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Community series in The Consequences of COVID-19 on the Mental Health of Students- Volume II

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Community series in the consequences of COVID-19 on the mental health of students - volume II

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ORIGINAL RESEARCH
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Psychological Distress and Access to Mental Health Services Among Undergraduate Students During the COVID-19 Lockdown in Uganda

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Background: Lockdown is an important public health approach aimed at curbing the raging effect of the coronavirus disease-2019 (COVID-19). This study aimed at determining the impact of prolonged lockdown on mental health and access to mental health services among undergraduate students in Uganda.

Methods: An online cross-sectional study was conducted anonymously among undergraduates across 10 universities in Uganda. The Distress Questionnaire-5 (DQ-5) and the Patient Health Questionnaire-2 (PHQ-2) were used. Logistic regression analysis was conducted to determine factors associated with psychological distress.

Results: We enrolled 366 participants with a mean age of 24.5 ± 4.6 years. The prevalence of psychological distress was 40.2% ($n = 147$) (cut off 14/25 based on DQ-5) while depression stood at 25.7% ($n = 94$; cut off 3/6 based on PHQ-2) with mean scores of 12.1 ± 4.6 and 1.7 ± 1.6 respectively. Female gender (aOR: 1.6, 95%CI: 1.0–2.6, $p = 0.032$), pursuing a non-medical program (aOR: 2.2, 95%CI: 1.3–3.7, $p = 0.005$) were factors associated with psychological distress while non-medical program (aOR: 2.2, 95%CI: 1.3–3.7, $p = 0.005$) was associated with increased depression. Access to mental health services was associated with both reduced distress (aOR: 0.5, 95%CI: 0.3–0.8, $p = 0.005$) and depression (aOR: 0.6, 95%CI: 0.3–0.9, $p = 0.034$). A majority (65.3%) of the participants reported knowing how to access mental health care and 188 (51.4%) reported having needed emotional support but, only 67 (18.3%) ever sought care from a mental health professional. Of those who had access, only 10 (7%), and 13 (9%) accessed a counselor or a mental health unit, respectively. The barriers to accessibility of mental health care included financial limitations (49.5%), lack of awareness (32.5%), lack of mental health professionals (28.4%), and stigma (13.9%).

Conclusion: Among university students in Uganda during the COVID- 19 lockdown, the burden of psychological distress and depression was substantial. However, access to mental health services was limited by several factors.

Keywords: psychological distress, depression, access mental health services, COVID-19, lockdown

INTRODUCTION

As of 9th October 2021, the coronavirus disease-2019 (COVID-19) has affected over 237 million people with over 4.8 million deaths worldwide. Several preventive measures as recommended by the World Health Organization (WHO) have been implemented at personal, family, community, country, and international levels (1). These measures include the lockdowns, curfews, and recently vaccination depending on the severity of the situation (1). The lockdown includes measures like home quarantine and avoiding any direct contact with any healthy or infected person, avoiding non-essential travel, observing social distancing rules like avoiding crowded public places and maintaining at least 2 m of distance between each person, closure of all learning institutions, cancellation of recreational venues, closing of public places and curfew (2, 3).

Lockdowns are short-term measures to reorganize, regroup, rebalance resources, and protect health workers who are in most cases overwhelmed by the high number of COVID-19 cases (4). However, prolonged impositions can be damaging. Lockdown is described as a hostile experience that can cause severe financial stress (5), social disorders such as social withdrawal, cyberbullying, alcohol misuse, and addiction; and mental health issues such as suicide attempts and depression (6). This is attributed to the separation from family and friends, loss of independence, lockdown length, monotonous lifestyle, lack of accurate information, and stigma (5). The enforcement of these stringent measures has significantly disrupted the lives of the student community by disorganization of their routines, leisure, examination postponement, graduation cancellations and increase in sedentary lifestyle. This exposes them to an increased risk of developing or deteriorating existing chronic health conditions such as major mental disorders.

This especially comes when the state of mental health among students is a developing area of concern. Various studies have indicated worrying data concerning the prevalence of depression and suicidal ideations among undergraduate students (7–10). Before the COVID-19 pandemic, the prevalence of depression among undergraduate students was reported at 21.5% (9). The restrictions set to curb the spread of COVID-19 including lockdowns not only deny people opportunities for social interaction, and pleasure but also put academic prospects of students in a turmoil which may collectively increase the risk of psychological distress and depression. Lockdowns also reduce the ability to seek help including mental health care services which may lead to detrimental outcomes such as severe depression, and suicidal ideations (8, 10). Therefore, this study aimed at assessing the prevalence of psychological distress and access to mental health services among undergraduate students in Uganda during the COVID-19 lockdown period.

METHODS

Study Design and Setting

An online descriptive, cross-sectional study was undertaken during the second COVID-19 lockdown between August and September 2021. The study was conducted among undergraduate students enrolled in the following universities in Uganda: *P*ublic universities (Makerere University, Mbarara University of Science and Technology, Kyambogo University, Gulu University, and Busitema University) and private universities (Kampala International University (KIU), Uganda Christian University (UCU), Islamic University in Uganda (IUIU), St. Augustine (King Caesar) International University, and Ndejje University).

Study Population

Eligible participants were undergraduate university students aged 18 years or older, able to access smartphones, and were within the social media channels namely WhatsApp Messenger and Facebook or Telegram were included in the study. The participants were excluded if they were not on any social media channels or could not access the internet. We could have performed a community-based national sampling survey, but it was not feasible due to the ongoing pandemic and lockdown measures to prevent the spread of COVID-19 by the time of data collection. Data was collected *via* an online Kobo toolbox®, which included an electronic informed consent form.

Sample Size Calculation and Sampling

The sample size was calculated using Epi Info StatCalc for infinite population surveys. With a 5% acceptable margin of error, design effect of 1.0, cluster effect of 1.0, and a power of 80%, the estimated sample size at a 95% confidence interval (95% CI) was 384 participants. To cater for non-response associated with online surveys, 10% of the estimated sample size was added leading to a final sample size of 422 participants.

Questionnaire Development

A well-researched and pre-validated questionnaire was used to collect information in three sections: sociodemographic characteristics (age, education details, tribe, ethnicity, sex, study program, year of study), the prevalence of psychological distress, and access to mental health services/ sources of mental health services.

Measurements

Psychological Distress

It was assessed using a 44-word questionnaire adapted from the Distress Questionnaire-5 (DQ-5) which is a reliable and validated tool for assessing psychological distress among the general population. It is also useful in screening for common

mental disorders in the general population. The participants indicated their level of agreement with the statements using responses, "Never" (1), "Rarely" (2), "Sometimes" (3), "Often" (4), or "Always" (5). A total score was then calculated by adding up each item score ranging from 5 to 25. Higher total scores were used to indicate greater psychological distress. Since this was a self-administered questionnaire, a cut-off of ≥14 was used to define psychological distress to increase specificity among study participants (11).

Questions adapted from the Patient Health Questionnaire-2 (PHQ-2) were also used to assess depression. The PHQ-2 is composed of two questions with four responses corresponding to scores from 0 to 3 consecutively. A PHQ-2 score ranges from 0 to 6 and the authors identified a score of 3 as the optimal cut point when using the tool to screen for depression.

The Cronbach's alpha for DQ-5 was 0.86 which is considered a good internal consistency while that PHQ-2 was 0.63.

Access to Mental Health Services

This was assessed by asking the participants to report their sources and means of access to mental health services for either mental health improvement, maintenance, or treatment.

Data Analysis and Management

Fully completed questionnaires were extracted from Kobo toolbox® and exported to a Microsoft Excel 2016 for cleaning and coding. The cleaned data was exported to STATA 16 for analysis. Numerical data were summarized as means and standard deviations or median and range as appropriate and categorical data was presented in figures and tables. Chi-square and Fischer's exact tests were used to assess the relationship between dependent and independent variables and multivariate logistic regression models were conducted after adjusting for confounders. A $p < 0.05$ was considered statistically significant.

RESULTS

Characteristics of Participants

A total of 366 participants were enrolled in this survey. More than half ($n = 232$, 63.4%) of the participants were younger than 25 years with an overall mean age of 24.5 ± 4.6 years. Majority of the participants were male ($n = 225$, 61.5%), mostly from Makerere university ($n = 119$, 32.5%), and studying medical-related programs ($n = 288$, 78.7%). Fifty-four (14.8%) participants had ever tested for COVID-19, and 266 (72.7%) had a close friend or relative that had recently tested positive for COVID-19 (**Table 1**).

TABLE 1 | Sociodemographic characteristics of participants.

Variable *N* = 366	Frequency, *n* (%)
Age, mean ± SD, years	24.5 ± 4.6
<25 years	232 (63.4)
≥25 years	134 (36.6)
Sex	
Female	141 (38.5)
Male	225 (61.5)
Religion	
Christians	335 (91.5)
Moslem	20 (5.5)
Others	11 (3.0)
Marital status	
Married	36 (9.8)
Single	330 (90.2)
Residence	
Rural	85 (23.2)
Urban	281 (76.8)
University	
Busitema University	47 (12.8)
KIU	48 (13.1)
MUST	76 (20.8)
Makerere University	119 (32.5)
Others	76 (20.8)
Study program*	
Medical	288 (78.7)
Non-medical	78 (21.3)
Personal history of COVID-19	
No	312 (85.3)
Yes	54 (14.8)
History of COVID-19 in a close friend/relative	
No	100 (27.3)
Yes	266 (72.7)
Access to mental health care services	
No access	255 (61.5)
Have access	141 (38.5)

**The study program defined a bachelor's degree a given participant was pursuing at the time of this study.*

Psychological Distress Among Participants

The prevalence of psychological distress among the participants was 40.2% ($n = 147$). The mean DQ-5 score of 12.1 ± 4.6. Sex ($p = 0.003$) and study program ($p = 0.046$) were the factors significantly associated with psychological distress among the participants (**Table 2**). Female participants had 1.6-fold higher odds of having psychological distress compared to their male counterparts (aOR: 1.6, 95% CI: 1.0–2.6, $p = 0.032$).

Depression Among Participants

The prevalence of depression was 25.7% ($n = 94$). The mean PHQ-2 score was 1.7 ± 1.6.

The study program was found to be one of the factors significantly influencing depression among undergraduate students (**Table 2**). Participants pursuing non-medical programs at their respective universities had two-fold higher odds of being depressed compared to those doing a medical program (aOR: 2.2, 95% CI: 1.3–3.7, $p = 0.005$), **Table 3.**

Access to Mental Health Care Services During COVID-19 Lockdown

The majority ($n = 239$, 65.3%) of the participants reported knowing how to access mental health care and almost half

TABLE 2 | Bivariate analysis of factors associated with depression and psychological distress during COVID-19 lockdown.

Variable	Psychological distress (DQ-5)			Depression (PHQ-2)		
	Psychologically distressed	Normal	*p*-Value	Depressed	Normal	*p*-Value
Overall	**147 (40.2)**	**219 (59.8)**		**94 (25.7)**	**272 (74.3)**	
Age						
<25 years	100 (43.1)	132 (56.9)	0.131	67 (28.9)	165 (71.1)	0.066
≥25 years	47 (35.1)	87 (64.9)		27 (20.1)	107 (79.9)	
Sex						
Female	70 (49.6)	71 (50.4)	0.003	44 (31.2)	97 (68.8)	0.056
Male	77 (34.2)	148 (65.8)		50 (22.2)	175 (77.8)	
Religion						
Christians	138 (41.2)	197 (58.8)	0.304	88 (26.3)	247 (73.7)	0.079
Moslem	7 (35)	13 (65)		4 (20)	16 (80)	
Others	2 (18.2)	9 (81.8)		2 (18.2)	9 (81.8)	
Marital status						
Married	11 (30.6)	25 (69.4)	0.216	8 (22.2)	28 (77.8)	0.617
Single	136 (41.2)	194 (58.8)		86 (26.1)	244 (73.9)	
Residence						
Rural	31 (36.5)	54 (63.5)	0.428	24 (28.2)	61 (71.8)	0.539
Urban	116 (41.3)	165 (58.7)		70 (24.9)	211 (75.1)	
University						
Busitema University	21 (44.7)	26 (55.3)	0.703	15 (31.9)	32 (68.1)	0.180
KIU	21 (43.8)	27 (56.3)		14 (29.2)	34 (70.8)	
MUST	33 (43.4)	43 (56.6)		23 (30.3)	53 (69.7)	
Makerere University	42 (35.3)	77 (64.7)		21 (17.6)	98 (82.4)	
Others	30 (39.5)	46 (60.5)		21 (27.6)	55 (72.4)	
Study program						
Medical	108 (37.5)	180 (62.5)	0.046	63 (21.9)	225 (78.1)	0.001
Non-medical	39 (50)	39 (50)		31 (39.7)	47 (60.3)	
Personal history of COVID-19						
No	127 (40.7)	185 (59.3)	0.612	81 (26)	231 (74)	0.769
Yes	20 (37)	34 (63)		13 (24.1)	41 (75.9)	
History of COVID-19 in a close friend/relative						
No	32 (32)	68 (68)	0.051	27 (27)	73 (73)	0.724
Yes	115 (43.2)	151 (56.8)		67 (25.2)	199 (74.8)	
Access to mental health care services						
No access	106 (47.1)	119 (52.9)	0.001	70 (31.1)	155 (68.9)	0.003
Have access	41 (29.1)	100 (70.9)		24 (17)	117 (83)	

($n = 188$, 51.4%) reported having needed emotional support. Only 67 (18.3%) participants had ever sought care from a mental health professional (**Figure 1**). Participants who had access to mental health care were less likely to be psychologically distressed (aOR: 0.5, 95%CI: 0.3–0.8, $p = 0.005$) or depressed (aOR: 0.6, 95%CI: 0.3–0.9, $p = 0.034$; **Table 3**).

Of the 141 participants who had access to mental healthcare services during the lockdown, only 10 (7%) accessed a counselor and 13 (9%) accessed a mental health unit (**Figure 2**).

The most common barriers to accessibility to mental health care included financial limitations ($n = 181$, 49.5%), lack of awareness of mental health ($n = 119$, 32.5%), lack of mental health professionals ($n = 104$, 28.4%), and stigma ($n = 51$, 13.9%; **Figure 3**).

DISCUSSION

In this study, we investigated the prevalence of psychological distress, depression, and access to mental health care services among undergraduate students during the COVID-19 lockdown in Uganda. Our findings suggest that almost half of the participants experienced psychological distress during the lockdown irrespective of their COVID-19 test results. Secondly, one-fourth of the participants experienced depression during the lockdown. These findings confirm the negative impact of lockdown on the mental health of undergraduate university students in Uganda.

Results from our study were only slightly higher than those reported in previous studies about depression in Uganda.

TABLE 3 | Multivariate logistic regression of the factors associated with psychological distress and depression during COVID-19 lockdown.

Variable	Psychological distress (DQ-5)		Depression (PHQ-2)	
	aOR (95% CI)	*p*-Value	aOR (95% CI)	*p*-Value
Age				
<25 years	1			
≥25 years	0.9 (0.6–1.5)	0.704	0.8 (0.45–1.4)	0.393
Sex				
Male	1.0			
Female	1.6 (1–2.5)	0.044	1.4 (0.8–2.2)	0.238
Religion				
Christian	1.0			
Moslem	0.9 (0.3–2.4)	0.813	0.8 (0.2–2.4)	0.630
Others	0.3 (0.1–1.6)	0.16	0.7 (0.1–3.6)	0.707
Study program				
Medical	1.0			
Non-medical	1.3 (0.8–2.3)	0.272	2.0 (1.1–3.4)	0.016
History of COVID-19 in a close friend/relative				
No	1.0			
Yes	1.6 (1–2.7)	0.066	0.9 (0.5–1.5)	0.671
Access to mental health care services				
No access	1		1	
Have access	0.5 (0.3–0.8)	0.005	0.6 (0.3–0.9)	0.034

However, psychological distress is rarely studied and to the best of our knowledge, this is the first study describing it among Ugandan undergraduates. A cross-sectional study to establish the prevalence and factors associated with depression among medical students at Makerere University College of Health Sciences, Uganda reported a 21.5% prevalence of depression (7). Likewise, the prevalence of depression was found to be 21% among adolescents in central Uganda but before lockdown (12). The prevalence of depression in our study though slightly higher compared to the previous studies in Uganda was not surprising given that it was conducted during the lockdown; a period considered stressful both mentally and emotionally as documented in other studies.

Internationally our results aligned with those reported in a cross-sectional web-based survey among university students in United Arab Emirates where 51% were in psychological distress (13) during the COVID- 19 pandemic as well as reported in the United Kingdom (14). On the contrary, a study in Italy among University students during the COVID-19 lockdown found only 21.4% to have experienced lockdown as a traumatic experience with 26% experiencing depressive symptoms (15).

With interest in Sub-Saharan Africa, our results are congruent with those reported from a cross-sectional study among a group of university students in Ethiopia where 53.2% of the participants were found to have mental distress, and the female students were more likely to be mentally distressed compared to male students. This was explained in terms of the susceptibility to stressors due to domestic violence and hormonal changes during menstruation as well as the structural determinants of mental health such as income and social rank/roles of women (16).

However, the difference in geographical locations and political—social living conditions as well as modes of investigation of psychological distress could explain the varying results. The different varying tools employed include the Self-Reporting Questionnaire-20 (SRQ-20) (16), Mini International Neuro-Psychiatric Interview for Children and Adolescents 2.0 (MINI-KID) (12), and Patient Health Questionnaire 9 (PHQ9) (7) whereas we used the DQ-5 and PHQ-2. This hence could account for the differences in results due to differences in sensitivity and specificity of the tools.

Besides gender, the study program was also a factor significantly influencing psychological distress among undergraduate students where participants who were doing a non-medical program at their respective universities, were twice as more likely to be depressed as those doing a medical program. There is a low-evidence working theory both nationally (17) and internationally (18) that medical students are prone to more psychological distress than their counterparts. The observed difference in this case, maybe explained by the timely opening of medical schools in Uganda during lockdown as opposed to nonmedical colleges hence giving medical students hope for continued studies and a means of productive engagement possibly reducing the risk of psychological distress as compared to their counterparts. Additionally, medical students are presumed to be oriented about early recognition of signs of psychological distress, risk factors, and measures to avoid them. In a similar study in UAE, psychological distress was found to be more associated with students with a history of mental illness, older students, students who exhibited anxiety concerning COVID-19 anxiety and fear, and those who spent more than 4 h reading about COVID-19 (13). An Italian study found the increase in length of home confinement to increase the likelihood of experiencing posttraumatic symptomatology by over three times (15).

Despite such demand, access to mental health has not been satisfactorily discussed in Uganda. A recent study described Uganda's mental health system as one with services disproportionately concentrated around the capital, with those living in the country having little access to mental healthcare. They described barriers to access to mental health as low funding as per international standards, high demand for services vs. supply, stigma, and traditional beliefs regarding causation that inhibit seeking mental health services. Among others were the high poverty rates rendering people too poor to pay for travel to clinics or the costs of medication as well as the poor living conditions at the national mental health facility (19).

Similarly, out of the 65% of the participants who reported knowing how to access mental health services and 51.4% who reported having needed emotional support, only 18.3% had ever sought care from a mental health professional. That said, among those who reported having access, only 7 and 9% were having access to a counselor and a mental health unit respectively. In line with the previous report, almost half of the participants cited financial limitations as a barrier to their access to mental health services in addition to stigma and

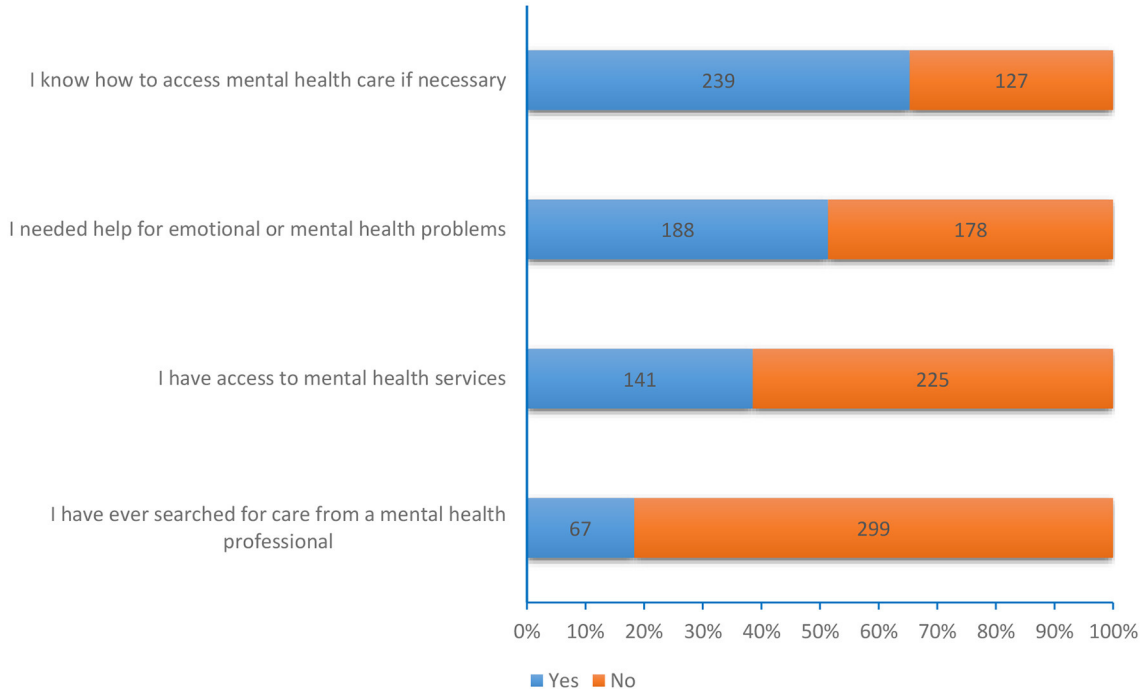

FIGURE 1 | Access to mental health services in the last 12 months of COVID-19 lockdown in Uganda.

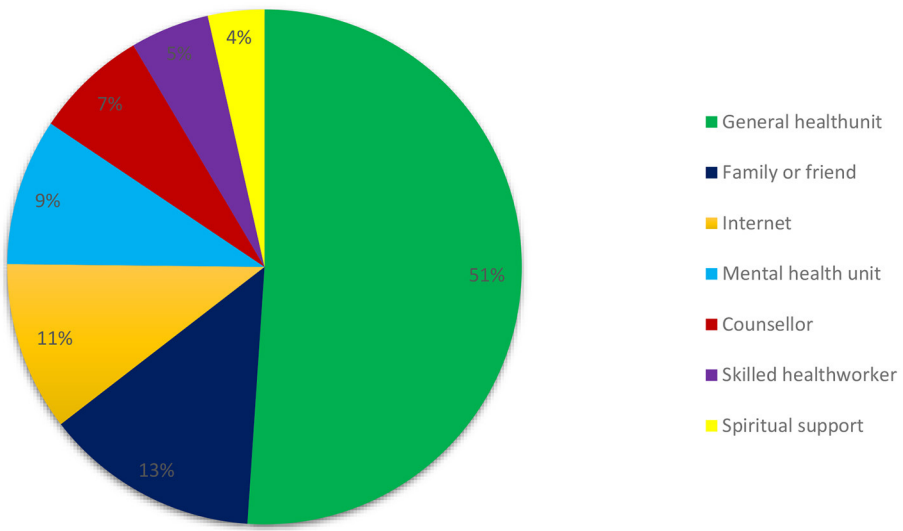

FIGURE 2 | Reference points and contact persons in case of need to access mental health care as outlined by participants.

lack of mental health awareness and professionals. Moreover, it was found in this study that having access to mental health care services may offer significant protection against psychological distress and depression. The role of accessibility to mental health services in protection against these challenges may be visualized in two ways; (1) it indirectly confirms that mental health is rather a disease than otherwise postulated which may reduce stigma among the general population, (2) early identification of mental illnesses is possible with prompt management. Therefore, more needs to be done in the development of the mental health sector in Uganda including financial input to support infrastructure development and revision of policies, especially in emergency times like this COVID-19 pandemic.

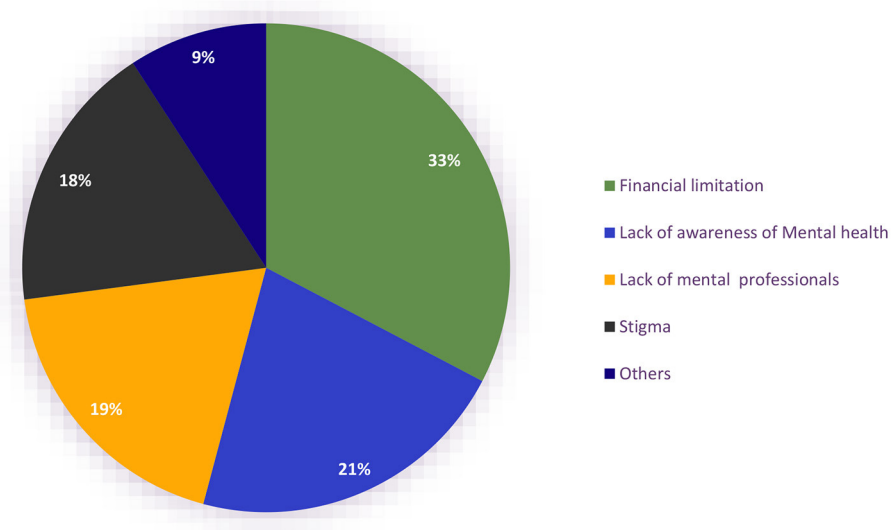

FIGURE 3 | Barriers to the accessibility of mental health services in Uganda during the COVID-19 lockdown.

Although only 14.8% of the participants had ever tested for COVID-19, the majority, (72.7%) had a close friend or relative that had tested positive in the recent past indicating the high COVID-19 disease experience. These findings are indicative of the raised prevalence of psychological distress and the several barriers to access to mental health services among university students, especially during this lockdown. These findings also highlight the gender-specific psychological distress prevalence hence bringing forth a need for investigation of gender-specific risk factors and interventions to address them.

Limitations

Several limitations should be taken into consideration as the reader interpret these findings. First, the cross-sectional design employed in our study does not allow for a causal interpretation of the results. Secondly, since the study was conducted at the time when the country was battling the second wave of COVID-19 and in total lockdown, data collection was only possible *via* online methods hence missing out on the population that did not own smartphones, those with poor connectivity to the internet or could not meet the data costs for participating in this study. This could lead to selection bias threatens the ability to generalize study findings. Third, since the questionnaire was self-administered, there was a possibility of obtaining correct answers without fully understanding the questions, recall bias and participants may have interpreted the questions differently. However, being an anonymous self-administered questionnaire could have allowed participants to answer sensitive questions with honesty without fear of being judged.

CONCLUSION

Among university students in Uganda during the COVID-19 lockdown, the burden of psychological distress and depression was substantial. However, access to mental health services was limited by several factors such as financial limitations, stigma, cultural beliefs, and a limited number of mental health care professionals.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Mulago Hospital Research and Ethics Committee. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data, took part in drafting the article or revising it critically for important intellectual content, agreed to submit it to the current journal, gave final approval to the version to be published, and agree to be accountable for all aspects of the work.

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Assessing Knowledge, Preventive Practices, and Depression Among Chinese International Students and Local Korean Students in South Korea During the COVID-19 Pandemic: An Online Cross-Sectional Study

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Depression among university students and international university students is an increasing problem globally. This study aimed to clarify the differences on the conditions and determinants of the knowledge, preventive practices and depression of the Chinese international students and local Korean students in South Korea during the COVID-19 pandemic. An online cross-sectional questionnaire including general demographic characteristics, COVID-19-related knowledge, preventive practice, and the Patient Health Questionnaire (PHQ-9) was applied from March 23 to April 22, 2020. A total of 533 university students (171 Chinese international students and 362 local South Korean students) were included in the study. The majority of both Chinese international students and local South Korean students had a good comprehension of COVID-19. Chinese international students in South Korea showed better preventive practice than local Korean students, while the proportion of moderate to severe depression of Chinese international students was relatively higher (28.07%) than that of local Korean students (22.38%). Determinants of depression of Chinese international students in South Korea were information satisfaction, likelihood of survival after infection, symptoms of a cough and feelings of discrimination, while for local Korean students were gender, educational level, family, suspected symptoms, self-assessed physical health status, COVID-19 detection, population contact history and online sources of information. These results could be used as a reference for decreasing the depressive symptoms among the university students.

Keywords: depression, preventive practices, PHQ-9, Chinese international students, South Korea, COVID-19

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INTRODUCTION

The coronavirus disease (COVID-19) first appeared in Wuhan, China, spreading nationwide between December 2019 and early 2020, and then quickly to various countries (1). On January 30, 2020, the World Health Organization (WHO) declared the SARS-CoV-2 outbreak as a public health emergency of international concern, and on March 11, in Geneva, Switzerland, WHO Director-General Desmond Tan attended a press conference wherein he stated that the outbreak should be considered a pandemic (2). Starting in February 2020, South Korea experienced a sharp increase in confirmed cases (3). As of November 8, 2021, there were 126,713 and 5,696 cumulative confirmed cases and deaths, respectively, in China and 381,694 and 2,980 cumulative confirmed cases and deaths in South Korea, and the pandemic is reoccurring and circulating at multiple points. Knowledge and preventive practice are important to restrict the spread and avoid the related mental health problems during COVID-19 (4).

The main routes of transmission are air, droplets, aerosols, and, to a lesser extent, urine and feces (5). The study of knowledge, attitudes, and perceptions of COVID-19 in sub-Saharan Africa noted that, although most participants had adequate knowledge, attitudes were not always positive (6). The effect of control measures on COVID-19 transmission in South Korea confirms the importance of maintaining social distance and emphasizing personal hygiene, such as wearing masks, washing hands, and avoiding gatherings (7). Numerous studies showed that this pandemic leads to additional mental health problems, including anxiety, depression, insomnia, suicide, and self-injury (8–10).

Higher education levels were associated with possible depression and a higher frequency of mask wearing (11). Following preventive health behaviors may be safer for people and their health, It is also associated with lower depression, anxiety, and stress (12). Higher levels of psychological distress were associated with higher levels of fear. Moreover, if higher levels of psychological problems were demonstrated by those who identified as patients and individuals in isolation, then resilience played a key role in overcoming the psychological impact (13). A Malaysian study noted that introducing adequate, easy-to-follow precautions and standard operating procedures by university healthcare workers was associated with a reduction in their depression, anxiety, and stress (14). The use of online psychotherapy and the promotion of online social platforms to maintain social communication and relationships were significantly associated with increased physical, psychological, and social quality of life (QoL) and decreased depressive and anxiety symptoms as well as depression with anxiety symptoms during the COVID-19 (15).

During COVID-19 pandemic, a significant increase in psychological distress, fear, allostatic load, fatigue, loneliness, and worry was observed across different populations (16–18). During an outbreak, children are restricted to their homes without outdoor activities or interaction with friends. Hence, the negative impact on mental health can be more severe (19). COVID-19 led to significantly higher unemployment and suicide rates, and insecurity and uncertainty about the future deteriorated the psychological condition of migrant workers (20). There is a higher prevalence of anxiety, burnout, depression, and psychological distress among healthcare workers (21). COVID-19 infection negatively affects the psychological state of soccer players, with higher scores for depression, stress, and psychological distress among soccer players with higher income loss (22).

Although some studies explored the psychological adverse effects of COVID-19, the investigation of depression symptoms during the COVID-19 pandemic among the Chinese and Korean students had received little attention. According to the Korea Education Development Agency, among the total number of international students in South Korea, 67,030 were Chinese in 2020, accounting for 43.6% (23). The university students in South Korea, who are socially vulnerable, are more prone to depression during the COVID-19 pandemic (24). Although there is no nationwide lockdown in South Korea, strict control measures are implemented in public places, educational institutions, churches, and university campuses, where isolation and disconnection from society are a greater burden for young college students (25).

Concerning the international students in South Korea, a study of psychological problems in Korea showed that the prevalence of anxiety and depression among them was 39.6 and 49%, respectively (9). The dire situation during COVID-19 exacerbated the difficult situation for Chinese international students studying in South Korea. They faced isolation and discrimination because China was the first country to experience a pandemic. They were unable to return home and faced many problems such as online classes, difficulty in buying masks, and psychological issues on foreign campuses (26). Higher severity of depression may lower university students' QoL (27). This aggravates their depressive condition.

Although living in the same country, the international students and local students may face different situations and confront different mental health problems during the pandemic (28). However, to date, no study has examined the difference between the Chinese international students' and local Korean students' knowledge, preventive practice, and depression in South Korea during the pandemic. Thus, this study aimed to investigate the differences between knowledge, preventive practice, and depression among Chinese international students and local Korean students in South Korea, and identify the determinants of depression among them to provide policy references on preventive measures.

MATERIALS AND METHODS

Data and Sample

Sampling Method

An online cross-sectional survey was used to collect data through an anonymous questionnaire in South Korea (during the COVID-19 pandemic). A total of 570 questionnaires were collected by snowball sampling, including many universities in South Korea. From March 23 to April 8, 2020, 180 responses from Chinese students and from March 23 to April 22, 2020, 390 responses from South Korean students were collected. Since

the subjects were university students, 37 students who positively answered the employment question were excluded, leaving 533 students (171 Chinese international students and 362 South Korean students in South Korea). All respondents expressed their willingness to participate and claimed to understand the research background and purpose.

Data Collection Procedure

First, the English version of the COVID-19 questionnaire used by Wang et al. (29) and colleagues was adopted. Second, the required sample size was calculated using the G*Power 3.19 program. Based on the parameters of a two-sided test and χ^2 test, a residual variance of 0.83, α probability = 0.05, and power = 0.95 for F tests and linear multiple regression analysis, the minimum total sample size was estimated to be 356.

With limited access to respondents due to social distancing policies in South Korea during the COVID-19 pandemic, an online cross-sectional survey was conducted. Before conducting the survey, the content of the questionnaire was verified through an online pre-survey of 15–30 students, to ensure that the questions were understandable, and the statements were appropriate. Researchers examined the questionnaires' reliability and the simplicity of the responses. Potential respondents were sent a specific link to participate. In total, with the help of collaborators and native Korean speakers, the questionnaire was placed on the Naver Form Tool survey platform in South Korea.

Measurements

The questionnaire included two sections: (1) a questionnaire on COVID-19 and (2) the Patient Health Questionnaire-9 (PHQ-9). The first section comprised questions that covered (1) demographics and physical health data, (2) knowledge of COVID-19, and (3) preventive practices in the past 14 days.

Description of the Variables

General Demographics

In this study, to reflect on the participants' demographic characteristics, the basic survey asked respondents about their gender, age, education level, marital status, family size, health insurance, chronic diseases, traveling status in the past 14 days, isolation, COVID-19 symptoms, and their self-assessed physical condition. The choices for education level were undergraduate and graduate and for marital status were single and married. Family size was divided into one person, two people, three to five people, and six or more people. Questions about medical insurance, chronic disease, traveling, self-quarantine, and symptoms were answered with yes or no. Regarding self-assessed physical condition, respondents were asked to choose from four levels: poor, fair, good, or very good.

Knowledge of COVID-19

Assessed knowledge of COVID-19 included transmission route, attention to updated information, information sources, concern for COVID-19, satisfaction with the information, confidence in diagnosis, infection probability, probability of survival after infection, concern for family members, feelings of being discriminated against, purchase face masks, and additional information about COVID-19.

Preventive Practices of COVID-19

The questionnaire included nine basic preventive practices. The responses to these questions corresponded to the degree to which a measure was practiced daily (1 = never do this and 5 = do this every day). The total score indicates the extent to which preventive practices were performed. The reliability (Cronbach's α) of the preventive practices of the COVID-19 scale in this study was 0.71 and the validity was 0.76.

Patient Health Questionnaire-9

Depressive symptoms were diagnosed according to the nine criteria for depression in the Diagnostic and Statistical Manual of Mental Disorders (DSM) published by the American Psychiatric Association (30). The options for each question in the PHQ-9 were (corresponding to the relative scores): not at all (0 points), occasionally (1 point), frequently (2 points), and almost every day (3 points). Respondents were divided into five groups according to their total score (31) (0–4, 5–9, 10–14, 15–19, and 20–27), corresponding to no depression, mild, moderate, moderately severe, and severe depression (32). The higher the score, the more severe the depression (33). The reliability of the PHQ-9 was 0.89, and its validity was 0.90 (34).

Statistical Analysis

In this study, SPSS 24.0 (IBM Corp., Armonk, NY, US) was used to conduct the statistical analysis, and *p*-values <0.05 were regarded as statistically significant. First, descriptive statistics, *t*-test, and chi-squared test were performed to compare each variable between the Chinese international and local students in South Korea. Second, stepwise linear regression was used to explore the determinants of depression among two student groups.

RESULTS

General Characteristics

As shown in **Table 1**, there were significant differences between the two groups, regarding gender, age, educational level, marital status, family size, health insurance, self-quarantine, symptoms, and self-assessed physical condition. Among them, the female respondents were far higher than the male respondents, specifically, among the Chinese international students. The average age of Chinese international students was 24.02 ± 4.14 years, while that of local South Korean students was 22.13 ± 3.11 years. Moreover, the proportion of graduate students, married respondents, families with two people, and medical insurance of Chinese international students was higher. In contrast, most Chinese international students in South Korea (83.04%) have experienced self-isolation, while more than 90% of local respondents stated that they have not. Chinese international students showed better physical condition and fewer suspected symptoms (10.53%) than local students (32.32%).

TABLE 1 | Demographics characteristics of the respondents.

Variables	Chinese international students in South Korea ($n = 171$) *N* (%)	Local South Korean students ($n = 362$) *N* (%)	Total ($n = 533$) *N* (%)	t/χ^2	*P*
Age					
Mean ± S.D	24.02 ± 4.14	22.13 ± 3.11	22.74 ± 3.58	2.075[a]	0.040
Gender					
Male	57 (33.33)	154 (42.54)	211 (39.59)	4.118[b]	0.042
Female	114 (66.67)	208 (57.46)	322 (60.41)		
Educational level					
Undergraduate	98 (57.31)	334 (92.27)	432 (81.05)	92.396[b]	<0.001
Graduate	73 (42.69)	28 (7.73)	101 (18.95)		
Marital status					
Single	159 (92.98)	358 (98.90)	517 (97.00)	13.944[b]	<0.001
Married	12 (7.02)	4 (1.10)	16 (3.00)		
Family size					
1 member	9 (5.26)	38 (10.50)	47 (8.82)	17.286[b]	0.001
2 members	24 (14.04)	17 (4.70)	41 (7.69)		
3–5 members	134 (78.36)	295 (81.49)	429 (80.49)		
6 members or more	4 (2.34)	12 (3.31)	16 (3.00)		
Medical insurance					
No	28 (16.37)	128 (35.36)	156 (29.27)	20.220[b]	<0.001
Yes	143 (83.63)	234 (64.64)	377 (70.73)		
Chronic diseases					
No	159 (92.98)	327 (90.33)	486 (91.18)	1.015[b]	0.314
Yes	12 (7.02)	35 (9.67)	47 (8.82)		
Traveled abroad					
No	166 (97.08)	359 (99.17)	525 (98.50)	2.177[b]	0.140
Yes	5 (2.92)	3 (0.83)	8 (1.50)		
Self-quarantine					
No	29 (16.96)	328 (90.61)	357 (66.98)	284.827[b]	<0.001
Yes	142 (83.04)	34 (9.39)	176 (33.02)		
Several symptoms					
No	153 (89.47)	245 (67.68)	398 (74.67)	29.167[b]	<0.001
Yes	18 (10.53)	117 (32.32)	135 (25.33)		
Specific symptoms					
Fever (yes)	3	5	8	1.425[b]	0.233
Chills (yes)	4	9	13	4.324[b]	0.038
Headache (yes)	5	58	63	19.117[b]	<0.001
Muscle pain (yes)	5	29	34	12.058[b]	0.001
Cough (yes)	4	35	39	9.200[b]	0.002
Dyspnea (yes)	8	20	28	3.948[b]	0.045
Dizziness (yes)	2	22	24	10.840[b]	0.001
Nasal cold (yes)	7	38	45	6.161[b]	0.013
Laryngitis (yes)	9	22	31	0.141[b]	0.708
Nausea (yes)	3	19	24	9.307[b]	0.002
Self-assessed physical condition					
Poor	1 (0.58)	7 (1.93)	8 (1.50)	20.712[b]	<0.001
Fair	17 (9.94)	92 (25.41)	109 (20.45)		
Good	85 (49.71)	154 (42.54)	239 (44.84)		
Very good	68 (39.77)	109 (30.11)	177 (33.21)		
COVID−19 detection					
Yes	11 (6.4)	7 (1.9)	18 (3.4)	7.204[b]	0.007
No	160 (93.6)	355 (98.1)	515 (96.6)		
Patient contact history					
Yes	2 (6.4)	8 (6.4)	10 (6.4)		
No	12 (6.4)	52 (6.4)	64 (6.4)	6.840[b]	0.030
Not clear	157 (6.4)	302 (6.4)	459 (6.4)		

[a] *t-test*, [b] χ^2.

TABLE 2 | Differences in knowledge of COVID-19.

Variables	Chinese international students in South Korea ($n = 171$) *N* (%)	Local South Korean students ($n = 362$) *N* (%)	Total ($n = 533$) *N* (%)	χ^2	*P*
Route of transmission					
Droplets (agree)	171 (100)	352 (97.24)	523 (98.12)	4.814	0.090
Objects (agree)	145 (84.80)	277 (76.52)	422 (79.17)	5.144	0.076
Air (agree)	116 (67.84)	155 (42.82)	271 (50.84)	29.455	<0.001
Updated information					
Infections (yes)	168 (98.25)	352 (97.24)	520 (97.56)	0.163	0.687
Deaths (yes)	169 (98.83)	345 (95.30)	514 (96.44)	4.202	0.040
Recoveries (yes)	163 (95.32)	323 (89.23)	486 (91.18)	5.366	0.021
Information sources					
Internet (yes)	169 (98.83)	338 (93.37)	507 (95.12)	7.462	0.006
TV (yes)	72 (42.11)	205 (56.63)	277 (51.97)	9.816	0.002
Radio (yes)	11 (6.43)	7 (1.93)	18 (3.38)	7.204	0.007
Newspaper (yes)	14 (8.19)	14 (3.87)	28 (5.25)	4.354	0.037
Family (yes)	54 (31.58)	86 (23.76)	140 (26.27)	3.669	0.055
Other (yes)	7 (4.09)	13 (3.59)	20 (3.75)	0.081	0.776
Concern about the disease					
Never	3 (1.75)	14 (3.87)	17 (3.19)	43.576	<0.001
Rarely	8 (4.68)	40 (11.05)	48 (9.01)		
Sometimes	35 (20.47)	110 (30.39)	145 (27.20)		
Often	48 (28.07)	131 (36.19)	179 (33.58)		
Everyday	77 (45.03)	67 (18.51)	144 (27.02)		
Satisfaction with the information					
Very dissatisfied	2 (1.17)	3 (0.83)	5 (0.94)	65.337	<0.001
Dissatisfied	12 (7.02)	110 (30.39)	121 (22.70)		
Satisfied	115 (67.25)	228 (62.98)	343 (64.35)		
Very satisfied	42 (24.56)	21 (5.80)	63 (11.82)		
Confidence about being diagnosed					
Do not believe	7 (4.09)	4 (1.10)	11 (2.06)	63.354	<0.001
Hard to believe	42 (24.56)	15 (4.14)	57 (10.69)		
To some extent	71 (41.52)	252 (69.61)	323 (60.60)		
Very believe	30 (17.54)	58 (16.02)	88 (16.51)		
Not clear	21 (12.28)	33 (9.12)	54 (10.13)		
Infection probability					
Very low	17 (9.94)	108 (29.83)	125 (23.45)	36.683	<0.001
Low	79 (46.20)	95 (26.24)	174 (32.65)		
High	58 (33.92)	114 (31.49)	172 (32.27)		
Very high	1 (0.58)	5 (1.38)	6 (1.13)		
Not clear	16 (9.36)	40 (11.05)	56 (10.51)		
The likelihood of survival after infection					
Very low	2 (1.17)	12 (3.31)	14 (2.63)	9.132	0.054
Low	2 (1.17)	9 (2.49)	11 (2.06)		
High	72 (42.11)	146 (40.33)	218 (40.90)		
Very high	85 (49.71)	151 (41.71)	236 (44.28)		
Not clear	10 (5.85)	44 (12.15)	54 (10.13)		
Concern about family members					
Not at all	27 (15.79)	16 (4.42)	43 (8.07)	28.536	<0.001
Little	71 (41.52)	191 (52.76)	262 (49.16)		
Very worried	68 (39.77)	123 (33.98)	191 (35.83)		
Not clear	5 (2.92)	32 (8.84)	37 (6.94)		

(Continued)

TABLE 2 | Continued

Variables	Chinese international students in South Korea ($n = 171$) *N* (%)	Local South Korean students ($n = 362$) *N* (%)	Total ($n = 533$) *N* (%)	χ^2	*P*
Whether they feel their country is discriminated against					
Yes	65 (38.01)	156 (43.09)	221 (41.46)	25.932	<0.001
No	87 (50.88)	111 (30.66)	198 (37.15)		
Not clear	19 (11.11)	95 (26.24)	114 (21.39)		
Whether purchased face masks					
Yes	26 (15.20)	253 (69.89)	279 (52.35)	139.228	<0.001
No	145 (84.80)	109 (30.11)	254 (47.65)		
For additional information on COVID-19					
Yes	160 (93.57)	206 (56.91)	366 (68.67)	72.552	<0.001
No	11 (6.43)	156 (43.09)	167 (31.33)		

Knowledge of COVID-19

Table 2 shows the participants' knowledge of COVID-19, with about 98.12% knowing that the virus can be transmitted by droplets, 79.17% agreeing that transmission is possible through objects touched by the infected person, and only half (50.84%) agreeing that it can be transmitted through the air. Most students in both groups (more than 90%) were interested in the latest information on infections, cures, and deaths. Their main sources of information are the Internet, TV, and family, and they rarely get information from other channels.

Chinese international students showed high levels of concern about COVID-19, with 45% worrying about it daily. Among the local South Korean students, 30% were dissatisfied with the information currently provided, compared to <10% of Chinese international students. Some showed a degree of confidence about getting infected (41.52% for Chinese international and 69.61% for local students) and 30% of respondents in each group said they were very likely to be infected, but most also thought they had a good chance of survival. Some from the two groups were significantly worried about their families (39.77% for Chinese international and 33.98% for local students). Nearly half of the Chinese international students surveyed felt there was no discrimination regarding their country, compared to 30% of local South Korean students. As many as 85% of Chinese international students stated that they could not buy masks for reasons such as the lack of South Korea's national health insurance and the shortage. A small number of local students (30.11%) were unable to buy masks due to long queues and lack of availability.

Differences in the Type of Information They Want to Obtain

Figure 1 shows the types of information that Chinese international students and local students wanted to obtain. The former were eager to access more information. More than half of the Chinese international students wanted to know specific details of symptoms, advice on prevention, up-to-date information, the number of people and places diagnosed, and the school's prevention code. The top five types of information in demand among local Korean students were up-to-date information, specific details of symptoms, availability, and effectiveness of vaccines/drugs, number of people and places infected, and prevention advice.

