to note that single-item measures of self-perceived health status have shown evidence for validity as well as sensitivity to change over time in previous research studies (63). Furthermore, where possible we took efforts to directly use or adapt items from previous surveys developed by recognized authorities including the National Institutes of Mental Health (CRISIS) and the BC Centre for Disease Control (41, 49). It would be strategic for future research to examine changes in students' mental health using validated screening

measures that can be compared against previous years and other pandemic research.

Use of repeated-measures across the two data collection points was a strength of this study, however without a comparable baseline measure of changes in well-being from Grade 7 to Grade 8 we cannot be certain what proportion of the declines are due to the pandemic vs. child age. That said, comparisons with other pandemic research corroborate that adolescents have reported lower well-being this year than previous years (5, 55). We also took efforts to address this limitation by controlling for child age and Grade 7 well-being in our analyses that examined associations between Grade 8 well-being outcomes and pandemic-related changes in social interactions, activities, and stressors. Another limitation is that we could not control for all potential confounders, for example parent mental health and family socioeconomic status, which may have influenced these associations. Loss to follow up between the two time points furthermore may have introduced sampling bias. We found no demographic differences between children at Grade 7 and those in the linked sample, however our analysis did show that children in the linked sample generally reported higher connectedness to adults and peer belonging than children lost to follow up. Underrepresentation in the linked sample of children with lower adult and peer connectedness may have attenuated the observed associations in this study. Furthermore, missing data on survey items within the linked sample may have introduced information bias in either direction.

IMPLICATIONS AND CONCLUSIONS

One of the unique aspects of this study was understanding students' experiences during the COVID-19 pandemic, in the school context, from their own perspectives. Several of the findings have potential interest to educators and administrators tasked with improving school systems during and beyond the pandemic. For example, the majority of students reported that it was a little easy or very easy to follow school safety protocols, with practicing physical distancing and avoiding big groups noted as the most challenging protocols for students. In the context of the school safety protocols, 61% of students felt safe from getting COVID-19 at school most of the time or always. What students have missed at school most during the pandemic are field trips, class parties, and school sports clubs. Students also reported on what has helped them cope with worries and stress related to the pandemic. Most frequently, students reported connecting virtually with friends, exploring interests, spending time outdoors, exercising, connecting with family in-person and virtually, and connecting with friends in-person. Schools may therefore want to prioritize enabling students to socialize safely, and promote time for explored interests and outdoor activities.

With regard to predicting changes in well-being from prior to during the pandemic our results indicate that improvements in relationships with parents and other adults at home during the pandemic consistently emerged as one of the most important predictors of optimism, life satisfaction, and lower sadness, underlining the importance of supportive social relationships.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the dataset is stored on a Secure Research Environment with Population Data BC (please see https://www.popdata.bc.ca). By regulations of Population Data BC, only individuals added to our research ethics and undergoing training with Population Data BC are allowed to access the data to ensure confidentiality. Requests to access the dataset should be directed to anne.gadermann@ubc.ca.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Behavioral Research Ethics Board, University of British Columbia. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AG co-led the conceptualization of the study, directed the project administration, formal analysis, and writing. KT, MGP, MG, MW, and KS-R contributed to the conceptualization of the study, interpretation of analyses, and writing of the manuscript. RG contributed to the conceptualization of the study, conducted the statistical analyses, and contributed to the writing of the manuscript. EO co-led the conceptualization of the study and contributed to the interpretation of analyses and writing of the manuscript. 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/fpubh.2022.823303/full#supplementary-material

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BRIEF RESEARCH REPORT
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Psychometric Properties of the Stress and Anxiety to Viral Epidemics-6 Items (SAVE-6) Scale for High School Students During the COVID-19 Pandemic

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Objectives: Owing to the COVID-19 pandemic, high school students have experienced a sudden change of school environment, which may result in difficulties related to mental health. The aim of this study is to estimate the reliability and validity of the Stress and Anxiety to Viral Epidemics-6 Items (SAVE-6) scale among high school students.

Methods: A cross-sectional online survey was conducted among 300 high school students. The following scales were administered: the SAVE-6, Generalized Anxiety Disorder-7 Items (GAD-7), and Patient Health Questionnaire-9 Items (PHQ-9). Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted, and the psychometric properties of the SAVE-6 were assessed.