Differences in Preventive Practices Between the Two Groups

Table 3 shows the preventive practices of Chinese international students and local Korean students in South Korea. The average total score of the Chinese international students (38.67%) was slightly higher than that of local Korean students (33.80%). There were statistically significant differences regarding the eight preventive behaviors between the two groups. This included when coughing and sneezing, wearing masks regardless of the presence or absence of symptoms, washing hands immediately after coughing, rubbing the nose, sneezing, washing hands after touching contaminated objects, avoiding public transportation, avoiding elevators, sitting in one row while having a meal, and avoiding meeting more than 10 people.

Results and Analysis of Depressive Conditions

A chi-square test was used to determine the difference in the level of depressive symptoms between Chinese international students and local Korean students (**Table 4**). In this study, depressive symptoms were classified as 0–4 (no depression), 5–9 (mild depression), 10–14 (moderate depression), 15–19 (moderate to severe depression), and 20–27 (severe depression). As shown in **Table 4**, the differences between the two groups were statistically significant ($\chi^2 = 11.224$, $p < 0.05$), and Chinese international students were slightly more depressed.

Linear stepwise regression was used to explore the factors affecting the depressive status of the Chinese international students (**Table 5**) and the local South Korean students (**Table 6**), separately. *P*-values <0.05 were regarded as statistically significant. All variables that were statistically significant in **Tables 1**–**3** were all included in **Tables 5**, **6**. These included age, gender, education, marital status, family size, health insurance, self-isolation, general symptoms and specific symptoms, self-assessed physical health status, means

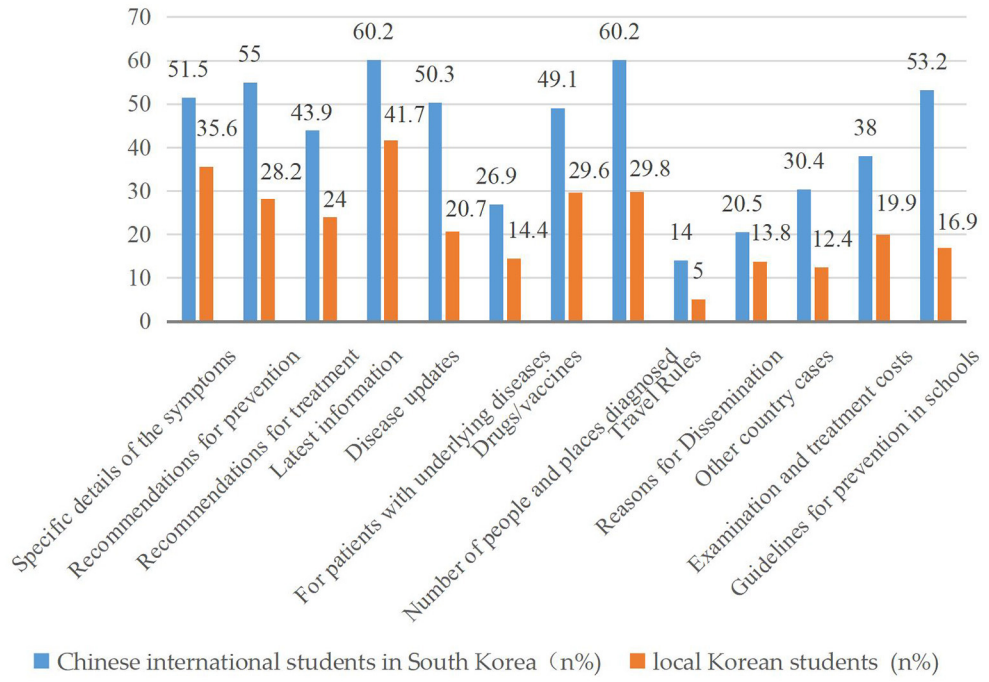

FIGURE 1 | Type of information expected between Chinese international students and local Korean students in South Korea.

of transmission, updated information, information sources (Internet, TV, radio, newspapers, family), level of satisfaction with information, COVID-19 testing, patient contact history, confidence in confirmed diagnosis, probability of infection and surviving infection, level of concern about family members, discrimination, mask purchase, additional information, and eight preventive measures. The results in **Table 5** showed that among Chinese international students, perceived discrimination in their country, probability of survival after infection, cough symptoms, and satisfaction with information were statistically significantly related to respondents' depression. Regarding the local South Korean students, the results in **Table 6** illustrated that gender, education level, family size, self-assessed physical health status, symptoms of nausea and dyspnea, nucleic acid testing, history of patient exposure, and receipt of outbreak-related information from family members and the Internet were statistically significantly related to respondents' depression.

DISCUSSION

Principal Findings and Comparison With Other Studies

This study used univariate and multiple linear regression analyses to clarify the relationship between knowledge, preventive practices, and depression among Chinese international students and local Korean students in South Korea. The results revealed that the determinants of depression affecting the two groups were different. Targeted measures should be taken to reduce depression.

Demographic Characteristics of Chinese International Students and Local South Korean Students

Most international students in the sample reported having insurance, However, it was international student insurance rather than South Korean national health insurance. This resulted in Chinese international students in South Korea being unable to buy masks at the beginning of the outbreak due to the restrictions of the national health insurance (35). Most of them in the sample were self-isolated, while the vast majority of local South Korean students did not experience self-isolation. This is because South Korea is a narrow and densely populated country, and the government did not take measures (36) for widespread self-isolation of the population in the early stages of the COVID-19 pandemic but only isolated and treated confirmed patients. The self-assessed physical health of the local South Korean students in the sample was less favorable overall, consistent with the findings of Sun Jung Kim's study (37), which found that Chinese students in South Korea had a high level of self-assessed health and cultural adaptation.

Knowledge and Preventive Practice of Chinese International Students and Local South Korean Students

In this study, both student groups were concerned about COVID-19 and showed a good level of knowledge, which is consistent with the results of other studies (38, 39). The Internet is the main information source, and they are satisfied with the information currently provided. This is because the central and local public

TABLE 3 | Preventive practices taken against COVID-19 (Mean ± S.D).

Variables	Chinese international students in South Korea (n = 171)		Local South Korean students (n = 362)		Total (n = 533)		t
	Mean ± S.D.	95% Conf. interval	Mean ± S.D.	95% Conf. interval	Mean ± S.D.	95% Conf. interval	
1.Covering mouth when coughing and sneezing	4.67 ± 0.80	4.55–4.79	4.46 ± 0.93	4.36–4.55	4.53 ± 0.89	4.45–4.60	2.63**
2. Wearing mask regardless of the presence or absence of symptoms	4.32 ± 0.80	4.20–4.44	3.16 ± 1.46	3.01–3.31	3.53 ± 1.39	3.42–3.65	9.73***
3. Washing hands with soap and water	4.84 ± 0.44	4.78–4.91	4.75 ± 0.60	4.69–4.82	4.78 ± 0.55	4.74–4.83	1.72
4. Washing hands immediately after coughing, rubbing nose, or sneezing	4.18 ± 1.05	4.02–4.33	3.62 ± 1.20	3.50–3.75	3.80 ± 1.18	3.70–3.90	5.14***
5. Washing hands after touching contaminated objects	4.93 ± 0.39	4.87–4.99	4.72 ± 0.67	4.65–4.78	4.78 ± 0.60	4.73–4.84	3.89***
6. Avoiding public transportation	4.74 ± 0.67	4.64–4.84	4.40 ± 0.96	4.30–4.50	4.51 ± 0.89	4.43–4.59	4.11***
7. Avoiding elevators	3.44 ± 1.40	3.23–3.66	2.33 ± 1.49	2.17–2.48	2.69 ± 1.55	2.55–2.82	8.41***
8. Sitting in one row while having a meal	2.80 ± 1.70	2.55–3.06	2.11 ± 1.41	1.97–2.26	2.33 ± 1.54	2.20–2.46	4.95***
9. Avoiding meeting more than 10 people	4.74 ± 0.89	4.61–4.88	4.25 ± 1.20	4.12–4.37	4.41 ± 1.13	4.31–4.50	4.83***
Total score	38.67 ± 4.62	37.9–39.3	33.80 ± 5.32	33.2–34.3	35.36 ± 5.59	34.8–35.8	10.258*

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

TABLE 4 | Difference in depressive symptoms between the Chinese international students and local Korean students.

PHQ-9	Chinese international students in South Korea (n = 171) N (%)	Local South Korean students (n = 362) N (%)	Total (n = 533) N (%)	t/χ^2
Total score[a]	7.19 ± 5.34	5.99 ± 5.46	6.38 ± 5.45	$t = 2.38$*
0–4 (non-depressed)	60 (35.09)	182 (50.28)	242 (45.40)	$\chi^2 = 11.224$*
5–9 (Mild)	63 (36.84)	99 (27.35)	162 (30.39)	
10–14 (Moderate)	31 (18.13)	50 (13.81)	81 (15.20)	
15–19 (Moderately severe)	11 (6.43)	22 (6.08)	33 (6.19)	
20–27 (Severe)	6 (3.51)	9 (2.49)	15 (2.81)	

[a]*The total score of the PHQ-9 is mean ± SD.*
*$p < 0.05$.

health authorities in South Korea provide daily updates of all laboratory-confirmed COVID-19 cases on their web pages including information on the number of national and local cases, age, sex, symptoms, date of onset of symptoms, source, date of exposure, and location of the infection (within or outside Korea) (40). Chinese international students generally perceive themselves as having a low probability of being infected, which is also linked to the widespread self-isolation of international students (4). The local students believe that the higher probability of infection is related to the surge in the number of infections in Korea at the beginning of the pandemic (41). Chinese students have significantly better preventive practice behaviors, specifically, Chinese international students are particularly better at wearing masks and washing their hands, which also suggests that they were more afraid of being infected and more vulnerable to the effects of the pandemic (42).

Differences in Depression Between Chinese International Students and Local South Korean Students

Depression rates were fairly high for both student groups, since the Chinese international students in South Korea have a

TABLE 5 | Stepwise regression analysis of the factors of depression due to COVID-19 among Chinese international students in South Korea.

Dependent variable	Independent variables	β	S.E.	β'	*t*	*P*
PHQ-9 scores	Constant	20.231	2.903		6.970	0.000
	Discrimination psychological	−1.234	0.406	−0.217	−3.037	0.003
	The likelihood of survival after infection	−1.377	0.506	−0.194	−2.721	0.007
	Symptoms of a cough	7.468	2.504	0.212	2.983	0.003
	Satisfaction With the information	−1.121	0.481	−0.167	−2.328	0.021

S.E., Standardized Error.

TABLE 6 | Stepwise regression analysis of the factors of depression due to COVID-19 among local South Korean students.

Dependent variable	Independent variables	β	S.E.	β'	*t*	*P*
PHQ-9 scores	Constant	19.749	3.007		6.568	0.000
	Gender	1.168	0.533	0.106	2.189	0.029
	Educational Level	−3.264	1.052	−0.160	−3.101	0.002
	Family size	−0.906	0.418	−0.111	−2.165	0.031
	Self-assessed physical condition	−1.649	0.339	−0.240	−4.866	0.000
	Symptoms of nausea	2.454	1.231	0.100	1.994	0.047
	Symptoms of dyspnea	8.454	3.575	0.115	2.365	0.019
	COVID-−19 detection	5.556	1.911	0.140	2.908	0.004
	Patient contact history	−1.227	0.586	−0.100	−2.095	0.037
	Get information from family	1.239	0.621	0.097	1.994	0.047
	Get information on the internet	−4.197	1.875	−0.106	−2.238	0.026

S.E., Standardized Error.

higher rate (18.13%) of moderate depression than local students (13.81%), and a slightly higher rate (3.51%) of severe depression than local students (2.49%). This result is consistent with many local South Korean studies. Jimhee's survey showed that the prevalence of depression among the general population of Korea at the beginning of the pandemic was 19%(43), Lee's study on adolescents in Daegu, South Korea, during the COVID-19 pandemic showed that 19.8% and 12.3% of students experienced depression and anxiety, respectively (44), Hoo's study of adults aged 20 to 49 in Chungnam Province, South Korea, during the COVID-19 pandemic found that 18.8% of participants had symptoms of depression (45). In Kim's study of 180 nurses during the pandemic, 30.6% had moderate or higher levels of depression (46). Kim and Lee's study found that depression's prevalence diagnosed in South Korea in 2016 was 3%, with a slightly higher prevalence among males (3.1%) than females (2.9%) among those aged 18–29 years (47), indicating the pandemic may increase the prevalence of the depression.

Satisfaction with information was associated with depression among Chinese international students in South Korea in this sample. Specifically, students who showed higher satisfaction were less likely to be depressed. This also confirmed the importance of the provision of accurate and truthful information by the government during a pandemic. Kim's research during the Korean pandemic indicated that useful information related to COVID-19 could help prevent infection as well as promote anxiety and fear, leading to negative behavior (47). Another factor that influenced depression among the Chinese international students in the sample was the likelihood of survival after infection. This is clear proof that international students are significantly worried about the pandemic (38). The feeling of being discriminated against was a predictor of depression among Chinese international students. This was consistent with the findings of a study by Li on Chinese and American students, who noted that the former live in fear of discrimination in the US, which significantly affected their emotions and self-esteem (48). Therefore, greater attention should be paid to international students' mental health to help them build self-esteem and self-confidence.

For the local South Korean students in the sample, gender and education level were predictors of depression. This was consistent with the findings of Won, who found higher rates of depression among women in a South Korean community survey (49). Self-assessed physical health status was associated with depression among local South Korean students. The result was similar to the findings of an online survey on 400 South Korean people conducted by Hye during the pandemic from March to June 2020, which found a statistically significant association between mental and physical health (25). Another noteworthy factor affecting depression among local South Korean students was the information source, mainly the Internet. South Korea had done a good job of disclosing all information about COVID-19 to the public openly and transparently, holding detailed press conferences twice a day since the first COVID-19 case was diagnosed, and full disclosure promotes public trust and support for the government (50). Alwin noted that the South

Korean government's transparency in sharing information about the main features of the outbreak and the standard procedures to be followed helped to combat the spread of rumors related to the outbreak (51). Information from families and family size could influence depression among local South Korean students, indicating the importance in their minds (52). Finally, nucleic acid testing and patient exposure history were correlated with depression among local South Korean students, which showed the importance of correct disclosure of information about COVID-19 (53).

Finally, there are two factors to be concerned about. First, the result showed that symptoms affected the depression among local South Korean and Chinese international students in South Korea. Symptoms of COVID-19 vary across patients, but the most common clinical symptoms include fever, malaise, cough, sputum, and shortness of breath at all stages of the disease, along with less common symptoms such as sore throat, headache, confusion, hemoptysis, shortness of breath and chest tightness. Moreover, minor symptoms include nausea, vomiting, diarrhea, and gastrointestinal complications. Therefore, it is difficult to identify the suspected COVID-19 symptoms because they are diverse, and for university students, the presence of a symptom adds to their psychological burden (54). Second, this study could not directly prove that personal precautions (wearing masks, washing hands regularly, and so on) would affect depression in both student groups. Christoph's findings also indicated that there is little evidence that public health measures were associated with direct mental health impairment (55). Wendy's research at American University also found that students' perceptions of wearing masks varied (56). While one study in Hong Kong concluded that the insecurity associated with wearing and reusing masks could increase the participants' psychological burden (57). A study conducted in mainland China among children and adolescents revealed that the frequency of wearing a mask and the duration of exercise were associated with mental health (58).

Implications

The South Korean government is supposed to continue its efforts and support student development during the outbreak. For the international students in South Korea, first, as a large group, the government should remove the restriction on buying masks from national insurance. Second, transparent, open, and truthful information should be provided to international students. Third, attention should be paid to international students' mental health, providing them warmth and care in a timely manner so that they can build their self-esteem and self-confidence. Fourth, psychiatrists could use telemedicine for psychotherapy and the continuation of interpersonal therapy (59). Regarding local South Korean students, first, the government should pay attention to the mental health status of university students of different genders and educational levels. Second, measures to lower the history of outside contact should be undertaken. Third, attention should be paid to physical health and improving university students' physical fitness in South Korea. Fourth, the family's role in preventing infection and caring for patients should not be overlooked. Fifth, the Internet should be used as a positive guide to deliver accurate information. Finally, the testing speed of COVID-19 should be accelerated. Clinicians should use the sequential model which integrates psychotherapy and pharmacotherapy to prevent the recurrence of depression (60).

Limitations and Future Research

This study had several limitations. First, it was conducted online, which may cause issues such as the uncertainty of the respondents' attitude and seriousness when completing it. Moreover, the self-assessed physical health status may not be the same as the one judged by professionals. Second, this study used snowball sampling and the sample size is not huge. Hence, the sample may not be representative of the general population. Third, the study would be more accurate if the comparison was between similar populations, with the only difference being nationality. It would be more informative to include the questionnaire used to assess the general demographics, knowledge of COVID-19, and preventive practices. Fourth, anxiety was not measured and anxiety level should be considered as a potential confounding variable in future studies. Besides, this study did not assess the factors that are associated with depression among university students such as the frustration due to loss of daily life and study interruptions, pre-existing depression, anxiety, and social support (61). Despite these limitations, this study provides useful information on the knowledge, prevention practices, and depression status of Chinese international and local Korean students in South Korea who experienced the most severe moments of the COVID-19 outbreak. It could serve as an evidence-based reference for providing psychological help to local and international students during the pandemic of infectious diseases.

CONCLUSIONS

This study investigated the conditions and determinants of knowledge, preventive behaviors, and depression among Chinese international and local students living in South Korea during the early stage of COVID-19 pandemic. The results revealed that both student groups had good knowledge of COVID-19. Chinese international students had better preventive practice and showed higher levels of depression. Information satisfaction, the likelihood of survival after infection, symptoms of a cough, and feelings of discrimination were the determinants of depression among Chinese international students. Gender, educational level, family, suspected symptoms, self-assessed physical health status, COVID-19 detection, population contact history, and online sources of information were the determinants of the local students. The data may serve as a preliminary study on lowering the negative impact of COVID-19 on the mental health of the international and native students in a country and can be used as a guide for further studies in different regions.

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 Chair, Yonsei University Mirae Institutional Review Board. Affiliation: College of Health Sciences/Health Administration. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

Conceptualization: EN and BZ. Methodology, software, and data curation: BZ. Validation: FK, EN, and BZ. Formal analysis and writing—original draft preparation: XJ. Investigation and resources: FK and BZ. Writing—review and editing and supervision: FK and EN. All authors have read and agreed to the published version of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.920887/full#supplementary-material

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The Association of Volunteer Motivation and Thriving at Work of College Students During COVID-19: Job Burnout and Psychological Capital as Mediators

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Thriving at work is a type of mental state in which an individual feels vigorous and learning at the same time in the job. Previous studies have shown that individual internal motivation is relevant to thriving at work and volunteer behaviors, but the role of motivation is still to be further explored. Based self-determination theory, this study focuses on the mediating effects of job burnout and psychological capital on the relationship between volunteer motivation and thriving at work. Three hundred forty-nine college student volunteers who participated in psychological assistance volunteer activities during the COVID-19 pandemic were investigated using the Volunteer Function Motivation Inventory, Maslach Burnout Inventory, PsyCap Questionnaire, and Thriving at work scale. The results indicated that job burnout and psychological capital mediate the relationship between volunteer motivation and thriving at work. The results not only offer important theoretical insights of Volunteer Motivation and Thriving at Work, but also generate practical implications regarding how to use motivating Volunteer behavior and enhanced wellbeing at work.

Keywords: volunteer motivation, thriving at work, job burnout, psychological capital, college student volunteer, COVID-19

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INTRODUCTION

During the COVID-19 pandemic in 2020, many college volunteers participated in pandemic prevention and control activities and performed various types of volunteering work in China (1). Volunteering is a long-term and free act of helping those who actively seek help after careful consideration in the context of an organization (2). Volunteering during the COVID-19 pandemic's prevention and control period has certain characteristics, and every volunteer is not only a participant, but also a witness to the pandemic (3). The vast majority were exposed to varying degrees of anxiety and panic from being isolated at home (4). In this case, what factors are related to the volunteers' working state and mental status? On the one hand, individual motivation directly has relations with the occurrence and development of voluntary behavior (5). On the other hand, the content of volunteer work also impacts volunteers in many different ways (6).

Volunteer Motivation and Thriving at Work

Thriving at work is a mental state where energy and learning are experienced at the same time, and people with a thriving sense of work feel their own growth and motivation (7). Previous studies have found that thriving at work has a positive predictive effect on individual job satisfaction and organizational loyalty (8), and a negative predictive effect on job burnout (9). Some studies also show that individual with higher thriving at work enjoy the pleasure of work more and thus exhibit more organizational citizenship behaviors (10). At the same time, thriving at work plays an important role in individual growth and health (11). Spreitzer et al. (12) found that after controlling for variables such as depression and anxiety, subjects with high thriving at work reported better physical and mental health. Because work status is closely related to the effectiveness of psychological assistance, it is of great significance to study psychological assistance volunteers' thriving at work and mental state at work (13).

Volunteer motivation is an internal psychological process in which individuals' voluntary behaviors are guided, stimulated and maintained by their goals or objects (14). Deci and Ryan (15) proposed self-determination theory, believing that an individual has an innate and inherent tendency to meet the three psychological needs of competence, autonomy, and relationship and to achieve psychological development. Competence needs refer to the successful completion of challenging tasks and achievement of desired results. Autonomy refers to the individual feeling behavioral autonomy. Relationship needs refer to the establishment of stable and reliable contact with others, groups and organizations. If external conditions help meet the three kinds of innate psychological needs, intrinsic motivation of individuals will be enhanced, more spontaneous and active, so as to have better mental health and behavioral performance. If external conditions are not conducive to satisfaction of these three basic psychological needs, then it is not conducive to internal motivation, and the individual's work attitude and behavior performance are negatively affected to some extent (16). With regard to mechanisms producing thriving at work, based on self-determination, the socially embedded model of thriving at work has been proposed (12). Baard et al. (17) have shown that a work environment that meets individual sense of autonomy, competence and relationship needs can improve intrinsic motivation. At the same time, a large number of studies have shown that individual intrinsic motivation has a significant predictive effect on their job performance, job satisfaction, job involvement, organizational commitment, organizational citizenship behavior, innovation behavior, mental health, and subjective wellbeing (18–20). Based on previous work, the current study presents hypothesis 1, as follows:

H1: Volunteer motivation is positively related to thriving at work.

Job Burnout, Volunteer Motivation, and Thriving at Work

Job burnout is a special type of work-related stress, which is a state of physical or emotional exhaustion that also involves a sense of reduced accomplishment and loss of personal identity (21). It includes emotional exhaustion, cynicism, and reduced personal accomplishment. Emotional exhaustion is when an individual believes that all of his or her emotional resources have been exhausted (22). Cynicism refers to the willingness of individuals to deliberately distance themselves from work and other people involved in the job (22). Reduced personal accomplishment is when an individual holds a negative opinion of himself or herself (22). Job burnout does not only harm the health of individual (23, 24), which reduces work performance of individual (25), will also increase the occurrence of bad behaviors and security accidents (26).

Internal motivation is motivation with the highest degree of autonomy, which refers to intrinsic satisfaction brought by individual activities or work itself (27). The internal motivation of work or activity is closely related to occupational stress and burnout (28). Previous studies have found that internal work motivation and external work motivation have different effects on job burnout (29). Previous evidence indicated that controlling motivation with low self-determination is in direct proportion to job burnout, while autonomous motivation with a high degree of self-determination is in inverse proportion to job burnout (30). The weakening of voluntary motivation based on one's own will is an important factor that leads to job burnout (30). Recent, under the framework of self-determined motivation theory, researchers have proposed five modes of work motivation regulation (27).

Bethencourt (31) takes the theoretical model of self-determination as its theoretical framework, with the three major psychological needs of autonomy, competence and relevance as independent variables, and individual participation as dependent variables. It detects the correlation between each other and predicts individual participation by using structural equations and regression modeling of applied data sets. The results show that there is a significant negative correlation between autonomous motivation and job burnout, while there is a significant positive correlation between controlled job motivation and job burnout. Jowett et al. (32) also indicated similar conclusions through the study of 211 professional athletes, and further proposed that the degree of individual self-determined motivation is an important factor in predicting their job burnout. Another explanation is the job demands-resources model (JD-R) proposed by Demerouti et al. **(author?)** (33). This model is a theoretical framework to systematically study the process of job burnout. In the JD-R model, one of the roles of work resources is to stimulate personal growth, learning, and development (34). At the same time, work resources correspond to the motivational process. When work demands are high, work resources are more closely related to workers' motivation (such as job involvement and job-related learning) and bring vitality to individuals (34).

Job burnout is a potential predictor of thriving at work (35). Porath et al. (7) found that thriving at work can promote sustainable development of people by influencing psychological (reduced burnout) and physiological (perceived health) aspects. Spreitzer et al. (36) pointed out that individual who were consistent with their state of thriving at work reported lower job burnout than their colleagues. Re-search by Spreitzer et al. (36) showed that thriving at work can improve job performance,

reduce burnout, and improve health. Therefore, hypothesis 2 and 3 are presented as follows:

H2: Job burnout is negatively associated with thriving at work.
H3: Job burnout has a mediating effect on the relationship between volunteer motivation and thriving at work.

Psychological Capital, Volunteer Motivation, and Thriving at Work

Psychological capital refers to a set of resources a person can use to help improve their performance on the job and their success (37). It includes optimism, hope and self-efficacy, and toughness of the four elements, respectively, representing current and future positive beliefs (optimistic), the ability to target and achieve the goal through appropriate path (hopefully), in the face of challenging tasks believe they have the ability to succeed (self-efficacy), and in the face of difficulties and adversity can stick to and hard work (toughness) (38).

When an individual participates in voluntary activities, if there is no positive psychological quality, the individual is not willing to communicate with others (39). At the same time, they tend to withdraw from difficulties and even stop their voluntary activities (40). So psychological capital plays an important role in promoting the development of voluntary behavior (39). However, in the process of the generation and development of voluntary behavior, voluntary motivation is considered to be the most important factor leading to the generation of voluntary behavior (2). That is, voluntary motivation directly affects voluntary behavior and promotes the generation and development of voluntary behavior (2). Volunteers' psychological capital quality, such as self-confidence, optimism, responsibility and hope, can stimulate individuals to produce higher voluntary motivation (41). And the improvement of volunteer motivation will further promote the generation and development of voluntary behavior (42).

According to resource conservation theory, people strive to pursue and maintain the resources they consider valuable, including autonomy, self-efficacy, self-esteem (43). Psychological capital can predict the individual's psychological development and working state (44). Individuals with a lower level of psychological capital have lower health status and lower job performance (38). Paterson et al. (45) found in their study that individual with higher level of psychological capital and more social sup-port showed more enjoyment of work and reported higher sense of work vitality. Carmeli and Spreitzer (10) also found that psychological capital has a positive effect on the working state. Specific performance is, psychological capital is higher, work is devoted, work exuberant feeling is higher. Therefore, hypothesis 4 and 5 are presented as follows.

H4: Psychological capital can positively predict thriving at work.
H5: Psychological capital has a mediating effect on the relationship between volunteer motivation and thriving at work.

The research model is presented as **Figure 1**.

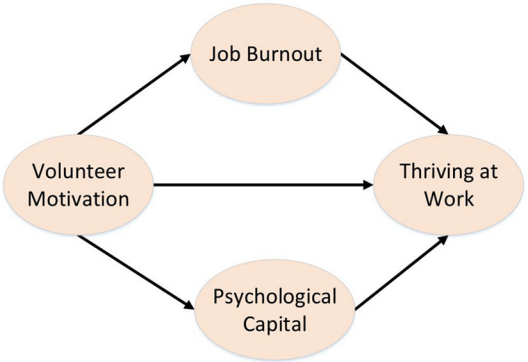

FIGURE 1 | Mediation model tested.

METHODS

Participants and Procedure

A cross-sectional online survey of Chinese college student between February 24 and April 19, 2020 was conducted. All participants were random recruited using the "WeChat," a popular Chinese social media APP. WeChat has location-based online groups, and it was arranged for WeChat group (online psychological assistance college student volunteers) moderators from localities within a large urban city in Eastern China (Zhengzhou, population = 10 million) to invite their residents to participate. Interested participants were shown an online informed consent statement and, for those agreeing, a Chinese language online survey. The survey was hosted on Survey Star (www.wjx.cn), offering features to prevent automated participation by bots. Specifically, the researchers sent links of online questionnaires to WeChat groups dominated by college student volunteers who had participated in a particular volunteer activity during the COVID-19 pandemic. To further screen participants, the self-reported questionnaire included questions such as "How many times did you volunteer during this year?"

The online survey system reminded individuals to complete all items; therefore, there is no missing data. After deleting participants entering the same response consecutively across dozens of items, 349 participants remained (201 females; age: mean $\pm$ SD = 20.83 $\pm$ 2.32 years).

Measures

In addition to surveying demographic data, the following measures were administered.

Volunteer Function Motivation Inventory

The Volunteer Function Motivation Inventory (VFMI) compiled by Clary et al. (46) and revised by Law et al. (47). The questionnaire is recognized as an authoritative tool to measure voluntary motivation. There are six subscales, namely, values expression, social communication, learning and understanding, career development, self-protection, and self-development. Each subscale includes 5 items. Participants rated each item according

to how much it corresponded to their participation in voluntary activities with Likert 7 points (1 = strongly disagree, 7 = strongly agree). The average scores of each dimension were calculated. The higher the score, the stronger the motivation to volunteer. The Cronbach's Alpha of the total questionnaire and the six subscales were 0.917, 0.770 (value expression motivation) 0.829 (learning understanding motivation) 0.756 (social interaction motivation) 0.718 (career development motivation) 0.774 (self-protection motivation) and 0.804 (self-enhancement motivation), respectively.

Thriving at Work Questionnaire

The questionnaire on thriving at work was compiled and revised Porath et al. (7). The questionnaire consists of 10 items in terms of learning and vitality with Likert 7 points (1 = strongly disagree, 7 = strongly agree). The higher the score, the higher thriving at work of individual. In this study, the overall internal consistency reliability coefficient value of the questionnaire is 0.835, and that of the vitality and learning subscales are 0.780 and 0.719, respectively.

Maslach Burnout Inventory—General Survey

The Maslach Burnout Inventory was revised by Li and Shi (48). There are three dimensions of Emotional Exhaustion, Cynicism, and Reduced Personal Accomplishment. There are 15 questions in total. Likert ratings with Likert 7 points are used for scoring. In this study, the overall internal consistency reliability of the Burnout Inventory was 0.895. The internal consistency confidence of the three dimensions of Emotional Exhaustion and pessimism is 0.938, 0.876, and 0.894.

Psychological Capital Questionnaire

The PsyCap Questionnaire (PCQ)was developed by Luthans et al. (49) and translated by Li et al. (50). The scale includes four dimensions: self-efficacy, hope, resilience, and optimism. There are 6 questions in each dimension, a total of 24 questions. Likert responses are scored with Likert 6 points. The Cronbach of the scale was 0.971. The internal consistency reliability of the four dimensions of self-efficacy, hope, resilience and optimism is 0.920, 0.904, 0.924, 0.921, respectively.

Data Analysis

SPSS software package was used to analyses the data (v. 26.0 for Windows; IBM Corporation, 2019). Mediation tests (displayed in **Figure 1**) were conducted using the PROCESS macro (51). Descriptive statistics and correlation analysis were used. We used the bias-corrected non-parametric percentile Bootstrap confidence interval method to analyze the mediating effect.

In the case of unrotated, Harman S One-factor Test obtained 15 factors of eigenvalue 1. The variance explained by the first factor is 30.5%, less than the upper limit of 40%. Therefore, there is no serious common method deviation problem in this study.

RESULTS

Descriptive Analysis

The correlation matrix and descriptive information on the sample and the measures used in the primary analyses for this study were showed in **Table 1**.

There were significant correlations between the different variables. People with higher volunteer motivation had a lower level of job burnout, and showed greater psychological capital and thriving at work.

Mediation Model Validation Analysis

The results showed that voluntary motivation had a significant positive predictive effect on work vigor ($\beta = 0.16$, $p < 0.001$). Job burnout had a significant negative predictive effect on thriving at work ($\beta = -0.42$, $p < 0.001$). Psychological capital has a significant positive predictive effect on the thriving at work ($\beta = 0.29$, $p < 0.001$; **Table 2**).

The mediating effect of job burnout and psychological capital between voluntary motivation and work vigor were analyzed. The results show that the indirect effect of job burnout on voluntary motivation is 0.10. Moreover, the Bootstrap 95% confidence interval does not contain 0, indicating that job burnout has a significant mediating effect between voluntary motivation and thriving at work. The indirect effect of psychological capital on

TABLE 1 | Description statistics and correlation analysis of each variable.

	M	*SD*	1	2	3	4	5	6	7	8	9	10
1. Protective	5.37	1.14	1									
2. Values	6.19	0.68	0.45**	1								
3. Career	4.50	1.22	0.68**	0.36**	1							
4. Social	4.85	1.08	0.68**	0.44**	0.66**	1						
5. Understanding	6.01	0.80	0.65**	0.60**	0.50**	0.55**	1					
6. Protective	6.01	0.80	0.68**	0.63**	0.55**	0.58**	0.86**	1				
7. Volunteer motivation	5.49	0.78	0.87**	0.66**	0.81**	0.83**	0.82**	0.85**	1			
8. Job burnout	2.42	0.85	−0.12*	−0.28**	−0.19*	−0.14*	−0.26**	−0.33**	−0.23**	1		
9. Psychological capital	4.97	0.64	0.27**	0.43**	0.19**	0.29**	0.39**	0.43**	0.39**	−0.61**	1	
10. Thriving at work	5.97	0.72	0.24**	0.41**	0.14*	0.27**	0.43**	0.47**	0.37**	−0.64**	0.61**	1

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

TABLE 2 | Regression analysis of mediation models (standardized).

Variable	Dependent variable thriving at work		Dependent variable job burnout		Dependent variable psychological capital		Dependent variable thriving at work	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Volunteer motivation	0.37	7.39***	−0.23	−4.30***	0.39	7.78***	0.16	3.96***
Job burnout							−0.42	−8.79***
Psychological capital							0.29	5.68***
R^2	0.14	0.05	0.15	0.50				
F	54.62***	18.53***	60.56***	116.46***				

***$p < 0.001$.

TABLE 3 | Mediation effect size analysis.

Effect of type	Effect size	Boot SE	Bootstrap 95%CI		Relative mediation effect
			BootLLCI	BootULCI	
Total indirect effect	0.21	0.04	0.13	0.29	55.83%
Job burnout	0.10	0.03	0.04	0.17	25.75%
Psychological capital	0.11	0.03	0.05	0.18	30.08%
Job burnout—psychological capital	−0.02	0.05	−0.11	0.09	

Boot SE, BootLLCI, and BootULCI respectively refer to the standard error, lower, and upper limit of 95% confidence interval of the indirect effects estimated by the percentile Bootstrap method of deviation correction.

voluntary motivation was 0.11. Moreover, the Bootstrap 95% confidence interval does not contain 0, which also indicates that the mediating effect of psychological capital between voluntary motivation and work vigor is also significant (see **Table 3**, **Figure 2**).

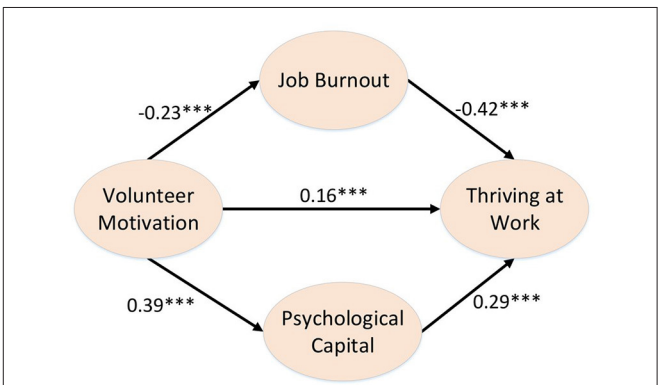

FIGURE 2 | Multiple mediation model. ***$p < 0.001$.

DISCUSSION

Volunteer Motivation Is Relevant to Thriving at Work

The results of this study showed that volunteer motivation can significantly positively predict thriving at work. It can be explained from three different perspectives. First, from the perspective of self-determination theory, thriving at work is related to internal motivation, and the internal work motivation of individual has a good predictive effect on their positive emotional experience, work creativity and mental health (52). Intrinsic motivation refers to the continuous interest, spirit of exploration and curiosity aroused by individual in the workplace, focusing on the effect of intrinsic motivation (53). This effect is not based on material rewards, but on certain psychological needs of the individual and the characteristics of the job itself. The main purpose of individual with high internal motivation to participate in work is not to obtain certain economic remuneration, but tends to their own interest, work activity, competency and other aspects of satisfaction (54). The cognitive state of individuals motivated by internal dynamics tends to be characterized by flexibility and persistence. And individuals are more likely to exhibit high levels of creativity and vitality (53). A study found that, other conditions being equal, individuals with high intrinsic motivation will put a lot of energy into active attempts in the process of solving problems, and their perseverance and persistence will be better (52).

The second perspective is that voluntary behavior is essentially a higher level of prosocial behavior. When individuals have prosocial motivation, they usually devote themselves to helping specific benefit groups (55). Relevant studies have shown that help-oriented prosocial motivation can produce a more lasting sense of pleasure and meaning for individuals, reduce stress, and enhance physical and mental health (56, 57).

Thirdly, according to the Action Identification Theory, when an individual takes an Action, he/she will be more concerned about the meaning of the Action (58). Individuals tend to have a high level of recognition. Work has become a carrier to express

personal values and goals, enabling individuals to find meaning and sense of value in their work and making them full of vitality (59).

It can be seen that volunteer motivation has an important impact on thriving at work. Therefore, future research can deeply discuss the relationship between volunteer motivation and thriving at work from the perspectives of value expression, knowledge acquisition, functional expansion, enhanced self-esteem, self-protection, and social communication, so as to help the positive development of individual thriving at work.

The Mediating Effect of Job Burnout and Psychological Capital

As for the mediating effect of job burnout, under the influence of volunteer motivation, individuals can reduce job burnout, and then show a stronger thriving at work. The possible reasons are: Volunteer motivation can predict job burnout (60). People with high voluntary motivation have a relatively low sense of frustration and pressure in work, so they are less likely to suffer from job burnout, and thus have a higher sense of organizational identity and thriving at work (61).

In addition, compared with job burnout, current study also found that psychological capital played a stronger mediating role in the relationship between volunteer motivation and thriving at work. Psychological capital is the comprehensive ability to meet the standard of positive organizational behavior (POB), which conforms to resource-based view (62). In other words, psychological capital is a key basic resource to manage and adjust other psychological resources to obtain satisfactory results. From the individual level, psychological capital is an important factor to promote individual growth and development and performance improvement (49). Reflected in the JD-R model, psychological capital can enhance an individual's internal motivation, make the individual feel the meaning of work, and continuously show the vitality, dedication, and concentration of work.

This study investigates the parallel mediating effect of job burnout and psychological capital, which is of great value and significance. First, the study examines the internal mechanism of thriving at work from the perspectives of emotion and cognition. This helps to provide a dual-mode intervention guide for the development of thriving at work dynamism. Secondly, this study adopts the parallel multiple mediation model. It is explained in two theoretical frameworks, namely the self-decision theory and job demands-resources model (JD-R model).This is not only conducive to the establishment of an empirical model of the influence of volunteer motivation on thriving at work, but also conducive to enterprises and organizations to take targeted measures to improve the level of individual thriving at work according to the different mechanisms of thriving at work. In addition, this study belongs to cross-sectional study. It is difficult to determine the relationship between job burnout and psychological capital. In the future, a follow-up study design could be considered to determine the relationship. To determine other possible modes of action (such as chain mediating action, etc.) of the two, thus enriching the model of thriving at work.

Limitation and Prospect

This study examine the mediating effect of job burnout and psychological capital on the influence of volunteer motivation on thriving at work. The internal mechanism of volunteer motivation influencing thriving in volunteer work is clarified. It enriches the research on the field of thriving in volunteer work. At the same time, it also has important guiding significance for the shaping and intervention of volunteers' thriving at work. However, this study also has the following two deficiencies: (1) lack of longitudinal tracking data. It is difficult to make causal inferences. Future research should attach importance to longitudinal research design to reveal the development law of thriving at work. Then discuss how to create a positive environment conducive to the vigorous and healthy development of volunteer work. (4) In addition to the mediating effect of job burnout and psychological capital, some moderating variables, such as responsibility and competence, may also have relations with the relationship between volunteer motivation and thriving at work. Future studies could explore further mechanism of volunteer motivation on thriving at work in more complex models.

In sum, the current study indicates that volunteer motivation can significantly predict volunteers' thriving at work. The findings support a mediating relationship between job burnout and psychological capital in the relationship between volunteer motivation and thriving at work.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The study was approved by the Local Ethics Committee at Tianjin Normal University, Tianjin, China. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

JL conducted data collection, data management, cleaning, and analysis. JL and SL wrote the first draft of the paper. SL and CG substantially revised the manuscript and designed the study protocol. All authors contributed to the article and approved the submitted version.

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Internet Addiction in Socio-Demographic, Academic, and Psychological Profile of College Students During the COVID-19 Pandemic in the Czech Republic and Slovakia

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Internet addiction is a serious problem among young adults that requires increased attention, especially at a time of distance learning during the coronavirus disease 2019 (COVID-19) pandemic. The aim of the study was to assess the relationships between internet addiction and selected socio-demographic, study-related, and psychological characteristics of college students. Internet addiction was measured using the Internet Addiction Test both overall and in its individual subscales (Salience, Excessive Use, Neglect Work, Anticipation, Lack of Control, and Neglect Social Life). The selected characteristics represented (1) socio-demographic profile (gender, age, residence, family), (2) academic profile (housing during the semester, form of study), and (3) psychological profile (depressive symptoms—the Patient Health Questionnaire, stress—the Perceived Stress Scale, anxiety symptoms—the Generalized Anxiety Disorder). Data collection took place during the first wave of the COVID-19 pandemic in 2020 at Czech and Slovak colleges, with 1,422 students from the Czech Republic and 1,677 students from Slovakia participating in the research. The analytical processes were carried out through descriptive analysis, non-parametric difference analysis, and multiple negative binomial regression. Mild internet addiction was found in 387 (27.2%) Czech and 452 (27.0%) Slovak students. Moderate internet addiction was identified in 49 (3.4%) students from the Czech Republic and in 100 (6.0%) students from Slovakia. Two (0.1%) Czech and three (0.2%) Slovak students reported severe internet addiction. Increased likelihood of internet addiction overall, as well as in most individual subscales, was found particularly among male students and students who lived away from home during the semester. Depressive symptoms and stress could also be considered significant predictors in both countries. These results are important for the development of effective strategies and

prevention programs, as Internet addiction may be a serious problem in the future, given the current times. When assessing internet addiction among college students, it would also be appropriate to evaluate the individual internet addiction subscales and their specifics.

Keywords: mental health, problematic internet use, depressive symptoms, anxiety symptoms, stress, study-related characteristics, socio-demographic characteristics, relationships

INTRODUCTION

A strong attribute of today's modern times is the internet, which has become an everyday part not only of young people. The increasing accessibility of the Internet over the last two decades has significantly changed young people's lives in many dimensions. The internet is ubiquitous, whether it is for entertainment, relaxation, escaping worries, shopping, but also for seeking study information and connecting with friends and family (1, 2). However, the dark side is the fact that the internet can suck young individuals into an online world where excessive time spent online can contribute to compulsive unhealthy behavior (3). In this sense, it is possible to speak of a non-substance drug that brings with it many consequences in the social and academic spheres, but also in mental health (4, 5). In other words, the internet can help with many needs, but it can also be a harmful element if a reasonable level of use is exceeded.

Youth itself represents a complicated phase in an individual's life in which he or she may succumb to various pitfalls. Studying at college is a critical period during which young people face many challenges, which is why college students are often identified as a vulnerable group (6). Starting college is already a great change, in which the student encounters many new situations and problems. Relationships, acceptance and integration, academic performance, meeting expectations, but also future employability are important aspects at this time. The consequences of problematic internet use by college students can be poor academic performance, disinterest in engaging in other activities, excessive daytime sleepiness (7), poor sleep quality (8), reduced academic engagement (dedication and vigor) (9), risky health behaviors (10), but also health problems, such as being under- or over-weight (11, 12), migraine (12, 13), back pain (12), or increased resting heart rate (14). These are reasons for increased vigilance about young people's use of the internet. Caution is also stressed in view of the fact that college students are seen as an important future pillar of society and economic prosperity.

In addition to the facts mentioned in the previous paragraph, the coronavirus disease 2019 (COVID-19) pandemic represents another psychological burden that has also affected the lives of students (15). The measures related to COVID-19 disrupted students' education, social contact, and leisure time. This period can undoubtedly be considered psychologically challenging, as evidence shows that common mental disorders occurred frequently among students during the pandemic (16), while distance learning through digital technologies was a critical aspect for mental health (17). The regulations led to greater use of modern technology, including the internet (18, 19), which may have put young people's mental health at risk. For this reason, many studies have been conducted around the world to clarify the consequences of the COVID-19 pandemic. Compared to the pre-pandemic period, many studies showed higher rates of online activity (20–23), but also higher rates of internet addiction (24). However, it is also important to know what factors play a significant role in this problem.

Problematic internet use can be understood as using the internet in a way that has a negative influence on an individual's life and can lead to addiction (25). When a problem is identified, increased attention is focused not only on the time spent online, but especially on consequences such as loss of control, unsuccessful quit attempts, or disrupted relationships with family and friends (26). In addition, evidence clearly shows that problematic internet use is a significant predictor of depression, anxiety, and stress in young people (27, 28). On the other hand, there are also findings indicating that the presence of common mental disorders may explain problematic internet use (16). According to Masaeli and Farhadi (29), internet-based addictive behaviors during the COVID-19 pandemic were mostly due to financial hardships, isolation, problematic substance use, and psychological distress, including depression, anxiety, and stress. In this context, depression, anxiety, and stress are known to be associated with more severe problematic use and/or internet addiction in students (6, 18, 30–35). Based on these findings, it can be assumed that depressive symptoms, anxiety symptoms and perceived stress may also prove to be significant predictors in other countries, such as the Czech Republic and Slovakia. In addition, studies show that individual aspects such as gender, age, residence and academic characteristics also play an important role in problematic internet use (18, 32, 36–43).

In terms of internet addiction among college students, the pre-pandemic period is not sufficiently mapped in the Czech Republic and Slovakia, which is indicative of the fact that little attention has been paid to this issue in these two neighboring countries. For this reason, research-based knowledge and its translation into practice are lacking. In Slovakia, Sebena et al. (44) highlighted the seriousness of problematic internet use among college students and confirmed that depressive symptoms predict their problematic internet use. In the Czech Republic, the issue was addressed by Chraska (45). In both countries, however, the research focus was mainly on primary and secondary school students (46–48). Thus, to the best of the authors' knowledge, there is a lack of research on the issue among college students in both the Czech Republic and Slovakia, which can be identified as a relevant research gap. On this basis, this

study examines the relationships between internet addiction and selected socio-demographic, academic, and psychological characteristics of Czech and Slovak college students during the COVID-19 pandemic. Knowledge of these relationships provides the opportunity to put in place effective protective and preventive measures to address the problem and avoid serious consequences in the future.

MATERIALS AND METHODS

The aim of the study was to assess the relationships between internet addiction and selected socio-demographic, academic, and psychological characteristics of Czech and Slovak college students. The research examined internet addiction from an overall perspective but also in sub-scales, namely Salience, Excessive Use, Neglect Work, Anticipation, Lack of Control, and Neglect Social Life. As indicated, the selected characteristics were concentrated in three areas, namely (1) socio-demographic profile (gender, age, residence, and family), (2) academic profile (housing during the semester, form of study), and (3) psychological profile (depressive symptoms, stress, and anxiety symptoms). The research was conducted based on the following research questions (RQs).

RQ1: How are selected socio-demographic characteristics associated with internet addiction in Czech and Slovak students?
RQ2: How are selected academic characteristics associated with internet addiction in Czech and Slovak students?
RQ3: How are selected psychological characteristics associated with internet addiction in Czech and Slovak students?

Measures

In addition to the usual socio-demographic and academic identification data, the online questionnaire also collected data on students' level of psychological distress.

Psychological distress was measured using already existing scales from previous studies. Thus, depressive symptoms were measured using the Patient Health Questionnaire (PHQ-9) and anxiety symptoms using the Generalized Anxiety Disorder (GAD-7) screening scale from the study by Kroenke et al. (49). The PHQ-9 has been widely validated to screen for depressive symptoms (50) and is considered a suitable instrument also for a sample of college students (51, 52). Similarly, the GAD-7 is a commonly used instrument for screening anxiety symptoms among college students and show good psychometric properties (53–55). For these scales, respondents could choose one of the following answers for each questionnaire item: not at all-−0, several days-−1, more than half the days-−2, nearly every day-−3. The total scores were the sum of the coded responses. Based on this, depressive symptoms were identified as follows: no depressive symptoms (0–4), mild depressive symptoms (5–9), moderate depressive symptoms (10–14), moderately severe depressive symptoms (15–19), and severe depressive symptoms (20 or more). Anxiety symptoms were identified as follows: no anxiety symptoms (0–4), mild anxiety symptoms (5–9), moderate anxiety symptoms (10–14), and severe anxiety symptoms (15 or more).

Perceived stress was measured using the Perceived Stress Scale (PSS-10) scale from the study by Cohen et al. (56). This instrument, with its many benefits, is widely recommended for use across cultures and also in student populations (57–59). In this case, respondents could select one of the following answers for each of the 10 items: never-−0, almost never-−1, sometimes-−2, fairly often-−3, very often-−4. The ranges of the total PSS-10 score indicated: low stress (0–13), moderate stress (14–26), and high stress (27–40). Accordingly, the higher the total score, the more severe the psychological distress.

The research focused predominantly on internet addiction as measured by the Internet Addiction Test (IAT) developed by Young (60). The IAT represents an instrument with satisfactory psychometric properties that is commonly used in studies focusing on college students (61, 62). The scale consisted of 20 items with the following answers: not applicable-−0, rarely-−1, occasionally-−2, frequently-−3, often-−4, always-−5. Internet addiction was identified as follows: normal level of internet usage (0–30), mild addiction symptoms (31–49), moderate addiction symptoms (50–79), and severe addiction symptoms (80–100). The IAT scale was composed of six subscales for which precise interval thresholds are not defined. Therefore, higher score (closer to the theoretical maximum) represented greater addiction. Young (63) explained these subscales as follows:

- Salience. A high score on salience-related items points to the fact that the individual is likely to feel preoccupied with the internet, hides his/her behavior from others, and may show a loss of interest in other activities and/or relationships due to a preference for more solitary time on the internet. A high score also shows that the individual uses the internet as a form of mental escape from disturbing thoughts and may feel that life without the internet would be boring, empty, and/or joyless. Salience is represented by five items (ID: 10, 12, 13, 15, 19) with a theoretical score range of 0–25.
- Excessive Use. A high score on items related to excessive use reflects the fact that the individual engages in excessive online behavior and compulsive usage, and is intermittently unable to control his or her time spent on the internet, which he or she hides from others. The individual with a high score is very likely to fall into depression, panic, or anger if forced to stay off the internet for a prolonged period of time. Excessive use is represented by five items (ID: 1, 2, 14, 18, 20) with a theoretical score range of 0–25.
- Neglect Work. A high score on items related to neglect work points to the fact that the individual may consider the internet to be a necessary appliance, much like a television or telephone. Given the amount of time spent online, work or school performance and productivity are likely to deteriorate, and the individual may begin to defend or hide time spent online. Time spent on the internet conflicts with responsibilities (duties, school, and work). Neglect work is represented by three items (ID: 6, 8, 9) with a theoretical score range of 0–15.

TABLE 1 | IAT scale items.

ID	Item	CZ			SK		
		Med	Mean	SD	Med	Mean	SD
1	How often do you find that you stay online longer than you intended?	3.00	2.53	1.221	3.00	2.71	1.223
2	How often do you neglect household chores to spend more time online?	2.00	1.69	1.092	2.00	1.71	1.153
3	How often do you prefer the excitement of the internet to intimacy with your partner?	0.00	0.56	0.906	0.00	0.49	0.894
4	How often do you form new relationships with fellow online users?	1.00	1.10	1.000	1.00	1.10	0.988
5	How often do others in your life complain to you about the amount of time you spend online?	1.00	1.16	1.049	1.00	1.19	1.080
6	How often do your grades or school work suffer because of the amount of time you spend online?	2.00	1.97	1.225	2.00	1.89	1.256
7	How often do you check your email before something else that you need to do?	3.00	2.51	1.395	2.00	2.48	1.366
8	How often does your job performance or productivity suffer because of the internet?	2.00	2.16	1.210	2.00	2.03	1.210
9	How often do you become defensive or secretive when anyone asks you what you do online?	1.00	1.02	1.095	1.00	1.05	1.194
10	How often do you block out disturbing thoughts about your life with soothing thoughts of the internet?	1.00	1.19	1.244	1.00	1.20	1.282
11	How often do you find yourself anticipating when you will go online again?	1.00	0.78	0.912	1.00	0.86	1.053
12	How often do you fear that life without the internet would be boring, empty, and joyless?	1.00	0.95	1.081	1.00	0.96	1.147
13	How often do you snap, yell, or act annoyed if someone bothers you while you are online?	1.00	0.83	0.978	1.00	1.00	1.067
14	How often do you lose sleep as a result of late-night log-ins?	1.00	1.19	1.209	1.00	1.31	1.317
15	How often do you feel preoccupied about the internet when offline, or fantasize about being online?	0.00	0.68	0.886	0.00	0.67	0.928
16	How often do you find yourself saying "just a few more minutes" when online?	1.00	1.51	1.351	1.00	1.70	1.415
17	How often do you try to cut down the amount of time you spend online and fail?	1.00	1.35	1.190	1.00	1.60	1.270
18	How often do you try to hide how long you've been online?	0.00	0.65	0.957	0.00	0.74	1.003
19	How often do you choose to spend more time online over going out with others?	1.00	0.86	1.043	1.00	0.86	1.104
20	How often do you feel depressed, moody, or nervous when you are offline, a feeling which goes away once you are back online?	0.00	0.42	0.789	0.00	0.45	0.782

SD, standard deviation; CZ, Czech Republic; SK, Slovakia.

- Anticipation. A high score on anticipation-related items shows that the individual is most likely to think about being online when not at a computer, and feel compelled to use the internet when offline. Thus, it is a compulsion to be on the internet. Anticipation is represented by two items (ID: 7, 11) with a theoretical score range of 0–10.
- Lack of Control. A high score on items related to lack of control items indicates that the individual has difficulty managing his or her time online. The individual often stays online longer than intended, and others may complain about the amount of time he or she spends online. Lack of control is represented by three items (ID: 5, 16, 17) with a theoretical score range of 0–15.
- Neglect Social Life. A high score on items related to neglecting social life points to the fact that the individual is likely to use online relationships to cope with situational problems and/or to reduce psychological strain and stress. The individual often establishes new relationships with other internet users and uses the internet to make social contacts that may be lacking in his/her life. Thus, it is about replacing offline social life with online. Neglect social life is represented by two items (ID: 3, 4) with a theoretical score range of 0–10.

Table 1 shows the IAT scale items, with the ID column representing the item number for easier assignment to individual subscales.

Data Collection Process and Sample Selection

Respondents completed an online questionnaire distributed in the first half of 2020 (the first wave of the COVID-19 pandemic in the Czech Republic and Slovakia). Each respondent was given the same information and instructions and no one was offered a reward. Respondents completed the questionnaires in their national language, i.e., Czech or Slovak. The translation was done from English into Slovak and then from Slovak into Czech. The Slovak version was chosen for translation into Czech on the basis of the high similarity between the Slovak and Czech languages. The translated versions were verified by experts and tested on a group of students to confirm their understanding of the questionnaire items.

The data collection process was carried out in two steps. In the first step, representatives of colleges (deans, vice-deans, study officers) and student councils were asked by emails to share the online questionnaire among their students and student groups, and invited them to complete it. The questionnaire was also distributed to students through the social network Facebook. In the second step, addressed emails (from publicly available contact databases) were sent to college teachers of certain fields of study in some colleges requesting them to distribute the questionnaire to their students. The aim of the second step was to reach the missing segments of students in order to achieve the target

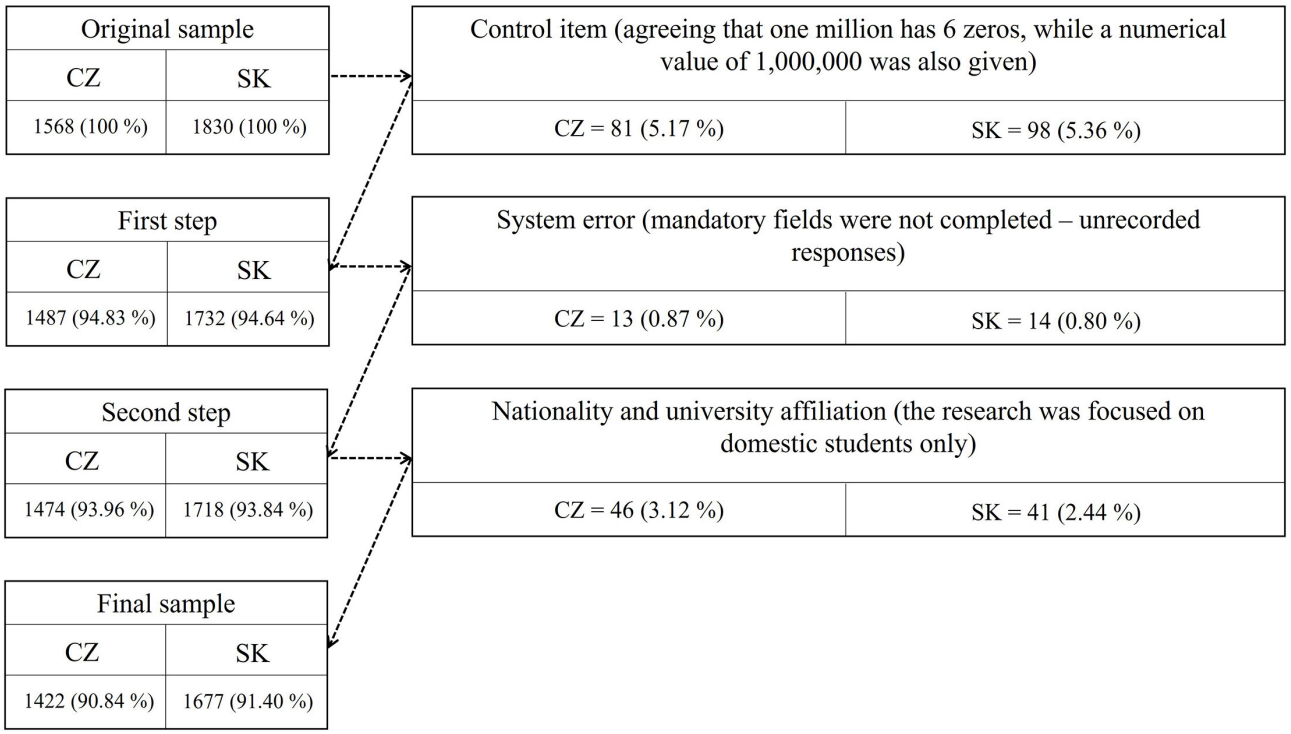

FIGURE 1 | Selection process to obtain the final sample.

sample structure. In order to have a representative sample in line with the study population, the sample was monitored based on the criterion of representation of colleges. In both countries, 80% of all colleges were covered. The interest was also to obtain a sample with a more consistent proportion of study fields and to have at least 30 observations for each field.

With regard to data processing, procedures were carried out to exclude irrelevant statistical units. Thus, 179 statistical units were excluded on the basis of a control item, 27 statistical units on the basis of the identification of a system error in the recording of responses, and 87 statistical units on the basis of the foreign nationality of the students (the survey focused on domestic students). In total, the research sample included 3,099 respondents (Czech Republic = 1,422; Slovakia = 1,677). For some identifying characteristics, respondents provided an apparently incorrect answer (e.g., 1,000 as the year of birth), these responses were deleted and appear as missing data in the analyzes. The selection process to obtain the final sample is provided in **Figure 1**.

Table 2 shows the basic characteristics of the research sample. Although the Czech Republic and Slovakia share a common history, the current specificities of these countries mean that each country should be evaluated separately. On this basis, it was possible to identify some inconsistencies. In terms of gender, higher proportions of female students were identified. This phenomenon is the result of a higher willingness of females to answer questionnaires, but also of the fact that more females (60%) than males (40%) attend college in the selected countries (64). The increased proportions in the younger age groups can be explained by the fact that students tend to be at a young age and older students (mostly part-time) represent a disproportionately smaller group in the higher education environment.

Statistical Analysis

The analysis focused on describing the data along with testing for differences, and on assessing possible relationships. Non-parametric tests of differences were used to assess differences, namely the Mann Whitney *U*-test for two categories and the Kruskal-Wallis *H*-test for three or more categories. Multiple negative binomial regression was used to assess the relationships, where the dependent variable was IAT and its subscales and the independent variables were characteristics such as gender, age, residence (urban/rural), family (incomplete/complete), housing during the semester (at home/away from home), form of study (part-time/full-time), PHQ-9, PSS-10, and GAD-7. The reference categories for nominal variables were selected with an emphasis on the frequency of observations in a given category and the logical interpretation of the results.

Statistical processing was performed using SPSS Statistic v. 26 (IBM, Inc., Armonk, NY, US) and programming language R v 4.1.2 (65).

RESULTS

This section presents the results of the analytical procedures. First, the mean values of the total IAT scores and the IAT subscale

TABLE 2 | Profile of the sample.

Variable	CZ			SK		
	n	%	% without missing	*n*	%	% without missing
Gender						
Male	349	24.5	24.5	606	36.1	36.1
Female	1,073	75.5	75.5	1,071	63.9	63.9
Age						
≤20	193	13.6	13.6	206	12.3	12.3
21–25	891	62.7	62.7	1,239	73.9	74.1
26–30	171	12	12	143	8.5	8.5
≥31	166	11.7	11.7	85	5.1	5.1
Missing	1	0.1	-	4	0.2	-
Place of Residence						
Rural	457	32.1	32.1	823	49.1	49.1
Urban	965	67.9	67.9	854	50.9	50.9
Family						
Complete	1,020	71.7	71.7	1,359	81	81
Incomplete	402	28.3	28.3	318	19	19
Housing during the semester						
Away from home	772	54.3	54.3	939	56	56
Home	650	45.7	45.7	738	44	44
Form of study						
Full-time	1,041	73.2	73.2	1,550	92.4	92.4
Part-time	381	26.8	26.8	127	7.6	7.6
PHQ-9						
No	683	48	48	877	52.3	52.3
Mild	406	28.6	28.6	479	28.6	28.6
Moderate	193	13.6	13.6	185	11	11
Moderately severe	91	6.4	6.4	90	5.4	5.4
Severe	49	3.4	3.4	46	2.7	2.7
PSS-10						
Low	186	13.1	13.1	193	11.5	11.5
Moderate	1,053	74.1	74.1	1,331	79.4	79.4
High	183	12.9	12.9	153	9.1	9.1
GAD-7						
No	849	59.7	59.7	1,097	65.4	65.4
Mild	372	26.2	26.2	385	23	23
Moderate	131	9.2	9.2	136	8.1	8.1
Severe	70	4.9	4.9	59	3.5	3.5
Field of study						
Education	277	19.5	19.5	80	4.8	4.8
Humanities and Arts	101	7.1	7.1	78	4.7	4.7
Social, Economic and Legal Sciences	665	46.8	46.8	671	40	40
Natural Science	50	3.5	3.5	73	4.4	4.4
Design, Technology, Production and Communications	93	6.5	6.5	164	9.8	9.8
Agricultural and Veterinary Sciences	67	4.7	4.7	53	3.2	3.2
Health Service	54	3.8	3.8	180	10.7	10.7
Services (tourism, sports, security, transport, logistics)	69	4.9	4.9	240	14.3	14.3
Informatics, Mathematics & ICT	46	3.2	3.2	138	8.2	8.2

CZ, Czech Republic; SK, Slovakia; n, frequency; ICT, Information and Communication Technologies.

scores in the sorting categories of the selected characteristics are presented. The presentation of results is provided in order of gender, age, residence, family, housing during the semester, form of study, depressive symptoms (PHQ-9), stress (PSS-10), and anxiety symptoms (GAD-7). Subsequently, the results of a regression model focusing on the relationships

TABLE 3 | Mean values of the IAT and its subscales in the classification by gender.

Country	Gender	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	Male	4.97	6.24	5.40	3.09	4.42	2.23	25.69
	Female	4.37	6.57	5.07	3.36	4.50	1.48	24.95
	Diff* sig. $\alpha < 0.05$	Yes	No	No	Yes	No	Yes	No
SK	Male	5.50	7.39	5.34	3.37	4.88	1.92	28.08
	Female	4.24	6.66	4.76	3.32	4.56	1.40	24.84
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	No	Yes	Yes	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; IAT, Internet Addiction Test.*

TABLE 4 | Mean values of the IAT and its subscales in the classification by age.

Country	Age	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	≤20	4.78	6.78	5.63	3.46	4.65	1.56	26.83
	21–25	4.74	6.82	5.44	3.34	4.88	1.71	26.35
	26–30	4.36	5.85	4.78	3.10	3.82	1.78	23.13
	≥31	3.13	5.04	3.44	3.03	2.86	1.43	18.67
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SK	≤20	5.08	7.24	5.34	3.41	4.95	1.65	27.71
	21–25	4.72	6.94	5.01	3.30	4.72	1.57	26.01
	26–30	4.79	7.30	5.06	3.87	4.56	1.72	27.21
	≥31	3.41	5.24	3.28	2.94	3.47	1.54	19.66
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	No	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; IAT, Internet Addiction Test.*

TABLE 5 | Mean values of the IAT and its subscales in the classification by residence.

Country	Residence	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	Rural	4.55	6.43	5.28	3.33	4.71	1.54	25.38
	Urban	4.50	6.52	5.09	3.27	4.37	1.72	25.02
	Diff* sig. $\alpha < 0.05$	No	No	No	No	Yes	No	No
SK	Rural	4.49	6.71	4.96	3.37	4.72	1.54	25.59
	Urban	4.90	7.13	4.98	3.31	4.64	1.64	26.41
	Diff* sig. $\alpha < 0.05$	No	No	No	No	No	No	No

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; IAT, Internet Addiction Test.*

between Internet addiction and these selected characteristics are presented.

Results of Frequency Analysis

In terms of overall IAT scores, 984 (69.2%) Czech students and 1,122 (66.9%) Slovak students showed no symptoms of internet addiction, i.e., normal internet usage. Mild internet addiction was found in 387 (27.2%) Czech and 452 (27.0%) Slovak students. Moderate internet addiction was identified in 49 (3.4%) students from the Czech Republic and in 100 (6.0%) students from Slovakia. Two (0.1%) Czech and three (0.2%) Slovak students reported severe internet addiction.

Results of Descriptive and Difference Analyzes

In **Tables 3–11**, the IAT subscales were compared between groups of students with selected sociodemographic, academic, and psychological characteristics. Socio-demographic and academic characteristics make it possible to identify groups of students who should be given increased attention. Psychological characteristics make it possible to capture the intensity of mental health problems that may co-occur with increased internet addiction.

Based on the results from **Table 3**, it was possible to confirm gender differences in Salience, Anticipation and Neglect Social Life in the Czech Republic. In the case of Salience and Neglect

TABLE 6 | Mean values of the IAT and its subscales in the classification by family.

Country	Family	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	Complete	4.49	6.54	5.21	3.32	4.51	1.64	25.27
	Incomplete	4.58	6.35	5.00	3.23	4.41	1.71	24.79
	Diff* sig. $\alpha < 0.05$	No	No	No	No	No	No	No
SK	Complete	4.70	6.85	4.96	3.36	4.65	1.58	25.93
	Incomplete	4.69	7.24	5.01	3.26	4.80	1.62	26.35
	Diff* sig. $\alpha < 0.05$	No	No	No	No	No	No	No

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; IAT, Internet Addiction Test.*

TABLE 7 | Mean values of the IAT and its subscales in the classification by housing during the semester.

Country	Housing during the semester	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	Away from home	4.96	7.01	5.49	3.34	4.69	1.75	26.84
	Home	4.00	5.87	4.74	3.24	4.23	1.56	23.11
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	No	Yes	Yes	Yes
SK	Away from home	5.02	7.35	5.37	3.41	4.99	1.64	27.58
	Home	4.28	6.38	4.46	3.25	4.28	1.53	24.01
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	No	Yes	No	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; IAT, Internet Addiction Test.*

TABLE 8 | Mean values of the IAT and its subscales in the classification by form of study.

Country	Form of study	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	Full-time	4.75	6.77	5.46	3.34	4.76	1.68	26.28
	Part-time	3.87	5.72	4.30	3.17	3.72	1.62	22.00
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	No	Yes	No	Yes
SK	Full-time	4.77	7.01	5.06	3.35	4.77	1.59	26.36
	Part-time	3.84	5.93	3.90	3.25	3.59	1.54	21.74
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	No	Yes	No	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; IAT, Internet Addiction Test.*

TABLE 9 | Mean values of the IAT and its subscales in the classification by severity of depressive symptoms.

Country	PHQ-9	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	No	3.45	5.25	4.37	2.97	3.72	1.53	20.80
	Mild	4.88	6.99	5.47	3.36	4.79	1.57	26.58
	Moderate	5.96	7.69	6.02	3.69	5.38	1.99	30.31
	Moderately severe	6.33	9.35	6.57	4.01	5.91	2.14	33.88
	Severe	7.31	9.59	7.39	4.31	6.33	2.12	36.92
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SK	No	3.61	5.74	4.07	3.00	3.88	1.42	21.48
	Mild	5.14	7.42	5.53	3.57	5.09	1.67	28.28
	Moderate	6.77	8.76	6.41	4.07	6.04	1.88	33.66
	Moderately severe	6.93	9.44	6.57	3.56	6.17	1.81	34.68
	Severe	8.11	11.91	7.54	4.22	7.24	2.35	41.07
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; PHQ-9, Patient Health Questionnaire for depressive symptoms; IAT, Internet Addiction Test.*

TABLE 10 | Mean values of the IAT and its subscales in the classification by stress level.

Country	PSS-10	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	Low	2.99	4.79	4.01	2.76	3.31	1.68	18.92
	Moderate	4.46	6.42	5.12	3.26	4.45	1.64	24.89
	High	6.39	8.59	6.51	4.01	5.87	1.78	32.82
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	No	Yes
SK	Low	2.75	5.00	3.51	2.76	3.35	1.28	18.40
	Moderate	4.73	6.89	4.98	3.39	4.68	1.61	26.09
	High	6.90	9.65	6.78	3.68	6.31	1.82	34.93
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; PSS-10, Perceived Stress Scale; IAT, Internet Addiction Test.*

TABLE 11 | Mean values of the IAT and its subscales in the classification by severity of anxiety symptoms.

Country	GAD-7	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT
CZ	No	3.85	5.75	4.75	3.06	4.05	1.57	22.54
	Mild	5.09	7.19	5.44	3.45	4.93	1.73	27.35
	Moderate	6.19	8.01	6.08	3.93	5.31	1.80	30.91
	Severe	6.39	8.90	6.76	4.06	5.73	2.14	33.93
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SK	No	4.10	6.26	4.57	3.15	4.29	1.51	23.66
	Mild	5.44	7.65	5.50	3.63	5.14	1.66	28.83
	Moderate	6.55	8.72	6.14	3.83	5.80	1.82	32.87
	Severe	6.68	10.34	6.39	3.88	6.34	2.00	35.46
	Diff* sig. $\alpha < 0.05$	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Diff sig. $\alpha < 0.05$—difference at a significance level of $\alpha < 0.05$ using Mann-Whitney U-test; CZ, Czech Republic; SK, Slovakia; GAD-7, Generalized Anxiety Disorder instrument; IAT, Internet Addiction Test.*

Social Life, higher mean values were measured for males, while in the case of Anticipation, a higher value was found for females. There was no difference in the total IAT scores between Czech male and female students. In contrast, significant gender differences between Slovak students were evident in all cases except Anticipation. In these significant cases, higher mean values were measured for males.

Table 4 shows the results of testing the differences in the IAT and its subscales between students in the age classification. Significant differences were evident among both Czech and Slovak students. The only case in which no significant difference was found was Neglect Social Life in the Slovak sample. With a focus on mean values, the most pronounced difference was observed in the oldest age group (31+), where the lowest values were found.

The results from **Table 5** indicated that whether students lived in rural or urban areas was unlikely to have a decisive effect in the development of Internet addiction. This was apparent from the fact that the only significant difference between urban and rural students was found in Lack of Control. In this analyzed case, a higher mean value was measured for Czech rural students.

Similar to residence, the family in which college students grew up did not appear to be significant in the development of internet addiction. This was supported by the results in **Table 6**, where no significant difference was found.

In addition to the mean values, **Table 7** shows the results of testing the differences in the IAT and its subscales between students who lived at home during the semester and students who lived away from home during the semester (e.g., dormitory, private accommodation, etc.). In the Czech sample, significant differences were identified in all cases except Anticipation. In the Slovak sample, significant differences were not found in two cases, namely Anticipation and Neglect Social Life. In all significant cases, higher mean values of internet addiction and its subscales were measured for students who lived away from home during the semester.

Significant differences were also revealed in the study form, which are presented along with the mean values in **Table 8**. For both Czech and Slovak students, significant differences were consistently observed in the total IAT score as well as in all its subscales except Anticipation and Neglect Social Life. Accordingly, Czech and Slovak full-time students reported higher mean values than part-time students.

Table 9 presents the mean values and the results of testing for differences between students with different severity of depressive symptoms. In all cases, significant differences were confirmed,

with a higher severity of depression being associated with a higher level of internet addiction. This was indicated by the mean values, which increased with higher severity of depressive symptoms in most cases. In other words, Czech and Slovak students with more severe depressive symptoms also showed higher scores for internet addiction and its subscales.

From **Table 10**, it was possible to conclude that the higher mean values of the total IAT scores, as well as the scores in the vast majority of the IAT subscales, were concentrated in the higher levels of stress. Thus, Czech and Slovak students with higher stress also reported higher internet addiction. Significant differences were found in most of the analyzed cases, with the exception of only one case, namely Neglect Social Life in the Czech sample.

The results in **Table 11** point to the fact that higher mean scores for internet addiction were observed in Czech and Slovak students with more severe anxiety symptoms. In all cases, significant differences in internet addiction were found between groups of students with different severity of anxiety symptoms.

Results of Multiple Negative Binomial Regression Analysis

The multiple negative binomial regression was used to assess the relationships between selected socio-demographic, academic, and psychological characteristics of Czech and Slovak college students and internet addiction. In this analysis, several variables (compared to previous outputs) appeared as cardinal variables. These variables were age (CZ = mean: 24.8 ± 6.2, min: 19, max: 52; SK = mean: 23.5 ± 4.5, min: 18, max: 54), PHQ-9 (CZ = mean: 6.3 ± 5.5, min: 0, max: 27; SK = mean: 5.8 ± 5.3, min: 0 max: 27), PSS-10 (CZ = mean: 19.8 ± 5.6, min: 4, max: 38; SK = mean: 19.3 ± 5.3, min: 2, max: 39), and GAD-7 (CZ = mean: 4.7 ± 4.6, min: 0, max: 21; SK = mean: 4.2 ± 4.3, min: 0, max: 21).

Table 12 presents the results of the analysis focusing on the possible relationships between the analyzed variables, and this table is divided into two parts by country—Slovakia (SK) and the Czech Republic (CZ). The table provides information on the β coefficient (positive coefficients present positive relationships and vice versa), p-value (relationships significant at $\alpha < 0.05$ are highlighted), standard error, and odds ratio (values >1 present positive relationships). As can be seen, a significant number of the analyzed relationships proved to be significant.

Focusing on Slovakia, significant relationships were most frequently found for gender, housing during the semester, PHQ-9 and PSS-10. In the Czech Republic, the results were similar to those in Slovakia, but more significant relationships were found also for age. In both countries, the results showed that male students were more likely to be seriously addicted to the internet compared to female students. Age was particularly significant in the Czech Republic, and the results revealed that younger students were more prone to internet addiction than older ones. Whether a student lived in an urban or rural area was relevant to internet addiction in only one case in both countries. In Slovakia, a slightly higher likelihood of Excessive Use [odds ratio (OR): 1.05] was identified for students living in urban areas. In the Czech Republic, there was a slightly higher likelihood of Lack of Control (OR: 0.93) for students living in rural areas. The family structure (complete/incomplete) in which the students grew up was not so important for internet addiction, as the only significant relationship was found in the Czech Republic. In this case, a slightly higher likelihood of Neglect Work (OR: 0.94) was identified for students from complete families. In terms of housing during the semester, the results indicated that Czech and Slovak students who lived away from home (dormitory, private accommodation, etc.) were more likely to suffer from internet addiction, including several conditions represented by the IAT subscales. The form of study proved to be significant in only one case in Slovakia. More specifically, Slovak full-time students were more likely to report Lack of Control (OR: 0.86) than part-time students. In both countries, depressive symptoms and stress could be considered significant predictors of internet addiction overall, but also in most subscales. Anxiety symptoms were significant in two cases in the Slovak sample. There was a slightly higher likelihood of lower anxiety symptoms and a higher rate of Neglect Work (OR: 0.93) and a slightly higher likelihood of lower anxiety symptoms and a higher rate of Lack of Control (OR: 0.95). One significant relationship was found in the Czech sample. It was possible to observe a slightly higher likelihood of lower anxiety symptoms and a higher rate of Lack of Control (OR: 0.95).

DISCUSSION

College students are definitely a vulnerable group in terms of psychological distress. They face many challenges during their studies, and therefore the college environment should be adapted to maintain and improve their mental health. Moreover, today's students face another threatening factor, i.e., the COVID-19 pandemic, which has brought with it many concerns and changes in the educational process (66, 67). Evidence shows that COVID-19-related fear (to die, to get sick) was relatively more common among young people (68). They were also worried the influence of COVID-19 on daily life, academic delays due to COVID-19, decreased social support during COVID-19 (69, 70). Thus, given that the pandemic poses a risk to the mental health of college students, it should be given adequate attention in research and practice.

Prevalence of Internet Addiction

From an overall perspective, during the first wave of the COVID-19 pandemic in the Czech Republic and Slovakia, mild and more severe symptoms of Internet addiction were identified in one third of college students. Moderate and severe symptoms (the cut-off point for IAT was ≥ 50) occurred in 6.02% of Slovak students and 3.5% of Czech students. In an international comparison, Thai students reported a similar prevalence, i.e., 5.8% (71), while substantially higher prevalence rates were observed in other studies. More specifically, 12.4% of internet-addicted students were found in Spain (72), 16.8% in the United States (73), 20% in Brazil (13), 28.4% in China (74), and 32.6% in Bangladesh (75). On this basis, it can be concluded that Czech and Slovak college students did not report such

TABLE 12 | Relationships of the IAT and its subscales with selected socio-demographic, academic, and psychological characteristics.

Negative binomial regression	Salience	Excessive use	Neglect work	Anticipation	Lack of control	Neglect social life	IAT total
	β p-value (SE) OR	*β p*-value (SE) OR	*β p*-value (SE) OR	*β p*-value (SE) OR	*β p*-value (SE) OR	*β p*-value (SE) OR	*β p*-value (SE) OR
SK							
α	**0.608† (0.161) 1.84**	**1.433† (0.103) 4.19**	**1.269† (0.109) 3.56**	**0.947† (0.107) 2.58**	**1.131† (0.116) 3.1**	−0.042 (0.168) 0.96	**2.728† (0.096) 15.3**
Gender: Male (ref.: Female)	**0.301† (0.041) 1.35**	**0.13† (0.026) 1.14**	**0.148† (0.027) 1.16**	0.028 (0.028) 1.03	**0.101† (0.029) 1.11**	**0.338† (0.043) 1.4**	**0.157† (0.025) 1.17**
Age	−0.003 (0.006) 1	−0.006 (0.004) 0.99	**−0.011*** (0.004) 0.99**	0.002 (0.004) 1	−0.005 (0.004) 0.99	<0.001 (0.006) 1	−0.005 (0.003) 1
Residence: Urban (ref.: Rural)	0.064 (0.04) 1.07	**0.052** (0.026) 1.05**	<0.001 (0.026) 1	−0.018 (0.027) 0.98	−0.021 (0.028) 0.98	0.032 (0.043) 1.03	0.021 (0.024) 1.02
Family: Incomplete (ref.: Complete)	−0.07 (0.051) 0.93	0.017 (0.032) 1.02	−0.012 (0.033) 0.99	−0.036 (0.035) 0.96	0.013 (0.036) 1.01	0.002 (0.053) 1	−0.022 (0.031) 0.98
Housing during the semester: Home (ref.: Away from home)	**−0.112*** (0.041) 0.89**	**−0.105† (0.026) 0.9**	**−0.127† (0.027) 0.88**	−0.032 (0.028) 0.97	**−0.1† (0.029) 0.9**	−0.053 (0.043) 0.95	**−0.096† (0.025) 0.91**
Form of study: Part-time (ref.: Full-time)	−0.101 (0.095) 0.9	−0.04 (0.061) 0.96	−0.073 (0.064) 0.93	−0.013 (0.064) 0.99	**−0.155** (0.07) 0.86**	−0.002 (0.099) 1	−0.078 (0.056) 0.93
PHQ-9	**0.207† (0.027) 1.23**	**0.154† (0.017) 1.17**	**0.169† (0.017) 1.18**	**0.084† (0.018) 1.09**	**0.161† (0.018) 1.17**	**0.109† (0.028) 1.11**	**0.164† (0.016) 1.18**
PSS-10	**0.293† (0.051) 1.34**	**0.166† (0.033) 1.18**	**0.193† (0.033) 1.21**	0.043 (0.035) 1.04	**0.169† (0.036) 1.18**	**0.116** (0.053) 1.12**	**0.185† (0.031) 1.2**
GAD-7	−0.04 (0.035) 0.96	−0.014 (0.022) 0.99	**−0.073*** (0.023) 0.93**	0.001 (0.024) 1	**−0.049** (0.024) 0.95**	−0.031 (0.037) 0.97	−0.036* (0.021) 0.97
Pseudo R^2 - Nagelkerke	0.15	0.181	0.183	0.036	0.139	0.062	0.194
CZ							
α	**1.129† (0.146) 3.09**	**1.581† (0.097) 4.86**	**1.727† (0.094) 5.62**	**1.059† (0.103) 2.88**	**1.61† (0.106) 5**	0.259* (0.153) 1.3	**3.06† (0.087) 21.32**
Gender: Male (ref.: Female)	**0.226† (0.049) 1.25**	0.012 (0.033) 1.01	**0.116† (0.03) 1.12**	−0.033 (0.036) 0.97	0.039 (0.035) 1.04	**0.451† (0.049) 1.57**	**0.093*** (0.03) 1.1**
Age	**−0.015† (0.005) 0.98**	**−0.007** (0.003) 0.99**	**−0.02† (0.003) 0.98**	**−0.007** (0.003) 0.99**	**−0.022† (0.003) 0.98**	−0.005 (0.005) 1	**−0.013† (0.003) 0.99**
Residence: Urban (ref.: Rural)	−0.017 (0.044) 0.98	0.018 (0.029) 1.02	−0.028 (0.028) 0.97	−0.016 (0.031) 0.98	**−0.071** (0.031) 0.93**	0.089* (0.048) 1.09	−0.012 (0.027) 0.99
Family: Incomplete (ref.: Complete)	−0.007 (0.046) 0.99	−0.059* (0.031) 0.94	**−0.061** (0.029) 0.94**	−0.045 (0.033) 0.96	−0.048 (0.033) 0.95	0.03 (0.049) 1.03	−0.043 (0.028) 0.96
Housing during the semester: Home (ref.: Away from home)	**−0.152† (0.045) 0.86**	**−0.123† (0.03) 0.88**	−0.051* (0.028) 0.95	<0.001 (0.032) 1	0.005 (0.032) 1.01	**−0.125*** (0.048) 0.88**	**−0.087*** (0.027) 0.92**
Form of study: Part-time (ref.: Full-time)	0.042 (0.062) 1.04	−0.016 (0.041) 0.98	−0.012 (0.039) 0.99	0.032 (0.044) 1.03	−0.032 (0.044) 0.97	0.119 * (0.065) 1.13	0.01 (0.038) 1.01
PHQ-9	**0.171† (0.029) 1.19**	**0.16† (0.019) 1.17**	**0.125† (0.018) 1.13**	**0.069† (0.021) 1.07**	**0.135† (0.02) 1.14**	**0.122† (0.031) 1.13**	**0.14† (0.018) 1.15**
PSS-10	**0.209† (0.05) 1.23**	**0.123† (0.033) 1.13**	**0.121† (0.031) 1.13**	**0.083** (0.035) 1.09**	**0.149† (0.035) 1.16**	−0.034 (0.051) 0.97	**0.136† (0.03) 1.15**
GAD-7	−0.005 (0.037) 0.99	−0.035 (0.024) 0.97	−0.039* (0.023) 0.96	0.011 (0.026) 1.01	**−0.053** (0.026) 0.95**	0.017 (0.039) 1.02	−0.021 (0.023) 0.98
Pseudo R^2 - Nagelkerke	0.139	0.175	0.183	0.056	0.165	0.092	0.192

*Significance: *p-value < 0.1, **p-value < 0.05, ***p-value < 0.01, †p-value < 0.001. Significant results are highlighted in bold.*

OR, odds ratio; CZ, Czech Republic; SK, Slovakia; PHQ-9, Patient Health Questionnaire for depressive symptoms; PSS-10, Perceived Stress Scale; GAD-7, Generalized Anxiety Disorder instrument; IAT, Internet Addiction Test.

a high prevalence as in other countries, despite the COVID-19 pandemic. A possible explanation is the cultural differences emphasized in the study conducted by Lozano-Blasco et al. (76). However, the problem is mainly the fact that internet addiction is currently not given sufficient attention in the Czech Republic and Slovakia, which may result in serious consequences in the near future.

Differences and Predictors of Internet Addiction

When assessing internet addiction overall as well as in its subscales, there were differences between students in almost all cases in Slovakia, while in the Czech Republic the occurrence of differences was not as frequent. In more detail, there were several significant differences between males and females. In the case of age, older students reported lower rates of internet addiction. At the same time, students who lived away from home during the semester were found to have significantly higher rates of internet addiction compared to students who lived at home. In terms of the form of study, it can be noted that higher scores for internet addiction and most of its subscales were observed in full-time students. The results for place of residence (urban and rural) and family structure did not show significant differences. The results showed that there were significant differences in internet addiction between the categories of depressive symptoms, anxiety symptoms, and stress symptoms. This finding can be interpreted in such a way that higher mean IAT scores occurred in students with higher levels of psychological distress. The results of the multiple negative binomial regression analysis showed that the main predictors of internet addiction in Czech and Slovak students include gender, age, housing during the semester, depressive symptoms, and stress. The main findings are discussed below.

Gender

In both countries, male students were more likely to suffer from internet addiction than female students. Other studies also revealed a higher risk of problematic internet use or internet addiction in male students compared to female students (18, 38, 40–43). The predominance of males in this type of problematic behavior is evident (77). Online behavior is considered more "normal" for males than females. In this context, social norms, socio-cultural attitudes, but also a lower digital participation of females may play an important role in terms of protective factors (78). However, there is also evidence of female susceptibility to internet addiction (79). A possible explanation for this is the pandemic itself, which may have erased male dominance in terms of internet addiction (6). Nevertheless, such a result occurs less frequently in studies. According to Lin et al. (36), the main online activity among college students with moderate and severe internet addiction was online gaming for males and online streaming for females. Having roommates who engage in similar internet entertainment was a risk factor for internet addiction only for males, while the absence of a romantic relationship was a risk factor for internet addiction only for females. Internet infatuation before college and difficulty adjusting to college life were common risk factors for both genders in the groups of students with mild and moderate internet addiction. In any case, gender is a significant factor in the issue of internet addiction (32).

Age

In terms of other demographic characteristics, Khazaie et al. (37) revealed that age is also one of the significant predictors of internet addiction. In this study, younger age appeared to be a risk factor especially in the Czech Republic. Similar findings were revealed by Fernández-Villa et al. (12). This is consistent with the findings of Arzani-Birgani et al. (38), who concluded that age is inversely related to internet addiction. Regarding the new younger generations, their greater susceptibility can be explained by an increase of individualism, lower sociability and enculturation (76).

Residence

With a focus on place of residence, Slovak urban students showed a slightly higher likelihood of Excessive Use, while Czech rural students showed a slightly higher likelihood of Lack of Control. The identified discrepancy between the analyzed countries requires further investigation. The results can be compared to those of Zewde et al. (40) who found in their study that students from urban areas are more likely to be addicted to the internet. It is generally known that urban areas are more internet accessible and urban individuals make greater use of the internet, which may explain the higher rates of addictive behavior in urban areas (80–82).

Housing During the Semester

This study also showed consistent results for housing during the semester. More specifically, Czech and Slovak students who lived away from home (dormitory, private accommodation, etc.) were more likely to be addicted to the internet compared to students who lived at home. The results of Ramón-Arbués et al. (39) also showed that the likelihood of problematic internet use was significantly related to the habitation status of college students. However, the results of this study are not consistent with those of Kivrak and Kivrak (83), who found that dormitory students suffer from internet addiction less than those staying at home. Thus, dormitory housing did not prove to be a protective factor in this study, although dormitory students seem to have more difficult access to the internet.

Family

In this study, family structure (complete/incomplete) was not found to be significant in the majority of cases; only one significant relationship with Neglect Work was found in the Czech Republic. This is inconsistent with other studies that emphasize the role of the family environment in the issue of Internet addiction (84, 85). Regarding the form of study, Slovak full-time students were more likely to report Lack of Control compared to part-time students. A similar result was found in a neighboring country, Poland. Thus, increased problematic internet use was observed in full-time students (43). However, this study did not show any other significant relationship between the form of study and internet addiction or its subscale. Thus, family and study form did not play as important a role as in

other studies. Possible explanations are cultural differences and different study conditions across countries.

Depressive Symptoms, Anxiety Symptoms, Stress

In addition to the socio-demographic profile, significant relationships were also clearly evident for the psychological profile of the students. In this context, Czech and Slovak students with depressive symptoms were more prone to internet addiction. In comparison with national studies, it was also revealed in Slovakia by Sebena et al. (44) that depressive symptoms predict problematic internet use. In international comparison, similar results were confirmed by Yoo et al. (86) and Chi et al. (84). Truzoli et al. (18) also revealed similar results and confirmed that students with severe depression are at higher risk of problematic internet use during the COVID-19 pandemic, while social support, self-efficacy, and self-esteem appeared to be protective factors in their study. It was possible to agree with Werner et al. (6), who found that depressive symptoms were associated with internet addiction in college students, and this phenomenon was observed in both the pre-pandemic and pandemic periods. However, a bidirectional association can also be considered. The fact is that baseline depression has a significant net-predictive effect on follow-up internet addiction, and baseline internet addiction has a significant net-predictive effect on follow-up depression (87). The issue is thus more complex than it seems.

In terms of stress, the results of this study are consistent with those of Yang et al. (31), who found that stress is associated with internet addiction in college medical students. Gong et al. (33) also confirmed a significant predictive effect of perceived stress on internet addiction among college students. Thus, it can be concluded that perceived stress increases the risk of internet addiction among young people (86).

Overall, the findings of this study are consistent with those of Mota et al. (16), who stated that common mental disorders are the variables that best explain problematic internet use, and emphasized that high levels of digital socialization should be considered in mental health care interventions targeting college students in the context of COVID-19. In other words, mental distress is a significant risk factor for internet addiction (88), and the presented study contributes to this knowledge. For students with depression and stress, internet use is believed to be a coping strategy for negative emotions (89–91) or stressful situations (89, 92).

Finally, this study revealed that lower anxiety occurred in students with a higher rate of internet addiction in subscales such as Neglect Work and Lack of Control. These findings can be explained by the fact that higher score on internet addiction may be a protective factor against anxiety in students, which was revealed in a study by Ismail et al. (93). On the other hand, there are inconsistent findings (94, 95). Cai et al. (30) found that students with more severe anxiety symptoms were independently and significantly associated with more severe problematic internet use. In other words, students with a higher level of anxiety tend to have a greater likelihood of internet addiction (32). Thus, it was possible to observe inconsistencies in the results with other studies (6), suggesting that the relationship between anxiety and internet use is a complex issue, as in the case of depression.

Based on all the above-mentioned findings, it was possible to agree that the co-existence of internet addiction and depressive symptoms, anxiety symptoms, and stress in college students indicates that internet addiction is associated with other psychological problems (38). From the opposite point of view, students who were psychologically well were less likely to be addicted (35, 42).

Implications for Mental Health Policies

Internet addiction and psychological distress in college students are two problems that require increased attention at all times, especially in a difficult period such as a pandemic. The findings of this study may emphasize the importance of the issue and encourage the development of early preventive and protective interventions against problematic internet use to promote the health of college students in the Czech Republic and Slovakia as two countries that are largely neglected in terms of proactive steps. In addition to promoting healthy use of the internet as such, policy makers should take actions to alleviate psychological distress among college students, which could be beneficial in reducing internet addiction. It is recommended to provide college students with the necessary psychological care, especially for symptoms of depression and stress. In these cases, excessive use of the internet is not recommended to improve mood, as it can contribute to deteriorating mental health (17). On the contrary, it is highly recommended to promote the benefits of physical activity (32, 96). This study also suggests that strategies and programs should particularly target male students and students who lived away from home during the semester. All relevant actors, including college teachers, experts, parents and policy makers, should be involved in addressing this problem, which requires a comprehensive approach. This is emphasized particularly in countries such as the Czech Republic and Slovakia, where it is evident that insufficient attention is being paid to this problem, which may have more serious consequences in the future. In these countries, access to help for students should be improved, both in the college environment and in the specialized counseling centers. In this context, it is recommended to identify in time the students who need this help, as well as to provide relevant assistance to students seeking help. However, all these steps inevitably require social, legislative and professional support, which is currently underestimated and insufficient in both countries (97). The authors call for greater research interest in this issue and for the implementation of evidence-based measures into practice in the Czech and Slovak conditions.

Strengths and Limitations

This study has many strengths, which include in particular the sample size, but also the uniqueness of the findings for mental health policies in the Czech Republic and Slovakia, where the issue is under-researched and poorly evidence-based. The findings of this study fill a substantial research gap in this region and can therefore be considered novel. The study offers a detailed statistical insight into the issue and provides a valuable basis for

further research, as well as effective mechanisms and successful strategies and programs.