Results: The results of the CFA indicated good model fit for the SAVE-6 scale among high school students ($\chi 2/df = 0.485$, CFI = 1.000, TLI = 1.010, RMSEA < 0.001, and SRMR = 0.029). In addition, the SAVE-6 scale demonstrated good reliability (Cronbach's alpha = 0.844, McDonald's Omega = 0.848, and split-half reliability = 0.883). The appropriate cut-off score for the SAVE-6 scale was estimated as $\geq$15, which corresponds to a mild level of anxiety as assessed by the GAD-7 ($\geq$5).

Conclusion: The SAVE-6 scale was found to be reliable and valid, and can be used as a tool to assess the stress and anxiety of high school students during the COVID-19 pandemic.

Keywords: COVID-19, epidemics, anxiety, stress, psychological

INTRODUCTION

The novel coronavirus (COVID-19) is an infectious disease that was first reported in Wuhan, Hubei Province, China. Since the first report in December 2019, COVID-19 rapidly spread to neighboring countries, and in March 2020, the World Health Organization (WHO) declared a consequent global pandemic.

In South Korea, the COVID-19 outbreak in 2020 occurred just before the beginning of the new school year, which is typically scheduled for March 2. The Ministry of Education postponed the commencement of the new school year for 5 weeks, and recommended online self-learning materials in the interim (1). As the pandemic prolonged, official preparations were made for online schooling, which began for the first time in Korean education history on April 9 (2). When school reopened in mid-May, several changes occurred in the classrooms. The students were regularly subject to health checks for the presence of fever or respiratory symptoms; they were required to adhere to social distancing guidelines and avoid close contact with peers. In addition, schools closed and reopened irregularly, according to changes in the social distancing guidelines announced by the Korean government. When schools were closed, online classes were conducted, but challenges, such as issues regarding technology use and difficulties in communication, were reported (3).

Based on the sudden change in the school environment, high school students, who spend a longer time at school, reported difficulties related to mental health (1). Attending school irregularly results in a loss of routine as well as increased feelings of loneliness and isolation. Developmental changes render high school adolescents highly dependent on peer groups, and friends become the primary source of social interaction. The COVID-19 pandemic has forced high school students to be socially isolated, increasing the likelihood of mental health problems including anxiety and stress (4). As an attempt to be socially connected during the pandemic, high school students may seek interaction on social media. However, social media use during the pandemic has been linked to negative mental health outcomes (5). Increased social media use and attending online classes result in excessive screen time, which may increase the risk of insomnia and anxiety (6). Thus, high school students are vulnerable to stress and anxiety during the pandemic, and an efficient screening tool is needed to identify and aid this at-risk group.

The Stress and Anxiety to Viral Epidemics-6 Items (SAVE-6) was developed as a self-rating scale for measuring one's anxiety response to the COVID-19 pandemic (7). It was based on the original SAVE-9, which was developed to measure healthcare workers' work-related stress and anxiety response to the viral epidemic (8). The reliability and validity of factor I of the SAVE-9 scale (namely, SAVE-6) were tested among the general population in South Korea (7), Lebanon (9), and the United States (10), as well as among special populations such as medical students (11), public workers (12), and cancer patients (13). Thus far, all participants in such validation studies have been $\geq$18 years old. Considering that scales developed in one population should be re-evaluated when applied to another population with different characteristics (14), it is necessary to assess the psychometric properties of the SAVE-6 among high school students. In this study, we aimed to explore the reliability and validity of the SAVE-6 scale among a sample of high school students in South Korea and to examine its applicability in measuring students' anxiety response to the COVID-19 pandemic.

METHOD

Participants and Procedure

This online survey was conducted in South Korea from October 18–24, 2021. Until this period, 40,599,114 (78.4%) individuals among the general population in Korea were vaccinated at least once, 33,966,716 (65.6%) received both shots of the vaccination, and 11,022 had received the booster shot (15). All 300 high school students voluntarily participated in this survey through a professional survey company, EMBRAIN[1]. The survey was conducted anonymously, and no personal identifiable information was collected. The study protocol was approved by the Institutional Review Board of the Asan Medical Center (2021-1361), which waived the requirement to obtain written informed consent.

The survey form included questions on participants' age, sex, grade, type of school, living area, and responses to questions on COVID-19 including: "Did you experience being quarantined due to infection with COVID-19?", "Did you experience being infected with COVID-19?", "Did you get vaccinated?", and "Do you want to get vaccinated, if the vaccine is available?" Participants' past psychiatric history was assessed through the question: "Have you experienced or been treated for depression, anxiety, or insomnia?" Furthermore, current psychiatric symptoms were assessed by the question: "Presently, do you think you are depressed or anxious, or do you need help for your mood state?" The survey form was developed in Korean and followed the Checklist for Reporting Results of Internet e-Surveys (CHERRIES) guidelines (16). After the e-survey was developed by the survey company, the usability and technical functionality was tested by an author of this study (TL) before its implementation.

The sample size was determined as 300 high school students, as a sample of 200–300 participants is considered appropriate for factor analysis in the development of a scale (17, 18). Furthermore, the sample size estimation was 30 participants per cell, indicative of a subsample (19). We allocated 50 samples each to six cells: biological sex (boy and girl) and grade (1st, 2nd, or 3rd). The company sent emails to 4,000 high school student panelists for study enrollment; of these, 1,183 panelists accessed this survey, and 354 completed it. Consent was obtained from the parents who agreed that their children could participate in the survey. Following these steps, we collected 300 participants' responses, representing 0.00023% of all registered high school students (1,299,965) in South Korea (20). The collected data were delivered to investigators, after the survey company excluded all identifiable private information.

MEASURES

Stress and Anxiety to Viral Epidemics-6 Items (SAVE-6)

The SAVE-6 scale (7) was developed from factor I of the SAVE-9 scale, which was originally developed to measure

[1]www.embrain.com

healthcare workers' work-related stress and anxiety response to the viral epidemic[2]. Specifically, the SAVE-6 can measure one's anxiety response to a viral epidemic. It consists of six items rated on a five-point Likert scale ranging from 0 (never) to 4 (always). The total score of the SAVE-6, which ranges from 0 to 24, reflects the levels of anxiety response to a viral epidemic. A higher score indicates a severe degree of anxiety. In this study, we applied the original SAVE-6, which was developed in Korean, to high school students without any modification.

Generalized Anxiety Disorder-7 Items

The Generalized Anxiety Disorder-7 Items (GAD-7) is a rating scale that can measure the severity of general anxiety (21). It consists of seven items rated on a four-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The total GAD-7 score ranges from 0 to 21, and a high score indicates severe general anxiety. In this study, we defined clinical anxiety as GAD-7 $\geq$ 10. We applied the Korean version of GAD-7[3]. Cronbach's alpha for this sample was 0.922.

Patient Health Questionnaire-9 Items

The Patient Health Questionnaire-9 Items (PHQ-9) is a rating scale that can measure the severity of depression (23). It consists of nine items rated on a four-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The total PHQ-9 score ranges from 0 to 27, and a high score indicates severe depression. In this study, we defined clinical depression as a PHQ-9 score $\geq$ 10. We applied the Korean version of PHQ-9 (see footenote 3). Cronbach's alpha for this sample was 0.910.

[2]www.save-viralepidemic.net

[3]www.phqscreeners.com

STATISTICAL ANALYSIS

First, we conducted exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to explore the factor structure of the SAVE-6 scale among high school students. The normality assumption was checked based on the skewness and kurtosis (acceptable range = $\pm$ 2) (24) of all six items. In the EFA, data suitability and sampling adequacy were assessed through the Kaiser-Meyer-Olkin (KMO) value and Bartlett's test of sphericity. In the CFA, model fit was assessed through the $\chi 2/df$ ratio, comparative fit index (CFI), Tucker-Lewis index (TLI), root-mean-square-error of approximation (RMSEA), and standardized root-mean-square residual (SRMR) values (25, 26). A multi-group CFA was run to assess whether the SAVE-6 can measure the anxiety response of high school students in a similar manner across the variables of sex, grade, and depression (PHQ-9 $\geq$ 10). Next, the psychometric properties of this scale were assessed through the modern test theory approach (graded response model [GRM]). The GRM provides two types of statistics: slope parameter and threshold parameter. Before running the GRM, assumptions of unidimensionality, local dependence, and monotonicity were assessed.