The study did not avoid certain limitations. In this respect, the situation in the Czech Republic and Slovakia during the pandemic did not allow for a fully balanced sample. For this reason, the ratio of male to female students was slightly skewed in favor of female students (especially in the Czech Republic). As males are generally more addicted to the internet compared to females, there may have been some bias. Differences in the duration and mode of online (distance) learning in the Czech Republic and Slovakia may have had some, but minimal, effects on the sample. During the pandemic, distance learning was implemented to a greater extent in Slovakia than in the Czech Republic. In terms of country development, it can be assumed that the initial implementation of distance learning in Slovakia was of lower quality than in the Czech Republic. However, the authors do not expect this bias to be so significant as to substantially affect the results.

The research was conducted during the pandemic characterized by many specifics (online learning, isolation, social distance, etc.); therefore, future research should focus on the post-pandemic state.

CONCLUSION

Internet addiction among young adults is a phenomenon of recent years that has been more highlighted by the COVID-19 pandemic. Physical distance has required college students to use the internet for virtually all daily activities during the pandemic. For this reason, it is important to identify and monitor vulnerable groups in order to prevent the situation from worsening in the future. However, this cannot be done without knowledge of the risk factors that commonly characterize students and which should be the focus of proactive actions. All of this was the motivation for conducting the presented study, which aimed to assess the relationships between internet addiction and selected socio-demographic, study-related, and psychological characteristics of college students in the Czech Republic and Slovakia. In addition, the rationale for the research was based on the previous lack of attention in these two countries. This study mapped the situation and pointed to a problem that could have serious consequences in the future. The main findings showed that male students and students who lived away from home during the semester were more likely to be addicted to the internet both overall and in terms of most of the individual subscales of internet addiction. Depressive symptoms and stress could also be considered significant predictors in both countries. Thus, these groups of students can be identified as vulnerable and should be targeted by protective and preventive actions. The existing relationships between internet addiction and positive screening for psychological distress and other demographic and academic characteristics of students are an alert for professionals to address and further investigate this serious issue. Knowledge of these relationships provides an opportunity to implement effective protective and preventive measures, such as psychoeducation, and to offer appropriate treatment.

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 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. All respondents were over 18 years of age and provided their informed consent to participate in this research.

AUTHOR CONTRIBUTIONS

BG: conceptualization, investigation, 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, supervision, and funding acquisition. MR: conceptualization, methodology, software, data curation, formal analysis, investigation, writing—original draft preparation, writing—review and editing, and visualization. TM: conceptualization, investigation, resources, writing—original draft preparation, writing—review and editing, visualization, supervision, and project administration. All authors contributed to manuscript revision, read, and approved the submitted version.

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Effects of Stressors of COVID-19 on Chinese College Students' Problematic Social Media Use: A Mediated Moderation Model

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Purpose: Isolation policies are long-term and strictly enforced in China during the COVID-19 outbreak. Social media might be widely used for communication, work, understanding the development of the epidemic, etc. However, these behaviors might lead to problematic social media use. The present study investigated the effect of stressors of COVID-19 on problematic social media use, as well as the internal mechanisms involved.

Methods: One thousand three hundred seventy-three Chinese college students (M_{age} = 19.53, SD_{age} = 1.09) were recruited randomly from four grades who completed Coronavirus Stress Scale, Fear of Missing Out Scale, Problematic Mobile Social Media Usage Assessment Questionnaire, and Regulatory Emotional Self-Efficacy Scale.

Results: Stressors of COVID-19 were positively related to problematic social media use. The link between stressors of COVID-19 and problematic social media use was mediated by fear of missing out. Additionally, the association between fear of missing out and problematic social media use, as well as the association between stressors of COVID-19 and problematic social media use were moderated by regulatory emotional self-efficacy.

Conclusion: The current findings reveal the mechanism that may be used to reduce the likelihood of problematic social media use in the context of the COVID-19 outbreak. To prevent and intervene in problematic social media use during the COVID-19 pandemic, this study stressed the importance of decreasing the fear of missing out and enhancing regulatory emotional self-efficacy.

Keywords: stressors of COVID-19, Chinese college students, problematic social media use, fear of missing out, regulatory emotional self-efficacy

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HIGHLIGHTS

- Stressors of COVID-19 were positively related to smartphone problematic social media use.
- The effect of stressors of COVID-19 on smartphone problematic social media use was mediated by fear of missing out.
- The effect of fear of missing out on smartphone problematic social media use was moderated by regulation emotional self-efficacy. The effect of stressors of COVID-19 and smartphone problematic social media use was moderated by regulation emotional self-efficacy.

INTRODUCTION

COVID-19 has caused significant negative consequences for the global economy, culture, life and public health (1, 2). Due to the COVID-19 pandemic, authorities implemented rigorous measures such as isolation to diminish infection rates (3, 4). Isolation policies that are long-term and strictly enforced may lead to significant changes in how adolescents engage socially (5, 6). Due to social distancing, smartphone social media use has increased for gathering epidemic information, studying, working, alleviating boredom, and social networking online (7, 8). Social media is an essential tool in daily life during the COVID-19 epidemic (9, 10).

However, excessive social media use can be harmful. There is a sense of withdrawal when the user temporarily leaves the online world (11, 12). Then, improper social media usage may increase the likelihood of addiction during the epidemic (13, 14). Since the classification of problematic Internet use is conceptually unclear, there is a lack of consensus among academics on the definition of problematic social media use (15, 16). In comparison, addiction-like symptoms and everyday life disruptions have been attributed to the use of social media which is characterized by "addiction-like" behavior and exacerbates disputes with family and friends (17, 18). Most scholars recognize that problematic social media use refers to individuals spending a significant amount of time on social media, resulting in impairment of the individual's social, physical and mental health (11, 19, 20). Increasing numbers of studies from various countries describe its potential negative consequences that cannot be ignored. For instance, researchers revealed that problematic use of social media was positively correlated with depression and insomnia (21). Furthermore, Al-Menayes (22) found that social media addiction harmed academic performance. Moreover, the research revealed that Facebook addiction predicted suicide ideation and behavior (23). Kaye (24) found that physical health was linked to excessive social media usage. As a result, although prior researchers have discovered the detrimental consequences of problematic social media use, little research was undertaken among Chinese college students during the epidemic, which is one of the study's focal focuses.

Stressors of COVID-19 and Problematic Social Media Use

Stress is caused by an inability to meet the multiple demands of one's environment, which may overwhelm an individual's capacity to adapt (25). Although keep social distancing played a very important role during the epidemic, it also negatively affected the individual's social activities. Due to the lack of effective medication for COVID-19, anxiety, and depression symptoms accompany a loss of control over an individual's daily activities (4, 26). Individuals suffered severe stress during COVID-19 (27, 28). Lazarus and Folkman distinguished two kinds of strategies in people's coping with stress: problem-focused coping and emotion-focused coping (29). One included an attempt to resolve the stress(itself)-causing the problem, while the other described people's attempts to manage the emotions that are prompted by stress. During the epidemic, people might obtain COVID-19 related information *via* social media with problem-focused coping strategies which could keep abreast of COVID-19 (8, 9). In addition, people might join online communities for social support to cope with their negative feelings caused by the pandemic (7, 30). Nevertheless, it's important to take into account the potentially harmful effects of problematic social media use through some online activities (17, 31). Previous researches showed the problematic use of SNS was favored by unmet need to belong and anxious attachment style (32, 33). Recent studies were conducted before the COVID-19 pandemic which had found daily stress had a significant effect on addictive social media (12, 34, 35). Therefore, we proposed that Chinese college students who experienced higher stressors of COVID-19 might be at higher risk of problematic social media use.

The Mediation Effect of Fear of Missing Out

According to stress-coping strategies (29), college students are subjected to stressors of COVID-19, which may lead to an increase in problematic social media use. Simultaneously, other psychological variables may also have a significant influence on the relationship between stress and problematic social media use. Then, while examining the impacts of stressors of COVID-19, it is critical to examine the mediators that influence the emergence of problematic social media use. Fear of missing out is characterized as a constant fear that others may be enjoying gratifying experiences that one is not a part of, and the urge to keep up with what others are doing (36). The fear of missing out has grown ubiquitous in popular society (37, 38). Eighty-one percent of participants in recent research of 936 people from various socio-demographic backgrounds reported experiencing fear of missing out at least periodically (39). Previous studies have found that the association between negative factors and social media engagement was mediated by fear of missing out (36). Meanwhile, fear of missing out was an important risk factor for social media engagement (37, 40). Earlier researches addressed fear of missing out as a trait variable, but more academic work has examined the degree to which environmental signals, such as checking social media postings, might cause state- fear of missing out (41). When individuals utilize digital tools to keep track of tantalizing things on social media about desirable online activities, they may get state-fear of missing out (42, 43). In this study, the variable we investigate is the state- fear of missing out. In contrast to previous studies, our study focuses on determining how fear of missing out has evolved during the COVID-19 epidemic when individuals reduced their outside activities in favor of online activities. People keep social distance to prevent the spread of COVID-19, which is an effective measure. However, the unique features of COVID-19 make it an exceptional situation, with concomitant anxiety and depressive symptoms accompanied by a loss of social support (i.e., control over daily life and offline social interaction) (28, 44). With chronic psychological deficits, people are continually looking for updates through social media (9, 45). According to the social compensation theory (46), individuals seeking online support are motivated by a lack of offline social support. Previous researchers found that online social media

could remind individuals that they might have missed otherwise (16, 43). During the epidemic, people mainly use smartphone social media to obtain information about the epidemic and conduct social activities to reduce negative emotions (27). With constant access to online social media, individuals increasingly expect and await feedback. Then, individuals are afraid of missing out on this instant information related to COVID-19 from authority and feedback from their friends (16, 42), which may lead to a higher level of fear of missing out during COVID-19. Fear of missing out includes unmet social needs and has symptoms of depression and anxiety (41, 42, 45). In conformity with the compensatory Internet use theory (47), when individuals experience negative events or emotions, they turn to the Internet to relieve these confusions, leading to Internet overuse. During the pandemic of COVID-19, pandemic-related social distancing and limiting public gatherings led to fewer socialization options. When people were under stressors, they often unconsciously unlocked their phones and used online social media (40, 48), which might increase problematic social media use (18, 35). As a result, stressors of COVID-19 are associated with an increased risk of problematic social media use in those who use social media to alleviate their fear of missing out on meeting their social support requirements. We hypothesized in this research that the association between stressors of COVID-19 and Chinese college students' problematic social media use was mediated by fear of missing out.

The Moderating Role of Regulatory Emotional Self-Efficacy

A stressor will not have a detrimental effect on those with adequate coping resources, according to stress-coping strategies (16, 29, 49). To put it another way, a person's behavior is not just determined by the amount of stress they experience but also by how effectively they are able to manage that stress (50). Researchers found that the ability of stress-coping moderated the relationship between stressful life events and a wide range of developmental outcomes, including substance use, externalizing problems, and internalizing problems (51–53). During the epidemic, not all individuals who experience stressors of COVID-19 increase their fear of missing out and suffer from problematic social media use. The heterogeneity of outcomes may reflect individual characteristics (54) that moderate (i.e., protect) the effect of stressors of COVID-19 on problematic social media use. One such protective factor may be regulatory emotional self-efficacy.

Regulatory emotional self-efficacy refers to a person's perceived degree of confidence in their capacity to manage emotions (55, 56). In accord with the self-efficacy theory (57), individuals only have the motivation to carry out the activity if they believe that the prospective result can be achieved. Previous studies have confirmed that regulatory emotional self-efficacy played a vital role in individuals' actual engagement in adaptive behavior (58, 59). Several previous findings have demonstrated that regulatory emotional self-efficacy was negatively related to addictive behavior, which plays a protective role (56–61).

The association between environmental risk factors and problem behaviors would be reduced by individual attributes such as regulatory emotional self-efficacy, in line with the "risk buffering hypothesis" (62–64). The hypothesis proposed that protective factors may mitigate the negative consequences of risk factors. Regulatory emotional self-efficacy may serve as a buffer in this study. As individuals feel more stress, psychological needs in their lives are not met, but individuals with higher levels of emotion management abilities leave individuals with lower needs for desired compensation which lead to less problematic social media use behaviors (65). Furthermore, as the fear of missing out rises, individuals in their lives are at a lower risk of tending to use mobile social media due to higher emotional management abilities (66). Then, potentially harmful results (problematic social media use) might be reduced by the combination of protective (regulatory emotional self-efficacy) and risk (stressors of COVID-19, fear of missing out) variables that interact. The "risk buffering hypothesis" is confirmed by empirical researches. For instance, Guo et al. (67) found that regulatory emotional self-efficacy played a moderated role in the association between parental psychological control and adolescent non-suicidal self-injury. Besides, the previous research also revealed that the link between emotional reactivity and suicide ideation was buffered by regulatory emotional self-efficacy (59). Meanwhile, Pan et al. (68) found that individuals with high levels of regulatory emotional self-efficacy have a lower risk of Internet addiction. Taken together, we predicted that regulatory emotional self-efficacy moderated the effect of stressors of COVID-19 on problematic social media use, as well as the effect of fear of missing out on problematic social media use.

The Present Study

To summarize, we developed a moderated mediation model to address three questions: (a) whether stressors of COVID-19 would be linked with problematic social media use, (b)whether the effect of stressors of COVID-19 on problematic social media use would be mediated by fear of missing out, (c)whether regulatory emotional self-efficacy would moderate the effect of

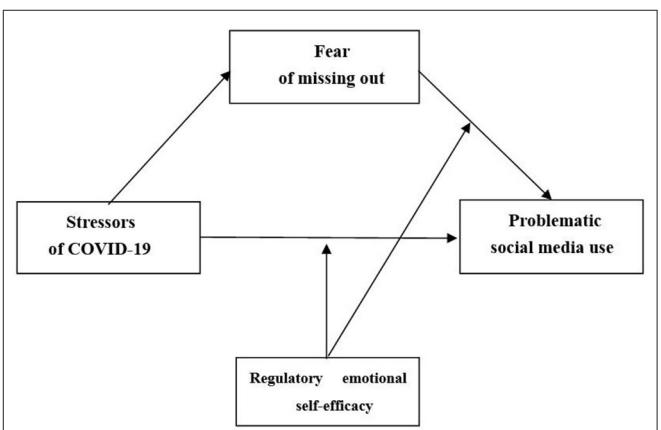

FIGURE 1 | Conceptual model.

fear of missing out on problematic social media use as well as the effect of stressors of COVID-19 on problematic social media use. The moderated mediation model was outlined in **Figure 1**. We put forward three hypotheses:

Hypothesis 1: Stressors of COVID-19 are positively correlated with problematic social media use.

Hypothesis 2: The effect of stressors of COVID-19 on problematic social media use would be mediated by fear of missing out.

Hypothesis 3: The effect of fear of missing out on problematic social media use would be buffered by regulatory emotional self-efficacy. The effect of stressors of COVID-19 on problematic social media use would be buffered by regulatory emotional self-efficacy.

METHOD

Participants

One thousand four hundred two Chinese college students were recruited in China. The criteria for unqualified participants were <100 s to complete questionnaires with a total of 47 questions and regularity of answers, such as the same score in each item or a regular pattern of scores (1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, etc.). After excluding unqualified samples (e.g., completed questionnaire <100 s and answered regularly), we finally collected 1,373 (M_{age} = 19.53, SD_{age} = 1.09) valid questionnaires with an effective response rate of 97.93% from 1,402 primary questionnaires. The mean age ranges from 18 to 23 years. 56.67% of participants were females. Regarding their grades, 26.91% were freshmen, 21.15% were sophomores, 29.31% were junior students, and 22.63% were senior students.

Instruments

The Coronavirus Stress Scale

We used the 5-item Coronavirus Stress Scale (69) to measure individuals' perceived COVID-19 related stress. All items (e.g., How often have you felt that you were unable to control the important things in your life due to the COVID-19 pandemic?) were rated on a five-point scale (from 1 = never to 5 = very often). Applied to Chinese samples, the cultural adaption and reliability of the revised scale are well (70, 71), and the validity of the revised scale is well (71–73). The goodness of fit [CFI = 0.91, TLI = 0.91, RMSEA = 0.08, 90% *CI* = (0.07, 0.09)] of confirmatory factor analysis of the Coronavirus Stress Scale in this study indicated that fit indicators in accordance with the cutoffs recommended in the literature actually showed a satisfactory adequacy, indicating that the scale had good construct validity. In this study, Cronbach's α for the scale was 0.90.

Fear of Missing Out Scale

We used the 10-item Fear of Missing Out Scale (36) to assess the missing out on social events and spending time with friends. Each item (e.g., I fear that my friends have more rewarding experiences than me.) was rated on a five-point scale (from 1 = Not at all true of me" to "5 = Extremely true of me). Applied to Chinese samples, the cultural adaption and reliability of the revised scale are well (40, 74, 75), and the validity of the revised scale is well (74, 76). The goodness of fit [CFI = 0.92, TLI = 0.91, RMSEA = 0.08, 90% *CI* = (0.07, 0.09)] of confirmatory factor analysis of the Fear of Missing Out Scale in this study indicated that that fit indicators in accordance with the cutoffs recommended in the literature actually showed a satisfactory adequacy, indicating that the scale had good construct validity. In this study, Cronbach's α for the scale was 0.89.

Problematic Mobile Social Media Usage Assessment Questionnaire

We used the 20-item Problematic Mobile Social Media Usage Assessment Questionnaire (77) to evaluate problematic smartphone social media usage. All the items (e.g., If you are delayed in doing business due to using social networks, you often regret that you have lost your time by playing on your mobile phone.) were rated on a five-point scale (1 = never to 5 = very often). Applied to Chinese samples, the cultural adaption and reliability of the revised scale are well (20, 78, 79), and the validity of the revised scale is well (20, 80). The goodness of fit [CFI = 0.93, TLI = 0.92, RMSEA = 0.07, 90% *CI* = (0.06, 0.08)] of confirmatory factor analysis of the Problematic Mobile Social Media Usage Assessment Questionnaire in this study indicated that fit indicators in accordance with the cutoffs recommended in the literature actually showed a satisfactory adequacy, indicating that the scale had good construct validity. In our study, Cronbach's α for the scale was 0.89.

Regulatory Emotional Self-Efficacy Scale

We used the 12-item Regulatory Emotional Self-Efficacy Scale (55) to measure the individual's confidence in the ability to regulate their own emotions. Responses to each item (e.g., Keep from getting discouraged in the face of difficulties?) were rated on a five-point scale (1 = not well at all to 5 = very well). Applied to Chinese samples, the cultural adaption and reliability of the revised scale are well (59, 61, 67), and the validity of the revised scale is well (81, 82). The goodness of fit [CFI = 0.92, TLI = 0.91, RMSEA = 0.07, 90% *CI* = (0.06, 0.08)] of confirmatory factor analysis of the Regulatory Emotional Self-Efficacy Scale in this study indicated that fit indicators in accordance with the cutoffs recommended in the literature actually showed a satisfactory adequacy, indicating that the scale had good construct validity. In our study, Cronbach's α for the scale was 0.92.

Procedure

The study was approved by the ethical committee of the first author's University. Before data collection, participants' consent was acquired. Questionnaires were delivered online Internet to comply with the epidemic prevention policy. All replies were anonymous, and all questionnaires had detailed instructions. Participants were not compensated in any way for their involvement in the research.

Analytic Approach

The data obtained from the normality tests revealed that none of the research variables deviated significantly from normalcy (83) (i.e., Skewness < |3.0| and Kurtosis < |10.0|). This study

used the methods for estimating multivariate normality which was explored in terms of calculating Mahalanobis distances and plotting them on a scattergram against derived chi-square values using Fortran and SPSS programs developed by Thompson (84). If the variables form a multivariate normal distribution, the points will form a straight line (85). The result indicated that that multivariate normality can be assumed. Descriptive statistics were the first to be computed. The PROCESS Models 4 and 15 macros for SPSS were used to analyze the mediation and moderated mediation models using 5,000 random sample bootstrapping confidence intervals (CIs). A thorough standardization procedure was followed before the data analysis.

RESULTS

Preliminary Analyses

The descriptive statistics and bivariate correlation of the relevant variables are shown in **Table 1**. Stressors of COVID-19 were positively associated with fear of missing out and positively associated with problematic social media use. Fear of missing out was positively associated with problematic social media use. Regulatory emotional self-efficacy was negatively associated with problematic social media use. As expected, the findings were in line with Hypothesis 1.

TABLE 1 | Descriptive statistics and correlation matrix for the main variables.

	M	*SD*	1	2	3	4	5
1. Age	19.53	1.09	1				
2. SOC	2.49	0.87	0.16	1			
3. FOMO	2.41	0.88	−0.04	0.53**			
4. PSMU	2.39	0.87	0.02	0.57**	0.75**		
5. RESE	3.31	0.69	−0.03	−0.06	0.25	−0.08**	1

*N = 1,373, **p < 0.01; SOC, Stressors of COVID-19; FOMO, Fear of missing out; PSMU, Problematic social media use; RESE, regulatory emotional self-efficacy.*

Testing the Mediating Role of Fearing of Missing Out

In the hypothesis, we anticipated that the association between stressors of COVID-19 and problematic social media use was mediated by fear of missing out. Model 4 of Hayes' SPSS macro PROCESS was used to test this hypothesis (86). **Table 2** shows the results of the regression analysis conducted to test mediation. Specifically, stressors of COVID-19 were shown to be positively correlated with fear of missing out, $\beta = 0.52$, $p < 0.001$, 95% *CI* [0.47, 0.57] and problematic social media use, $\beta = 0.56$, $p < 0.001$, 95% *CI* [0.53, 0.61]. Stressors of COVID-19 had a positive residual direct effect on problematic social media use. The results demonstrated that the association between stressors of COVID-19 and problematic social media use was mediated by fear of missing out, indirect effect = 0.32, $SE = 0.02$, 95% $CI = [0.28, 0.37]$. The mediated impact accounted for 57.13% of the overall effect of stressors of COVID-19 on problematic social media use. Our hypothesis 2 was confirmed by the results.

Testing for Moderated Mediation

Model 15 in SPSS macro PROCESS was used to examine if regulatory emotional self-efficacy might moderate the direct link between stressors of COVID-19 and problematic social media use, and the mediation effect of fear of missing out, as expected in this study (in particular, the association between problematic social media use and the fear of missing out). **Table 2** shows the findings.

The analysis revealed that stressors of COVID-19 were linked to problematic social media use [$\beta = 0.22$, $p < 0.001$, 95% *CI* (0.17, 0.26)], whereas the fear of missing out was linked to the problematic social media use [$\beta = 0.66$, $p < 0.001$, 95% *CI* (0.63, 0.71)]. Aside from that, the interaction of stressors of COVID-19 and regulatory emotional self-efficacy [$\beta = 0.04$, $p < 0.05$, 95% *CI* [0.01, 0.07]) for problematic social media use was found to be significant, as was the interaction of fear of missing out and regulatory emotional self-efficacy ($\beta = -0.05$, $p < 0.001$, 95% *CI* (−0.08, −0.02)] for problematic social media use. Regulatory emotional self-efficacy was shown to reduce the links between stresses of COVID-19 and fear of missing out on problematic

TABLE 2 | Linear regression models.

Predictors	Dependent variable (FOMO)		Dependent variable (PSMU)		Dependent variable (PSMU)		Dependent variable (PSMU)	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Age	−0.11	−4.74	0.01	0.41	0.04	2.30	0.03	2.23*
SOC	0.52	23.02***	0.56	25.77***	0.24	12.11***	0.22	10.63***
FOMO					0.62	31.37***	0.66	30.38***
RESE							−0.05	−2.53*
SOC × RESE							0.04	2.55*
FOMO × RESE							−0.05	−3.47***
R^2	0.29		0.33		0.61		0.62	
F(df)	186.97*** (3, 1,369)		227.33*** (3, 1,369)		538.88*** (4, 1,368)		314.97*** (7, 1,365)	

*N = 1,373; *p < 0.05, ***p < 0.001; SOC, Stressors of COVID-19; FOMO, Fear of missing out; PSMU, Problematic social media use; RESE, regulatory emotional self-efficacy.*

social media use (i.e., the relationship with stressors of COVID-19 and problematic social media use, as well as the relationship between fear of missing out and problematic social media use, might be significantly moderated by regulatory emotional self-efficacy). Consequently, the postulated moderated mediating model was shown to be well.

Figure 2 depicts a graphic representation of the interaction effect. In college students with low regulatory emotional self-efficacy, fear of missing out was shown to be a strong effect on problematic social media use, as demonstrated by simple slope tests, $b_{simple} = 0.71$, $t = 23.34$, $p < 0.001$. Fear of missing out, on the other hand, was shown to be a significant effect on problematic social media use among college students who had high regulatory emotional self-efficacy, but the relationship was considerably weaker, $b_{simple} = 0.61$, $t = 27.56$, $p < 0.001$, showing a buffering impact of regulatory emotional self-efficacy (**Figure 2A**). Finally, in **Figure 2B**, the visual representation of the interaction effect is shown. The results of simple slope tests revealed that stressors of COVID-19 significantly affected problematic social media use in both college students with high and low levels of regulatory emotional self-efficacy; however, for college students with high levels of regulatory emotional self-efficacy, the effect of stressors of COVID-19 on problematic social media use was stronger ($b_{simple} = 0.26$, $t = 11.76$, $p < 0.001$) than college students with low levels of regulatory emotional self-efficacy ($b_{simple} = 0.18$, $t = 6.01$, $p < 0.001$), demonstrating that regulatory emotional self-efficacy acted as a buffer in the opposite direction.

Further comparing the indirect effects, the difference between a high degree of regulatory emotional self-efficacy and a low degree of regulatory emotional self-efficacy also reached a significant level [Index of moderated mediation, Index = – 0.028, 95% $CI = (-0.06, -0.02)$], indicating the degree of regulatory emotional self-efficacy weakens the indirect effects of fear of missing out between stressors of COVID-19 and problematic social media use. The indirect effect of stressors of COVID-19 on problematic social media use *via* fear of missing out was further moderated by regulatory emotional self-efficacy, according to the bias-corrected percentile bootstrap analysis. The indirect impact of stressors of COVID-19 on problematic social media usage through fear of missing out was particularly significant for college students with low levels of regulatory emotional self-efficacy, $\beta = 0.37$, $SE = 0.02$, 95% $CI = [0.33, 0.43]$. The indirect effect was likewise significant for college students who had strong refusal self-efficacy, but was lower for those who had weak refusal self-efficacy, $\beta = 0.32$, $SE = 0.02$, 95%$CI = [0.27, 0.37]$. As a result of the findings, hypothesis 3 was supported by all two moderating routes shown in **Figure 1**.

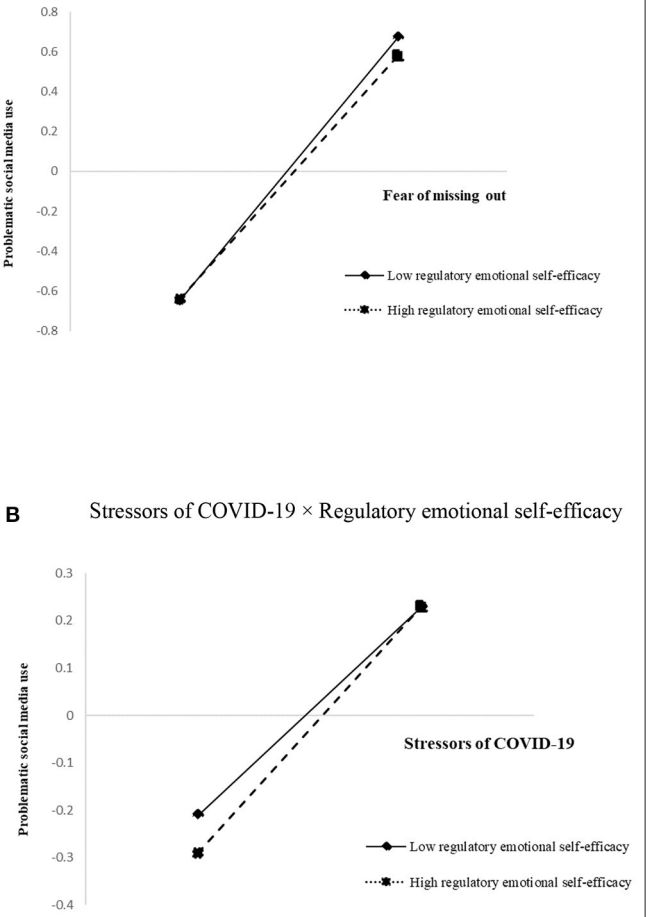

FIGURE 2 | The plot of the relationship between fear of missing out and problematic social media use at two levels of regulatory emotional self-efficacy **(A)**. The plot of the relationship between stressors of COVID-19 and problematic social media use at two levels of regulatory emotional self-efficacy **(B)**. **(A)** Fear of missing Out × Regulatory emotional self-efficacy. **(B)** Stressors of COVID-19 × Regulatory emotional self-efficacy.

DISCUSSION

In this study, we explored the effects of stressors of COVID-19 on Chinese college students' problematic social media use. The results suggested that stressors of COVID-19 were positively related to problematic social media use. Furthermore, the effect of stressors of COVID-19 on problematic social media use was mediated by fear of missing out. The effect of fear of missing out on problematic social media use was moderated by regulatory emotional self-efficacy, as well as the effect of stressors of COVID-19 on problematic social media use. Then, we had a clear grasp of how and when stressors related to COVID-19 were associated with problematic social media use.

The findings revealed that stressors of COVID-19 were closely correlated with problematic social media use. It meant that college students who experienced a higher level of stressors of COVID-19 were more likely to engage in problematic social media behavior. The result was consistent with the general strain theory (87), which proposes that different types of stress cause individuals' negative experiences that ultimately lead to problematic behaviors. During the epidemic, effects of the absence of specific drugs for COVID-19 and the reduction in social interaction due to keeping a social distance (4) predispose

individuals to develop negative emotions (26). As epidemic prevention measures were strictly enforced, access to social interactions decreased and mobile phone use increased (64), with the consequently increased availability of mobile social media use (16, 44). Through the use of social media, individuals were able to obtain positive social feedback and momentarily forget about negative emotions (21, 88). Therefore, such a process increased the risk of problematic social media use.

The Mediation Role of Fear of Missing Out

Our study showed that fear of missing out mediated the association between stressors of COVID-19 and problematic social media use. Then, in light of stressors of COVID-19, fear of missing out might be one of the explaining mechanisms for why some individuals are more prone to raise problematic social media use.

In the mediation process of the relationship between stressors of COVID-19 and the fear of missing out, stressors of COVID-19 have raised the fear of missing out among college students, which is consistent with social compensation theory (46). Individuals with high levels of stressors of COVID-19 are more likely to use social media to access positive psychological experiences that are not available in the context of isolation (16, 89). Individuals pay more attention to the information in the network with higher stressors of COVID-19 (14, 34, 90), and are more worried about missing important information about themselves or others in social media (42). In the mediation process of the relationship between fear of missing out and problematic social media use, college students with higher fear of missing out are more likely to exhibit problematic social media use. This finding of the study conforms with the compensatory Internet use theory (47). A previous study found that individuals with a higher level of fear of missing out required the psychological need to stay informed and avoid missing out on the experiences, thoughts, and experiences of others (91). This psychological need is greatly satisfied through the use of smartphone social media (1), and this psychological comfort also creates a sense of physical excitement in the individual (92), which can easily lead to social media overuse (45, 93).

The Moderation of Regulatory Emotional Self-Efficacy

The association between fear of missing out and problematic social media use was moderated by regulatory emotional self-efficacy as well as the association between stressors of COVID-19 and problematic social media use. There are two different types of protection: risk-buffering and reverse risk-buffering (94). Regulatory emotional self-efficacy functioned as a buffer to the effect of college students' fear of missing out on problematic social media use. Fear of missing out on problematic social media use is mitigated by regulatory emotional self-efficacy. During the pandemic, individuals with high regulatory emotional self-efficacy are less likely to resort to problematic social media use for psychological satisfaction. The reason is that they can successfully manage their emotions (66) even when they are experiencing high fear of missing out. Individuals with high regulatory emotional self-efficacy, even if they suffer anxiety, fear, and other emotions, are more confident to deal with these negative emotions (95, 96). Therefore, our study results suggest that examining the "risk buffering hypothesis" (62) is crucial to understanding how college students' problematic social media use is impacted by the stressors of COVID-19.

In contrast, the effect of stressors of COVID-19 on smartphone problematic social media use is stronger for college students with high regulatory emotional self-efficacy than for those with a low level of regulatory emotional self-efficacy. Accordingly, the benefits of regulatory emotional self-efficacy are negated in the presence of high stressors of COVID-19 based on our findings. Stressors of COVID-19 can induce negative emotions (1), and the anonymity, convenience, and escapist nature of smartphone social media can provide individuals with relief and escape from these negative emotions (13, 97), prompting individuals to use mobile social media to cope with stress. People who have high regulatory emotional self-efficacy are more confident in their abilities, so they may appear to overrate themselves and tend to fall into blind optimism, and overestimate their abilities (55, 98, 99) that is typical of overconfidence (100, 101). Overconfidence among college students may lead to cognitive biases such as "superiority," the illusion of control, and over-optimism in smartphone use. Thus, if college students with high regulatory emotional self-efficacy who are under a high level of stressors of COVID-19 overestimate their sense of control when using their smartphones or underestimate the negative consequences of excessive smartphone social media use, regulatory emotional self-efficacy may aggravate their smartphone problematic social media use. The risk mitigation capacity of the protective factor may deteriorate when risk variables rise to an excessive degree. The result is in line with the protective-limiting hypothesis (杯水车薪) (102). The hypothesis proposed that in the presence of a high-risk factor, the preventive effects of the protective factor are diminished. Researchers have sufficiently supported the protective-limiting hypothesis in explaining the moderating effect (64, 103–105).

Implication and Limitations

The results of this study have implications for both theory and practice. Theoretically, as a follow-up to prior research, this study emphasized the mediating function served by fear of missing out, as well as the moderating role played by regulatory emotional self-efficacy amid the epidemic, respectively. The effect of stressors of COVID-19 on college students' smartphone problematic social media use was little explored before the outbreak of COVID-19. Social compensation theory, compensatory Internet use theory, and self-efficacy theory are all supported by this study's findings, which give empirical proof to the prior research. Practically, in the context of the epidemic, our findings have crucial implications for preventing and intervening with smartphone problematic social media use among college students. College students are at an important period in their academic, cognitive and physical, and mental development. They are more emotionally sensitive and vulnerable to stressful life events (106). colleges and families should provide measures to increase the satisfaction of their

needs. For example, the college could carry out various activities, cultivate good interests and hobbies, increases social channels, etc., so that college students could meet their own needs. College students could face up to and accept their emotions and reinterpret the significance of events in some epidemic situations. With the reduction of negative emotions caused by stressors of COVID-19, it is possible to reduce the risk of problematic social media use.

There are certain limits to the current research that should be mentioned. Firstly, a cross-sectional design was used, which makes it impossible to infer causality in this study. Future studies may use experimental and longitudinal methods to further clarify causality. Secondly, response bias may have influenced the findings in this investigation, as in any study that relied only on self-reported data for data collection. Future research may attempt to gather data from a broad number of informants to further explore the existing results. Thirdly, the sample is not very heterogenous regarding age. To draw even more generalizable conclusions, the findings need be reproduced with additional, more inclusive or even representative samples. Fourthly, we introduce the idea of online social support as a way to compensate social isolation when fear of missing out is presented. This would be a more conceptual robust option, and researchers may look into more protective factors such as emotional regulation self-efficacy, rather than only risk factors such as fear of missing out in the future study.

CONCLUSION

In sum, fear of missing out is an important mediating component in the assessment of the effect mechanism of stressors of COVID-19 on problematic social media use, as shown by this study. It is recommended that future research take this variable into account more thoroughly. Moreover, regulation emotional self-efficacy is not always a defender of protective variables and a buffer against the risk factors. A lot of things need to be done for college students to get help which includes mental health courses, individual and group psychological counseling, as well as improving their emotion management skills so that college students couldn't use social media problematically.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

JZ: writing—original draft. BY: supervision and project administration. LY and JZ: investigation and writing—review and editing. LY and BY: resources. FX: revision of the manuscript. All authors contributed to the article and approved the submitted version.

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Moderating Role of Resilience Between Depression and Stress Response of Vocational Middle School Students During the COVID-19 Pandemic

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Object: In this study, we aimed to explore the influences of stress responses and psychological resilience on depression of vocational middle school students during the initial COVID-19 outbreak in China.

Methods: An online questionnaire survey on the students of a medical school in Jiangxi Province, China, and obtained 3,532 valid questionnaires. A self-compiled general situation questionnaire, Stress Response of COVID-19 Questionnaire, the Resilience Scale for Chinese Adolescents and Center for Epidemiological Studies Depression Scale (CES-D) were used. Hierarchical regression analysis was used to explore the regulatory role of psychological resilience between stress response and depression.

Results: (1) There were significant differences in gender between vocational middle school students' evaluation ($t = 3.07$, $P = 0.002$) and defense ($t = 3.28$, $P = 0.001$) of the pandemic. Males had higher cognitive evaluation of the pandemic than females, and females had more defense against the pandemic than males. (2) There is a significant difference between vocational middle school students from different grades in depression level ($F = 3.62$, $P = 0.03$), pneumonia defense ($F = 13.65$, $P < 0.001$) and pneumonia panic ($F = 3.10$, $P = 0.045$). (3) Depression level ($F = 7.17$, $P < 0.001$), pneumonia evaluation ($F = 2.78$, $P = 0.04$) and pneumonia panic ($F = 3.32$, $P = 0.02$) of the students concerning the spatial distance of the pandemic. (4) The severity of urban pandemic affects the evaluation of pneumonia among vocational middle school students. (5) Depression was negatively correlated with psychological resilience and pneumonia evaluation, and positively correlated with pneumonia panic. Psychological resilience was positively correlated with pneumonia evaluation and pneumonia defense, and negatively correlated with pneumonia panic. (6) Psychological resilience could reduce the level of depression caused by pneumonia evaluation and pneumonia panic.

Conclusion: There were significant differences in depression level and stress responses in grades, gender and spatial distance of pandemic. Resilience has a significant negative moderator effect on the relationship between pandemic panic and depression. Resilience has a significant positive moderator effect on the relationship between pandemic evaluation and depression.

Keywords: resilience, depression, stress response, vocational middle school students, the COVID-19 pandemic

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INTRODUCTION

The novel coronavirus pandemic (COVID-19), which began in December 2019, is a global public health emergency, and its impact has continued to this day. As the virus mutates rapidly, spreads rapidly and may bring adverse consequences such as health problems, it brings anxiety and panic to people. In order to deal with the spread of the virus, various countries and regions have launched different response strategies, such as reducing aggregation, lockdown of the cities, shutdown or home office, school suspension or e-learning. Although these measures are designed to protect people from the virus, they also bring new problems. The fear of infection and the disruption of routine life lead to the decline of people's mental health, and the incidence rate of psychological problems such as depression, anxiety, loneliness, substance abuse, suicide risk, sleep and eating disorders are significantly higher compared with the situation before the pandemic (1).

Teenagers have been paid special attention in the research of people's mental health during the pandemic. Like everyone else, they are worried that they and their families will be infected by the virus and that they will infect others without their knowledge (2). In the worst period of the pandemic, they need to temporarily stop the traditional face-to-face learning and rely more on online distance learning. They are far away from campus and peers, and their normal social communication is affected. Since the adolescents are not mature enough, their mental health is affected in some way and the incidence of various psychological disorders is higher than that before the pandemic when they are faced with the pressure of pandemic, isolated family life and learning style (3–5). In different research reports, the positive screening rate of adolescent depression reaches 20–40%. Anxiety and other stress-related psychological disorders also increased significantly more than other age groups (6–8). In addition to the above reasons, the pressure facing junior high school students and senior high school students also makes their levels of depression and anxiety higher. One way to help them reduce their levels of depression and anxiety is to improve their resilience.

Psychological resilience usually refers to the ability of individuals to mobilize personal resources (protective factors) to maintain or quickly recover normal psychological functions after experiencing adversities or traumas. It is a successful response to the "self-adjustment mechanism". It is found that individuals with high resilience perceive less psychological distress and have a higher level of mental health than those with low resilience (9). During the new coronavirus pandemic, a survey of 3,042 subjects showed that individuals with high resilience had lower levels of anxiety and depression than those with low resilience. In the youth group, affected by learning pressure, parent-child relationship, cognitive limitations and lack of experience, their psychological resilience is often less than that of adults (2).

In the study of teenagers, junior high school students and senior high school students are the objects of more attention, but the research of other adolescent groups is relatively scarce, such as secondary vocational school students in this study. These students enter vocational schools after graduating from junior high school. They usually will graduate and start working after 3–5 years of study. Compared with high school students of the same age, they generally do not face the pressure of entering a higher school, so they have less pressure, but they will have the pressure of employment. In this study, our respondents came from a secondary occupational vocational middle school (hereinafter referred to as vocational middle school). Most of the students in this school are nursing majors, and others are medical related majors. This means that they have to face not only the pressure of employment, but also the possibility of close contact with the pandemic as medical workers.

The purpose of this study is to understand the current situation of stress response and depression of vocational middle school students during the pandemic of COVID-19 through questionnaire survey, and to explore the impact of COVID-19 stress response on depression, as well as the regulatory role of psychological resilience between COVID-19 stress response and depression. In addition, we will also analyze the effects of variables such as the severity of COVID-19 and spatial distance on depression.

Accordingly, we simulated the relationship model between stress response and depression and proposed the following hypothesis:

Hypothesis 1: The stress response of COVID-19 will lead to the depression of vocational middle school students.

Hypothesis 2: Psychological resilience plays a regulatory role between stress response and depression during the COVID-19 pandemic.

METHODS

Study Population and Sample

In this study, the students of a secondary occupational vocational middle school were investigated by anonymous cluster sampling through the Internet in Jiangxi Province, China. The survey was carried out in April 2020. A total of 4,074 questionnaires were distributed, and 3,532 valid questionnaires were recovered, with an effective recovery rate of 86.25%. There were 379 males and 3,153 females. The average age was 17.03 ± 1.29 years.

Rating Instruments

Self-Compiled General Situation Questionnaire

Including gender, age, grade, major, city (determine the severity of urban pandemic according to the number of infected people in the city, 1 = infected people < 50, 2 = infected people 51–100, 3 = infected people 101–150, 4 = infected people more than 150), the infection situation of COVID-19 in the district/administrative village (determine the spatial distance between COVID-19 and the participants according to this, 0 = unaffected, 1 = home isolators, 2 = suspected patients, 3 = confirmed patients).

Stress Response of COVID-19 Questionnaire

Revised according to the SARS Stress Response Questionnaire compiled by Tong (10). The Stress Response of COVID-19 Questionnaire was revised, with 13 questions in total. And three contents are measured: pandemic evaluation, pandemic panic, pandemic defense. Cronbach's α coefficients of pandemic

evaluation, pandemic panic, and pandemic defense were 0.62, 0.73, and 0.66 respectively.

The Resilience Scale for Chinese Adolescents

The Resilience Scale compiled by Hu and Gan (11) was used to measure the resilience level of vocational health school students. There are 27 questions in the scale, which are scored by 5 points. The scale is divided into two dimensions: individual manpower and support, including 15 questions for individual manpower and 12 questions for support. The higher the total average score, the higher the Resilience. In this study, Cronbach's α coefficient is 0.89.

Center for Epidemiological Studies Depression Scale

Using the Center for Epidemiological Studies Depression Scale (CES-D) compiled by Radloff (12), there are 20 items in the scale, which are graded from 0 to 3, among which 4 items are reverse scores. The sum of scores of all items is the total score of the scale. If the total score is less than or equal to 15, it indicates that there is no depression. Depression may be judged when the score is 16–19. If the total score is greater than or equal to 20, it indicates that there is depression. The higher the score, the more severe the degree of depression. In this study, the Cronbach's α coefficient is 0.87.

Statistical Analyses

SPSS22.0 was used to collate and analyze the data. The data were descriptively analyzed by using mean and standard deviation. Independent sample *t*-test and one-way ANOVA were used to compare the effects of gender, grade, severity of urban pandemic and spatial distance of pandemic on stress response to COVID-19 and depression level. Correlation analysis was used to explore the relationship between stress response, depression and psychological resilience**.** Hierarchical regression analysis was used to explore the regulatory role of psychological resilience between stress response and depression.

RESULT

Stress Response, Resilience and Depression

The positive rate of depression screening was 19.4% in our study. Unpaired *T*-test and one-way ANOVA were used to analyze the influencing factors of depression and stress response of vocational middle school students. The results are shown in **Table 1**. The evaluation of pandemic situation ($t = 3.07$, $P = 0.002$) and defense ($t = 3.28$, $P = 0.001$) were significantly different in gender, while the depression level of vocational middle school students was borderline significant in gender. Compared with females, males have a higher cognitive evaluation of the pandemic situation, and females have more defensive and depression than males. There were significant differences in depression level ($F = 3.62$, $P = 0.03$), pandemic defense ($F = 13.65$, $P < 0.001$)and pandemic panic ($F = 3.10$, $P = 0.045$)in different grades. There were differences in the severity of urban pandemic. There are significant differences in depression level ($F = 7.17$, $P < 0.001$), pandemic panic ($F = 3.32$, $P = 0.02$)and pandemic evaluation ($F = 2.78$,$P = 0.04$) among spatial distance of pandemic.

Correlation Between Continuous Variables

After controlling gender and age, the descriptive statistics and correlation analysis are shown in **Table 2**. The results show that depression is negatively correlated with resilience and pandemic evaluation, and positively correlated with pandemic panic. Resilience was positively correlated with pandemic evaluation and pandemic defense, but negatively correlated with pandemic panic. In the stress response of COVID-19 subscale, pandemic evaluation was negatively correlated with pandemic panic and positively correlated with pandemic defense.

Hierarchical Regression Analysis

According to Wen et al. (13), the moderator effect of resilience on stress response of COVID-19 and depression was investigated. The regression analysis results are shown in **Table 3**. Pandemic evaluation, pandemic defense and resilience can significantly negatively predict depression. Pandemic panic can positively predict depression. At the same time, resilience has a significant negative moderator effect on the relationship between pandemic panic and depression. Resilience has a significant positive moderator effect on the relationship between pandemic evaluation and depression. Therefore, resilience has moderator effect on the relationship between pandemic defense and depression.

DISCUSSION

During the pandemic period, the overall depression level of the subjects in this study was lower than that of other people of the same age group in the same period (5). Due to the lack of mental health data of this group before the outbreak, we speculate that the reason for this result may be related to the survey time, the method of using online survey, the limitations of sampling and the fact that the respondents are not in high-risk areas. Because in other surveys with more extensive sampling, even among senior medical students who have more knowledge reserves and clinical experience, the positive screening rate of depression during the pandemic is still as high as 24.3%, which is 70% higher than that before the pandemic (5). The sampling time of this survey is April 2020. At this time, the condition of the pandemic in China has been in the stage of steady decline, and Jiangxi Province, where the medical school is located, is not a serious pandemic area. These may be the reasons why the positive screening rate of depression is lower than the average level. Because in the same period, the results of a repeated survey on the pandemic emotional state of young people in the United States showed that the positive rate of depression among the respondents was quite high in May 2020, but it also decreased 1 month later (14).

Gender is one of the important factors affecting depression (15, 16). Other studies have similar findings, that is, the level of depression in female is higher than that in males, and the difference is significant, which may be related to women's strong risk perception. It has been found that during the outbreak

TABLE 1 | The mean score and standard deviation of depression and stress response.