TABLE 1 | Clinical characteristics of participants (*N* = 300).

Variables	Mean ± SD, N (%)
Sex (male)	150 (50.0%)
Age, years	17.0 ± 0.9
Grade	
1st grade	100 (33.3%)
2nd grade	100 (33.3%)
3rd grade	100 (33.3%)
School type	
High school, general	221 (73.7%)
Special purpose high school	22 (7.3%)
Specialized vocational high school	44 (14.7%)
Autonomous private high school	11 (3.7%)
Others	2 (0.7%)
Questions on COVID-19	
Did you experience being quarantined due to infection with COVID-19? (Yes)	68 (22.7%)
Did you experience being infected with COVID-19? (Yes)	5 (1.7%)
Did you get vaccinated? (Yes)	126 (42.0%)
(Among participants who did not get vaccinated: *N* = 174) Do you want to get vaccinated if a vaccine is available? (Yes)	112 (64.4%)
Psychiatric history	
Have you experienced or been treated for depression, anxiety, or insomnia? (Yes)	52 (17.3%)
Presently, do you think you are depressed or anxious, or do you need help for your mood state? (Yes)	38 (12.7%)
Rating scales	
Stress and Anxiety to Viral Epidemics-6 Items	14.4 ± 5.0
Generalized Anxiety Disorders-7 Items	4.5 ± 5.0
Patients Health Questionnaire-9 Items	7.9 ± 6.6

Item analysis was conducted to estimate internal consistency reliability (Cronbach's alpha, McDonald's Omega, and split-half reliability [odd-even]). In addition, the floor and ceiling effect, mean inter-item correlation, corrected item-total correlation, standard error of measurement, Ferguson's delta, IRT reliability, and Rho coefficient were calculated. Convergent validity was examined using Pearson's correlation analysis to estimate the correlation of the SAVE-6 with the GAD-7 and PHQ-9. Two-independent sample *t*-tests were performed to examine the mean differences in SAVE-6 scores between high school students with (PHQ-9 $\geq$ 10) and without depression (PHQ-9 $<$ 10), and between students with (GAD-7 $\geq$ 10) and without anxiety (GAD-7 $<$ 10). Finally, a receiver operating characteristic (ROC) analysis was conducted to determine the appropriate cut-off score of the SAVE-6 scale in accordance with a mild degree of GAD-7 ($\geq$5). Microsoft Excel 365, IBM SPSS v26, JASP v0.14.1, and Rstudio were used for statistical analysis.

RESULTS

Demographic Characteristics

Participants' demographic characteristics are presented in **Table 1**. The participants were residents of Seoul (n = 55, 18.3%), Pusan (n = 9, 3.0%), Daegu (n = 15, 5.0%), Daejeon (n = 14, 4.7%), Gwangju (n = 5, 1.7%), Incheon (n = 25, 8.3%), Ulsan (n = 8, 2.7%), Gyeonggi Province (n = 81, 27.0%), Chungcheong Province (n = 19, 6.3%), Jeolla Province (n = 16, 5.4%), Gyeongsang Province (n = 41, 13.7%), Gangwon Province (n = 8, 2.7%), and Jeju Province (n = 4, 1.3%).

Initial Exploratory Factor Analysis

The normality assumption for all six items of the SAVE-6 was checked. We observed that all items were normally distributed according to skewness and kurtosis, which were within the range of $\pm$ 2 (**Table 2**). The KMO measure (0.87) and Bartlett's test of sphericity (p $<$ 0.001) confirmed that the data were suitable for factor analysis. A single factor model of the SAVE-6 was confirmed by the results of a scree plot and EFA with oblimin rotation.