Variable		Depression			Pandemic evaluation			Pandemic panic			Pandemic defense		
		M ± SD	F/t	p	M ± SD	F/t	p	M ± SD	F/t	p	M ± SD	F/t	p
Gender	Male	9.62 ± 7.86	−1.67	0.095	9.88 ± 1.75	3.07	0.002	6.28 ± 2.33	1.57	0.116	13.88 ± 3.07	−3.28	0.001
	Female	10.34 ± 8.01			9.60 ± 1.708			6.09 ± 1.75			14.42 ± 2.71		
Grades	1	10.71 ± 8.16	3.62	0.027	9.55 ± 1.74	2.11	0.120	6.02 ± 1.76	3.10	0.045	14.19 ± 2.84	13.65	0.000
	2	10.10 ± 7.80			9.67 ± 1.75			6.12 ± 1.86			14.22 ± 2.71		
	3	9.87 ± 7.95			9.68 ± 1.65			6.21 ± 1.85			14.73 ± 2.66		
Severity of urban pandemic	1	10.45 ± 7.99	1.54	0.203	9.55 ± 1.70	7.38	0.000	6.06 ± 1.90	0.26	0.852	14.39 ± 2.68	0.60	0.604
	2	10.54 ± 7.98			9.69 ± 1.68			6.10 ± 1.78			14.48 ± 2.75		
	3	10.63 ± 7.72			9.37 ± 1.81			6.16 ± 1.82			14.29 ± 2.80		
	4	9.98 ± 8.09			9.72 ± 1.68			6.11 ± 1.82			14.33 ± 2.76		
Spatial distance of pandemic	0	9.98 ± 7.82	7.17	0.000	9.66 ± 1.72	2.78	0.040	6.08 ± 1.81	3.32	0.019	14.31 ± 2.75	2.33	0.072
	1	11.51 ± 7.59			9.30 ± 1.81			6.16 ± 2.01			14.58 ± 2.94		
	2	11.62 ± 8.38			9.44 ± 1.59			6.47 ± 1.98			14.74 ± 2.78		
	3	11.67 ± 9.3			9.88 ± 1.66			6.14 ± 1.71			14.51 ± 2.69		

TABLE 2 | Correlation analysis of depression, resilience and stress response.

	M	SD	1	2	3	4	5
1. Evaluation	9.63	1.72	1.00				
2. Panic	6.11	1.82	−0.07***	1.00			
3. Defense	14.36	2.75	0.09***	0.35***	1.00		
4. Depression	10.26	7.99	−0.18***	0.38***	0.01	1.00	
5. Resilience	3.37	0.53	0.17***	−0.15***	0.06***	−0.50***	1.00

*** $p < 0.001$.

of 2019 coronavirus disease, the perceived risk and severity of the virus are related to poor mental health (17). The study of 2019 coronavirus disease found that women spend more time thinking about COVID-19 than men every day, and have more depressive symptoms than men. In addition, in the cognitive evaluation of influenza 2019 coronavirus disease, males' COVID-19 cognitive score is higher than that of female, and females' score in pandemic defense is higher than that of males. The reason may be that men have a better understanding of 2019 coronavirus disease, which leads to the reduction of depression. However, women's cognitive evaluation of 2019 coronavirus disease is comparatively lower, and this consequently leads to the aggravation of depression. However, female will also take more defensive measures to help themselves reduce their emotional distress. This result explains the relationship between gender, depression and stress response to some extent. Some studies have reached similar conclusions. They found that women tend to take defensive actions when coronavirus disease occurs in 2019 (18, 19), so they are more willing to follow prevention and control recommendations, such as wearing masks and avoiding going to public places (20).

This survey shows that the severity of urban pandemic affects pandemic evaluation, but did not affect pandemic panic and pandemic defense, and had no significant difference in depression. This shows that although the severity of COVID-19 pandemic is different in different cities, there is no obvious difference in the effects on panic, defense and depression of vocational middle school students. This is consistent with the research results of Huang et al. (21) on nursing students and nurses, and their research conclusions also show that the severity of urban pandemic has no significant impact on the subjects' emotions and coping styles. The reason for this result may be that in our survey sample, even in those cities with severe COVID-19, the number of confirmed cases in COVID-19 is not much, only 217 cases at most. In the case of great differences in the pandemic situation in COVID-19, whether it is a cross-provincial and cross-regional comparative study or a comparison of different countries (the United States and Israel), it is found that the depression and anxiety of people in countries or regions with severe pandemic situation are significantly higher than those in countries or regions with mild pandemic situation, and the difference is significant (2). Distance has significant influence on depression, pandemic evaluation and panic of vocational middle school students. On the whole, the closer COVID-19 is to an individual (i.e., when there are infected people in the community or village), the higher the level of depression and panic of the individual, that is, the presence of confirmed cases of COVID-19 near the individual's residence will lead to more tension and emotional and behavioral problems, which is consistent with the research results of Huang et al. (22).

The results of correlation analysis showed that resilience was negatively correlated with pandemic panic and depression, and

TABLE 3 | Regression analysis of depression.

	Equation 1 (variable: depression)		Equation 2 (variable: depression)		Equation 3 (variable: depression)	
	β	t	β	t	β	t
Spatial distance	0.074	4.408***	0.061	3.974**	0.043	3.234**
Pandemic evaluation			−0.145	−9.450***	−0.450	−5.147***
Pandemic panic			0.405	24.797***	1.072	11.960***
Pandemic defense			−0.117	−7.167***	−0.204	−2.197*
Resilience					−0.501	−4.634***
Pandemic evaluation × resilience					0.547	4.258***
Pandemic panic × resilience					−0.805	−8.429***
Pandemic defense × resilience					0.201	1.622
R^2	0.005***		0.181***		0.370***	
ΔR^2	0.005***		0.177***		0.190***	
F	19.427***		195.958***		260.042***	

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

positively correlated with pandemic evaluation and pandemic defense. Further regression analysis showed that pandemic evaluation, pandemic defense and pandemic panic can directly predict depression, and pandemic evaluation and pandemic panic can also adjust depression level through resilience. From the difference between the weak resilience group and the strong resilience group, it can be concluded that even if the cognitive evaluation of pandemic is low and the degree of panic is high, the high resilience can reduce the depression and relieve the negative emotional reaction caused by stress (6). In the research of various catastrophic events, resilience has been found to protect individual mental health and help people cope with disasters and tide over crises (23, 24). Among the survivors of the earthquake, tsunami and nuclear disaster in Japan, higher resilience indicates lower level of post-traumatic stress disorder and depressive symptoms. After Wenchuan earthquake, the same group of subjects were followed up three times in 6 months, 18 months and 24 months, which showed that resilience played an important role in the post-traumatic growth of individuals after the earthquake (25). In the COVID-19, adolescents' psychological resilience is affected by factors such as active coping, social support, family economy and parents' education level. Adolescents with high psychological resilience have a more stable psychological state and a higher level of mental health when coping with this stress event (24). Another survey of medical staff found that improving sleep quality and life satisfaction can improve the psychological resilience of medical staff and increase their ability to deal with risks (26). Therefore, good resilience not only means survival and adaptation to challenges, but also indicates growth, development and better after crisis events (27).

In conclusion, improving resilience can help individuals recover from normal life faster, reduce the occurrence of depression or alleviate depressive symptoms. Through the research and comprehensive analysis of vocational middle school students, we believe that during the period of pandemic isolation at home, it can improve the individual's ability to deal with negative life events by improving the individual's awareness of pneumonia by imparting correct knowledge, enhancing the individual's defense ability against pneumonia, and reducing the psychological panic of pneumonia through psychological regulation and social security. The individual can still maintain adequate adaptability and reduce the level of depression during stressful events (28). Other studies have found that the impact of psychological and social factors on negative emotions may be greater than the direct impact of the virus itself on individuals, so healthy diet, regular exercise and appropriate emotional connection with others all help to increase resilience (29, 30). For groups with high levels of depression, such as women, young people and people with low educational background, support services and activities to strengthen mental health can be provided in a planned way (31).

LIMITATIONS

Although we have obtained some meaningful results through research and analysis, there are still some deficiencies in this study. Firstly, as a cross-sectional study, it is difficult to clarify the causal relationship between variables, which needs to be supplemented by necessary longitudinal research. Secondly, the homogeneity of the sample is high, and the imbalance between men and women may lead to weak representativeness of the results and large statistical errors. Therefore, it is necessary to increase the data of different groups and improve the popularization value of the results. Thirdly, the self-report form used in the survey is also easy to lead to the deviation of the results. Despite the above limitations, this study managed to find out the probability of depression and its influencing factors by exploring the relationship between psychological variables. These findings will help to provide reference results for future research and provide data support for relevant departments and scholars to take targeted psychological intervention measures.

CONCLUSION

Compared with females, males have a higher cognitive evaluation of the pandemic situation, and females have more defensive

and depression than males. There were significant differences in depression level, pandemic defense and pandemic panic in different grades. There were differences in the severity of urban pandemic. There are significant differences in pandemic level, pandemic panic and pandemic evaluation among spatial distance of pandemic. Resilience has a significant negative moderator effect on the relationship between pandemic panic and depression. Resilience has a significant positive moderator effect on the relationship between pandemic evaluation and depression.

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 Academic Ethics Committee of Wannan Medical College. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

LH and LF conceived and designed the review. MJ and LL wrote the manuscript. LH analyzed the data. HR, LL, LJ, BL, and XS revised the manuscript. All authors contributed to the article and approved the submitted version.

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Purpose in Life and Character Strengths as Predictors of Health Sciences Students' Psychopathology During the COVID-19 Pandemic

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Background: Health sciences students experience high levels of psychopathology conditioned by psychosocial, financial, and academic factors. However, COVID-19 pandemic might even have worsened their mental health. Thus, this article aims to evaluate how the exposure to COVID-19 pandemic has affected these students' mental health and to determine the effect of purpose in life and character strengths on this psychopathology.

Methods: A cross-sectional study of unpaired samples was carried out in Spain during the first and third waves of the pandemic in 70 medical and 52 nursing students.

Results: The risk factor that most determined the appearance of anxiety was the exposure of family and friends to COVID-19 (OR = 4.01; $p < 0.001$), while the most protective factors were honesty (OR = −1.14; $p = 0.025$) and purpose in life (OR = −0.18; $p < 0.001$). Purpose in life also protected against the onset of depression and total psychopathology. In addition, we observed studying medicine was a protective factor against total psychopathology while being a nursing student was associated with high levels of acute stress.

Conclusion: Exposure of the students' family and friends to SARS-CoV-2 favored the appearance of symptoms of anxiety. Honesty had a preventing role in the onset of anxiety and a high purpose in life was protective against the appearance of anxiety, depression, and total psychopathology.

Keywords: COVID-19, character strengths, medical students, mental health, moral courage, nursing students, psychopathology, purpose in life

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INTRODUCTION

Studying health sciences acts as a risk factor for developing psychopathology, such as anxiety, depression, acute stress and alcohol or substance abuse (1). Starting university represents a series of vital changes for students, all of which must be managed with specific strategies to deal with these challenges appropriately. Problems arise when most students lack these strategies or when their strategies are inadequate (2).

During their academic training, medical, and nursing students experience high levels of distress which is conditioned by psychosocial, financial, and academic factors (3–5). This fact does not only means that students cannot get the most out of their training, but also affects other areas of their lives (6), including their mental health.

A recent analysis carried out by the State Council of Medical Students (CEEM in its Spanish acronym) concluded that up to 41% of medical students presented at least one sign of depression, and 24.7% experienced high levels of anxiety (5). In the same vein, some studies (3, 4) have shown that nursing students experience signs of depression in a similar proportion to those in the CEEM study, but that they also show much higher levels of anxiety, at around 50%, with women predominating in both groups. These figures indicate the growing appearance of psychopathology in future healthcare professionals, starting from the earliest moments of their training. In fact, it has been shown that many healthcare workers already suffer from anxiety and depression problems from the very beginning of their university education (2). In addition, alcohol and substance abuse is another issue related to the health sciences students, especially since the COVID-19 pandemic (7).

As seen, anxiety, depression, acute stress, and alcohol or substance abuse are considered very prevalent conditions in health sciences students. Because of this, an attempt has been made to identify possible predisposing factors so that effective prevention measures can be implemented (8). In this sense, it has been shown that stressful life situations, such as the current context of the COVID-19 pandemic, are very important factors for the emergence of these types of psychopathology (7, 9). The psychological impact of COVID-19 pandemic has recently been evaluated not only in health sciences students (10), but also in healthcare workers (11) and general population (12) worldwide.

Among university careers, medicine and nursing are two traditionally vocational choices, a fact that the virus has significantly highlighted (13). Students who choose one of these disciplines tend to do so because they were moved by a specific purpose in life (PIL), described as an individual's perception of the objective and value of their life (11); character strengths, which are the positive parts of the core personality that impact how you think, feel and behave (14); and varying degrees of moral courage, defined as the ability to face danger or social disapproval when performing what one believes to be their duty (15). They develop their PIL, character and personal values through "holistic intelligence," in other words by considering human beings as a whole, not only as something physical or psychological, but also considering moral integrity, service to others, and generosity (16). Although medical and nursing careers complement each other and must work together, there are several differences between the two (17–19); for instance, in terms of the education length, type of training received, and focus on care, care actions, professional–patient relationships, work self-management, and the need for specialization.

Research has been published on the psychopathological consequences of COVID-19 in students in general (20), but no scientific articles have specifically related the presence of symptoms with PIL, character strengths and moral courage among medical and nursing students. Thus, this study aimed to evaluate the possible predictor effect of these dimensions and to determine what other elements could help predict the appearance of psychopathology in health sciences students.

MATERIALS AND METHODS

This study had a cross-sectional, observational design and used two unpaired samples. A group of 70 medical students and another group of 52 nursing students from a Spanish university, all of whom were studying the last year of their respective degrees, were obtained through intentional sampling by sending the questionnaire to their e-mail and mobile phones. We used G*Power software to calculate the sample size required to evaluate the differences in the psychopathological variables between the two groups using *t*-test. For an effect of 0.5, with an alpha of 0.05, power of 0.80, and an N2/N1 allocation ratio of 1.3, a group size of minimum 59 for group 2 (medicine) and 45 for group 1 (nursing) would be required (total $n = 104$), so the sample recruited (70 medical students and 52 nursing students) is sufficient. The data were collected between 20 April and 27 May 2020 (2019–2020 academic year) when Spain was immersed in the peak of the first COVID-19 wave, and between 4 December 2020 and 19 January 2021 (2020–2021 academic year) during the third wave, with the latter having had the greatest generalized impact on society (21).

After signing their informed consent to participate, study participants completed a self-assessment using a series of instruments in Spanish.

First, they completed a questionnaire on sociodemographic variables.

Variables that evaluated psychopathology were considered as dependent variables. In the analyzes, total scores of the scales were used and dichotomous variables were created differentiating those that exceeded the cut-off point (CP) of each scale and those that did not. To assess anxiety, depression, and acute stress we used the Beck's Anxiety Inventory (BAI) [CP = 8; reliability = 0.90; adequate factorial, discriminant and criterion validity (22)], Beck's Depression Inventory (BDI) [CP = 14; reliability = 0.89; adequate factorial, convergent, discriminant, and criterion validity (23)], and an *ad hoc* questionnaire based on the DMS-5 criteria for assessing acute stress (reliability = 0.81), respectively. Drug abuse was assessed using the Drug Abuse Screening Test (DAST-10) [CP = 1; reliability = 0.89; proven predictive validity (24)] and alcohol abuse was examined using the Alcohol Use Disorders Identification Test (AUDIT) [CP for women = 6, and CP for men = 8 (25); reliability = 0.75; adequate criterion and predictive validity (26)].

Variables that evaluated the different types of exposure to COVID-19 (personal exposure and that of their family and friends) were considered as independent variables. A 2 item Likert like questionnaire used in a previous study (11) was administered. Total exposure was calculated by summing personal and family and friends exposure. PIL, character strengths and moral courage were also considered as independent variables. The former was analyzed using the PIL scale

TABLE 1 | Sociodemographic characteristics and differences between the study groups.

	Total *n* = 122	**Nursing students *n* = 52**	**Medical students *n* = 70**	
	% (*n*)/*M* (*SD*)	**% (*n*)/*M* (*SD*)**	**% (*n*)/*M* (*SD*)**	***t*/χ^2(*p*) *post hoc*/CTR**
Age	24.8 (4.842)	25.38 (6.350)	24.34 (3.292)	$t = 1.080$ ($p = 0.284$)
Sex				$\chi^2 = 6.556$ ($p = 0.010$)
Female	82.0 (100)	**92.3 (48)**	74.3 (52)	2.6/–2.6
Male	18.0 (22)	7.7 (4)	**25.7 (18)**	–2.6/2.6
Religiosity Yes	53.3 (65)	57.7 (30)	50.0 (35)	$\chi^2 = 3.442$ ($p = 0.632$)
Marital status				$\chi^2 = 7.123$ ($p = 0.028$)
Single	93.4 (114)	86.5 (45)	**98.6 (69)**	–2.7/2.7
Married	5.7 (7)	**11.5 (6)**	1.4 (1)	2.4/–2.4
Divorced	0.8 (1)	1.9 (1)	0.0 (0)	1.2/–1.2
Physical illness yes	13.1 (16)	7.7 (4)	17.1 (12)	$\chi^2 = 2.339$ ($p = 0.126$)
Smoker yes	18.9 (23)	**28.8 (15)**	11.4 (8)	$\chi^2 = 5.917$ ($p = 0.015$) 2.4/–2.4
Psychiatric history yes	14.8 (18)	11.5 (6)	17.1 (12)	$\chi^2 = 0.745$ ($p = 0.388$)
Psychological/Pharmacological treatment during quarantine yes	3.3 (4)	1.9 (1)	4.3 (3)	$\chi^2 = 0.223$ ($p = 0.637$)

CTR, corrected typified residuals; those less than –1.96 or greater than 1.96 were considered significant. The groups from among the categorical variables in which the CTRs were significant are shown in bold. n, sample; M, average; SD, standard deviation; χ^2, Pearson chi-squared test; t, Student's t-test.

[CP = 113; adequate internal consistency and construct validity (27)], calculating a dichotomous variable that differentiated between those who presented a high sense of PIL and those who did not. Global Assessment of Character Strengths-24 (GACS-24) [reliability = 0.78 (28)] was used to assess the character strengths of the participants. Finally, moral courage was assessed with the Moral Courage Scale for Physicians (MCSP) [reliability = 0.90; proven factorial, convergent, discriminant and concurrent validity (29)] and the Professional Moral Courage Scale (PMCS) [construct validity achieved (30); reliability = 0.85; supported factorial and convergent validity (31)].

SPSS software (version 27) for Microsoft (IBM Corp., Armonk, NY.) was used for all the statistical analyses. After the exploratory (normality, independence, homoscedasticity, linearity, non-collinearity) and descriptive study, the variables were subsequently compared using Student's t-distribution for quantitative variables and Pearson chi-squared tests for categorical variables. Linear regression models were created for the psychopathological variables, introducing exposure to SARS-CoV-2, PIL, character strengths and moral courage as independent variables. Finally, the data were modeled using the PROCESS plugin (v3.4) for SPSS (32).

The ethical principles set out in the Declaration of Helsinki and by the Council of Europe Convention were followed and the informed consent of all participants was obtained. Moreover, data confidentiality was guaranteed according to the General Data Protection Regulation (GDPR; 2018). This study was authorized by the Investigation Commission at the Provincial Hospital Consortium in Castellon (ref. A-15/04/20) and the Clinical Research Ethics Committee of the Cardenal Herrera-CEU University (ref. CEI20/068).

RESULTS

Sociodemographic Characteristics

Regarding sociodemographic characteristics, most of the students were women, although this predominance was higher in the nursing student group ($\chi^2 = 6.556$; $p = 0.010$). Significantly more students in the medical student group were single (98.6%; $n = 48$) while more were married in the nursing student group (11.5%; $n = 6$; $\chi^2 = 7.123$; $p = 0.028$). Finally, there were significantly less smokers in the medical student group (11.4%; $n = 8$) than in the nursing student group (28.8%; $n = 15$; $\chi^2 = 5.917$; $p = 0.015$) (**Table 1**).

COVID-19 Exposure, Purpose in Life, Character Strengths, and Moral Courage

Table 2 shows that there were no differences in exposure to COVID-19 between these groups, either at a personal or a family and friends level. However, compared to the nursing students, medical students presented lower scores for the GACS-24 item about love ($M = 5.87$; $SD = 1.382$ vs. $M = 6.38$; $SD = 0.844$; $t = 2.535$; $p = 0.013$) and about teamwork ($M = 5.89$; $SD = 1.123$ vs. $M = 6.37$; $SD = 0.768$; $t = 2.652$; $p = 0.009$). In addition, we observed significantly higher PMCS score among medical students ($M = 10.97$; $SD = 1.142$) than in nursing students ($M = 10.25$; $SD = 1.846$; $t = –2.487$; $p = 0.015$).

Psychopathological Variables

In terms of psychopathology (**Table 3**), compared to nursing students, medical students had lower mean BAI scores ($M = 8.24$; $SD = 7.767$ vs. $M = 11.19$; $SD = 8.381$; $t = 2.005$; $p = 0.047$) and less presented an anxiety disorder (42.9%; $n = 30$ vs. 63.5%; $n = 33$; $\chi 2 = 5.072$; $p = 0.024$). Medical students ($M = 5.33$; $SD = 4.596$) also had lower ASD scores than nursing students ($M = 7.29$; $SD = 4.820$; $t = 2.281$; $p = 0.024$) and a lower proportion of ASD (17.1%; $n = 12$ vs. 36.5%; $n = 19$; $\chi 2 = 5.922$; $p = 0.015$). Finally, medical students ($M = 24.46$; $SD = 16.582$) had less psychopathological symptoms than nursing students ($M = 31.85$; $SD = 18.375$; $t = 2.324$; $p = 0.022$).

TABLE 2 | Exposure to SARS-CoV-2 and moderating variables.

	Total *n* = 122	Nursing students *n* = 52	Medical students *n* = 70	
	% (*n*) / *M* (*SD*)	% (*n*) / *M* (*SD*)	% (*n*) / *M* (*SD*)	*t*/χ^2(*p*) *post hoc*/CTR
Personal exposure	0.56 (0.980)	0.63 (1.067)	0.50 (.913)	$t = 0.749$ ($p = 0.455$)
Family/friends exposure	0.52 (0.633)	0.63 (.742)	0.43 (.527)	$t = 1.709$ ($p = 0.091$)
Personal and family/friends exposure	1.07 (1.200)	1.26 (1.285)	0.93 (1.120)	$t = 1.559$ ($p = 0.122$)
PIL	110.18 (14.401)	111.44 (14.549)	109.24 (14.323)	$t = 0.833$ ($p = 0.406$)
PIL yes	50 (61)	59.6 (31)	42.9 (30)	$\chi^2 = 3.352$ ($p = 0.067$)
GACS-24	136.84 (15.490)	137.67 (14.230)	136.21 (16.437)	$t = 0.513$ ($p = 0.609$)
Creativity	5.10 (1.256)	5.17 (1.184)	5.04 (1.313)	$t = 0.565$ ($p = 0.573$)
Curiosity	5.92 (1.103)	5.94 (1.018)	5.90 (1.169)	$t = 0.209$ ($p = 0.835$)
Critical thinking	5.65 (1.113)	5.58 (1.016)	5.70 (1.184)	$t = -0.603$ ($p = 0.548$)
Passion for learning	5.98 (1.195)	5.98 (1.229)	5.97 (1.179)	$t = 0.043$ ($p = 0.966$)
Wisdom	5.82 (1.021)	5.65 (0.988)	5.94 (1.034)	$t = -1.556$ ($p = 0.122$)
Courage	5.16 (1.255)	5.15 (1.227)	5.17 (1.285)	$t = -0.076$ ($p = 0.939$)
Perseverance	5.69 (1.409)	5.71 (1.273)	5.67 (1.511)	$t = 0.155$ ($p = 0.877$)
Honesty	5.56 (1.362)	5.37 (1.237)	5.70 (1.438)	$t = -1.348$ ($p = 0.180$)
Vitality	5.78 (1.139)	5.94 (1.056)	5.66 (1.190)	$t = 1.372$ ($p = 0.173$)
Love	6.09 (0.831)	**6.38 (0.844)**	5.87 (1.382)	$t = 2.535$ ($p = 0.013$)
Amability	6.41 (0.831)	6.50 (0.728)	6.34 (0.899)	$t = 1.034$ ($p = 0.303$)
Intelligence	5.84 (1.160)	5.85 (1.092)	5.83 (1.215)	$t = 0.082$ ($p = 0.934$)
Teamwork	6.09 (1.012)	**6.37 (0.768)**	5.89 (1.123)	$t = 2.652$ ($p = 0.009$)
Justice	5.92 (0.941)	5.88 (1.003)	5.94 (0.899)	$t = -0.337$ ($p = 0.737$)
Leadership	5.30 (1.346)	5.25 (1.203)	5.33 (1.452)	$t = -0.318$ ($p = 0.751$)
Forgiveness	5.43 (1.226)	5.40 (1.376)	5.46 (1.112)	$t = -0.236$ ($p = 0.813$)
Humility	5.99 (0.940)	6.06 (0.850)	5.94 (1.006)	$t = 0.666$ ($p = 0.507$)
Prudence	5.68 (1.235)	5.69 (1.147)	5.67 (1.305)	$t = 0.092$ ($p = 0.927$)
Selfcontrol	5.30 (1.390)	5.48 (1.244)	5.17 (1.484)	$t = 1.218$ ($p = 0.226$)
Wonder	5.85 (1.034)	5.83 (1.098)	5.87 (0.992)	$t = -0.234$ ($p = 0.815$)
Gratitude	6.58 (0.641)	6.44 (0.777)	6.69 (0.498)	$t = -1.977$ ($p = 0.051$)
Optimism	5.31 (1.361)	5.44 (1.259)	5.21 (1.433)	$t = 0.914$ ($p = 0.362$)
Sense of humor	6.08 (0.992)	6.15 (0.872)	6.03 (1.076)	$t = 0.688$ ($p = 0.493$)
Spirituality	4.31 (1.855)	4.44 (1,765)	4.21 (1.925)	$t = 0.670$ ($p = 0.504$)
MCSP	7.47 (1.187)	7.42 (1.242)	7.50 (1.152)	$t = -0.353$ ($p = 0.725$)
PMCS	10.66 (1.519)	10.25 (1.846)	**10.97 (1.142)**	$t = -2.487$ ($p = 0.015$)

CTR, corrected typified residuals; those less than –1.96 or greater than 1.96 were considered significant. The groups from among the categorical variables in which the CTRs were significant are shown in bold. When the post hoc tests in the quantitative variables were significant, we have indicated the highest scoring group; n, sample; M, average; SD, standard deviation; χ^2, Pearson chi-squared test; t, Student's t-test; GACS-24, Global Assessment of Character Strengths-24; PIL, purpose in life.

Linear Regressions and Data Modeling

Table 4 shows the results of the linear regressions, which allowed us to predict psychopathological variables based on the SARS-CoV-2 exposure as well as PIL, character strengths and moral courage variables. The BAI score was predicted by exposure of family and friends to the virus, GACS-24 spirituality, PIL, and GACS-24 honesty. The BDI-II score was predicted by PIL, while that of the ASD could be predicted by occupation. The AUDIT score was predicted by being a smoker, age, and the sum of character strengths from the GACS-24. Finally, total psychopathology was predicted with PIL, occupation, and the exposure of family and friends.

Finally, **Figure 1** shows a model describing the predictor effect of family and friends exposure to SARS-CoV-2, PIL, spirituality, and honesty in BAI. Family and friends exposure to SARS-CoV-2 (B[95% CI] = 3.61 [1.59, 5.63]; $p < 0.001$), PIL (B[95% CI] = –0.15 [–0.24, –0.05]; $p = 0.002$), spirituality (B[95% CI] = 1.67 [0.92, 2.41]; $p < 0.001$), and honesty (B[95% CI] = –1.14 [–2.14, –0.14]; $p = 0.024$) all directly affected BAI. In addition to a direct effect on anxiety, PIL also had an indirect effect through honesty (B[95% CI] = 0.02 [0.008, 0.04]; $p = 0.004$), while spirituality had an indirect effect through PIL itself (B[95% CI] = 2.81 [1.49, 4.13]; $p < 0.001$).

DISCUSSION

This is the first work to evaluate the effect of the COVID-19 pandemic on the development of psychopathology in health sciences students while also considering the effects exerted by PIL, character strengths and moral courage.

In our work the more exposure of family and friends of the health science students, the greater their risk of developing anxiety. Recent studies have shown that exposing family to

TABLE 3 | Psychopathology in students.

	Total *N* = 122	Nursing students *n* = 52	Medical students *n* = 70	
	% (*n*) / *M* (*SD*)	**% (*n*) / *M* (*SD*)**	**% (*n*) / *M* (*SD*)**	***t* / χ^2(*p*) *post hoc*/CTR**
BAI	9.50 (8.133)	**11.19 (8.381)**	8.24 (7.767)	$t = 2.005$ ($p = 0.047$)
Anxiety yes	51.6 (63)	**63.5 (33)**	42.9 (30)	$\chi^2 = 5.072$ ($p = 0.024$) 2.3/–2.3
BDI-II	7.96 (6.329)	9.17 (6.116)	7.06 (6.377)	$t = 1.844$ ($p = 0.068$)
Depression yes	15.6 (19)	21.1 (11)	11.4 (8)	$\chi^2 = 2.146$ ($p = 0.143$)
AS score	6.16 (4.773)	**7.29 (4.820)**	5.33 (4.596)	$t = 2.281$ ($p = 0.024$)
Acute stress yes	25.4 (31)	**36.5 (19)**	17.1 (12)	$\chi^2 = 5.922$ ($p = 0.015$) 2.4/–2.4
DAST-10	0.20 (0.616)	0.29 (0.776)	0.14 (0.460)	$t = 1.206$ ($p = 0.232$)
Drugs yes	13.1 (16)	15.4 (8)	11.4 (8)	$\chi^2 = 0.410$ ($p = 0.522$)
AUDIT	3.32 (2.785)	3.38 (3.504)	3.27 (2.126)	$t = 0.206$ ($p = 0.837$)
Alcohol yes	14.8 (18)	17.3 (9)	12.9 (9)	$\chi^2 = 0.470$ ($p = 0.493$)
Psychopathology	27.61 (17.680)	**31.85 (18.375)**	24.46 (16.582)	$t = 2.324$ ($p = 0.022$)
Mental disorder yes	66.4 (81)	69.2 (36)	64.3 (45)	$\chi^2 = 0.327$ ($p = 0.567$)

CTR, corrected typified residuals; those less than –1.96 or greater than 1.96 were considered significant. The groups from among the categorical variables in which the CTRs were significant are shown in bold. When the post hoc tests in the quantitative variables were significant, we have indicated the highest scoring group; n, sample; M, average; SD, standard deviation; χ^2, Pearson chi-squared test; t, Student's t-test; BAI, Beck Anxiety Inventory; BDI-II, Beck Depression Inventory-II; AS, Acute Stress; DAST-10, Drug Abuse Screening Test; AUDIT, Alcohol Use Disorders Identification Test.

COVID-19 was the main reason why healthcare workers did not go to work (33), being also the most important factor for the development of anxiety, depression and acute stress (11).

Previous studies have already shown the ability of PIL to positively moderate the prevention of psychiatric disorders (34, 35). A high PIL score reduces the likelihood of the appearance of anxiety (36, 37). In fact, PIL can affect anxiety both directly and indirectly, through honesty (**Figure 1**). In addition, and in line with previous research (38), a high PIL is also protective against the onset of depression. Taking all of this into account in medical and nursing students, it is worth highlighting the protective role that a high PIL has in terms of the appearance of anxiety, depression and total psychopathology.

TABLE 4 | Significant odds ratios of linear regression models predicting the presence of psychopathology.

Response	Predictors	OR (95% CI)	*P*-value
BAI	Exposure of family/friends	4.013 (1.806, 6.220)	<0.001
	GACS-24 Spirituality	1.047 (0.311, 1.783)	0.006
	PIL	–0.180 (–0.276, –0.084)	<0.001
	GACS-24 Honesty	–1.144 (–2.140, –0.149)	0.025
BDI-II	PIL	–0.201 (–0.272, –0.130)	<0.001
ASD	Occupation (nursing student)	–1.960 (–3.661, –0.259)	0.024
AUDIT	Smoker	1.749 (0.507, 2.991)	0.006
	Sum of strengths GACS-24	–0.035 (–0.065, –0.004)	0.027
	Age	–0.133 (–0.231, –0.034)	0.009
Total PSY	Exposure of family/friends	5.189 (0.546, 9.382)	0.029
	PIL	–0.394 (–0.604, –0.184)	<0.001
	Occupation (nursing student)	–8.304 (–14.254, –2.354)	0.007

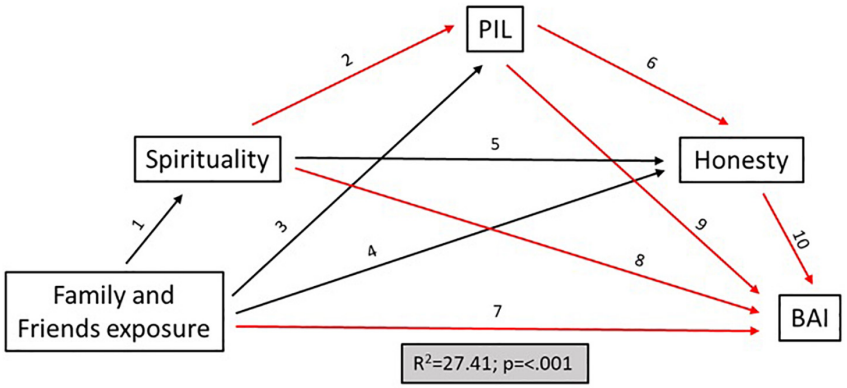
Predictor variables plus age, sex, spirituality, psychological/psychiatric treatment during the pandemic, physical illness, and psychiatric history were all entered into all the forward models. BAI, Beck Anxiety Inventory; BDI-II, Beck Depression Inventory-II; AS, Acute Stress; AUDIT, Alcohol Use Disorders Identification Test; PSY, psychopathology.

On the contrary, intense spirituality is associated with lower subjective wellbeing in medical students (39) and can increase the levels of anxiety and depression (40–42), also among nursing personnel (43). However, other studies have opposite conclusions, stating that spirituality protects against the appearance of psychopathology (44–46). One of the possibilities for which this phenomenon could occur is "spiritual distress," a state of suffering related to an impaired ability to experience purpose/meaning in life through connection with oneself, others, the world or a higher being (47). Spiritual distress frequently occurs in response to changes in health and life processes that disrupt a person's sense of purpose/meaning, just as it might happen in a pandemic. In fact, there are studies that linked participation in stressful events with increased spiritual distress and psychopathology (48). Thus, intense spirituality would act in two different ways: (1) Boosting the PIL and enhancing its protective role; (2) Acting as a vulnerability factor through the concept of spiritual distress (**Figure 1**).

Opposite to prior studies (11), no significant results have been found regarding the predictor role of moral courage. This could be explained because the health sciences students have not yet worked and therefore did not experience moral distress from it (difference between an individual's moral expectations and the behavior they are actually able to implement) which is the responsible of developing psychopathology (49).

To sum, our work indicated that anxiety levels can predicted by the degree of family and friends' exposure to SARS-CoV-2, PIL, honesty and the students' level of spirituality (**Figure 1**).

Our research showed that nursing students had a higher incidence of anxiety, acute stress and total psychopathology, as seen prior to the pandemic (4). In fact, occupation (nursing) have been linked to higher risk of acute stress levels, coinciding these findings with the results of recent works (50) that demonstrated



1: .29 [−.23, .82]; p=.267
2: 2.81 [1.49, 4.13]; p<.001
3: −1.12 [−5.00, 2.74]; p=.564
4: .09 [−.27, .46]; p=.598
5: .10 [−.03, .23]; p=.133
6: .02 [.008, .04]; p=.004
7: 3.61 [1.59, 5.63]; p<.001
8: 1.67 [.92, 2.41]; p<.001
9: −.15 [−.24, −.05]; p=.002
10: −1.14 [−2.14, −.14]; p=.024

FIGURE 1 | Explanatory model between purpose in life, spirituality, honesty, exposure, of family and friends, and the Beck's Anxiety Inventory. Significant relationships are marked in red. BAI, *Beck Anxiety Inventory*; PIL, purpose in life.

a high prevalence of acute stress among nursing personnel. Nevertheless, being a medical student was a protective factor against total psychopathology. Although no previous research has compared the profile of both these groups of students, we believe that our results should be considered based on the differences in the academic plan and the vocational peculiarities of the medical and nursing professions. Medicine is characterized by an analytical approach, oriented toward diagnosis and treatment, with more distant treatment, while nursing is characterized by close contact with the patient, taking an emotional approach that requires empathy. This may be associated with the greater involvement of nursing staff in the processes of the patients they treat, meaning that they integrate part of the suffering of others and thereby themselves tend to develop symptoms of anxiety, stress, or depression.

This theory would be reinforced by the finding that occupation (nursing) can predict high levels of acute stress and the better results for GACS-24 teamwork and love item obtained by nursing students. As an alternative hypothesis, medical students may have greater social desirability than nursing students meaning that they therefore tend to minimize psychopathology. Indeed, previous studies have shown an inverse relationship between social desirability and psychopathology (51). However, other elements could also influence the development of mental pathologies in students. For example, discontinuity in the educational process, conversion toward solely digital teaching models, and the lack of resources provided by academic institutions are factors that affect students and may have increased their levels of anxiety and stress (52). In addition, the suspension of clinical practices during the pandemic, and at a time of increased healthcare pressure in hospitals, in parallel to the maintenance of students' academic obligations during the periods of confinement, could also have contributed to the development of symptoms (53).

Therefore, it is advisable to pay attention to the education of health sciences students as it could affect their future mental health. Likewise, not addressing the psychopathology they present as students would have a negative impact on their future job performance (54). One way to prevent this psychopathology would be to incorporate to their student training workshops and seminars aimed at reinforcing their purpose in life through individual introspection exercises on personal goals and passions (55).

Finally, we must mention the main limitations of this study. Firstly, this work was carried out at a single Health Sciences Faculty, which may reduce its external validity compared to multicenter studies. Secondly, when weighing up the impact of the COVID-19 pandemic we must consider the cumulative incidence in each region or country, which was lower in the province where the study was carried out compared to other areas in Spain and other countries. Sociodemographic differences between both groups of students should also be considered because these could influence the presence of psychopathology. Thirdly, because of the cross-sectional nature of this study, we cannot state with certainty that the psychopathological results we found responded exclusively to the COVID-19 pandemic and the predictor variables. The intentional sampling used in the recruitment should also be considered as a possible methodological weakness.

CONCLUSION

This study shows that the COVID-19 pandemic impacted the development of psychopathology in health sciences students. Specifically, exposure of the students' family and friends to SARS-CoV-2 favored the appearance of symptoms of anxiety. Studying medicine was a protective factor against total psychopathology

while being a nursing student was associated with high levels of acute stress. In contrast, honesty had a preventing role in the onset of anxiety and a high PIL was protective against the appearance of anxiety, depression, and total psychopathology.

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 Investigation Commission at the Provincial Hospital Consortium in Castellon (ref. A-15/04/20) and the Clinical Research Ethics Committee of the Cardenal Herrera-CEU University (ref. CEI20/068). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

IE, AB, and GH: conceptualization. IE and IA: data curation. AB: formal analysis. MP, DP, and VQ: investigation. IE, MP, DP, and VQ: draft preparation. IE, MP, DP, VQ, AB, IA, and GH: review and editing. GH: funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Life Satisfaction and Suicidal Ideation Among Chinese College Students During the Recurrent Outbreak of COVID-19: A Moderated Mediation Model

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The present study examined a moderated mediation model between life satisfaction and suicidal ideation among Chinese college students during the recurrent outbreak of COVID-19. Seven hundred and ninety college students participated in the study and completed questionnaires on life satisfaction, suicidal ideation, depression, and gratitude. Findings indicated that (1) Depression played a partial mediating role between life satisfaction and suicidal ideation. Life satisfaction was not only directly affected suicidal ideation, but also indirectly affected suicidal ideation through the mediating effect of college students' depression; (2) Gratitude played a moderating role in the effect of life satisfaction on depression, and the link between life satisfaction and suicide ideation was only significant for those with higher gratitude. This study provides practical implications for the prevention of suicidal behavior among Chinese college students during the recurrent outbreak of COVID-19.

Keywords: life satisfaction, suicidal ideation, depression, gratitude, COVID-19, Chinese college students

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INTRODUCTION

In March 2020, the World Health Organization (WHO) declared COVID-19 as a global pandemic (1). In order to prevent the further spread of the pandemic, people were forced to maintain social distance. While keeping social distance is an important measure to control the spread of COVID-19, it may affect people's mental health (2). Studies suggest that social distance may increase people's feelings of loneliness and hopelessness, which may lead to suicide (3). A longitudinal study in Germany found that the 12-month suicide ideation of German college students increased from 26.6% in 2019 to 60% in 2020, that is to say, the proportion of college students suffering from suicidal ideation in 2020 was twice as high as in previous years (4). In China, the study found that suicidal ideation among college students has been on the rise from 8.5% in February 2020 to 14.3% in June 2020 (5). So, a possible reason for the increase in suicide rates may be the isolation measures during the COVID-19 pandemic. With the increasing popularity of internet devices, people can gather a wide variety of information through the internet, and individuals at risk of suicidal behavior often approach suicide by searching the internet for information and news about self-harm and suicidal behavior, especially during adolescence (6). The World Health Organization

regards reducing the incidence of non-fatal suicidal behavior and suicide mortality as the focus of suicide prevention and intervention work (7). Therefore, in the Internet era, we need to pay more attention to individual suicidal ideation to prevent occurrence of suicidal behavior. Therefore, it is essential to explore the influencing factors of people's suicidal ideation during public health emergencies which facilitates the advancement of suicide prevention as well as pandemic control.

Life Satisfaction and Suicidal Ideation

Suicide is the leading cause of death among people aged 15–34 in China (8). 47.2% of the abnormal deaths among college students in China are suicide (9). Suicidal ideation refers to those who have lost the desire to live but have not yet caused physical injury (10). During the recurrent outbreak of COVID-19, suicidal ideation may be higher among college students due to isolation and social distancing. Therefore, it is necessary to understand the influencing factors and mechanisms of suicidal ideation in college students.

Life satisfaction refers to an individual's stable and universal overall evaluation of life conditions (11). Research showed that the pandemic affected life satisfaction (12, 13). The coronavirus threatens people's safety and desire for survival, affecting their quality of life (13). As a result, people are less satisfied with their lives during COVID-19. Life satisfaction was significantly negatively correlated with suicidal ideation (14), and life dissatisfaction was an important cause of suicide (15). To better explore the relevant factors of suicidal ideation in college students during the pandemic, it is very important to study the relationship between life satisfaction and suicidal ideation.

Depression as a Mediator

Depression is a key indicator for diagnosing an individual's mental health (16), and usually refers to persistent negative emotional experiences in people's lives, such as oppressive, anxiety, sadness, pain, etc. (17). Individuals with depression often experience sleep disturbance, loss of appetite, and in severe cases, suicidal ideation (18). Depression seriously threatens the physical and mental development of adolescents (19), especially college students in their late adolescence (17). A study shows that depression due to COVID-19 is prevalent among Chinese college students (20) and the combined prevalence of elevated clinical depressive symptoms in adolescents during the COVID-19 pandemic is estimated to be 30.6% (21). Individuals with lower life satisfaction are more inclined to adopt negative coping styles in daily life, experience more negative emotions, and are more likely to be depressed (22, 23). Also, according to the research, temperaments greatly impact psychological distress and suicidality. Among them, the suicide attempt rate of severe depression is as high as 50%, which shows that depression is very harmful to individual psychology (24). At the same time, typical individual risk factors for suicidal ideation include psychiatric disorders, especially depression (25). Depressed individuals are prone to have suicide ideation due to low mood, pessimism, and world-weariness, and suicidal ideation is commonly seen in people with depression (26–28). Thus, we posit the following hypothesis:

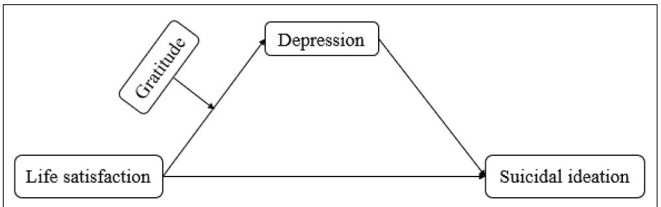

FIGURE 1 | The moderated mediation model.

Hypothesis 1. Depression will mediate the relationship between life satisfaction and suicidal ideation.

Gratitude as a Moderator

Gratitude refers to an emotional trait in which an individual responds to the help of others with gratitude, thereby enabling himself to obtain a positive experience or result, which can have a positive impact on the individual's psychological development (29). At present, most of the research in the field of gratitude has focused on the relationship between gratitude and positive emotions such as life satisfaction and wellbeing (30, 31), but some researchers have found that the trait of gratitude is also closely related to the negative emotions of individuals (32, 33). According to the extended construction theory of gratitude, individuals with high gratitude traits pay more attention to the construction of interpersonal relationships, and use their interpersonal resources to solve problems, thereby reducing negative emotions that affect them, such as depression (34). Lin (35) find that gratitude is one of the important protective factors for adolescents' mental health, and it is significantly and negatively associated with depression among college students. Thus, not only does life satisfaction reduce a person's risk of depression, but also gratitude traits reduce a person's risk of depression, both of which are protective factors against depression. According to the protective-protective factor model (36), the presence of one protective factor enhances the effect of another protective factor (37). According to the model, the effect of protective factors (life satisfaction) on depression in college students may be greater for individuals with high protective factors (gratitude). Specifically, the alleviating effect of high life satisfaction on depression is stronger when individuals have higher gratitude, while the alleviating effect of high life satisfaction on depression is weaker in individuals with lower gratitude. Thus, we posit the following hypothesis:

Hypothesis 2. Gratitude will moderate the relationship between life satisfaction and depression.

The Present Study

Taken together, the current study had two aims. First, we tested whether depression mediated the relationship between life satisfaction and suicidal ideation among Chinese college students during the recurrent outbreak of COVID-19. Second, we examined whether gratitude moderated the associations between life satisfaction and depression during the recurrent outbreak of COVID-19 (**Figure 1**).

METHODS

Participants

This study was approved by the Ethics Committee of the School of Psychology, Jiangxi Normal University. Convenience sampling strategies were used. Eight hundred and nineteen questionnaires were distributed, and 790 valid questionnaires (284 males, $M_{age} = 20.83$, $SD_{age} = 1.60$) were finally collected, with a recovery rate of 96.5%. In this study, the exclusion criteria for invalid questionnaires were (1) the total score of the camouflage subscale of the Suicidal Ideation Scale ≥ 4, (2) regular responses (i.e., the same option being selected repeatedly or answer in the pattern of 1, 2, 3, 4, 5), and (3) too short a response time (<3 min). Among the 790 participants, 102 were freshmen, 260 were sophomores, 237 were juniors and 191 were seniors. All participants provided informed consent and completed the survey voluntarily.

Measures

Life Satisfaction Scale

The Chinese version (38) of the Life Satisfaction Scale (39) was used to measure life satisfaction. There is one dimension with five items (e.g., "*In most ways my life is close to my ideal*"). Each item is scored on a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The average score of the five items was calculated, with higher average scores representing higher life satisfaction. In the present study, the McDonald's ω coefficient of the Life Satisfaction Scale was 0.93.

Gratitude Scale

The Chinese version (29) of the Gratitude Questionnaire (40) was used to measure gratitude. Participants rated six items (e.g., "*When I set myself an objective, I continue until I achieve it*") on a seven-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The average score of the six items (two items are reverse scored) was calculated, with higher scores reflecting greater gratitude. In the present study, the McDonald's ω coefficient of the Gratitude Questionnaire was 0.78.

Depression Scale

Depression was measured by the nine-item Patient Health Questionnaire (41). The Chinese version was revised by Bian et al. (42). This scale consists of nine items (e.g., "*Feeling down depressed or hopeless*"). Each item was rated on a four-point scale (0= *not at all to* 3= *almost every day*). The average score of the nine items was calculated, with higher scores reflecting more severe depression. In the present study, the McDonald's ω coefficient of the Patient Health Questionnaire was 0.94.

Suicidal Ideation Scale

Suicidal ideation was measured by the Self-Rating Idea of Suicide Scale (43). The scale was specially developed under the background of Chinese culture. This scale consists of 26 items (e.g., "*I wanted to end my life*"), including 4 subscales: hopelessness (12 items), sleep (4 items), optimism (5 items), and camouflage (5 items). The camouflage subscale was used to determine whether the participant's responses were truthful. If the total score of the camouflage subscale ≥ 4, the test was invalid. Therefore, the scores of the camouflage subscale were not included in the total score and the study used the mean scores of the three subscales of hopelessness, sleep, and optimism (43), with higher scores representing higher suicidal ideation. The scale is scored from 0 to 1, with 0 representing no and 1 representing yes. In the present study, the McDonald's ω coefficient of the Self-Rating Idea of Suicide Scale was 0.86.

Procedure

The survey was hosted on Wenjuan Web (Shanghai Zhongyan International Science and Technology, Shanghai, China; https://www.wenjuan.com/) from January 2 to 12, 2022. Most Chinese college students were still in school preparing for their final exams during this period, so participants were not in a closed-school period. Specifically, we first created an online survey, and then generated a QR code to facilitate publishing. The QR code was then sent to WeChat and QQ groups (i.e., online social media platforms) where interested participants could participate in the study. Participants completed the survey anonymously to collect information on gender, age, life satisfaction, suicidal ideation, gratitude, and depression. In this study, participants provided informed consent. In this study, all responses were anonymous. There was no compensation for participating in this study, and the participants participated entirely voluntarily. The study was approved by the ethics committee of the first author's university.

RESULTS

Preliminary Analyses

The means and Pearson correlations among the study variables are presented in **Table 1**. Life satisfaction was negatively correlated with depression ($r = -0.22$, $p < 0.001$) and suicidal ideation ($r = -0.41$, $p < 0.001$), and positively correlated with gratitude ($r = 0.23$, $p < 0.001$). Gratitude was negatively correlated with depression ($r = -0.35$, $p < 0.001$) and suicidal ideation ($r = -0.31$, $p < 0.001$). Additionally, depression was positively correlated with suicidal ideation ($r = 0.68$, $p < 0.001$).

Testing for Mediation Effect

Hypothesis 1 was tested with Equation 4 of the PROCESS macro (44). As **Table 2** Equation 1 (suicidal ideation) showed, life satisfaction was negatively related to suicidal ideation [$\beta = -0.41$, $t = -12.65$, 95%CI (-0.48, -0.35), $p < 0.001$]. According to Equation 2 (depression) and Equation 3 (suicidal ideation), life satisfaction was significant negatively related to depression [$\beta = -0.23$, $t = -6.48$, 95%CI (-0.29, -0.16), $p < 0.001$] and significant negatively related to suicidal ideation [$\beta = -0.27$, $t = -10.84$, 95%CI (-0.32, -0.22), $p < 0.001$]. Depression was positively associated with suicidal ideation [$\beta = 0.61$, $t = 24.36$, 95%CI (0.56, 0.66), $p < 0.001$]. Thus, hypothesis 1 was supported, and depression partially mediated the relationship between life satisfaction and suicidal ideation.

Moderated Mediation Effect Analysis

The moderated mediation model was tested with Model 7 of the SPSS macro-PROCESS (44). The results were shown in

TABLE 1 | Descriptive statistics.

	M	*SD*	1	2	3	4
1 Life satisfaction	4.67	1.25	1			
2 Gratitude	5.02	0.84	0.23***	1		
3 Depression	1.06	0.77	−0.22***	−0.35***	1	
4 Suicidal ideation	0.29	0.23	−0.41***	−0.31***	0.68***	1

*N = 790; ***p < 0.001.*

TABLE 2 | Testing the mediation effect of life satisfaction on suicidal ideation.

Predictors	Equation 1 (suicidal ideation)		Equation 2 (depression)		Equation 3 (suicidal ideation)		Equation 4 (depression)	
	β (95%CI)	*t*	*β* (95%CI)	*t*	*β* (95%CI)	*t*	*β* (95%CI)	*t*
Age	−0.01 (−0.05, 0.03)	−0.38	−0.0004 (−0.04, 0.04)	−0.02	−0.008 (−0.04, 0.02)	−0.49	−0.001 (−0.04, 0.04)	−0.07
Gender	−0.03 (−0.19, 0.07)	−0.88	−0.08 (−0.23, 0.06)	−1.14	−0.009 (−0.11, 0.09)	−0.18	−0.07 (−0.21, 0.06)	−1.03
Life satisfaction	−0.41 (−0.48, −0.35)	−12.65***	−0.23 (−0.29, −0.16)	−6.48***	−0.27 (−0.32, −0.22)	−10.84***	−0.15 (−0.21, −0.08)	−4.38***
Depression					0.61 (0.56, 0.66)	24.36***		
Gratitude							−0.33 (−0.39, −0.26)	−9.62***
Life satisfaction × gratitude							−0.12 (−0.18, −0.06)	−4.05***
R^2	0.17		0.05		0.53		0.16	
F	53.36***		14.09***		218.52***		29.82***	

*N = 790; ***p < 0.001.*

Equation 4 of **Table 2**. The product of life satisfaction and gratitude (the interaction term) was significantly associated with depression [$\beta = -0.12$, $t = -4.05$, 95%CI (−0.18, −0.06), $p < 0.001$], suggesting that gratitude could moderate the relationship between life satisfaction and depression. Specifically, gratitude could moderate the first half of the indirect pathway. Hypothesis 2 was supported.

For descriptive purposes, we plotted and explored life satisfaction against depression, separately for low and high gratitude. The interaction effect was visually plotted in **Figure 2**. Simple slope tests showed that for college students with high gratitude, life satisfaction was significantly associated with depression ($\beta = -0.27$, $t = -6.06$, $p < 0.001$). As for college students with low gratitude, life satisfaction had no significant effect on depression ($\beta = -0.03$, $t = -0.65$, $p > 0.05$).

FIGURE 2 | Interaction between life satisfaction and gratitude on depression.

DISCUSSION

Through a survey of 790 Chinese college students, this study found that life satisfaction was significantly negatively associated with college students' suicidal ideation during the recurrent outbreak of COVID-19. After verifying the direct link, this study constructed and tested a moderated mediation model to explore the mechanism of life satisfaction on suicidal ideation. This study further found that depression played a partial mediating role between life satisfaction and suicidal ideation in college students. Gratitude moderated the relationship between life satisfaction and depression.

Life Satisfaction and Suicidal Ideation

A significant negative association between life satisfaction and suicidal ideation was found which was consistent with the findings of non-pandemic period studies (45, 46). Individuals with low life satisfaction are more likely to have feelings of hopelessness, which can easily lead individuals to have suicidal thoughts (47). This suggests that we should pay attention to college students' life satisfaction, both during pandemic and non-pandemic periods, and enhance college students' life satisfaction to reduce their suicidal ideation.

The Mediating Role of Depression

Based on verifying the relationship between life satisfaction and suicidal ideation of college students, this study also deeply explored the mediating effect of depression on life satisfaction and college students' suicidal ideation, that is, life satisfaction affected college students' suicidal ideation through depression during the recurrent outbreak of COVID-19, which supported the hypothesis 1. The results of the study showed a significant negative association between life satisfaction and depression, which was consistent with pre-pandemic studies (22). Compared to the pre-pandemic period, people were less satisfied with their current living situation due to fear of COVID-19 and various control measures, as well as economic and psychological stress during the pandemic, leading to a decrease in life satisfaction (12). Low life satisfaction leads to more negative affect, which affects individuals' mental health and thus increases their risk of depression. A study showed that the depression incidence rate caused by the COVID-19 increased by about 27.6% in 2020 (48). And the depression detection rate in the Chinese general population during the COVID-19 pandemic outbreak was as high as 53.5% (49). Therefore, we suggest that the life satisfaction of college students should be taken seriously whether or not during the COVID-19 pandemic.

Depression is one of the risk factors for suicide. The persistent negative effect brought by depression makes individuals prone to thoughts of wanting to end their lives and escape the pain of the situation at hand. As a result, individuals with depression are more likely to tolerate and accept suicide (50). According to clinical studies, 15% of patients with major depression have a high risk of suicide (51). The findings of this paper also confirm a significant correlation between depression and suicide ideation, which was consistent with studies conducted during non-pandemic periods (52, 53). A study in Japan found a 16% increase in monthly suicide rates during the second wave of the COVID-19 pandemic (July to October 2020) (54). Thus, we need to be especially concerned about the depression status of college students, especially during the COVID-19 pandemic, which is very important for suicide prevention among college students. During the pandemic, individuals face challenges to their mental health due to quarantines and other measures. This study enriches previous studies based on university students who were under pandemic control measures and has important implications for the prevention of suicidal ideation among university students during the COVID-19 pandemic.

The Moderating Role of Gratitude

This study also examined the moderating role of gratitude between life satisfaction and depression. The present study found that gratitude was significantly and negatively associated with depression, which was consistent with the findings of the pre-pandemic COVID-19 study (55). Gratitude plays an important role in post-traumatic growth, especially during the pandemic period, and gratitude has many physical and psychological benefits for individuals, which can lead to a decrease in depression (56, 57). Therefore, activities to express gratitude can be actively pursued, which may help to cope with some of the psychological problems during the COVID-19 pandemic. This study also found that gratitude has a mitigating effect on the relationship between life satisfaction and depression during the recurrent outbreak of COVID-19, that is, when the individual's gratitude was low, the effect of life satisfaction on depression was not significant; but when the individual's gratitude was high, the inhibitory effect of life satisfaction on depression was significant. However, the pre-pandemic studies of COVID-19 did not examine the moderating role of gratitude between life satisfaction and depression. According to the gratitude coping hypothesis, individuals with high gratitude respond positively to stresses and difficulties; on the contrary, individuals with low gratitude adopt more negative attitudes to deal with the hardships in life, resulting in negative behaviors such as avoidance, and thus adversely affect individual physical and mental health (58). Fredrickson (59) believes that individuals with high gratitude are good at dealing with interpersonal relationships and can get help and support from interpersonal resources in the face of difficulties, thus reducing irritability and depression. During the pandemic, grateful individuals may be better able to cope with COVID-19-related stress and are more likely to seek support from others (60). These findings have implications for the prevention of depression in college students in the future. Therefore, it is important to improve the gratitude and life satisfaction of college students during both pandemic and non-pandemic periods. According to our research results, college students who have low life satisfaction and low gratitude were most likely to be depressed, so attention should be paid to improving their life satisfaction and gratitude.

Limitations and Future Directions

This study had some limitations. First, this study did not consider other control variables, such as other demographic variables (except age and gender) and mental state variables that may have an impact on the study results. In the future, these control variables should be taken into account. Second, this study adopted a cross-sectional design, which cannot infer the causal relationship between variables in a strict sense. In the future, a longitudinal tracking experimental design can be considered to further examine the relationship between variables. Third, this study adopted a self-report questionnaire. Surveys may be affected by social favorability, especially for qualities that are highly socially desirable, such as gratitude. In the future, measures with less social favorability can be considered, such as the use of forced-choice questionnaires. Finally, considering the current study was conducted among Chinese college students

during the recurrent outbreak of COVID-19, its generalizability was limited and future studies should be conducted in a more diverse sample to verify the validity of the current study in other cultural contexts.

Despite these limitations, this study also has some practical implications. First, according to the research results, low life satisfaction will not only increase the depression of college students but also affect their suicidal ideation of college students. Therefore, colleges and relevant departments should pay attention to the quality of life of college students, to better promote the improvement of life satisfaction of college students and reduce the risk of depression and suicide. Second, considering that depression plays a mediating role between life satisfaction and suicidal ideation in college students, attention should be paid to the depression status of college students and their mental health. Finally, gratitude can moderate the impact of college students' life satisfaction on depression, and college students are also a critical period for the formation and development of individual gratitude (61). Therefore, it is necessary to pay attention to cultivating the gratitude characteristics of college students and to use effective intervention methods (such as "conscious focus on blessings") to improve their gratitude awareness. Empirical research has shown that gratitude interventions can improve people's gratitude and life satisfaction (62).

CONCLUSION

In summary, although further research was needed, this study represented an important step in exploring how life satisfaction may be related to suicidal ideation among Chinese college students during the recurrent outbreak of COVID-19. This study showed that depression played a partial mediating role between life satisfaction and suicidal ideation. Life satisfaction was not only directly and positively related to suicidal ideation, but also indirectly affected suicidal ideation through the mediating effect of college students' depression. Moreover, gratitude played a moderating role in the effect of life satisfaction on depression, and the relationship between life satisfaction and suicidal ideation became stronger to college students with high gratitude.

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

AUTHOR CONTRIBUTIONS

ZY, HL, and BY designed the study. ZY collected the data. ZY, HL, BY, and CT analyzed the data and conceptualized the models. CT supervised the project. DH and LL made important modifications to the paper. All authors have seen, wrote, approved the manuscript, and revised the manuscript.

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The impact of social support and stress on academic burnout among medical students in online learning: The mediating role of resilience

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Background: As the COVID-19 pandemic continues, online learning and long-term isolation from social and clinical settings has exacerbated mental health problems and symptoms of academic burnout among medical students. However, few studies have discussed symptoms of academic burnout as a result of reduced social support, and increased stress among medical students during the process of online learning. To fill this gap, this study investigated the influencing factors and mechanism of academic burnout in medical students' online learning process. Both the positive inhibition effect of positive factors such as social support, and the negative aggravation effect of negative factors such as stress were explored, while the mediating and protecting role of resilience is also discussed.

Method: We collected survey data from a total of 817 medical students from a medical school in China who participated in online learning during the fall 2021 semester. An online questionnaire was sent to the students in January, 2022. Items adapted from the DASS Scale developed by Lovibond and Lovibond were used to measure medical students' stress levels. The perceived social support of medical students was assessed by the Gregory MSPSS. Resilience was evaluated by the 10-Item Connor–Davidson Resilience Scale (CD-RISC). Items from the Maslach Burnout Inventory–Student Survey (MBI-SS) were used to calculate students' academic burnout. Descriptive analysis, correlation analysis, hierarchical linear regression analysis and structural equation modeling were used to analyze the collected data.

Results: The results identified that in the context of online learning there was a positive correlation between medical students' stress and academic burnout, and their resilience played a partial mediating role. However, social support did not directly affect academic burnout, but inhibited the prevalence of academic burnout through resilience. In addition, stress was negatively related to resilience, while social support was positively related to resilience. Resilience was found to be negatively related to medical students' academic burnout in online learning.

Conclusion: The results of this study can provide a reference for the future development of appropriate educational strategies and coping measures to ameliorate the academic burnout of medical students.

KEYWORDS

stress, social support, resilience, academic burnout, medical students, online learning, COVID-19

Introduction

Since the COVID-19 outbreak, online learning has become an expanded form of learning on campus in response to sudden lockdowns. Meanwhile, the COVID-19 pandemic also has profound impacts on medical students' learning, with the majority of medical students experiencing online learning (1). The advantage of online learning is flexibility without the limitation of time and place, which ensures the orderly development of teaching, and plays an important role in ensuring that students complete theoretical courses (2). At the same time, online learning poses many challenges to education systems, and has an especially negative effect on medical students (3).

The most significant challenge is the poor learning outcomes of online learning for medical students, such as decreased academic performance and low learning satisfaction (4). What is more, a survey of medical students' online learning during the COVID-19 pandemic suggested that nearly half of medical students were experiencing academic burnout (5), which is closely related to their mental health status (6).

Medical students reported higher levels of academic burnout and showed more signs of stress, anxiety, and depression than students in other majors. The COVID-19 pandemic has exacerbated the poor mental health of the medical student population (7), particularly the stress of medical students (8). Through a comparative study of 764 medical students before and after the COVID-19 pandemic, Li et al. (9) found that medical students were experiencing increasing stress during the COVID-19 pandemic. Prior research explored the mental health problems of medical students, and discussed social support at the same time (10, 11). During the COVID-19 pandemic, "physical isolation" was implemented to prevent infection. As a way of isolating teachers and students, there was a transition from classroom learning to virtual learning, which could lead to individual isolation and lack of social support (12).

Stress was identified as a decisive risk factor for burnout, while social support was regarded as a protective factor for burnout in prior studies (13). The burnout of medical students, as future doctors, will affect public health (14). Meanwhile, it has been confirmed that stress (15) and perceived social support (16) of medical students also had an influence on the development of resilience, which is a protective mechanism against burnout (17–19).

The mounting evidence confirmed the independent correlation between stress, social support, resilience and academic burnout, as well as the mediating effect of resilience on job stress and burnout (20, 21). However, there are the following deficiencies: firstly, the role of resilience in the relationship between social support and academic burnout remains unknown; secondly, the previous research on stress and the resilience of medical students was mostly based on clinical training and campus learning, or was to explore the problems of medical students' mental health during the COVID-19 pandemic. However, research probing the possible relationship between stress, social supports, resilience, and academic burnout among medical students in the context of online learning during the COVID-19 pandemic is rare.

Since the outbreak of the COVID-19 pandemic, there has been increasing evidence reported that online courses which cannot provide practical and experimental opportunities for medical students has led to academic burnout and stress among medical students (22). Resilience, as a positive psychological resource, should be studied as a protective mechanism for the mental health of medical students to reduce losses in the field of medical education during the COVID-19 and post-COVID-19 era. Therefore, the purpose of this study is to explore the relation between stress, social support, resilience and academic burnout, especially the mediating role of resilience among medical students in online learning during the COVID-19 pandemic.

Theoretical background and hypotheses

Stress, social support, and academic burnout among medical students

Burnout, which is a serious issue in the public health area, can be characterized as emotional exhaustion, cynicism, and low personal efficacy (23, 24). In this study, we focus on academic burnout in the medical student population, which has a higher rate of burnout symptoms than other populations

(25). Differing from job burnout, academic burnout emphasizes that students are exhausted due to learning demands, have a cynical attitude toward learning, and have a low sense of learning achievement as students (26). A number of studies have shown that medical students who suffer from academic burnout have a higher level of stress (27–29). Stress is defined as the transactional process that occurs when an event is perceived to be relevant to an individual's well-being, has the potential to cause harm or loss, and requires mental, physical and/or behavioral efforts to manage the event and its outcome (30). The outward manifestations of stress are difficulty in relaxing, irritability, nervous excitability, and impatience (31). Stress plays an important role in the overall mental health and academic performance of medical students. Students who are stressed or under a high degree of stress for long periods of time show poor academic performance and mental health problems such as anxiety and depression (32, 33). Often the stress has a negative impact on individual studies or life. A significant correlation has been found between stress and academic burnout among medical students. For instance, through a cross-sectional study of 241 medical students, Yusoff et al. (34) summarized that neuroticism, emotional intelligence, and stress negatively predicted academic burnout, that is, stress should be considered as a risk factor of academic burnout among medical students.

Therefore, according to the important connection between stress and burnout mentioned above, it is necessary to investigate both of these two factors among medical students in online learning. Specifically, researchers have found that medical students experienced a higher degree of stress in online learning than prior school learning during the COVID-19 pandemic (7, 35), and it is worth our attention whether such stress will lead to a higher degree of academic burnout among medical students in online learning during the COVID-19 pandemic. Thus, we proposed the following hypothesis:

H1a: Stress is positively correlated with academic burnout among medical students in online learning during the COVID-19 pandemic.

Online learning during the COVID-19 pandemic has been implemented to control the spread of infection. The transition from classroom learning to virtual learning isolated medical students from campus, clinical settings, teachers, and friends, and may have led to personal isolation and a lack of social support (11, 12). Social support, which is considered as an important factor in an individual's mental health, refers to the psychological or physical help provided by family, friends, and others to an individual facing difficulties (36). Different from the role of stress, social support is a protective factor for the academic burnout of medical students. For instance, perceived social support was established as a protective factor for effective coping with three domains of burnout in Kilic et al.'s (13) study. A meta-analysis of the relation between social support and students' burnout indicated that social support, especially school and teacher support, has a strong negative relationship with student burnout (37). Thus, medical students are spatially isolated from school and teachers during COVID-19, and the impact of reduced social support on academic burnout deserves our attention. Therefore, we proposed that:

H1b: Social support is negatively correlated with academic burnout among medical students in online learning during the COVID-19 pandemic.

The mediating role of resilience between stress-social support and academic burnout

Resilience can be described as a relatively good psychological consequence of coping with challenges, adversities, and other adverse events (38, 39). The concept of resilience indicates the reason why individuals with high levels of stress can also thrive and gain a higher level of competence to cope with challenges. Resilience is thought to be a resource that individuals use to resist stress, and to cushion the negative effects of stress in some studies. Bajaj et al. (40) verified that there is a negative correlation between stress and resilience among undergraduate students. Shi et al. (41) showed that reducing the perceived stress of medical students can enhance their resilience. Thus, we proposed that:

H2a: Stress is negatively correlated with resilience among medical students in online learning during the COVID-19 pandemic.

In contrast to stress, social support has been proved to be an effective mechanism for improving individual resilience in several studies. For instance, Ozsaban et al.'s (42) research demonstrated that nursing students with high levels of psychological resilience perceived higher levels of social support, while Goulet et al. (43) indicated that female college students with higher levels of social support showed higher levels of resilience than those with lower levels of social support. Thus, we proposed that:

H2b: Social support is positively correlated with resilience among medical students in online learning during the COVID-19 pandemic.

Resilience is considered to be a protective mechanism against the consequences of burnout in several studies. For example, Guo et al. (44) found that resilience was an important predictor of burnout among nurses. Houpy et al. (45) indicated that the resilience of medical students is lower than that of the general population sample, and that resilient students did not experience symptoms of burnout and were able to deal with difficult clinical events well. Thus, we hypothesized that:

H3: Resilience is negatively correlated with academic burnout among medical students in online learning during the COVID-19 pandemic.

As for the mediating role of resilience, some evidence has been provided by several studies. For example, Janus et al. (46) indicated that the relationship between stress and depressive symptoms was weakened for students with high resilience. In Kaplan et al.'s research (47), the relationship between mindfulness and burnout was partially mediated by resilience. Hao et al. (20) found that resilience can prevent burnout from developing by relieving stress among civil servants in China. Based on the existing literature, it can be concluded that the impact of mental health factors including stress on burnout is mediated by resilience. Thus, we proposed that:

H4a: The link between stress and academic burnout is reduced when the mediating variables of resilience are controlled.

Besides, the mediating role of resilience on the association between social support and loneliness (48), mental well-being (49), and sleep quality (50) was proved. Nevertheless, direct evidence that resilience is the mediator in the relationship between social support and burnout has not been provided by the existing literature. Both social support and stress are predictors of resilience and burnout. It is also worth exploring whether the impact of the sharp decrease in perceived social support on burnout is affected by resilience. Stress is a risk factor for academic burnout, while social support is a protective factor for academic burnout. In addition to exploring the influence mechanism of "stress-resilience-academic burnout," it is also worth exploring whether the impact of the sharp decrease in perceived social support on the burnout of medical students is affected by the mediating effect of resilience during the COVID-19 pandemic. Furthermore, Meneghel et al. (51) confirmed that job social resources had an impact on team resilience, and in turn affected performance. According to the Job-Demand Resources Model, social support is an important job resource; therefore, we can speculate that resilience plays a mediating role in the relationship between social support and medical students' negative performance, that is, academic burnout. The results can offer suggestions for providing effective and appropriate social support for future medical students when facing stressful situations with high resilience for avoiding burnout. Thus, we proposed that:

H4b: The link between social support and academic burnout is reduced when the mediating variables of resilience are controlled.

Hypothesized conceptual model

The Job-Demand Resources Model (JD-R model) proposes that the work characteristics of all jobs can be summarized as job demands and resources which include stress, social support, and so on (52). During the COVID-19 pandemic, medical students, as future doctors, were under stress to learn online, which can drain their mental resources and lead to burnout (53). Social support can then serve as job resources to help medical students resist burnout (54). The mediating effect of resilience on the relationship between job demands and workers' performance, as well as job resources and workers' performance has been explored in prior studies. For example, Ceschi et al. (55) confirmed the moderating role of resilience in the mediating influence mechanism of resilience on the relationship between job demands and task performance based on the Job-Demand Resources Model. Therefore, this study speculated that the resilience of medical students may alleviate the burnout caused by the stress of job demands, and may also play a mediating role in the negative correlation between social support and burnout. Based on the above theoretical background and the JD-R model, this study explored the relationship between medical students' stress, social support, and academic burnout, as well as the mediating role of resilience among them. Five hypotheses and the hypothesized conceptual model of this study were proposed, as shown in Figure 1.

Methodology

Participants and procedures

A total of 817 medical students from a medical college in Nanjing, China, who had previously studied online at home due to the COVID-19 pandemic during the fall 2021 semester, were recruited. All the participants completed anonymous online surveys *via* Questionnaire Star (https://www.wjx.cn/) which is widely used as a professional online survey tool in China. In order to ensure the reliability of the research results, ethical considerations were followed to conduct the study. The purpose and voluntary nature of the study were explained to the medical students in advance. The researchers also stated that no sensitive information would be passed on, ensuring the anonymity of participants. According to national legislation and the institutional requirements, no confirmation documents or agreements were required to prove the consent of the participants. Participants' behaviors in filling out the questionnaire represented that they agreed to participate in the study. All the questionnaires were filled out with participants' consent in the end. After excluding invalid data, 807 valid questionnaires were collected (339 males, 42.00%; 468 females, 58.00%).

Measurements

Demographic information

The first part of the questionnaire collected demographic information about participants including gender, grade (1st year, 2nd year, 3rd year, 4th year and above), major (clinical medicine or other), as well as basic information about online learning

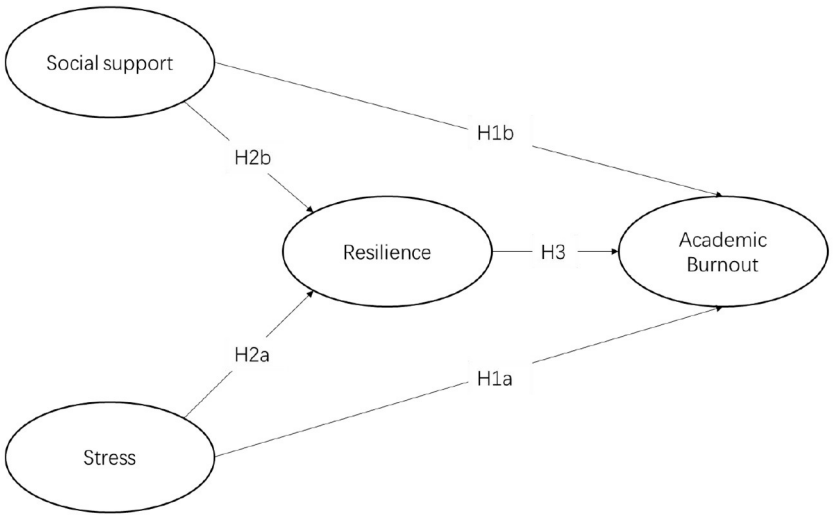

FIGURE 1
Hypothesized model.

during the COVID-19 pandemic, such as the number of online courses and daily online learning duration.

The second part of the questionnaire, consisting of four 6-point Likert scales (rating from "5" strongly agree to "1" strongly disagree), measured the mental status of medical students in online learning during the 2021 fall semester, including stress, resilience, and academic burnout, as well as social support.

Stress scale

The items measuring medical students' stress were selected from the DASS scale developed by Lovibond and Lovibond (56). The reliability and validity of this scale for assessing individuals' depression, anxiety, and stress in Chinese environments has been verified (57), with seven items measuring individual stress. In order to fit the special background of online learning, the items were adjusted, for example, "During the process of online learning, I found it hard to wind down," "During the process of online learning, I tended to over-react to situations," "During the process of online learning, I felt that I was using a lot of nervous energy," and so on. A higher score indicates a greater severity of stress.

Social support scale

To measure medical students' perceived social support during the COVID-19 pandemic, the Multidimensional Scale of Perceived Social Support (MSPSS) designed by Gregory et al. (58) was applied. The MSPSS, adjusted for the context of online learning, comprises 12 items, for example, "My family really tries to help me in online learning, such as providing me with online learning equipment, etc." The higher the total score, the higher the degree of social support that is received by medical students in online learning during the COVID-19 pandemic.

Resilience scale

The scale measuring medical students' resilience in online learning during the COVID-19 pandemic was adapted from the 10-Item Connor–Davidson Resilience Scale (CD-RISC) (59). Similarly, all the items were adjusted to fit the context of online learning, for example, "During the process of online learning, coping with stress can strengthen me," and "During the process of online learning, I am able to adapt to change." A higher score on this scale indicates a higher level of resilience facing online learning during the COVID-19 pandemic.

Academic burnout scale

Medical students' academic burnout was measured using the Maslach Burnout Inventory–Student Survey (MBI-SS) validated by Schaufeli et al. (26). The scale, consisting of 15 items, has been shown to be useful for measuring burnout in groups of students who are exhausted by learning demands. The revised questions are more in line with the characteristics of online learning, for example, "I feel used up at the end of a day of online learning," and "After online learning, I have become less enthusiastic about my studies." A higher score indicates a greater degree of academic burnout.

TABLE 1 Results of CFA.

Fit indices	x^2/df	GFI	AGFI	NFI	CFI	RMSEA
Result	2.816	0.945	0.930	0.964	0.976	0.047
Threshold	<3.0	>0.9	>0.9	>0.9	>0.9	<0.05

TABLE 2 Results of reliability and validity analysis.

Variables	FL	CR	AVE	Cronbach's α
Social support	0.573∼0.877	0.8548	0.6014	0.842
Stress	0.705∼0.925	0.9217	0.7037	0.920
Resilience	0.709∼0.888	0.9437	0.7064	0.943
Academic burnout	0.783∼0.924	0.9368	0.7485	0.935

TABLE 3 Result of discriminant validity analysis.

Constructs	Social support	Stress	Resilience	Academic burnout
Social support	**0.776**			
Stress	−0.256	**0.839**		
Resilience	0.571	−0.417	**0.840**	
Academic burnout	−0.306	0.738	−0.483	**0.865**

Item analysis

Item analysis was used to eliminate inappropriate questions from the questionnaire to modify the hypothesized model of this study. At the beginning, there were totally 44 items in the original questionnaire, which included seven items for the Stress Scale, 12 for the Social Support Scale, 10 for the Resilience Scale, and 15 for the Academic Burnout Scale. Firstly, the items with factor loadings below 0.4 were deleted. (60). After this process, four items in the Social Support Scale, one in the Resilience Scale, and five in the Academic Burnout Scale, the factor loadings of which were below 0.4, were deleted. Secondly, first-order confirmatory factor analysis (CFA) was applied to remove inappropriate items from each structure based on residuals until the residuals reached the ideal threshold (61). After conducting CFA (as shown in Table 1), two items in the Stress Scale, four in the Social Support Scale, two in the Resilience Scale, and five in the Academic Burnout Scale were deleted. Finally, 21 items in total remained for further analysis, including five for the Stress scale, four for the Social Support scale, seven for the Resilience scale, and five for the Academic Burnout scale.

Reliability and validity analysis

The results of reliability and validity analysis are shown in Table 2. Internal consistency reliability (Cronbach's alpha) exceeded 0.8 for all items, and composite reliability (CR) values for all items ranged from 0.855 to 0.944, indicating good reliability of this study's constructs. (61).

The convergent validity and discriminant validity were tested to verify the validity of all the items. As shown in Table 3, the values of both factor loading and average variance extracted (AVE) were higher than 0.5, indicating the acceptable convergent validity of all items. Meanwhile, all the items' square root of AVE were higher than the Pearson correlation values in the off-diagonal constructs. Thus, the discriminant validity of the constructs was suitable.

Data analysis

Statistical analysis was conducted using SPSS 25.0, including descriptive statistical analysis of demographics and categorical variables, difference analyses of academic burnout in the different groups, and correlation analysis between variables. According to prior studies (1, 62), the results of normality verification do not need to be reported. Then, academic burnout (the dependent variable) was analyzed by hierarchical regression analysis. Demographic characteristics, stress, social support, and resilience were put into the regression equation in steps as follows. Step 1: Demographic characteristics including gender, grade, major, online learning time, number of online courses; Step 2: stress; Step 3: social support; and Step 4: resilience. Finally, structural equation modeling (SEM) analysis conducted using the Amos 26.0 software tested whether resilience mediated the relationship between stress-social support and academic burnout of medical students in online learning during the COVID-19 pandemic. Stress and social support were modeled as independent variables, resilience as a mediating variable, and academic burnout as a dependent variable.

Results

Descriptive and difference analysis

Descriptive statistics of demographic characteristics and academic burnout difference in categorical variables are shown

TABLE 4 Descriptive analysis and differences in academic burnout among medical students ($N = 807$).

Variables	N	%	Academic burnout		
			Mean	SD	F
Gender					5.739
Male	339	42	2.71	0.89	
Female	468	58	2.64	0.76	
Grade					4.208**
Freshman	193	23.9	2.53	0.84	
Sophomore	205	25.4	2.62	0.81	
Junior	170	21.1	2.74	0.82	
Senior and above	239	29.6	2.79	0.79	
Major					5.71
Clinical medicine	599	74.22	2.66	0.84	
Others	208	25.78	2.7	0.75	
Online learning time (h)					0.759
1∼3	195	24.2	2.65	0.76	
3∼6	432	53.5	2.71	0.79	
>6	180	22.3	2.62	0.94	
Numbers of online courses					2.395
1∼4	312	38.7	2.6	0.78	
5∼8	391	48.4	2.74	0.79	
>8	104	12.9	2.66	1.03	

**Significant at the 0.01 level.

TABLE 5 Result of the correlative analysis.

	Mean	SD	1	2	3	4
1. Social support	3.65	0.69	1			
2. Stress	2.67	0.78	−0.256**	1		
3. Resilience	3.55	0.65	0.571**	−0.417**	1	
4. Academic burnout	2.67	0.82	−0.306**	0.738**	−0.483**	1

**Significant at the 0.01 level.

in Table 4. Of the 807 medical undergraduates in total, 58% (N = 468) were female and 42% (N = 339) were male. The distribution of grades was even, with 193 (23.9%) in their first year of study, 205 (25.4%) in the second year; 170 (21.1%) in the third year; while 239 (29.6%) were in their fourth year and above. Most of the medical students were from clinical medicine (N = 599, 74.22%). About half of the medical students (N = 432, 53.5%) spent 3∼4 h on online learning per day during COVID-19, while 195 (24.2%) spent 1∼2 h and 180 (22.3%) spent over 6 h. About half of the medical students (N = 391, 48.4%) took 5∼8 online courses, while 312 (38.7%) took 1∼4 online courses and 104 (12.9%) took more than 8 online courses. Fourth year students experienced greater severity of academic burnout in online learning than first year students who had just entered college ($p < 0.01$).

Correlative analysis

The results of means, standard deviations of social support, stress, resilience, and academic burnout as well as the correlative analysis are demonstrated in Table 5. Both social support and resilience were significantly and negatively correlated with medical students' academic burnout in online learning ($p < 0.01$), while stress was significantly and positively correlated with academic burnout ($p < 0.01$) among medical students in online learning.

TABLE 6 Hierarchical linear regression analysis (stress as independent).

Block		Academic burnout		
		Model 1	Model 2	Model 3
1	Demographics			
	Gender	−0.052	−0.011	−0.018
	Grade	0.132**	0.063**	0.038
	Major	−0.018	−0.012	−0.033
	Online learning time	−0.055	−0.023	0.006
	Number of online courses	0.038	−0.002	−0.001
2	Stress		0.732**	0.646**
33	resilience			−0.213**
R^2	0.020	0.549	0.585	
ΔR^2	0.014	0.546	0.581	

**Significant at the 0.01 level.

TABLE 7 Hierarchical linear regression analysis (social support as independent).

Block		Academic burnout		
		Model 1	Model 2	Model 3
1	Demographics			
	Gender	−0.052	−0.039	−0.054
	Grade	0.132**	0.101**	0.056
	Major	−0.018	−0.034	−0.062
	Online learning time	−0.055	−0.027	0.020
	Number of online courses	0.038	0.030	0.029
2	Social support		−0.294**	−0.039
33	resilience			−0.464**
R^2	0.020	0.105	0.245	
ΔR^2	0.014	0.098	0.238	

**Significant at the 0.01 level.

Hierarchical linear regression analysis

Academic burnout was regarded as the dependent variable, and demographics including gender, grade, major, online learning time, and number of online courses were treated as the control variable. Stress and social support as independent variables were introduced into the hierarchical linear regression analysis.

Stress, resilience, and academic burnout

Stress and resilience were successively introduced into the regression model. As shown in Table 6, stress was a significant predictor of academic burnout, accounting for 54.9% of variation. When resilience was added to the model, the standardized regression coefficient (β) between stress and academic burnout decreased from 0.733 to 0.646. This result indicated that resilience might play a partial mediating role in the relationship between stress and academic burnout among medical students in online learning during the COVID-19 pandemic.

Social support, resilience and academic burnout

Social support was also regarded as an independent variable to carry out the hierarchical linear regression analysis. The results are shown in Table 7. After controlling for gender, grade, major, online learning time, and number of online courses, social support predicted academic burnout in online learning among medical students with an explanatory variance of 9.8%. When resilience was introduced into the model, it made a new contribution and increased the explanatory variation of academic burnout by 14%. However, the standardized regression coefficient of stress to depression decreased from 0.294 to 0.039 ($p > 0.05$), which suggested that resilience may completely mediate the impact of social support on academic burnout.

Structural equation modeling of the mediating role of resilience

The results of structural equation modeling analysis conducted using Amos 26.0 are presented in Table 8. The observed data fit well with the proposed structural model, which indicated that resilience not only had a direct influence on academic burnout, but also significantly and indirectly affected medical students' academic burnout in online learning *via* stress and social support. Firstly, the direct pathways from stress and social support to academic burnout are illustrated in Figure 2. Stress had a significant and positive influence on academic burnout ($\beta = 0.801$, $p < 0.01$; H1a supported), while social support had no effect on academic burnout ($\beta = -0.408$, $p > 0.05$; H1b rejected). Figure 3 illustrates the indirect pathways from stress and social support to academic burnout *via* resilience. As is shown, stress was negatively associated with resilience ($\beta = -0.313$, $p < 0.01$; H2a supported), social support was positively associated with resilience ($\beta = 0.562$, $p < 0.01$; H2b supported), and resilience had a negative association with academic burnout ($\beta = -0.177$, $p < 0.01$; H3 supported). The bootstrap and bias-corrected method was employed to test the indirect effect of resilience. As shown in Table 9, resilience played a mediating role between stress and academic burnout ($p < 0.01$, a * b = 0.056, H4a accepted), as well as social support and academic burnout ($p < 0.01$, a * b = −0.100, H4b accepted). In combination with the indirect effect and the direct effect, it can be concluded that resilience partially mediated the

TABLE 8 Result of SEM analysis.

Fit indices	x^2/df	GFI	AGFI	NFI	CFI	RMSEA
Result	2.816	0.945	0.930	0.964	0.976	0.047
Threshold	<3.0	>0.9	>0.9	>0.9	>0.9	<0.05

relation between stress and academic burnout, while resilience completely mediated the relation between social support and academic burnout.

Discussion

The purpose of this study was to explore the relationship between stress, social support, resilience, and academic burnout among medical students in online learning during the COVID-19 pandemic, and to examine the mediating effect of resilience on stress-social support and academic burnout. To achieve this objective, this study provided empirical evidence in the relationship between stress, social support, resilience, and academic burnout based on relative theoretical concepts and conclusions from prior research on medical students. This study fills a gap in the existing literature.

Firstly, the results of this study indicate that stress and resilience positively predicted academic burnout, and social support insignificantly predicted academic burnout. That is, stress might be a risk predictor of academic burnout, while resilience might be a protective predictor of academic burnout. Secondly, as expected, the relationship between stress and academic burnout was partially mediated by resilience among medical students in online learning, while resilience completely mediated the relation between social support and academic burnout. The findings are described and explained in more detail below.

The correlation between stress, social support, resilience and academic burnout

Stress: Positively related to academic burnout but negatively related to resilience

Compared with students from other majors, the problem of stress is more prominent among medical students (63, 64). During the COVID-19 pandemic, medical students have had to acquire knowledge through online courses, which has put enormous stress on them in terms of both their academic study and opportunities of employment (65). Results of this study indicated that stress has a positive effect on academic burnout in the online learning process of medical students, indicating that it is one of the important risk factors of academic burnout, and the occurrence of academic burnout should be avoided by regulating students' stress in online learning; thus, H1a was supported. This finding was in line with prior studies which confirmed that stress was interlinked with academic burnout among medical students [e.g., (66–68)]. Guruprakash et al. (66) pointed out that after experiencing great stress, medical students would show painful emotions and have relatively higher scores for burnout. Specifically, the Job Demands and Resources (JD-R) model proposed that the increase in job demands (stress) can lead to job burnout (53). He et al. (69) also confirmed that stress as one of the job demands was positively related to clients' burnout on the basis of the central postulates of the Job Demands and Resources (JD-R) model. Due to the sudden changes in online learning during the COVID-19 pandemic, medical students have reported higher levels of confusion and stress than before (70, 71). During the period of the COVID-19 pandemic, the level of medical students' stress was inevitably increased as they had to study online at home, which would accordingly result in negative effects on their study (72); academic burnout should be one of the adverse reactions.

In addition to having a negative impact on medical students' online learning, especially aggravating their academic burnout, stress will also cause mental health problems. This study found that there was a negative correlation between stress and resilience of medical students in online learning during the COVID-19 pandemic; thus, H2a was supported. This finding is consistent with the research of Yu et al. (73) which indicated that lower stress during COVID-19 was significantly associated with higher resilience at the time of admission.

Therefore, it is necessary to provide students with effective strategies and coping methods to manage and reduce stress in the post-COVID-19 pandemic era. Studies have shown that self-care activities such as exercise, healthy diet, and building good interaction with others can buffer stress (74), while qualities such as self-efficacy, happiness, and optimism can alleviate stress (75).

Social support: Unrelated to academic burnout but positively related to resilience

Specifically, Santen et al. (27) confirmed that the low level of support and high stress resulted in a high degree of burnout which gradually developed in the course of medical education. Social support is important for helping medical students overcome academic burnout in most situations, as has been confirmed in most literature. However, these views deviate from another finding of this study, that is, social support, differing from stress, was not a significant predictor of medical students' academic burnout in online learning, and thus H1b was rejected. Social support can effectively reduce the risk of academic burnout based on the precondition of subjective support and learners' use of support (76). Fontana et al. (77) also implied that social support seeking behavior did not effectively reduce the prevalence of burnout among medical interns. Through a

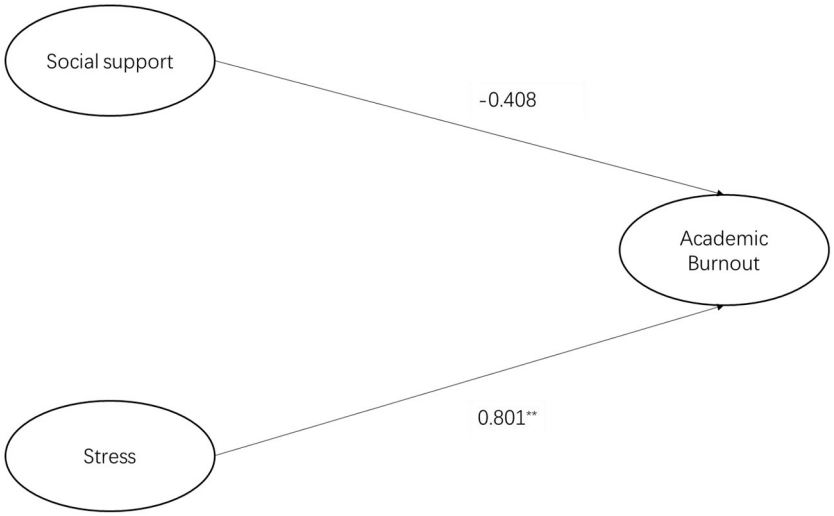

FIGURE 2
SEM of stress, social support, and academic burnout.

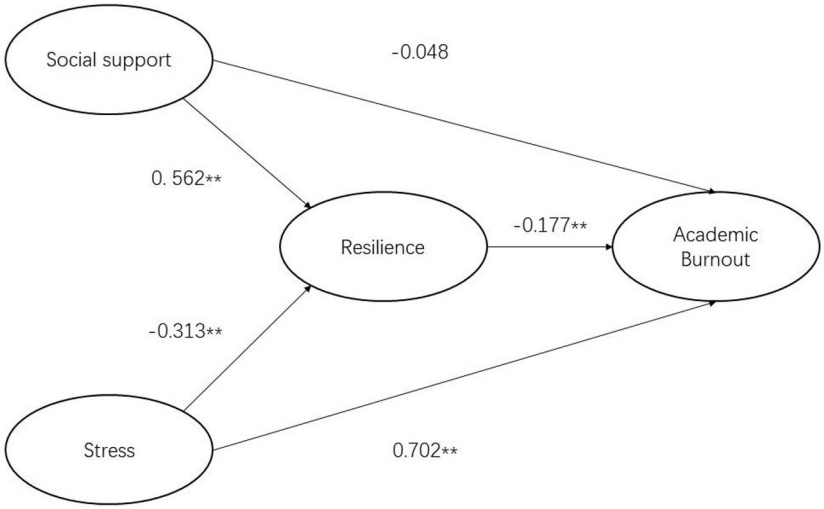

FIGURE 3
SEM of the mediating role of resilience between stress, social support, and academic burnout.

systematic literature review, Chunming et al. (78) concluded that social factors such as the degree of social support, or the environmental factors around students jointly affect the burnout of medical students. Furthermore, García-Sierra et al. (54) found that differing from job demands which were significant predictors of nurses' burnout, social support significantly predicted nurses' engagement according to the Job Demands and Resources (JD-R) model. Therefore, social support might not independently alleviate the symptoms of academic burnout in medical students in the context of online learning.

However, the positive relationship between social support and medical students' resilience in online learning was found in this study, and thus H2b was supported. This finding is in accordance with previous literature on the correlation between social support and resilience. Casapulla et al.'s (79) research indicated that social support perceived or experienced by medical students is an important factor in their progress toward resilience. Bore et al. (80) also provided evidence that social support positively correlated with medical students' social support. When dealing with a crisis such as the COVID-19 pandemic, effective social support can alleviate negative

TABLE 9 Indirect effect of the model.