Confirmatory Factor Analysis

The CFA (estimation method = DWLS) showed a good model fit for the SAVE-6 scale among high school students (χ2/df = 0.485, CFI = 1.000, TLI = 1.010, RMSEA = 0.000, and SRMR = 0.029; **Table 3**). The factor loadings were between 0.554 and 0.794 (**Table 2** and **Figure 1**). The results of the multi-group CFA suggested scalar invariance across sex, grade, and depression (PHQ-9 $\geq$ 10) (**Supplementary Table 1**). These results indicated that the SAVE-6 scale can measure the anxiety response of high school students in a similar manner across sex, grade, or depression.

Graded Response Model Analysis

The results for the assumptions of the modern test theory showed that, for high school students, the SAVE-6 is strongly

TABLE 2 | Item properties of the SAVE-6 scale among high school students.

Items	Response scale (%)						Descriptive statistics			CITC	CID	Factor loading (95% CI)
	0	1	2	3	4	M	SD	Skewness	Kurtosis			
Item 1. Are you afraid the virus outbreak will continue indefinitely?	3.3	6.7	21.7	48.0	20.3	2.75	0.96	−0.842	0.657	0.555	0.831	0.609 (0.503, 0.716)
Item 2. Are you afraid your health will worsen because of the virus?	4.3	14.0	21.7	39.7	20.3	2.58	1.09	−0.553	-0.415	0.713	0.801	0.794 (0.684, 0.904)
Item 3. Are you worried that you might get infected?	6.7	12.0	22.7	35.7	23.0	2.56	1.16	−0.586	-0.442	0.740	0.794	0.831 (0.7118, 0.943)
Item 4. Are you more sensitive toward minor physical symptoms than usual?	8.7	18.3	27.7	33.7	11.7	2.21	1.14	−0.303	-0.703	0.604	0.822	0.659 (0.564,0.754)
Item 5. Are you worried that others might avoid you even after the infection risk has been minimized?	23.0	29.7	20.0	19.7	7.7	1.59	1.25	0.330	-0.983	0.510	0.844	0.554 (0.472, 0.636)
Item 6. Do you worry that your family or friends may become infected because of you?	4.0	8.3	22.0	40.3	25.3	2.75	1.05	−0.746	0.105	0.644	0.815	0.709 (0.601, 0.817)

0 = never, 1 = rarely, 2 = sometimes, 4 = often, 5 = always, M = mean, SD = standard deviation, CITC = corrected item-total correlation, CID = Cronbach's alpha if item deleted, CI = confidence interval.

unidimensional. An absence of local dependence was evident, as all p values (adjusted for false discovery rate) of the G^2 were non-significant. The assumption of monotonicity was also met, as the absence of significant violation values was evident. These results suggested that all the assumptions for applying a modern test theory model were met. **Supplementary Table 2** shows the slope parameters of the SAVE-6 for high school students, ranging from 1.367 to 3.373 (mean = 2.151). Items 1, 4, and 5 had a high slope parameter, and Items 2, 3, and 6 had a very high slope parameter. These high and very high slope parameters demonstrated the efficiency of items in providing reasonable information about the latent trait assessed by the SAVE-6 for high school students. The threshold parameters (**Supplementary Table 2**) suggested that Item 5 is the most difficult of all items, followed by Item 4. Item 5 had only one negative coefficient and the other three coefficients were positive. This suggested that an above average level of latent trait or theta is required to endorse Likert-type response options from "sometimes" to "always." For Items 1, 2, 3, and 6, an above average level of latent trait or theta was required to endorse the Likert-type response option "always." The scale information curve (**Supplementary Figures 1**, **2**) presented an improved understanding of the information provided by the SAVE-6 for high school students. Based on the curve, this scale contributed further details about high school students between the −1.75 and −0.15 θ levels. There were two peaks in the curve, which might be due to the polytomous nature of the data.