Pathway	β	se	Bias-corrected 95% CI	
			LL	UL
Stress→ Resilience→ AB	0.056**	0.018	0.026	0.096
Social support→ Resilience→ AB	−0.100**	0.026	−0.156	−0.054

**Significant at the 0.01 level.

emotions, improve self-efficacy, and build up confidence and courage to cope with the crisis (81).

Therefore, providing the necessary and proper social support services for medical students who experience high levels of burnout and low levels of resilience (82) during the online learning of the COVID-19 pandemic is crucial, as it might maximize the resilience level of medical students to some extent. For example, schools can offer online psychological counseling services or online courses on mental preparation for public health events for medical students (11).

Resilience: Negatively related to academic burnout

In addition to finding that increased social support and decreased stress can prevent the symptom of burnout, resilience is also an important strategy to diminish burnout in this study; thus, H3 was supported. Previous studies on the correlation between resilience and academic burnout among medical students indicated similar results as this study. Pharasi and Patra (83) concluded that resilience is a protective mechanism against burnout. Through the investigation of medical students, Forycka et al. (82) reported that students with a higher level of resilience presented a better attitude toward online courses and showed lower levels of academic burnout.

Zuniga et al. (84) noted that teaching self-awareness, formal educational interventions, and self-regulation skills can help improve resilience and promote wellbeing, even during a pandemic. Dunn et al. (85) developed a special model called the "Coping Reservoir" to promote resilience in medical students to combat burnout symptoms. Through a survey of medical students who had completed long-term resilience skills training, Mugford et al. (86) concluded that planned rest time, establishment of a support system, and mindfulness skills were all effective measures to train resilience.

The partial mediating role of resilience in stress and academic burnout

As expected, the relationship between stress and academic burnout was partially mediated by resilience among medical students in online learning; thus, H4a was supported. This finding is in concordance with Farquhar et al. (87), who pointed out that resilience has a preventive effect on burnout because it can reduce medical students' perception of stress. In the literature on the stress of medical students, resilience training is also regarded as an effective factor to relieve the impact of stress (88). Duarte et al. (89) concluded that resilience played a mediating role in perceived stress and burnout (exhaustion) among medical students during the COVID-19 lockdown. Resilience is considered necessary for medical students to overcome the stress from academic and future employment and to achieve academic success (90). Through an empirical investigation of a large sample of medical students, Peng et al. (91) concluded that resilience can greatly mitigate the impact of mental health problems on medical students and help students adapt to negative life events. The COVID-19 pandemic, which has forced students to study online at home and has disconnected them from school and practice sites, is a negative life event for medical students without a doubt. Intermittent online learning during the COVID-19 pandemic period has aggravated the stress of medical students, and academic burnout is one of the chain reactions of stress. Resilience, as a mediator of medical students' stressors, has positive and far-reaching significance for the development of medical students (92). Therefore, resilience strategies should be proposed to mediate the negative correlation between stress and burnout among medical students.

Learning coping skills of adapting to stress is an effective measure to strengthen resilience indicators and to reduce the negative effects of stress among medical students (93). Building reliable resilience of students also needs the assistance of teachers. Faculty strategies for decreasing stress and increasing resilience among medical students has been presented in prior studies (87). It is feasible to communicate negative emotions related to stress with students, as well as to share teachers' experiences of stress and resilience through structured activities such as lectures and conferences. In addition, teachers can guide students to maintain positive mental imagery when facing stress.

The complete mediating role of resilience in social support and academic burnout

Although the direct effect of social support on academic burnout was not found, resilience played a complete mediating role in the relation between social support and academic burnout among medical students in online learning during the COVID-19 pandemic. This finding is consistent with the research of Klinoff et al. (94), which revealed that the significant association between social support and burnout was mediated by resilience. Similarly, Shang and Yang (95) demonstrated that social support received by athletes inhibits or prevents the prevalence of burnout through psychological resilience. The social support caused by the isolation from society does

not directly cause academic burnout of medical students in the COVID-19 pandemic, but rather the structure that poor social support leads to low resilience causes the aggravation of academic burnout among medical students in the process of online learning. Therefore, when providing social support policies for medical students, more attention should be paid to enhancing their resilience relying on social support, so as to compensate for the symptoms of academic burnout.

Conclusions

During the continuing COVID-19 pandemic, online teaching was introduced as an important supplement to regular teaching. Online learning and the COVID-19 lockdown have led to a sharp decrease in social support for medical students and an increase in stress, which requires resilience to mitigate the swelling of academic burnout caused by the sudden decrease in social support and the surge in stress. The conclusions of this study provide some suggestions for stress relief, social support provision, resilience development, and academic burnout mitigation for medical students in future online learning.

The results of this study demonstrated that stress exhibits a direct positive effect on academic burnout and an indirect effect on academic burnout through resilience, whereas social support has no direct effect on academic burnout, but exerts an indirect effect on academic burnout through the mediation path of resilience. Therefore, it is suggested that intervention measures be provided to reduce the academic burnout of medical students in online learning during the COVID-19 pandemic, especially focusing on the stress and resilience of medical students, and providing strategies for enhancing resilience while increasing social support to better reduce academic burnout of medical students.

Implications

The implications of this research for society or practice are presented below from theoretical and practical perspectives.

The theoretical contributions of this study are as follows. Firstly, this study has enriched the literature on stress, social support, resilience, and academic burnout among medical students. In the past, the research on medical students' mental health or academic performance was mostly confined to the traditional face-to-face learning environment or internship background. There are few studies on the relationship between stress, social support, resilience, and academic burnout in the context of online learning.

Secondly, in this study, stress (the negative predictor) and social support (the positive predictor) were used as independent variables to explore the variation of medical students' academic burnout, and two mediation path models with resilience as the mediator were constructed. Different from previous mediating models that considered only one independent variable, this study better demonstrates the buffering effect of resilience on the impact of positive and negative factors on academic burnout.

Finally, distancing measures taken during the COVID-19 pandemic have imposed unprecedented restrictions on medical students' learning. Medical students' stress, perceived social support, and resilience levels were considered as predictors of academic burnout over the years. Therefore, it is of great significance to explore the prevalence of academic burnout among medical students in online learning for the continuation of medical education.

The theoretical model of this study also has practical contributions which might be used in practice and teaching. The biggest practical contribution of this study is that it identifies the appropriate intervention measures for mental health maintenance and academic burnout offsetting for multiple levels of medical students, and for teachers and education departments. These interventions will help reduce the risk of stress and academic burnout, and enhance the sense of perceiving social support and more stable resilience among medical students.

This research was conducted in the fall semester of 2021, when most Chinese universities had accumulated some experience of online teaching and students had already conducted several rounds of online learning at home. Therefore, compared with the research on online teaching carried out in the early stage of the COVID-19 pandemic, the conclusion of this study may provide more valuable references for other countries to carry out online teaching in the future.

Limitations and future study

One limitation of the study is the adoption of a cross-sectional design. Although statistical methods have been used to explore a causal relationship between stress, social support, resilience, and academic burnout, the explanation is not sufficient. Therefore, it is necessary to conduct longitudinal studies on similar cohorts in the future to further explore their internal associations.

Another limitation of this study is the quantitative analysis of the self-assessment tools used in this study to measure the indicators of stress, social support, resilience, and burnout of medical students. In the future, a mix of quantitative and qualitative approaches can be designed to present integrated and individual experiences and ideas in greater detail and to make possible solutions and suggestions more reasonable.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Second Affiliated Hospital of Nanjing Medical University. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

All authors contributed equally to the conception of the idea, implementing and analyzing the experimental results, writing the manuscript, and reading and approving the final version of the manuscript.

Conflict of interest

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

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Family satisfaction and self-efficacy among low-income adolescents during the COVID-19 pandemic: A comparative analysis of parents' educational attainment

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Purposes: Given that the period from middle to high school is important to develop and cultivate self-efficacy, reduced support in low-income families might negatively influence the development of self-efficacy among low-income students since COVID-19. This study aims to investigate the association between family satisfaction and self-efficacy among low-income students since COVID-19 and the moderating effect of parents' educational attainment on the relationship.

Methods: 255 low-income students in South-Korea were selected for the final sample. The PROCESS macro 3.4 for Statistical Product and Service Solutions was used to analyze the data.

Results: Family satisfaction was positively related to self-efficacy among low-income students. There was a significant moderating effect of parents' educational attainment on the relationship between family satisfaction and self-efficacy among low-income students during the COVID-19 pandemic.

Discussion: Financial support and COVID-19 benefits should be prioritized to low-income families with adolescents to improve family relationships, leading to increase self-efficacy among low-income students. Social welfare programs targeting family relationships in low-income households should be especially targeted toward low-income households without a parent who received higher education. Life-long education should be provided to parents in low-income families who did not gain higher education as their educational attainment influences the self-efficacy of their adolescent children.

KEYWORDS

low-income adolescents, family satisfaction, self-efficacy, parents' educational attainment, COVID-19

Introduction

From January 2020 to June 2022, there have been more than 18 million confirmed cases of COVID-19 in South Korea, with more than 24,000 associated deaths (1). COVID-19-related school closures for 5 weeks from March to April 2020 drastically disrupted the lives of South Korean adolescents (2). From early April to late May or early June, depending on the students' grade, they proceeded to have fully online schooling (2). During this time, researchers found that high self-efficacy was important for adolescents' positive adaptation and functioning (3, 4).

Self-efficacy in adolescence

Self-efficacy is a person's perceived capability to achieve something or complete a task (5, 6). Adolescence is an important developmental period for self-efficacy, affected by parental, school, and peer influences (7). Self-efficacy is also inversely associated with income and savings (5, 6, 8–10). A few studies have examined self-efficacy among low-income adolescents, and adolescents in households with higher incomes tend to report higher self-efficacy of many types than those in lower-income households (5, 6, 10). Among Chinese adolescents aged 12–18 years, family's combined annual income was positively correlated with adolescents' general self-efficacy (5). In another sample of Chinese high schoolers, students who were poor (i.e., a monthly income of less than $56 per person) had significantly lower general self-efficacy than those who were not (6). Thus, there is some evidence to suggest that self-efficacy differs by family income among adolescents, but more research is needed.

Some research has investigated the importance of self-efficacy in adolescence and beyond during the COVID-19 pandemic. In a sample of Italian adolescents surveyed during the nationwide COVID-19-related lockdown, researchers found that both emotional and self-regulated learning self-efficacy positively predicted adolescents' subjective wellbeing and positive coping during the lockdown (3). Moreover, in a sample of parent-child dyads that included elementary-aged, pre-adolescent and adolescent children, youth who had greater general self-efficacy had a smaller increase in mental health symptoms during the COVID-19 outbreak, as compared to data collected before (4). In data collected from Chinese high school students in April 2020, two types of self-efficacy (internet self-efficacy and self-efficacy of interacting with learning content) were positively associated with positive mind states related to online learning as well as students' perceived effectiveness of online learning (11).

Two studies examined the importance of self-efficacy among university students during COVID-19. In March 2020, a measure of academic self-efficacy was inversely associated with anxiety among Spanish university students (12). In spring semester 2021, academic self-efficacy significantly predicted Korean university student's engagement in their hybrid learning (13). Last, a few studies examined the importance of self-efficacy during COVID-19 among adults of all ages. In a longitudinal study of French adults conducted over eight weeks of COVID-19-related lockdown, higher self-efficacy was associated with higher positive affect (14). Similarly, in a sample of Italian adults, emotion regulation self-efficacy was inversely associated with adults' anxiety and depressive symptoms during COVID-19, and in a sample of Turkish adults, self-efficacy related to COVID-19 prevention was associated with better mental health outcomes (15, 16). Thus, research has examined the importance of self-efficacy for academic and mental health outcomes during COVID-19, but more research is needed on adolescents, as much research has looked at adults.

Adolescent self-efficacy and parental educational attainment

Compared to adolescents whose parents have higher educational attainment, adolescents with parents who have low or no higher educational attainment also have lower perceived self-efficacy in most studies (5, 11, 12). For example, in a sample of Chinese adolescents aged 12 to 18 years, both mothers' and fathers' educational attainment were positively correlated with adolescents' general self-efficacy scale score (5). Additionally, in a large, nationally representative sample of American 10th graders, family socioeconomic status [SES] – mothers', fathers', and/or guardians' educational attainment - was positively associated with math and English self-efficacy (11). Moreover, in a longitudinal study of Polish adolescents, when mothers' educational level increased over time, so did their adolescent children's general self-efficacy scores (12). In another sample of regular and vocational high school students in China, students in regular high schools reported significantly higher maternal and paternal educational attainment (13). Although parental educational attainment and adolescent self-efficacy were not directly compared, students in regular high schools, whose parents had higher educational attainment, reported higher self-efficacy than the vocational high school students (13). In another sample of African American high school students, those who reported higher parental SES – including parental educational attainment – reported higher career self-efficacy than adolescents with lower parental SES (14). Moreover, among American 9th graders, students whose mothers did not obtain higher education had lower coping self-efficacy, or belief in their own ability to deal with stress (15). Despite the positive correlations found between parental educational attainment and their adolescent children's self-efficacy, other co-variates such as cultural capital should be considered to explain the relationship between the two variables (7).

Only two studies were located that examined the relationship between self-efficacy and parental educational attainment during adolescence and young adulthood in the context of the COVID-19 pandemic; none were located looking at adolescents only (17, 18). First, general self-efficacy was not significantly associated with parental education in a sample of 16–25-year-olds in the U.K. in a survey collected from February to October 2021 (18). Second, researchers surveyed university students in December 2020, after the students returned to campus, and the authors found that parental education predicted students' perceived self-efficacy to prevent COVID-19 infection (17).

Self-efficacy and family satisfaction

A few studies have examined the relationship between self-efficacy and family satisfaction in adolescent and adult samples (16, 19, 20). In a sample of young to elderly adults, family satisfaction was associated with self-efficacy to manage work-family conflict (20). Moreover, two studies included the relationship between adolescents' family satisfaction and filial self-efficacy, the latter of which was defined as "perceived capability to exercise their expanding agentic role in their relationships with their parents" (19). In the first study, Italian adolescents with higher perceived filial self-efficacy reported higher family satisfaction at baseline and 2 years later (19). In the second study, researchers used data from parent-adolescent dyads to determine that adolescents' filial self-efficacy was associated with family satisfaction through collective family efficacy, which included the filial self-efficacy variable as well as dyadic parent-child efficacy and dyadic spousal efficacy (16). As only a few studies were located examining this relationship, more research is needed on the relationship between adolescents' family satisfaction and self-efficacy.

Self-efficacy and factors related to family satisfaction were also examined in the context of the COVID-19 pandemic. In a sample of mothers whose children (kindergarten through grade 2) engaged in schooling from home during lockdowns, mothers' self-efficacy related to teaching was inversely associated with mother-child conflict during schooling, as well as positively associated with mothers' perceived mother-child closeness (21). Further, parenting self-efficacy was inversely associated with family functioning in a sample of families with children in first grade during the COVID-19-related lockdowns in Italy (22). Thus, more research is needed examining family satisfaction and other dynamics in families with adolescent children in the context of COVID-19.

Family satisfaction and parental educational attainment

Two studies were found that examined variables related to family satisfaction and parental educational attainment (23, 24). First, in the only study found to directly examine the relationship between adolescents' self-reported family satisfaction and parental educational attainment, adolescents living in remarried families reported higher satisfaction with their parent and stepparent if either their parent or stepparent had higher educational attainment (23). Additionally, family members' higher educational attainment was positively associated with more frequent family communication, two means of which (face-to-face and phone) were positively associated with perceived family wellbeing (24). The family wellbeing variable included aspects of family harmony and happiness, which may be associated with family satisfaction (17, 25).

Two studies were located that examined family dynamics and parental educational attainment among families with adolescent children during COVID-19. In a sample of parents of children aged 3–17 years in March 2020 in Wuhan and Shanghai, China, parents with a higher educational attainment (bachelor's degree or above) were less irritable toward their children and reported higher closeness with their children than parents with lower educational attainment (high school or below) (26). Second, during the COVID-19 pandemic, adolescents in the Midwestern US who had parents with low or moderate levels of education (a bachelor's degree or below) had a more significant increase in family stressors during the pandemic and associated lockdowns than did adolescents with parents with a high level of education (a graduate degree) (27). Thus, more research is needed on this relationship with families with adolescent children in the context of COVID-19.

The present study

Evidence suggests that self-efficacy differs by household income or SES (5, 6). Since coronavirus disease has spread around the world, low-income families have experienced more economic difficulties, leading to lower support for their children. Given that the period from middle to high school is important to develop and cultivate self-efficacy, reduced support in low-income families might negatively influence the development of self-efficacy among low-income students since COVID-19. Similarly, research has shown that self-efficacy differs among adolescents based on their parents' educational attainment (5, 11, 12). Another variable affected by parental educational attainment is family satisfaction (23, 24), which thereby may be associated with self-efficacy (16, 19, 20). Individuals who are satisfied with their family members may be more likely to have higher self-efficacy based on emotional communication and support (16, 19, 20). Since the onset of the COVID-19 pandemic, family relationship quality and satisfaction may have been negatively affected by restrictions and stressors related to the pandemic (18, 28). Parents' educational attainment may also influence the relationship between family satisfaction and self-efficacy as higher education is helpful for communication skills, helping children with their own educational needs,

and providing access to additional sources of knowledge and information (29, 30). Although some research has found relationships between these constructs among adolescents, we know of no study that examined the moderating impact of parental educational attainment on family satisfaction and self-efficacy among low-income adolescents, particularly in the context of the COVID-19 pandemic. Thus, this study aims to (1) investigate the association between family satisfaction and self-efficacy among low-income students since COVID-19; and (2) explore the moderating effect of parental educational attainment on the relationship. Based on these, we hypothesized that low-income adolescents who were satisfied with family relationships would have higher levels of self-efficacy and parental educational attainment would moderate the association between family satisfaction and self-efficacy among low-income adolescents.

Methods

Participants and sampling

Respondents in this study were middle and high school students in South Korea enrolled in a nationwide mentorship program, which was provided by the Korea Development Bank foundation, a non-profit organization. Students from low-income families were eligible to participate in the program, which was determined based on a poverty line. The poverty guideline was announced every year by the government, and the KDB foundation used it to recruit and choose low-income students. Data was collected in April 2021 through an online survey and students who did not respond initially were contacted again. Google Forms was used to implement the online survey and create a link to share with participants. To reach out to potential participants, we used contact information that was collected when students and their caregivers agreed to participate in the mentorship program. The questionnaire developed by the research team and refined by public school teachers and social workers was distributed to 264 low-income students *via* the link to access to the online survey. For distribution, we sent the online survey link to students via a text message, and all of the low-income students had a smartphone or cellphone on which to receive the message. Along with the survey, both low-income students and their caregivers received a consent form for participation. If either a participant or their caregiver declined to participate in the survey, the student was not included in this study. Participants who completed the survey obtained a $5 gift card for their participation. A total of 255 low-income students were selected for the final sample after some students or their caregivers declined to participate. Private information such as names or addresses was not collected in this study and the data does not include any identifiable information. Thus, this research was approved by the Institutional Review Board (#210216-2A).

Measures

Self-efficacy

In this study, self-efficacy indicates a subjective belief regarding the ability to address difficulties someone may encounter. This was measured by the General Self-Efficacy Scale (GSE) (21). The GSE has been utilized in many countries, including South Korea, with good reliability and validity (22). This scale includes ten items: "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."; and "I can usually handle whatever comes my way." Four response options (1 = Not at all true; 2 = Hardly true; 3 = Moderately true; 4 = Exactly true) were provided to respondents. The sum of the item was calculated and a higher score means higher self-efficacy. The Cronbach's alpha of the GSE in the current study was 0.90.

Family satisfaction

Participants were asked to report how much they were satisfied with their relationship with their family members. The family satisfaction scale developed by Olson was employed to measure it (31). The measure was a five-point Likert-type scale with 10 items. The five response options ranged from very dissatisfied to extremely satisfied. Question included: "The degree of closeness between family members"; "Your family's ability to cope with stress"; and "Family members concern for each other." The 10 items were summed, and a higher sum indicated better family satisfaction. The measurement in the current study had a Cronbach's alpha of 0.94.

Parent's educational attainment

The educational attainment of respondents' parents was reported. Both their mothers and fathers reported their education level by selecting one of the following: "Middle school"; "High school"; "Bachelor's degree (Bachelor's, Associate's degree and some college)"; and "Graduate or professional degree." If both mothers and fathers received further education than a high school diploma, they were considered to be in the group with higher education. On the other hand, the remaining group was regarded as those with non-higher education. For instance, a student whose father received a high school diploma and whose mother obtained a Bachelor's degree was regarded as being in the group with non-higher education.

Baseline variables

Middle and high schoolers' age, gender, academic performance, and whether they have siblings were included in this study. Given that respondents engaged in a mentorship program, the level of satisfaction with the program was

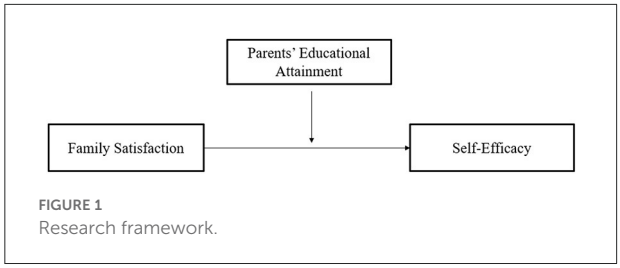

FIGURE 1
Research framework.

controlled in the present study. The scale had seven items with a five-point Likert-type measurement and a Cronbach's alpha of 0.94.

Analysis strategies

The PROCESS macro 3.4 for Statistical Product and Service Solutions (SPSS) was utilized to explore whether parents' educational attainment moderates the relationship between family satisfaction and self-efficacy among low-income students during COVID-19 pandemic. To test the moderating effect, a bootstrap approach using Model 1, suggested by Preacher and Hayes, was conducted at 95% bootstrap confidence intervals (32, 33). The research design used for this study is shown in Figure 1.

Results

Descriptive statistics of the variables used in the current study are reported in Table 1. The summed scores for self-efficacy and family satisfaction were 29.83 and 38.85, respectively. Almost 40% of students had two parents who had both received higher education. Students' average age was 17.36, which may be adjusted to an international age of 16.36 as babies in Korea are considered 1 years old at birth. Approximately half of the total population were girls and the summed score of positive relationships with mentors was 31.03. About one-fourth of students had no siblings and student's average academic performance was C, with their average scores of primary classes being 7.66.

A moderating effect was found in Table 2. There was a significant moderating effect of parents' educational attainment on the relationship between family satisfaction and self-efficacy among low-income students during the COVID-19 pandemic (β = **-0.16**, p < **0.0**5). In terms of a moderating effect, Figure 2 showed a specific difference between those whose parents received higher education and those whose parents did not. Regardless of parents' educational attainment, family satisfaction was positively associated with self-efficacy. That is, regardless of parental educational attainment, students showed higher self-efficacy if they have higher levels of family satisfaction. On the other hand, low-income students whose

TABLE 1 Descriptive statistics.

Variables	% or mean (SD)
Self-efficacy	29.83 (5.58)
Family satisfaction	38.85 (8.43)
Parents' educational attainment	39.6%
Satisfaction with the program	31.03 (4.59)
Age	17.36 (1.75)
Academic performance	7.66 (3.73)
Gender (girl)	49.4%
Being an only child	24.3%

TABLE 2 Moderating effects of parents' educational attainment on self-efficacy (unstandardized coefficients & standard error).

Variables	
(Constant)	11.19 (4.20)
Family satisfaction	0.29 (0.05)***
Age	0.01 (0.18)
Gender (girl)	−1.00 (0.63)
Academic performance	0.29 (0.08)***
Being an only child	0.36 (0.73)
Satisfaction with the program	0.16 (0.07)*
Moderator	
Parents' educational attainment	7.25 (3.03)*
Moderating effect	
Family satisfaction * Parents' educational attainment	−0.16 (0.08)*

*p <0.05; ***p <0.001.

parents did not have higher education reported a lower self-efficacy score than those whose parents received higher education (27.08 vs. 29.52). The effect of parents' educational attainment was more strongly associated with self-efficacy among low-income students who had parents who did not receive higher education (4.96), while the effect was relatively minor for low-income students with parents with higher education (2.31). Moreover, parents' educational attainment and family satisfaction were positively related to self-efficacy among low-income students ($\beta = 7.25$, $p < 0.05$; $\beta = 0.29$, $p < 0.001$). Additionally, higher levels of students' academic performance and satisfaction with the program were related to higher self-efficacy ($\beta = 0.29$, $p < 0.001$; $\beta = 0.16$, $p < 0.05$).

Discussion

This study demonstrates how family satisfaction positively influenced self-efficacy among adolescents who have grown up in low-income households. During the COVID-19 pandemic, inequality in children's development has increased depending on parent's abilities. That is, low-income students with parents

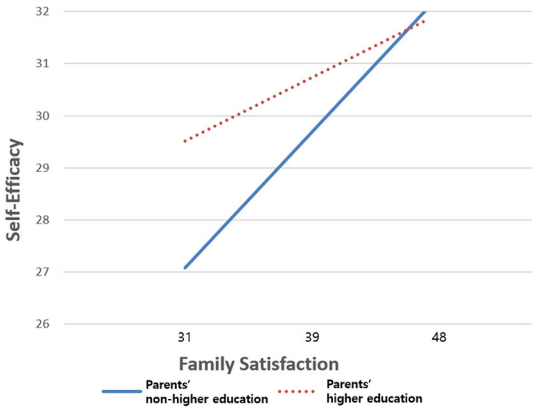

FIGURE 2
Moderating effect of parents' educational attainment on the relationship between family satisfaction and self-efficacy among low-income adolescents.

who have few resources might experience difficulties increasing their self-efficacy since COVID-19. This phenomenon existed before COVID-19 (1, 13, 14, 19), but it may have been even more evident since COVID-19 emerged. Thus, the current study included a comparative analysis to examine how parents' educational attainment influences the relationship between family satisfaction and self-efficacy among low-income adolescents since COVID-19. This research identified that parents' higher education moderated the association between adolescents' family satisfaction and self-efficacy. In other words, parents' educational attainment is important to increase self-efficacy among low-income students and family satisfaction is also key to increasing self-efficacy among low-income students whose parents did not receive higher education.

Since COVID-19 has spread around the world, vulnerable groups such as low-income families and adolescents have been more exposed to difficulties (26, 34). Given that low-income students might not have sufficient support for development of self-efficacy compared to those in middle or high economic classes, it is necessary to pay more attention to development of their self-efficacy. However, little evidence exists in understanding self-efficacy among low-income students. Generally, family satisfaction is related to self-efficacy (28–30), and this was confirmed in the current study, particularly among adolescents in low-income families. However, parents in low-income households might be busier and more exhausted in workplace since COVID-19 because an economic recession has made it more challenging to make money and be employed, particularly for low-income families (26). Unstable wages and job insecurity might interrupt communication or cohesion among or satisfaction with family members (27, 35). Therefore, low-income families might experience difficulties maintaining family relationships during COVID-19. This may negatively influence self-efficacy among low-income students as they feel they are not able to succeed academically or perhaps socially without such technology. Thus, financial support and COVID-19 benefits should be prioritized to low-income families with adolescents to improve family relationships, particularly between parents and their children. That is, during COVID-19, improving economic status among low-income families might be beneficial to increase family satisfaction, leading to increase self-efficacy among low-income students.

This study's findings also indicated that parents' educational attainment in low-income families moderated the association between family satisfaction and self-efficacy among adolescents. Educational attainment among parents is one important way to help their children develop high self-efficacy (11, 12, 36). This study showed that 39.6% of parents in low-income households received higher education. Thus, in more than half of low-income families, both parents had not received higher education. As the current study demonstrated that low-income students whose both parents received higher education consistently reported higher levels of self-efficacy, the group of low-income students with at least one parent who did not receive higher education had lower self-efficacy. This phenomenon may be worsened during COVID-19 because low-income students have had fewer chances to access additional resources such as after school programs or in-person tutoring due to tight COVID-19 restrictions and have suffered from negative academic, nutrition and mental health impacts as a result (37).

Moreover, as students who are satisfied with their family relationships tend to have higher self-efficacy, greater family satisfaction may buffer against low self-efficacy among low-income students whose parents did not receive higher education. This study confirmed that the effect of family satisfaction on self-efficacy was greater for the group of low-income students without a parent who received higher education vs. those with at least one parent who received higher education. Therefore, social welfare programs targeting family relationships in low-income households should be especially targeted toward low-income households without a parent who received higher education. Further, low-income households have encountered more financial strains during COVID-19, perhaps leading parents to have to work more h and thus not have as much time to communicate with their children, resulting in lower levels of family satisfaction. Thus, financial support such as COVID-19 wage subsidies, job stability fund programs, and employee retention subsidies should be expanded to financially help low-income parents. in order to maximize the effect of family satisfaction on self-efficacy among low-income students, and these benefits should be focused on low-income families in which neither parent received a higher education. On the other hand, this study demonstrated that low-income students with two parents who received a higher education were more likely to have higher self-efficacy.

Thus, life-long education should be provided to parents in low-income families who did not gain higher education as their educational attainment influences the self-efficacy of their adolescent children. Further, to address inequalities in children's psychological development, more opportunities for higher education should be provided to low-income students to help them increase their income and economic status into adulthood.

Conclusion and limitations

Although it is important to help adolescents to develop self-efficacy, little has been studied about self-efficacy among low-income students since COVID-19. This study contributes to understanding how to increase self-efficacy among low-income adolescents since COVID-19 by considering their parents' educational attainment. However, this study has a few limitations that must be considered. First, the results may be applied to other countries, especially Asian countries which have similar attributes of economics, politics, and culture. However, we suggest that before findings are examined in the context of other cultures, that such cultural differences should be considered. Second, even though this study used a nationwide sample, the participants were limited to students who were registered in a mentorship program. This study controlled for level of satisfaction with the mentorship program, but the sample might not be a representative of or generalizable to all low-income students, as low-income students not enrolled in the mentorship program were not surveyed. Third, for educational attainment, we classified it into two groups: both parents whose educational level was greater than high school and those who were not. This classification might limit effect of educational attainment among some groups in which one of parents received higher education.

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

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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Risk perception and mental health among college students in China during the COVID-19 pandemic: A moderated mediation model

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Since the outbreak of the COVID-19 epidemic, it has spread on a large scale around the world, seriously affecting people's physical and mental health. In China, almost all schools have postponed semesters, suspended offline classes, and implemented closed-off management, which has brought significant challenges to the study and life of college students. The study aimed to explore the relationship between risk perception, perceived stress, perceived control, and mental health among Chinese college students. This cross-sectional study was conducted among 1,856 college students. The results showed that risk perception was positively correlated with mental health. After adding the mediating variable of perceived stress, risk perception still significantly predicted mental health. In addition, the interaction term of perceived stress and perceived control significantly negatively predicted mental health. Specifically, perceived stress significantly affected mental health in the low-perceived control group. In contrast, in the high-perceived control group, the predictive effect of perceived stress on mental health disappeared. The present study showed that perceived stress partially mediated the relationship between risk perception and mental health; perceived control moderated the relationship between perceived stress and mental health, and high perceived control could buffer the effect of perceived stress on mental health.

KEYWORDS

coronavirus disease, risk perception, perceived stress, mental health, perceived control

Introduction

The novel coronavirus disease (COVID-19) pandemic has spread rapidly all over the world, which has brought significant changes to the country, such as economic recession, corporate downtime, unemployment, and school closures. Due to the lethality, contagion, lack of specific treatment, and threat to the personal safety of this epidemic, it has posed a serious impact on people's physical and mental health in crisis events (1). This is the worst large-scale public health emergency in China in recent years. Therefore, it is of great practical significance to construct and analyze the impact of public health emergencies on people's mental health and coping behaviors in this context.

The college years have been found to be a particularly important time for lifespan development (2). For many people, college life should be a happy and exciting time. However, the reality of the rapid global spread of COVID-19 pandemic has brought many challenges for college students. The abrupt disruption of daily life, the cancelation of expected campus activities, the loss of social connections, and the change of learning styles have created a sense of threat, uncertainty, and stress (3). Unlike previous viral threats such as SARS, Ebola, and MERS, the COVID-19 pandemic has been more vividly presented in the massive and sustained global media coverage since the outbreak. Gao et al. (4) found that mental health problems were positively associated with frequent social media exposure during the COVID-19 outbreak. Therefore, college students exposed to mobile phones and the internet for a long time may have more mental health problems (5–7). Evidence suggested that college students experienced more psychological distress, manifested by higher levels of both anxiety and depressive symptoms than general workers during the pandemic (7). Ma et al. (5) found in an online survey of Chinese college students from 108 colleges and universities (N = 746,217) that about 45% of the participants had mental health problems, and about 35, 21, and 11% of the participants reported probable acute stress, depressive and anxiety symptoms, respectively.

Perceiving and avoiding risk are human instincts, which are adaptive evolution produced by humans. However, there is a substantial deviation between objectively present risk and subjective risk perception. Specifically, when faced with risk information, individuals often do not make risk assessments based on rationality, but make risk perceptions based on intuition (8). Risk perception refers to an individual's intuitive feeling and understanding of various objective risks in the outside world, including the judgment of the possibility and potential hazards of crisis events (8). The risk resilience model suggest that risk factors and adverse environments can exacerbate adverse outcomes (e.g., fear, anxiety, depression) (9, 10). In this model, risk can be defined in different ways, including negative life events in recent months or in a lifetime, large-scale community trauma, adverse living environments, and cumulative risk calculations that combine these different types of risk factors (9). Wineman (11) believed that the direction and severity of the consequences of sudden public health crises were uncertain, and this uncertain risk perception would increase people's psychological pressure and negative emotions, which seriously affects people's mental health. This view had also been verified and research had found that risk perception was significantly associated with mental health (12, 13). For example, during the SARS and Ebola outbreaks, higher perceived risk was found to be associated with more significant mental health problems (13). Consistent results were also found in COVID-19 disease, that the severity of perceived risk was associated with poor mental health (14, 15). Sloan et al. (15) found that risk perception (e.g., fear of contracting COVID-19) was associated with poor mental health. Liu et al. (14) also found that higher risk perception was significantly associated with greater depressive symptoms in the Chinese population. During the COVID-19 pandemic, high levels of risk perception, such as fear of contracting the virus, might translate into serious mental health problems, including anxiety, depression, insomnia, and social withdrawal (16).

When a person feels threatened by a risk, stress is likely to occur (17). Faced with the same stressor, each person has different perceptions of stress due to their own experiences. Perceived stress refers to the psychological confusion or threat caused by various stimulating events and adverse factors, usually manifested as physical and mental tension and discomfort (18). Cohen et al. (19) considered that the impact of "objectively" stressful events depended to some extent on a person's perception of stress. Within stress process theory, many stressful experiences don't spring out of a vacuum. Negative life events may induce adverse changes in people's lives and these adverse changes intensify the level of stress that people experience. Thus events create stress not only or even primarily through their direct demand for readjustment, but also through their indirect exacerbation role strains (20). Individuals would predict future outcomes by making comprehensive judgments on risk information in negative life events. If this outcome was full of uncertainty and harmfulness, stress would follow. It could be said that perceived stress mainly stemmed from a sense of threat and expectations of adverse future outcomes (21). The main feature of risk perception is the sense of threat caused by uncertainty (22). During the pandemic, unpredictable and threatening conditions such as these create perceived stress in college students. Although there was no relevant research on risk perception and perceived stress among college students, we have found a relationship between perceived stress and perceived risk in other groups (1, 23). For example, Li and Lyu (1) found that perceived stress was positively correlated with risk perception among the Chinese general public and the higher the level of risk perception, the greater the perceived stress of people. This may be because that perceived stress occurs when an individual feels inability to control the situation or manage emotional response to it (24). In addition, there

is also an association between perceived stress and mental health (25–27). Perceived stress is an important risk factor for the low mental health of college students (25). For example, perceived stress was positively correlated with depression and anxiety (26) and negatively correlated with sleep quality (28). Stress process theory posits that social experiences translate into distinct health outcomes through exposure to stress and its coping ability (20). Risk perception brings perceived stress to college students, which may lead to negative psychological symptoms (29). Therefore, we speculated that perceived stress may mediate the relationship between epidemic risk perception and mental health.

The Stress-buffering Hypothesis states that an individual's positive traits will mitigate the potential negative effects of perceived stress on psychological functioning and optimize event outcomes (30, 31). This may indicate that the relationship between perceived stress and mental health is moderated by other factors. As a positive trait, perceived control is a subjective perception of objective control, which refers to the belief that individuals can influence the progress of events through themselves, rather than external factors, and achieve the desired results (32). Individuals with high perceived control are able to take control of their lives, while individuals with low perceived control exhibit behavioral rigidity because they feel that the world cannot be changed (33). Previous researches had demonstrated an interrelationship between perceived stress and perceived control, with perceived control contributing to stress reduction (34). This may be because individuals with high perceived control have a strong sense of self-efficacy (35), and perceived control encourages individuals to adopt positive coping styles to solve problems, thereby reducing their perceived stress (36, 37). Enhanced perceived control can also improve health and life satisfaction (38). Researches had shown that perceived control was closely related to mental health (39–41). Enhanced perceived control helped to reduce the experience of stress and the risk for anxiety and depression (42, 43), and buffer the detrimental effect on subjective wellbeing (44, 45). Additionally, one study demonstrated that perceived control buffered the effects of stress on psychological distress (34, 46). The risk resilience model suggest that risk factors and adverse environments can exacerbate adverse outcomes (e.g., fear, anxiety, depression), and that individuals with adequate internal and external resources can offset the adverse outcomes of risk factors (9). According to the transactional model of stress (47), perceived control is an important internal (stress coping) resource for the individual. Accordingly, as perceived control decreases, college students who face high risk factors (perceived stress) experience a more negative mental health states. Specifically, compared with college students with high perceived control, the perceived stress of college students with low perceived control has a more serious negative impact on their mental health. Therefore, we speculated that perceived control would play a moderating role in the relationship between perceived stress and mental health.

In conclusion, the study aim to investigate the mediating role of perceived stress in the relationship between risk perception and mental health, and examine the moderating role of perceived control in the relationship between perceived stress and mental health. Based on previous research, we proposed two hypotheses (see **Figure 1**):

> Hypothesis 1: Perceived stress mediated the relationship between risk perception and mental health among Chinese college students during the COVID-19 pandemic.

> Hypothesis 2: Perceived control moderated the relationship between perceived stress and mental health among Chinese college students during the COVID-19 pandemic.

Materials and methods

Participants and procedure of recruitment

Participants were recruited from 8 to 15 November in 2021 during the COVID19 pandemic, and all data were collected through self-report questionnaires in wjx.cn, a reliable Chinese online platform. A total of 1,856 final samples of college students from 15 provinces or autonomous areas in China were retained after excluding cases of invalid answers (e.g., continuous use of an option, too-short answering time), with a valid response rate of 97.7%. To protect participants' privacy, data collection process was anonymous. The research team collected no personally identifiable information.

Among the participants, 86.7% were girls and 13.3% were boys, aged from 17 to 25 years (M = 20.1, SD = 1.6). The sample included 673 first-year students, 431 sophomores, 511 juniors, and 241 seniors. The study emphasized voluntary participation and did not provide participants with incentives. The ethical committee of the School of psychology, Northwest Normal University, approved this study before data collection.

Measures

Mental health

Symptom checklist 90 [SCL-90; (48)] was used to measure participants' mental health. This scale has 90 items rated on a 5-point Likert scale representing symptom severity, ranging from 1 (no symptom) to 5 (severe symptom). Total score range from 90 to 450, with higher scores indicating worse mental health. The scale has shown good validity and reliability in

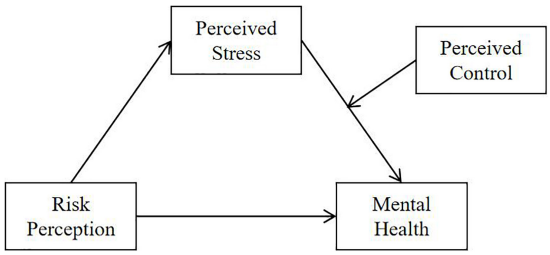

FIGURE 1
The expected moderated mediation model.

Chinese college students (49), and the Cronbach's alpha in this study was 0.98.

Risk perception

The Perceived Risk of COVID-19 Pandemic Scale (PRCPS) was used to measure risk perception (50). This scale has 9 items, including the degree of worrying about contracting COVID-19 (not at all to very worried), the chance of contracting COVID-19 (zero to very high), and imagining yourself contracting COVID-19 (very difficult to very easy), etc. Total scores range from 9 to 47, with higher scores indicating greater risk perception. The Cronbach's alpha in this study was 0.81.

Perceived stress

The Perceived Stress Scale-10 (PSS-10) was used to measure the extent of perceived stress over the past month (19). This scale has 10 items, rated on a 4-points Likert scale ranging from 0 (never) to 4 (very often). Total scores range from 0 to 40, with higher scores indicating greater perceived stress. The scale has shown good validity and reliability in Chinese college students (51), and the Cronbach's alpha in this study was 0.88.

Perceived control

The Sense of Control Scale was used to measure perceived sense of control (40). This scale has 12 items rated on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Items include "I can do just about anything I really set my mind to" and "I often feel helpless in dealing with the problems of life" (reverse scoring). Total score range from 12 to 84, with higher scores indicating greater levels of perceived control. It has strong reliability (52), and the Cronbach's alpha in this study was 0.73.

Statistical analyses

Data analyses were performed with IBM SPSS 21.0 statistical software (IBM, Armonk, NY, United States) for Windows, and the significance level was set at $p < 0.05$ throughout the analyses. Firstly, we used the SPSS to calculated the descriptive statistics and the relationship among the variables by Pearson's correlation analysis. Secondly, we used the SPSS macro PROCESS (Model 14) proposed by Hayes (53) to test the moderated mediation model. All regression coefficients were tested using the bias-corrected percentile bootstrap method. Bootstrapping (5,000 bootstraped samples) with 95% confidence intervals (CIs) was conducted to examine the significance of the mediation and moderation effects, and 95% CIs without zero indicated that the effects was significant. All model estimations were conducted with Mplus 8.3 (54) using maximum likelihood estimation. Monte Carlo power analyses suggested that the sample size was sufficiently large to detect small effects [i.e., 0.10 (55)] in moderated mediation model with power > 0.80 (all above 0.95, see **Supplementary Table 1**). In addition, we controlled for participants' gender (0 = female, 1 = male) because it was reported to be related to individuals' mental health (56).

Results

Common method deviation test

Harman Single-factor Test was used to test the common method deviation, and it was found that there were 12 factors with eigenvalues greater than 1. The first factor could explain 21.76% of the variation, which was less than the standard threshold value of 40%. This result indicated that there was no obvious common method deviation in this study.

Descriptive statistics and correlation analyses

The descriptive statistics and correlations were presented in **Table 1**. Risk perception, mental health, perceived stress, and perceived control were found to be significantly correlated with each other. Epidemic risk perception was positively associated with mental health ($r = 0.233$, $p < 0.01$) and perceived stress ($r = 0.132$, $p < 0.01$), but negatively correlated with perceived control ($r = -0.241$, $p < 0.01$). Perceived stress was positively associated with mental health ($r = 0.229$, $p < 0.01$), but negatively correlated with perceived control ($r = -0.185$, $p < 0.01$). Perceived control was negatively correlated with mental health ($r = -0.424$, $p < 0.01$).

Examination of moderated mediation model

Table 2 showed the main results of our moderated mediation model. Model 1 examined the effect of risk perception on perceived stress, and Model 2 examined the effects of risk perception, perceived stress, and perceived control on mental

TABLE 1 Descriptive statistics and correlations.

Variables	*M*	*SD*	1	2	3	4	5
Risk perception	17.61	5.37	1				
Mental health	120.70	40.20	0.233**	1			
Perceived stress	18.72	6.53	0.132**	0.229**	1		
Perceived control	56.12	9.30	−0.241**	−0.424**	−0.185**	1	
Gender	0.13	0.33	−0.073*	0.021	−0.082*	−0.042	1

N = 1,856. *$p < 0.05$, **$p < 0.01$. Gender: 0, female; 1, male.

health. Firstly, risk perception positively predicted perceived stress (β = 0.13, SE = 0.02, $p < 0.01$), and perceived stress positively predicted mental health (β = 0.15, SE = 0.02, $p < 0.001$). Secondly, when perceived stress was added, risk perception still positively predicted mental health (β = 0.13, SE = 0.02, $p < 0.001$). Bootstrap method was further used to test the mediating effect of perceived stress. The results showed that the 95% confidence interval does not include 0. Therefore, perceived stress partially mediated the relationship between risk perception and mental health. Hypothesis 1 was verified. Thirdly, the interaction term of perceived stress and perceived control could significantly predict mental health (β = −0.11, SE = 0.02, $p < 0.001$). Thus, these results suggested that the relationship between perceived stress and mental health was moderated by perceived control, that is, the influence of perceived control on mental health of college students was a moderated mediating effect. Hypothesis 2 was verified. Additionally, gender affected perceived stress (β = −0.21, SE = 0.07, $p < 0.001$), but not mental health ($p > 0.05$).To further illustrate how perceived control regulates the relationship between perceived stress and mental health, we took the one standard deviation above and below the mean of perceived control to draw the interaction effect graph (see **Figure 2**). The simple slope test (57) showed that with low perceived control (i.e., one standard deviation below the mean), perceived stress had a significant positive predictive effect on mental health (*simple slope* = 0.26, SE = 0.03, $p < 0.01$), while with high perceived control (i.e., one standard deviation above the mean), perceived stress could not significantly predict mental health (*simple slope* = 0.04, SE = 0.03, p = 0.21).

Discussion

We examined the effect of risk perception on the mental health of college students and the role of perceived stress. In addition, we explored the effect of perceived control in the relationship between perceived stress on the mental health. Our findings indicated that college Students' risk perception had a significant predictive effect on their mental health, and perceived stress partially mediated the relationship between risk perception on the mental health. Furthermore, the relationship between perceived stress and mental health was moderated by perceived control.

The effect of risk perception on mental health

The results revealed that risk perception has a positive predictive effect on college Students' mental health, that is, the higher the risk perception, the worse the mental health, which is consistent with previous research results (1, 58). This result also provided evidence for the main effect principle of the risk resilience model, which stated that risk factors and unfavorable circumstance exacerbate unfavorable outcomes (9). The negative life event of the COVID-19 epidemic has severely disrupted the normal life of college students. Due to the long incubation period, rapid contagion rate, the potential for lethality, and the lack of pharmacological interventions, this undoubtedly affects risk perceptions in some ways and leads to negative mental health outcomes (1, 59). In addition, college students may use social media more frequently than other groups (60). The social amplification of risk framework believes that crisis events interact with public psychology, social organization and social culture, and then amplify or reduce people's risk perception of the events (61, 62). One study had found through the case analysis method that consumers' trust crisis in the brand after accepting exaggerated information from mass media was higher than that caused by direct consumption experience (63). Huynh (64) also found that frequent use of social media was associated with higher risk perceptions of COVID-19. High-risk perception of the epidemic can easily lead to anxiety and depression, and affect mental health.

The mediating effect of perceived stress

More importantly, the findings showed that perceived stress partially mediates the relationship between risk perception and mental health. Research showed that risk perception was significantly correlated with perceived stress, and risk perception of environmental threats often translated into perceived stress (1, 65). Excessive risk perception of the epidemic may increase the individuals' perceptions of insecurity and uncertainty about their current situation, resulting in increased perceived stress. In addition, the higher the perceived stress, the worse the mental health of college students (25, 26). The college student population is one of the most susceptible groups in the epidemic and faces considerable stress in terms of health, academics, economy, and interpersonal relationships, which may be an important reason for the poor mental health of college students during the pandemic (6, 7). Overall, this result showed that risk perception of the pandemic triggered

TABLE 2 Path analysis results.