Reliability, Evidence Based on Relationships With Other Variables, and Cut-Off Value

The SAVE-6 scale showed good reliability (Cronbach's alpha = 0.844 and McDonald's Omega = 0.848, split-half reliability [odd-even] = 0.883). When an item was dropped, the Cronbach's alpha ranged from 0.794 to 0.844. The mean inter-item correlation (0.478) was between the recommended range (0.15–0.50). The scale also demonstrated good IRT reliability (0.851) and Rho coefficient (0.875) and had good discrimination power (Ferguson's delta = 0.978). The total SAVE-6 score was significantly correlated with the scores of the GAD-7 [r = 0.387 (95% CI, 0.287, 0.479), $p < 0.001$] and PHQ-9 [r = 0.161 (95% CI, 0.048, 0.269), $p < 0.001$]. The SAVE-6 score was significantly higher among students having depressive symptoms [PHQ-9 $\geq$ 10, $t(298) = 2.300$, $p = 0.022$] or anxiety [GAD-7 $\geq$ 10, $t(298) = 4.478$, $p < 0.001$]. In addition, the SAVE-6 score was significantly higher among girls than boys [$t(298) = 3.234$, $p < 0.001$] but did not differ significantly among students according to their vaccination status [$t(298) = 0.801$, $p = 0.424$].

The ROC analysis, conducted to determine the appropriate cut-off score for the SAVE-6, showed that a score of 15 was an appropriate cut-off point in accordance with a mild degree of anxiety assessed through the GAD-7 ($\geq$5; area under the curve [AUC] = 0.694, sensitivity = 0.71, specificity = 0.58).

DISCUSSION

In this study, we aimed to assess the psychometric properties of the SAVE-6 among high school students, who were faced with a stressful situation during the COVID-19 pandemic. The current study confirmed the reliability and validity of the SAVE-6 among high school students, similar to previous studies that evaluated its factor structure for other populations (7, 9–12). In addition, we observed that the SAVE-6 could measure anxiety responses for boys or girls, according to different grades, as well as the incidence of depression among them.

The SAVE-6 scale was derived from the SAVE-9 scale, which was developed to measure healthcare workers' work-related stress and anxiety response to a viral epidemic. The SAVE-6 was derived from factor I of the SAVE-9 scale (anxiety about the viral epidemic), which was applied to the general population during the COVID-19 pandemic. In this study, we added evidence of the applicability of the SAVE-6 scale not just for the adult population ($\geq$18 years) (7, 9–12) but also for high school students. Given the mental health difficulties that high school students are experiencing during the COVID-19 pandemic, the SAVE-6 can serve as a valid and reliable screening tool to assess the stress and anxiety symptoms of those at risk. Further research is required to verify the psychometric properties of the SAVE-6 in younger students.

The SAVE-6 score was significantly higher among high school students who were reported having depression or anxiety compared to those without depression or anxiety. This result reflects that the SAVE-6 scale can help assess high school students' anxiety response to viral epidemics efficiently. In this study, we observed that the SAVE-6 score was significantly higher among girls than boys. In previous studies, the SAVE-6 score was found to be significantly higher among females than males (7, 9, 12). This female preponderance concerning viral anxiety needs to be considered when developing viral anxiety scales.

The factor loading of Item 5 was slightly low, but acceptable. Students' adaptation to the COVID-19 pandemic might be a reason for these lower factor loadings. The survey was conducted in October 2021, when 72% of nationals in South Korea were vaccinated (15). At the time, the government also envisioned the possibility of "living with Corona," which means treating COVID-19 like the seasonal influenza, and eased the social distancing guidelines (27). In addition, in this study, only 42.0% of participants reported being vaccinated. The Korean government began the vaccination of high school students in mid-July 2021 (28), which may have influenced the results.

The cut-off score of the SAVE-6 among high school students was determined as 15 for this sample. Previously, we explored the cut-off point of the SAVE-6 scale, which was reported as 12–16, in accordance with a mild degree of generalized anxiety (GAD-7 $\geq$ 5). In studies conducted among the general population (7) and medical students (11), 15 was determined as the cut-off score, similar to this research. While the cut-off score can be influenced by cultural or group differences, we considered a score of 15 on the SAVE-6 scale as the optimal cut-off score for viral anxiety, which accords with the score for mild anxiety in the

TABLE 3 | Scale-level psychometric properties of the SAVE-6 among high school students.

Psychometric properties	Scores	Suggested cut-off
Floor effect	1.3	15%
Ceiling effect	2.7	15%
Mean inter-item correlation	0.478	Between 0.15 and 0.50
Cronbach's alpha	0.844	≥0.7
McDonald's Omega	0.848	≥0.7
Split-half reliability (odd-even)	0.883	≥0.7
Standard error of measurement	1.979	Smaller than SD (2.51)/2
Ferguson delta	0.978	≥0.9
Rho coefficient	0.875	≥0.7
IRT reliability	0.851	≥0.7
Model fit of confirmatory factor analysis		
χ^2 (df, *p* value), χ^2/df	4.368 (9, 0.886), 0.485	Non-significant, <5
CFI	1.00	>0.95
TLI	1.01	>0.95
RMSEA [90% CI value] (*p* value)	0.000 [0.000, 0.031] (0.987)	<0.08
SRMR	0.029	<0.08

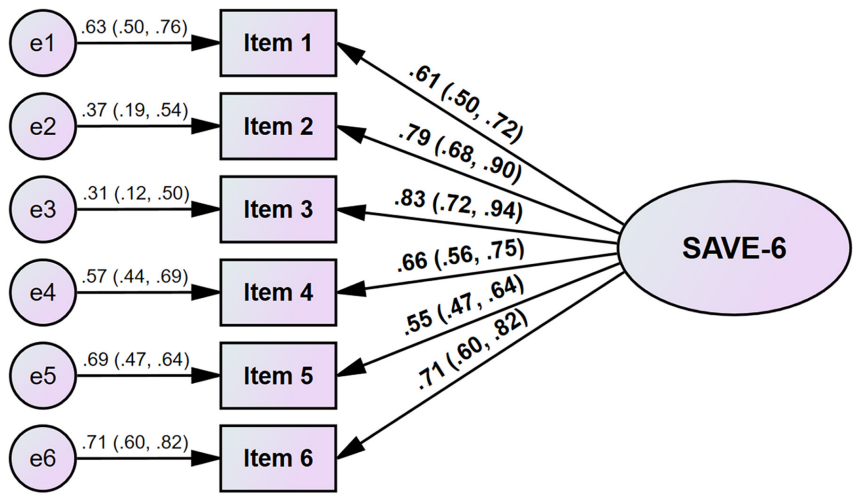

FIGURE 1 | Factor structure of the SAVE-6 among high school students.

GAD-7. The low specificity (0.58) of the 15 points on the SAVE-6 scale must be addressed, although the sensitivity (0.71) was sufficient. However, it should be noted that we tried to validate a rating scale to measure the anxiety response specific to this viral epidemic. The GAD-7, based on which we defined the cut-off score for the SAVE-6, does not assess anxiety specific to this viral epidemic. Thus, we do not have a "gold standard" for a viral anxiety measurement tool. Therefore, the cut-off score of the SAVE-6 is not suited for specificity but aims for a similar level of the SAVE-6 scale in accordance with a popularly used rating scale.

This study had several limitations. First, it was conducted via an online survey system rather than through a face-to-face, structured interview format. This may lead to bias, as the enrolled participants were registered as panelists in the survey company system. Furthermore, the anonymous online survey may have affected the reliability of responses. However, we were able to include participants from all areas of South Korea via this system without fear of spreading the virus, a risk factor in face-to-face interviews. Second, a small number of confirmed cases (n = 5, 1.7%) and a relatively high proportion of participants in this study receiving vaccination may have influenced the results. Until now, we did not report the validation results among participants who were vaccinated. In addition, 53.7% of participants in our previous study (9) reported being infected. This discrepancy may influence the differences between various studies in terms of validating the SAVE-6. Third, the status of the pandemic and educational environment such as the school or teaching system, availability of remote learning methods, or cultural differences related to education might influence students' anxiety level.

In conclusion, we observed that the SAVE-6 has good reliability and validity, and it can be applied to assess high school students' anxiety response to the COVID-19 pandemic. During

this pandemic era, we hope that the SAVE-6 scale can be applied to measure the viral anxiety of high school students who are in stressful situations and need psychological support.

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 Institutional Review Board of Asan Medical Center (2021-1361), which waived the requirement to obtain written informed consent. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

SC and ÖFA contributed to conception and design of the study. TL and SC collected the data. OA and SC performed the statistical analysis. TL, OA, SC, and ÖFA wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, 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/fpsyt.2022.815339/full#supplementary-material

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