	Model 1 (Perceived stress)			Model 2 (Mental health)		
	β (*SE*)	*t*	95%CI	β (*SE*)	*t*	95%CI
Gender	−0.21 (0.07)	−3.15***	(−0.35, −0.08)	0.08 (0.06)	1.31	(−0.04, 0.20)
Risk perception	0.13 (0.02)	5.49**	(0.08, 0.17)	0.13 (0.02)	6.08***	(0.09, 0.17)
Perceived stress				0.15 (0.02)	7.26***	(0.11, 0.19)
Perceived control				−0.35 (0.02)	−16.18***	(−0.39, −0.31)
Perceived stress* Perceived control				−0.11 (0.02)	−5.22***	(−0.16, −0.07)
F	21.42***			110.72***		
R^2	0.02			0.23		

N = 1,856. **$p < 0.01$, ***$P < 0.001$.

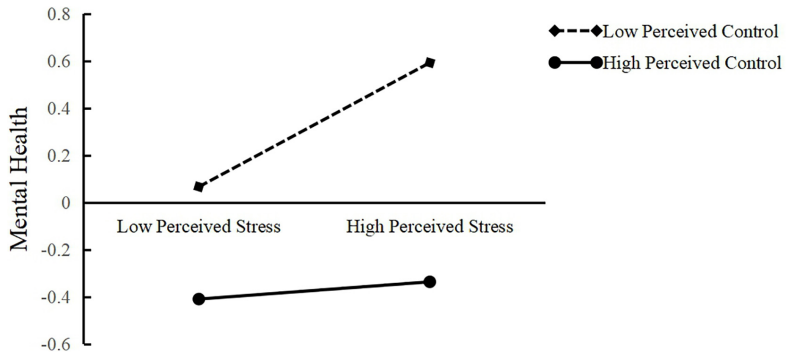

FIGURE 2
Perceived control moderates the relationship between perceived stress and mental health.

perceptions of stress, which in turn affected the mental health of college students, suggesting that perceived stress was a potential mechanism to explain the effects of risk perception on mental health in college students. This is consistent with the views of the stress process theory and the risk resilience model. Stress process theory argues that negative life events can lead to adverse changes in people's lives that exacerbate the level of perceived stress, and social experiences (negative life events) translate into distinct health outcomes through exposure to stress (20). One risk factor can increase the likelihood of exposure to another risk factor, thereby increasing the likelihood of college students being affected by multiple risk factors. The risk resilience model also points out that extrinsic risk factors and adverse circumstances can exacerbate adverse outcomes (e.g., fear, anxiety, depression), and different types of risk factors can be calculated cumulatively. The college student population itself was not fully mature enough to deal with crises, and when they exposed to negative life events (e.g., the COVID-19 pandemic), both fears about the current situation and fear of adverse future consequences would add up to a huge psychological stress, which in turn exacerbates negative mental health states. On the other hand, previous research had demonstrated that positive messages, such as government proactive preventive measures, could reduce the level of risk perception (66). Other stress reduction strategies such as physical activity, mindfulness training, and a healthy diet could reduce perceived stress (67). These training methods may be able to improve the mental health of college students by reducing risk perception and perceived stress.

The moderating effect of perceived control

As stated in Hypothesis 2, perceived control moderated the relationship between perceived stress and college Students' mental health. Under low perceived control condition, perceived stress effected mental health, and conversely, perceived stress had no significant effect on mental health under high perceived control condition. This result could be explained by the stress transactional model. The theory states that when individuals perceive stress, they will conduct cognitive appraisal. The first stage is the primary cognitive appraisal, in which the individual judges the severity of the stress internally. If the stress is considered to be threatening, a secondary cognitive appraisal is performed, in which the individual assesses own resources to deal with the stress. Perceived control is a critical factor in the secondary cognitive appraisal process and is an important personal (coping) resource (47, 68). When perceived control resource is insufficient to deal with external threats, perceived stress may lead to emotional distress and mental

health problems, whereas perceived stress does not affect mental health (69). Individuals with high perceived control believe that changes in the environment depend on their own actions, efforts, and choices (70), and employ more problem-focused coping than emotion-focused coping (71). Research had found that perceived control was related to perceptual stress (72). For example, Bollini et al. (73) found that perceived control reduced the increase in perceived stress produced by exposure to aversive stimulus, and perceived control over the stress attenuated cortisol secretion. Perceived control can reduce perceived stress, possibly because perceived control is associated with a strong sense of self-efficacy and the ability to adapt to society, and it encourages individuals to actively deal with and solve problems, thereby reducing the individual's perceived stress (37). Additionally, many studies have found that perceived control was significantly associated with mental health, and individuals with high perceived control have better mental health (39). This study supported the risk resilience model. The main effect principle of the risk resilience model suggests that risk and adversity exacerbate the propensity for adverse outcomes. Whereas the compensatory effect states that enough positive internal and/or external assets could offset the adverse outcomes suffered from the negative effects of risk factors. Therefore, people with sufficient assets are less exposed to risk, and have better results than those with the same risk level but insufficient assets. This also explains that in this study, compared with the low perceived control condition, the effect of perceived stress on mental health was smaller or even disappeared under the high perceived control condition. In conclusion, this study showed that perceived control could serve as a protective factor to buffer against the adverse effects of the COVID-19 pandemic on college Students' mental health. However, college students with low levels of perceived control may be affected by perceived stress and experience adverse psychological symptoms. Therefore, we need to provide more psychological assistance to those college students with poor perceived control to protect their mental health and prevent them from developing more mental health problems.

Limitations and future research

The present study has several limitations that should be noted. Firstly, this study adopted a cross-sectional design to explore the relationship among risk perception, perceived stress, perceived control, and mental health of college students. However, the cross-sectional design has its limitations. Future studies could use other approaches, such as longitudinal designs or experimental studies, to continue to explore this question in greater depth. Secondly, the study used a convenient sampling method to collect data. The sample size varies greatly in different provinces/regions and was not balanced by gender. Therefore, the interpretation of the data results should be cautious. Future studies could explore the relationship among these variables based on a more balanced sample from multiple regions. Finally, due to the use of an online survey, all participants' data could only be assessed using self-report instruments. There may be specific errors in the self-report method, such as social desirability bias and response sets, in which participants respond to questions according to socially accepted standards rather than true intentions or their own specific behavior patterns. In future research, structured interviews and evaluations by others (such as teachers and friends) could be used to assess the psychological state of college students more accurately.

Conclusion

The present study showed that risk perception of COVID-19 was significantly correlated with mental health. Furthermore, perceived stress mediated the relationship between risk perception and mental health, and perceived control moderated the relationship between perceived stress and mental health among Chinese college students during the COVID-19 pandemic.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the School of psychology, Northwest Normal University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

LL: conceptualization, investigation, data collection, formal analysis, writing – original draft, and writing – review and editing. HC: conceptualization, resources, investigation, data collection, methodology, visualization, supervision, and writing – review and editing. LY: conceptualization, funding acquisition, investigation, data collection, and project administration. CY: conceptualization, resources, investigation, data collection, and visualization. XW: conceptualization, resources, investigation, and data collection. YM: conceptualization, investigation, and data collection. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.955093/full#supplementary-material

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Pathological online game use of secondary vocational school students: Current situation and its relation to self-esteem and self-identity

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Secondary Vocational School Students are particularly susceptible to online game addiction due to adolescent characteristics and superimposed pressures of academic and employment. Based on the theoretical framework of self-identity and self-esteem, the present research conducted a questionnaire survey using samples of secondary vocational school students to investigate the relationship between pathological online game use (POGU), self-esteem and self-identity. The results showed that 15.56% of secondary vocational students' level of POGU met the diagnostic criteria, and POGU and self-esteem appeared significant differences in gender and family types. Moreover, lower self-esteem and self-identity were associated with higher POGU and self-esteem played a partial mediating role in the relationship between self-identity and POGU. We briefly discussed practical implications of our findings and the future research.

KEYWORDS

secondary vocational school, self-esteem, self-identity, pathological online game use, adolescent

Introduction

The proportion of online game users accounted for more than half (53.6%) of the overall Internet users as of December 2021 [China Internet Network Information Center (CNNIC), 2022]. What is accompanied by this is the problem of online game addiction that had attracted the attention of many researchers. Although there are currently many different expressions about the concept of online game addiction, such as problematic online game use, excessive online gaming, and pathological online game use (POGU) (1–3), most researchers agree to view online gaming overuse as a potential addiction, which may impair attention and academic performance, cause interpersonal problems, produce a range of emotional problems such as increased loneliness and reduced psychological well-being, and even lead to depression and suicide (4–7). This study adopts Gentile's definition of pathological online game use (POGU), which focuses on one's inability to control his excessive use of online game and the negative impact it has on emotion and school performance, either to escape difficulties or lower their intensity (1).

Because online games provide high enjoyment and interactivity with a delicate reward mechanism (8), they have great appeal to adolescents who lack self-control. In addition, as adolescents, secondary vocational school students are particularly vulnerable to social pressures, lack of social support, and satisfaction of psychological needs (9). Previous cross-sectional studies revealed negative correlation between self-identity and POGU (10–12). Self-identity contains how one evaluates the real self, how one envisions the future self and how one adjusts oneself to adapt to surrounding changes, which tap into the feeling that an individual has of understanding himself or herself (13–15). A person with an established self-identity knows enough about himself and is capable of grasping the meaning of the ideals and values he holds (16).

The concept of self-esteem is centered on self-affirmation and self-identification, which is a type of inner consciousness, and is an important factor in personal growth (17–23). Rosenberg (24) defines self-esteem as an attitude toward oneself, which can be positive or negative. It is when one believes he is good enough when dealing with something or being enraptured in a certain state that one gains self-esteem. A significant negative correlation exists between self-esteem and POGU (25–27), the lower the individual's self-esteem, the more likely they are to be addicted to mobile games. Meanwhile, Lemmens et al. (27) declared that self-esteem could be a significant predictor of later pathological online gaming behaviors with autoregressive structural equation models. Self-esteem is the perceived difference between one's ideal self and one's real self, and it is a protective factor for Internet addiction (28), for high self-esteem can help people maintain more positive attitudes in stressful situations and reduce undesirable behaviors (29), thus people with high self-esteem are expected to be less likely to indulge in online games. Teenagers who attend secondary vocational schools have unique characteristics that set them apart from other teenagers. In most cases, they are diverted from the general education because of their ineligibility for it and are "forced" to enter the vocational education. Currently, vocational education is not well understood by the general public, and there are still some prejudices against secondary vocational school students (30). This social prejudice is a cognitive result of stereotypes, which not only affect the out-group's perception of the in-group, but also how in-group members react to that perception, namely, the meta- stereotype (31, 32). According to social identity theory (33, 34), identity is primarily formed by identifying with the group, and when members of the group compare themselves with out-groups and find themselves to be in disadvantage, their self-assessments are skewed negatively, thus resulting in identity threat that hinders achieving positive self-esteem.

Therefore, we hypothesize that self-identity can predict POGU through self-esteem, i.e., self-esteem plays a mediating role in self-identity and POGU.

Methods

Study design and samples

Seven hundred and ninety students were sampled by convenient sampling method from five secondary vocational colleges in Fuzhou, Fujian Province, China. All subjects participated in the experiment voluntarily, and 756 questionnaires were collected, with a recovery rate of 95.70%. After eliminating invalid questionnaires, 720 valid questionnaires were received and the efficiency rate was 91.14%. Among them, 388 (53.89%) were male students and 332 (46.11%) were female students; 139 (19.31%) were only children and 581 (80.69%) were non-only children; 352 (48.89%) were first-year students, 198 were (27.50%) second-year students and 170 (23.61%) were third-year students.

Materials

Demographic questionnaire. The first part of the questionnaire was to collect demographic data on the subjects, including gender, grade level, family type, and whether they were the only child.

Pathological online game use questionnaire. The second part of the questionnaire is to investigate the addiction to online games. It contained 11 items from Gentile's Pathological Video-Game Use Questionnaire in Chinese version (5) and was demonstrated by previous studies with good reliability and validity conducted with Chinese adolescents (35, 36). This questionnaire is a single-dimensional questionnaire, consisting of a total of 11 question items. Subjects were asked to make a three-point scaled frequency assessment of the situation presented by each item (e.g., do you spend more and more time playing or learning to play online games?), namely 0 = never, 1 = sometimes, 2 = often and were recorded into 0, 0.5, 1 for never, sometimes and often, respectively (37). The total score of these 11 items was summed and the higher the score, the more severe the online game addiction (5). In the current study, the Cronbach's alpha coefficient for this questionnaire was 0.854.

Self-esteem scale

The scale was compiled by Rosenberg in 1965. Ji Yifu and Yu Xin translated it into Chinese version (38). There are a total of 10 question items (e.g., "I feel that I have several good qualities") including 5 positive questions and 5 reverse questions. The four-point scoring method is adopted from 1 (strongly disagree) to 4 (strongly agree), and the total score is 10–40, with items 3, 5, 8, 9, and 10 scored reversely, and the higher the score, the higher the level of self-esteem. However, some studies suggest that item 8 "I wish I could have more respect for myself" carries different cultural implications for Chinese (39), so this study

TABLE 1 Descriptive statistics and correlation co-efficient between variables ($M \pm SD$).

Variable	*n*	PERC	*M*	*SD*	1	2	3	4	5	6	7
1. POGU	–	–	2.499	2.024	1						
2. SE	–	–	26.996	4.606	−0.281**	1					
3. SI	–	–	51.254	7.562	−0.352**	0.645**	1				
4. Grade			–	–	0.041	0.015	−0.007	1			
First	352	48.89									
Second	198	27.5									
Third	170	23.61									
5. Gender			–	–	−0.220**	−0.078*	0.012	−0.004	1		
Male	388	53.89									
Female	332	46.11									
6. FT			–	–	0.068	−0.141**	−0.091*	0.06	0.038	1	
One–parent family	92	12.78									
Two–parent family	603	83.75									
Other (raised by generations)	25	3.47									
7. OCON			–	–	−0.036	−0.021	−0.042	−0.018	0.143**	−0.112**	1
Yes	139	19.31									
No	581	80.69									

POGU, pathological online game use; SE, self-esteem; SI, self-identity; FT, family type; OCON, only child or not.
**$p < 0.01$, *$p < 0.05$.

scored it positively. In this study, the Cronbach α coefficient of the questionnaire was 0.751.

Self-identity scale

The Self-Identity Scale (SIS) developed by Ochse and Plug in 1986 based on Ericson's theory is widely used in adolescent groups. The scale has a total of 19 problem items (e.g., "I feel my way of life suits me"), and the four-point scoring method is used from 1 (strongly disagree) to 4 (strongly agree). The reverse scoring method is used for the item 1, 2, 4, 8, 9, and 12 to18 with higher scores presenting higher self-identity. Li Yi an and Lou Wenjing tested the reliability and validity of this scale with high school students as subjects, and found that this scale had good reliability and validity. The Cronbach α-coefficient of the overall scale was 0.727 (16). In this study, the Cronbach α coefficient of the questionnaire was 0.774.

Procedure

This study was conducted class by class. To ensure the accuracy of the survey results, two post-graduate students in psychology served as the experimenters and were trained before the implementation of formal measure. The experimenters explained the instructions to the subjects and asked them to fill in the questionnaire according to their real feelings and experience, and the results would be kept confidential. Afterwards, the subjects were given a professional online questionnaire website link and began to answer the questionnaire, which included four parts, demographic questions, SES, SIS, and POGU questionnaire, respectively. The subjects were thanked and debriefed after completion.

Results

Common method bias

In this study, Harman's single-factor test was performed on all items in the questionnaire, and the KMO value was 0.900, and the significance of Bartlett's test was 0.000. Eight factors were extracted from 40 items through principal component analysis (PCA). The variance contribution rate of the first factor is 20.458%, lower than the critical value of 40%, indicating that the common method bias is acceptable.

Descriptive statistics

Table 1 includes the mean and standard deviation value for all variables. POGU total score measures the tendency of secondary vocational school students to be addicts of online games, where a higher score indicates an even stronger tendency of addiction. According to the delimitation standard of addiction with a total score of $\geq$5 which means exhibited at least 5 of the 11 criteria (40), a further analysis showed that

the number of students whose POGU scores met the criteria was 112, accounting for 15.56% of the total number of students surveyed. As for the self-esteem, its average score is about 27 with SD of 4.606. In terms of self-identity, a total of 66 to 68 points indicates a high level of self-identity, based on an average score between 56 and 58 and a standard deviation between 7 and 8, and total scores less than 49 to 50 suggest a lower self-identity (18). In this study, the average score of self-identity is 51.25, indicating that the overall self-identity of secondary vocational school students is at a relatively low level.

Analysis of differences in demographic variables

There were significant differences in POGU behavior between different genders, with boys significantly higher than girls ($p < 0.01$, Cohen's $d = 0.451$); the same tendency could be found in self-esteem ($p < 0.05$, Cohen's $d = 0.157$), with boys' average score significantly higher than that of girls. But gender didn't differ significantly on self-identity scores. Also, significant difference could be drawn among family types on POGU and self-esteem but not on self-identity to the extent that average scores of students from other families were significantly higher than those from single-parent and two-parent families on POGU ($p < 0.05$, $\eta^2_p = 0.010$) and students from two-parent families scored significantly higher than single-parent families and other types of families on self-esteem ($p < 0.01$, $\eta^2_p = 0.021$). While "only child or not" and grade level didn't differ significantly on each of the three independent factors.

Correlation analysis

Through correlation analysis, the Pearson correlation coefficient of variables including POGU, self-esteem, self-identity, grade, gender, family type, and only child or not of secondary vocational students is obtained, as shown in Table 1.

The findings were consistent with previous studies conducted with other groups, namely, POGU was negatively associated with self-esteem ($r = -0.281$, $p < 0.01$); the statistically significant positive correlation was also found between self-identity and self-esteem ($r = 0.645$, $p < 0.01$). POGU was negatively correlated with self-identity ($r = -0.352$, $p < 0.01$).

Regression analysis

A stepwise regression analysis was conducted in SPSS24.0 to analyze the data, and the results are shown in Table 2. Gender, grade, family type and "only child or not" were incorporated into the models as control variables in three models. The results in model 1, in which self-identity as the independent variable and POGU as the dependent variable, showed that self-identity had a significant negative relationship with POGU ($\beta = -0.346$, $p < 0.001$). In model 2 where self-identity as independent variable and self-esteem as the independent variable, the results suggested that higher self-identity correlated with higher self-esteem ($\beta = 0.639$, $p < 0.001$). In model 3, self-identity and self-esteem was jointly added into the independent variables and POGU served as dependent variable. It revealed that there was a significant negative relationship between self-esteem and POGU ($\beta = -0.122$, $p < 0.01$). Therefore, the results demonstrated that, for secondary vocational school students, self-esteem serves as a mediator between self-identity and POGU. At the same time, self-identity still has a negative relationship with POGU ($\beta = -0.268$, $t = 3.74$, $p < 0.001$), indicating that self-identity not only directly affects POGU, but also affects POGU behavior indirectly through self-esteem. In other words, lower the level of self-esteem and self-identity, the stronger the POGU behavior.

Mediating effect analysis

The mediation effect test was conducted in PROCESS Procedure for SPSS 3.5 with number of bootstrap samples set for 5,000 (41). In this study, self-identity was used as the independent variable, self-esteem as the mediating variable, and POGU as the dependent variable with gender, grade, family type and "only child or not" as covariates, and the results of the data were obtained in Tables 3A,B. It can be seen from Table 3A that self-identity still has a direct negative relation with POGU, but the effect is weakened. The regression coefficient is −0.072, the mediating effect coefficient is −0.021, and the lower and upper limits of the 95% confidence interval for the mediating effect of self-esteem (−0.039, −0.003) does not contain 0, indicating that self-esteem has a partial mediating effect between self-identification and video game addictive behavior. According to Table 3B and the formula of the effect share: ab/c, it can be calculated that this mediating effect accounts for 22.581% of the total effect. Finally, the model formula can be derived as: POGU = 8.729–0.054* self-esteem-0.072* self-identity. The model was plotted according to the results (see Figure 1).

Discussion

The survey found that 15.56% of the sample of secondary vocational school students met the diagnostic criteria of online game addiction. Compared with high school students, secondary vocational students face both academic and employment pressure in the process of developing self-awareness, which may make them more eager to find ways to relieve their stress. On the other hand, as has been well documented, the vivid virtual world created by video games can make people temporarily stay away

TABLE 2 Linear regression analysis on the relationship between self-esteem and self-identity of secondary vocational students on video game addictive behavior ($n = 720$).

IV	Model 1 (DV: POGU)		Model 2 (DV: self–esteem)		Model 3 (DV: POGU)	
	β	*t*	*β*	*t*	*β*	*t*
Gender	−0.215	−6.258***	−0.084	−2.939**	−0.226	−6.546***
Grade	0.035	1.025	0.024	0.850	0.038	1.116
FT	0.041	1.185	−0.080	−2.792**	0.031	0.901
OCRN	−0.015	−0.419	0.009	0.312	−0.013	−0.389
SI	−0.346	10.123***	0.639	22.480***	−0.268	−6.028***
SE					−0.122	−2.723**
VIF	1.000		1.000		1.711	
D–W	2.081		2.123		2.097	
R^2	0.174		0.430		0.183	
F	30.101		107.668		26.545	

IV, independent variable; DV, dependent variable; POGU, pathological online game use; FT, family type; OCON, only child or not; SI, self-identity; SE, self-esteem.
$p < 0.01$,*$p < 0.001$.

TABLE 3A Test results of the mediating effect of self-esteem.

Effect model	Coeff	*se*	BootLLCI	BootULCI	Relative coeff
Total effect	−0.093	0.009	−0.111	−0.075	
Direct effect (SI => POGU)	−0.072	0.012	−0.095	−0.048	77.419%
Indirect effect (SI => SE => POGU)	−0.021	0.001	−0.039	−0.003	22.581%

POGU, pathological online game use; SI, self-identity; SE, self-esteem.

TABLE 3B Test results of the mediating effect of self-esteem.

Dependent variable	Independent variable	R^2	*F*	coeff	*se*	*t*
POGU						
	Self-identity	0.174	30.101	−0.093	0.009	−10.123***
Self-esteem						
	Self-identity	0.430	107.668	0.389	0.017	22.48***
POGU						
	Constant			8.729	0.639	13.655***
	Self-identity	0.174	30.101	−0.072	0.012	−6.028***
	Self-esteem	0.183	26.545	−0.054	0.020	−2.723**

POGU, pathological online game use.
***p < 0.001, **p < 0.01.

from real-world anxiety and gain the joy of gaming (8, 42, 43). Due to the lack of self-control, secondary school students are especially prone to getting caught up in gaming and unable to extricate themselves. Through the analysis of the POGU behavior within different demographic variables, we also found there are no significant differences in grade level, child status, and family income, while significant differences in genders and family types. The average score of POGU was higher in the male students than in the female, which is consistent with the previous research (44, 45). In a large-scale survey on the online game addiction behavior of teenagers from primary school students to college students, researchers found the proportion of girls addicted to online games was lower than that of boys (44). Ustinaviciene et al. (45) also discovered the same tendency and illustrated that POGU was related to game type and the time spent on it. Namely, male students who played action or combat

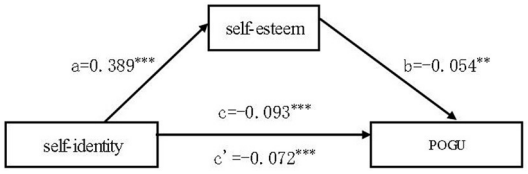

FIGURE 1
Model of the mediating role of self-esteem between self-identity and POGU (pathological online game use), ***$p <$ 0.001, **$p <$ 0.01. c: direct effect of self-identity on POGU; c': total effect of self-identity on POGU.

games were more likely to become addicted than those who played logic computer games, whereas female students who played games for more than 5 h a month were more inclined to become addicted. Several studies have replicated this findings, for example, a recent study of game use among 5,607 Norwegian adolescents showed a significant gender difference in game use, with boys being five times more likely than girls to start playing since age 14 and girls are using social media more often (46). Game type preference also shows gender differences and can be predicted by psychological characteristics, for example, girls' positive feelings about themselves make them more likely to choose First-Person Shooters as their favorite game genre, while boys' internalization difficulties may predict a lower choice of Massively Multiplayer Online Role Playing Games (MMORPGs) (47). Meanwhile, male's playtime was fully mediated by their higher role-playing and shooter games preferences (48). In terms of family type, the average score of online game addiction among students who are in skip-generation raising is significantly higher than that of two-parent and single-parent families. Parental involvement in the use of online games is crucial, and children's use of these games requires greater attention, support, and supervision of their part, and skip-generation raising shifts more responsibility for children from parents to grandparents, leading to the lack of parental education which closely related to adolescent game addiction,for example, in a review study, researchers found that parent-child relationships were strongly associated with problematic game addiction in adolescents, and paternal relationships could serve as a protective factor for children's game addiction (49).

In the demographic analysis of self-esteem, it is found that there is no significant variability across grades and whether they were only children, but there is significant variability across gender, family type and monthly household income. The finding on gender and grade is different from that of Zhang Yan et al. (50) on the analysis of variance. Their study indicated that in secondary vocational technical schools, girls reported greater self-esteem than boys and first-year students scored higher than their older counterparts. Based on the results of the current survey, it has been found that the level of self-esteem of male and female students is significantly different with male students tending to have a higher average level of self-esteem than female students. The imbalance in self-esteem for different genders may be, in part, due to the traditional view suggested by Chen Xuehong et al. (51) in their study that men, presumed to be the mainstay of the society, supposed to possess more good qualities and pay more attention to the internal verification of themselves than females. The same trend was also confirmed in other groups of adolescents,for example, Moksnes and Espnes (52) conducted a survey of 1,239 Norwegian teenage students and found that boys had higher levels of self-esteem and life satisfaction than girls. Aremu et al. (53) indicate that although there is no significant difference in self-esteem levels between boys and girls, more girls reported low self-esteem scores. Regarding the difference in family type, the level of self-esteem of secondary vocational school students in two-parent families was significantly higher than that of the other family types. It shows that parental companionship plays an important role in children's personality improvement. Self-esteem is structured by the intimate relationship with parents (54), and previous studies have also shown that children in divorced families have lower levels of self-esteem than those in intact families (55), and even children in joint physical custody report higher self-esteem than those living exclusively with one parent (56). In terms of monthly family income, compared to students from low-income families, students from high-income families have higher self-esteem levels. This is consistent with research on general high school students' self-esteem: students from high-income families may have higher self-esteem levels than students from low-income families (57).

A relatively low level of self-identity was found among secondary vocational school students. The society has certain prejudice against secondary vocational school students and assumes that only those who are not capable enough, namely got unsatisfactory grades in their high school-entrance examination, will come to these schools. This perspective further leads to the students' disapproval of their own ability and identity as a member of secondary vocational school students, leaving them a negative attitude toward their own, thereby causing low self-identity. Secondary vocational school students yearn for seeking self-identity in online games and they are eager to release their real selves in the game in which they project their emotions onto specific roles, the avatar, without sticking to the restrictions of the real world but to freely express themselves, either to get emotional satisfaction or to escape from the disorder in reality. In this way, they realize their self-worth through the construction of the role identity, their perceived self-identity (58), and if the players get satisfaction from the game, they are more likely to continue game usage (10). Meanwhile, there are also neural mechanism studies that reveal that the phenomenon of higher identification with game avatars in online game addicts may be related to self-concept impairment (59), for example, Leménager et al. (60) found higher activation levels in the

left angular gyrus, a brain region that has also been shown to be strongly associated with self-identity,when addicted players perceived game avatars compared to perceived themselves. The same evidence has been confirmed by other researchers (61). The analysis of the differences in self-identity in terms of demographic variables also found that while no significant differences were observed among gender, grade, family type, or whether they were only children, the monthly household income per capita showed significant variation. This suggests that family socioeconomic status and the level of self-identity are related potentially.

Meanwhile, it shows that self-identity is also positively associated with self-esteem. Students with higher self-identity understand themselves better and act in school and life in a more optimistic manner. Consequently, they are able to appreciate themselves more, evaluate themselves more positively and have higher levels of self-esteem. In contrast, a negative outlook is prevalent among students with low self-identity, and they often feel useless and uncertain of their roles, thus developing low self-esteem. Further, self-identity and self-esteem both correlate negatively with POGU. From Erikson's theory of stages of psychological development (62) and Maslow's need - hierarchy theory (63), self-esteem and self-identity play a key role in building a solid personality. High self-esteem and self-identity enable people to make a comprehensive assessment and analysis of themselves and people with high self-esteem and self-identity are better at handling situations that may come their way and finding enjoyment and meaning in life, thus be less likely to become addicted to online games. However, it may be demanding for those who lack self-esteem to handle pressure and problems in life and they are compelled to flee from reality and seek a sense of belonging and accomplishment from the virtual world of online games. This inappropriate "sense of belonging and accomplishment" will make secondary vocational school students deeply immersed in online games and unable to extricate themselves.

Conclusion

The correlation analysis results of POGU, self-esteem and self-identity of secondary vocational school students show that there is a significant negative correlation between POGU and self-esteem and self-identity, and a significant positive correlation between self-esteem and self-identity. Regression analysis showed self-esteem played a mediating role between self-identity and POGU.

Based on regression analysis of the effects of self-esteem and self-identity on POGU behaviors, we also found that although both self-esteem and self-identity significantly and negatively predicted online game addictive behaviors, the coefficient of R^2 was small, indicating that the explanatory rate of them on online game addictive behaviors was low. This result may be caused by many factors which contribute to addiction to online games in proportion. Previous studies have found many influencing factors of addiction to online games, such as parental support (25, 64, 65), school belonging (66), boredom proneness (67) and so on. In view of this, other relevant variables should be considered for further research in future studies.

The mediating effect of self-esteem is analyzed, and it is found that self-esteem plays a partial mediating role between self-identity and addiction to online games, which means that self-identity may also affect the addictive behavior of online games through other factors. Further research and discussion can be made in the future. From data obtained from the study, it suggests the obvious influence of self-esteem and self-identity on pathological online game use online game, and also provides direction and ideas for formulating relevant educational strategies.

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 of the School of Psychology, Fujian Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

LY was responsible for the conceptualization. YC finished the data curation and methodology design. MZ finished the original draft under supervision of JZ. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Media multitasking, depression, and anxiety of college students: Serial mediating effects of attention control and negative information attentional bias

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Background: The COVID-19 epidemic provides an environment for frequent media multitasking, which might associate with an increase in depression and anxiety. Since many studies have found that media multitasking negatively affects cognitive capacity, we propose a cognitive perspective to explore how media multitasking may associate with mental health. This study examined the potential mediating role of attention control and negative information attentional bias in the relationship between media multitasking and anxiety and depression.

Methods: Participants (n = 567) were recruited from college students in China. They completed an online survey that included the Media Multitasking Inventory (MMI), Attention Control Scale (ACS), Attention to Positive and Negative Information Scale (APNI), Generalized Anxiety Disorder Scale (GAD-7), and Patient Health Questionnaire (PHQ-9). After exploring the correlations between the measures, serial mediation models were examined.

Results: The results indicated significant positive correlations between media multitasking and anxiety and depression. Media multitasking, anxiety, and depression were negatively correlated with attention focusing, while positively correlated with negative information attention bias. Media multitasking did not correlate with attention shifting. Mediation modeling demonstrated that attention focusing and negative information attention bias played a serial mediating role in the relationship between media multitasking and anxiety and depression. However, the results did not support the serial mediation model through attention shifting and negative information attention bias.

Conclusion: Media multitasking does not directly influence anxiety and depression, while attention focusing and negative information attention bias

play serial mediating roles in their relationship. This study highlights the potential cognitive mechanisms between media multitasking and anxiety and depression, providing theoretical support for interventions in individual mental health during the epidemic.

KEYWORDS

media multitasking, attentional control, attention bias, depression, anxiety

Introduction

The global mental health report released by the WHO recently showed that depression and anxiety increased by 25% globally in 2020, the year of the COVID-19 epidemic outbreak (1). The development of technology has allowed for the high accessibility and portability of media devices, which facilitated working and studying at home during the pandemic.

Media multitasking is typically known as simultaneously engaging in multiple media tasks, such as checking messages on the cellphone while watching TV or reading a book while listening to music (2, 3). The convenience of mobile devices makes it possible to do multiple media activities simultaneously. Surveys have shown that when they use media, people spend 25–50% of their time consuming multiple media simultaneously (4, 5), and this number is continuously growing (6). It is important to notice that numerous studies showed that media multitasking behavior could detrimentally affect cognitive ability, such as attention and memory (7–9). Other studies have even found that media multitasking poses a potential threat to the mental health of the public (10, 11).

Several studies suggested that frequent media multitasking behaviors may hurt mental health, possibly leading to anxiety and depression (12, 13). Becker et al. proposed that media multitasking can predict the levels of depression and social anxiety of college students, even under the control of other factors (such as total time spent on media and personality traits) (14). At the same time, there has been little research on how media multitasking affects anxiety and depression, most of which prioritized the mediating role of personality traits or environmental factors such as peer relationships and stress (15, 16). For example, Shin et al. (17) proposed that media multitasking may serve as an avoidance-oriented behavioral coping strategy to divert attention from unpleasant information. Long-term avoidance behavior is not beneficial for acquiring adaptive coping strategies (i.e., problem-solving); thus, frequent media multitasking over time may lead to greater susceptibility to anxiety and depression (18). However, it has been suggested that cognition plays a mediating role between behavior and emotion (19, 20). For example, a study found that mindfulness moderated the relationships between mobile phone addiction and anxiety and depression (21). However, the cognitive process by which media multitasking negatively affects anxiety and depression is not clear.

Negative information attention bias refers to a tendency to attend to threatening or negative stimuli compared to neutral stimuli (22). More and more evidence shows that negative information attention bias is not only a phenomenon or symptom accompanying some psychological disorders, but also a central cognitive factor in their development, maintenance, and recurrence (23, 24). Attention bias to negative stimuli could result in anxiety and depression (25, 26). Cret performed attentional bias modification training (ABMT) on participants, and the results showed that participants in the negative ABMT condition had higher levels of anxiety than before the training, suggesting a causal link between attentional bias toward emotional information and anxiety (27). Krejtz et al. also confirmed that the depressive symptoms of depressed patients could be effectively reduced by changing negative information attentional bias (28). In addition, a previous study found that ordinary individuals will be attracted to negative information while media multitasking and the negative information elicited more significant unpleasantness (29). All those evidence supports the hypothesis that negative information attention mediates the association between media multitasking and anxiety and depression.

Why do some people show a cognitive processing pattern of negative information attention bias? Some studies suggest it may be due to reduced attentional control ability (27, 30). Attentional control refers to top-down flexible regulation of attentional resources, involving allocating attention in the face of competing or conflicting demands (31). According to attention control theory (30, 32), the negative information attention bias of anxious and depressed individuals is a cognitive deficit dependent on attentional control. The theory considers that anxiety and depression disrupt the balance between the goal-directed attentional system (top-down control) and the stimulus-driven attentional system (bottom-up control). So, with a higher level of anxiety or depression, people may prioritize allocating attentional resources to the negative stimulus, which in turn increases the level of anxiety and depression, resulting in a vicious circle. Some studies have

found that higher attentional control facilitates people to recruit cognitive resources to inhibit unintentional attention to negative stimuli in a top-down way, whereas lower attentional control predisposes a person to over-preference for negative stimuli (33, 34). Other studies also found that attentional control may be an essential protective factor for mental health. People with valid attentional control can avoid negative thoughts, coping styles, and emotional reactions, thereby maintaining a lower level of anxiety or depression (17, 35). Therefore, attentional control may influence attentional bias and lead to anxiety and depression.

In the past decades, many studies found that media multitasking is associated with poor cognitive functioning. Notably, it leads to a reduced attentional control ability (36, 37). Attentional control ability has two aspects: attention focusing (the ability to maintain attentional engagement when facing distraction) and attention shifting (the ability to switch between different tasks or shift attention from distractions to new or related tasks) (33). For attention focusing, Ophir et al. initially found that heavy media multitaskers are more liable to fail when they need to filter distractions (2). This finding is proved by many subsequent studies (38, 39). However, the relationship between media multitasking and attention shifting is mixed. Some researchers found that heavy media multitaskers alternate between two different tasks with more difficulty and pay higher shifting costs (40, 41). At the same time, other studies indicated that heavy media multitaskers are more efficient with task-shifting (42, 43). In brief, the negative effect of frequent media multitasking on attention focusing was confirmed by multiple studies, whereas the results about attention shifting were inconsistent. Thus, we will consider the two aspects separately in the present study.

Based on the above literature review, it is reasonable to conclude that frequent media multitasking behavior may lead to poor attention control. Consequently, it forms the negative information attention bias, eventually leading to the occurrence or exacerbation of anxiety or depression symptoms. Thereby, the present research will test the hypotheses below. (1) Media multitasking is positively correlated with anxiety and depression; (2) Media multitasking, anxiety, and depression have a significant negative association with attentional control (including attention focusing and attention shifting) and a significant positive association with negative information attention bias; (3) Attentional control (separated as attention focusing and attention shifting) and negative information attention bias play a serial mediating role in the relationship between media multitasking, anxiety, and depression (see **Figure 1**). This study has potential significance for understanding the relationship between media multitasking and mental health from a cognitive perspective. This understanding will be used to prevent potential mental illness induced by media multitasking during the COVID-19 pandemic.

Methods

Participants and procedure

A cross-sectional study was conducted on an online survey tool, Wen Juan Website.[1] We recruited all participants *via* WeChat (a popular Chinese social media platform). College students from one university usually have one joint WeChat group. Several students from Tianjin Normal University initially sent the recruitment messages to WeChat groups of students. The snowball sampling method was adopted to increase the sample size. We encouraged participants who saw and joined our study to share the link with more college students. To avoid data duplication, each IP address was only granted access to the survey once. Also, we identify the location of the participants *via* IP address. Finally, we obtained samples from 28 provinces in China, most of which were from Tianjin, Fujian, Sichuan, and Beijing.

All subjects participated voluntarily and were informed that the survey was anonymous and confidential. The study obtained the electrical consent of all subjects. All procedures in this study met the ethical standards of the Chinese Psychological Association[2] and conformed to the 1964 Declaration of Helsinki and subsequent amendments or similar ethical standards. The Ethics Committee of Tianjin Normal University approved the study (022050901).

A total of 617 students participated and completed the survey. After excluding unqualified samples (e.g., some participants completed the questionnaire battery in <180 s or >15 min), we finally collected 567 valid participants with an effective response rate of 91.90%. The participants were 21.4 years old on average (SD = 2.24 years), with 241 males (42.50%) and 326 females (57.50%). Most participants were undergraduates (n = 501, 88.36%), and the remaining were postgraduate students.

Measures

Media multitasking inventory

The Media Multitasking Inventory (MMI) was initially developed by Ophir et al. (2) and developed by Madore et al. (8). In this study, the MMI was modified from Madore et al. The questionnaire includes two parts. In part 1, participants were instructed to report the total number of hours per week typically spent doing each of eight media activities: self-regulated learning (doing homework, self-study, writing papers), reading (novels, comics, etc.), taking phone calls or video calls, playing video games, watching videos (watching

1 https://www.wenjuan.com

2 https://www.cpsbeijing.org/

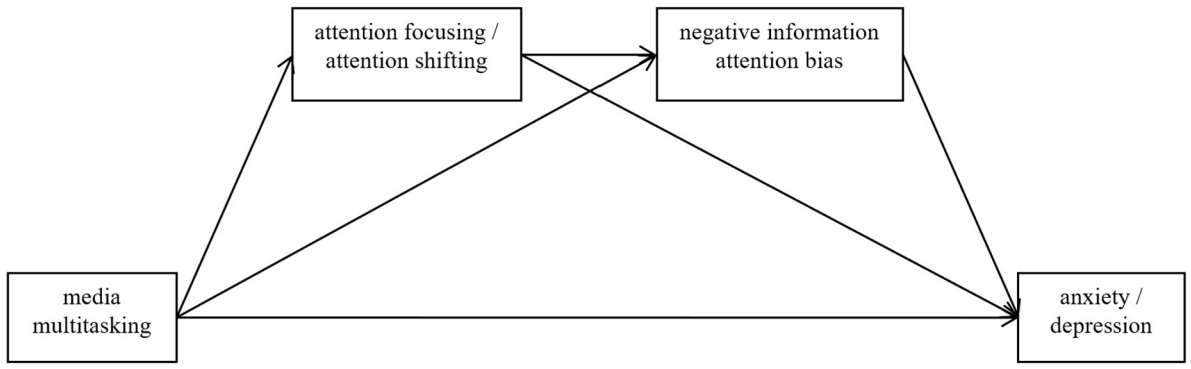

FIGURE 1
The mediating pathway of attention focusing/shifting and negative information attention bias in media multitasking influence anxiety/depression.

TV, movies, online videos, etc.), listening to music, browsing the Internet (news web and other non-social websites), using social media applications (chatting online with WeChat, posting or browsing on Weibo, etc.). In part 2, participants indicated how often they simultaneously engaged in each of the other activities while doing the primary media activities on a four-point Likert scale [never (0), occasionally (0.33), often (0.67), always (1)]. MMI index is calculated as an indication of the level of media multitasking the participant engaged in during a typical media-consumption hour (2). MMI is designed to measure the frequency of specific media multitasking behaviors without further inferences about possible latent variables. Thus, it is a valid index for the media multitasking activity (9).

The attention to positive and negative information scale

The Attention to Positive and Negative Information Scale (APNI) was developed by Noguchi et al. to measure the attention bias of individuals toward negative or positive information, and the revised Chinese version was used in this study (44, 45). The scale includes 30 items in total, which is divided into two dimensions: positive information attention bias (19 items) and negative information attention bias (11 items). Items are rated on a 5-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"). Only the negative attention bias dimension was used in this study (APNI-N). Examples of the items in APNI-N are: "I don't forget when others do things that hurt me," "I pay special attention to bad news on the television news." The Cronbach's alpha for this sample was 0.91.

The attentional control scale

The Attentional Control Scale (ACS) was developed by Derryberry et al. to measure a general capacity for attentional control, and the revised Chinese version was used in this study (33, 46). The scale is divided into two dimensions: attention focusing (8 items, e.g., "When concentrating, I can focus my attention so that I become unaware of what's going on in the room around me," "My concentration is good even if there is music in the room around me") and attention shifting (8 items, e.g., "It is easy for me to alternate between two different tasks," "I can quickly switch from one task to another"), for a total of 16 items. Each item is rated on a 4-point Likert scale from 1 ("almost never") to 4 ("always"). Possible scores range from 16 to 64, with higher scores indicating a greater capacity for attentional control. The Cronbach's alpha for this sample was 0.81.

Generalized anxiety disorder questionnaire-7

The Generalized Anxiety Disorder Questionnaire (GAD-7) was developed to assess the defining symptoms of GAD in the last 2 weeks (47). There are seven items rated on a 4-point Likert scale from 0 ("not at all") to 3 ("nearly every day"). Examples of the items are: "Feeling nervous, anxious or on edge," "Not being able to stop or control worrying." Scores range from 0 to 21, with higher scores indicating more severe anxiety symptoms. The Cronbach's alpha of this scale in this sample was 0.90.

Patient health questionnaire-9

The Patient Health Questionnaire-9 (PHQ-9) was used as a self-administered screening tool for assessing the severity of depressive symptoms. PHQ-9 includes nine items based on the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) for depression (48). The questionnaire was measured by participants reporting their mood during the immediately preceding 2 weeks. Each item was scored on a 4-point Likert scale from 0 ("not at all") to 3 ("nearly every day"). Examples of the items are: "Feeling down, depressed, or hopeless," "Little interest or pleasure in doing things." Scores range from 0 to 27, with higher scores indicating more severe depression symptoms. The Cronbach's alpha of this scale in this sample was 0.92.

Data analysis

Data analyses were conducted by the IBM SPSS Statistics for Windows, version 26.0 (IBMCorp., Armonk, NY, United States). First, descriptive analyses were conducted for the variables of interest for the total sample. Then Harman's single-factor test was conducted to examine the common method bias. Pearson correlation was used to examine the correlations among variables. This study used deviation-corrected percentile bootstrapping to test. To test the significance of the indirect effect using the Hayes Process Macro (model six) for SPSS with a 95% bias-corrected confidence interval (CI) based on 5,000 bootstrap samples. A significant mediation was determined if the CI around the indirect effect did not include 0.

Harman's single-factor test was used to test for common method bias (49). The results of unrotated factor analysis showed that seventeen factors with eigenvalues greater than one emerged and accounted for 65.23% of the total variance. The first principal factor explained 30.30% of the variance (<40%). Therefore, it indicated that common method bias was not a concern in this study.

Results

Descriptive statistics and correlations

The Descriptive statistics and Pearson correlation results are shown in Table 1. Specifically, media multitasking was significantly positively correlated with anxiety (r = 0.195, p < 0.01) and depression (r = 0.221, p < 0.01) and negative information attention bias (r = 0.358, p < 0.01), but significantly negatively correlated with attention focusing (r = −0.303, p < 0.01), and not correlated with attention shifting. Moreover, attention focusing, attention shifting was significantly and negatively correlated negative information attention bias (r = −0.535, p < 0.01; r = −0.358, p < 0.01), anxiety (r = −0.390, p < 0.01; r = −0.300, p < 0.01), and depression (r = −0.410, p < 0.01; r = −0.331, p < 0.01). Negative information attention bias was significantly and positively correlated with anxiety (r = 0.521, p < 0.01) and depression (r = 0.515, p < 0.01). The results showed that subjects with more likeness to engage in media multitasking had lower levels of attention focusing and more attention bias toward negative information, thus having higher anxiety and depression scores.

The serial mediating analysis

Media multitasking-anxiety serial mediated analysis

Attention focusing and attention shifting are separated as two independent dimensions to create the mediation model. Multiple mediation analysis was conducted with media multitasking as the independent variable, attention focusing and negative information attention bias as mediating variables, anxiety as the dependent variable, and gender and age as covariates. The models with attention focusing and negative information attention bias as mediating variables were significant. The results are shown in Table 2. Results indicate that Media multitasking cannot significantly predict anxiety (β = −0.026, p = 0.515), but significantly predict attention focusing and negative information attention bias (β = −0.299, p < 0.001; β = 0.212, p < 0.001). In addition, attention focusing can significantly predict negative information attention bias (β = −0.469, p < 0.001), anxiety was significantly predicted by attention focusing and negative information attention bias (β = −0.157, p < 0.001; β = 0.441, p < 0.001).

Then we performed a bootstrap analysis using the bias correction non-parametric percentage test to further examine the serial mediating effects. The results revealed (see Table 3) that the direct effect of media multitasking on anxiety was not significant (p = 0.515) and that attention focusing and negative information attention bias mediated the relationship between media multitasking and anxiety. Specifically, this mediating effect consisted of three pathways, namely indirect pathway 1: media multitasking → attention focusing → anxiety; indirect pathway 2: media multitasking → negative information attention bias → anxiety; indirect pathway 3: media multitasking → attention focusing →negative information attention bias → anxiety. The effect values of the three pathways were 0.266, 0.531, and 0.349, respectively. The 95% confidence interval of the three paths did not contain 0, indicating that the serial mediation effect was significant (pathway model see Figure 2).

The models with attention shifting and negative information attention bias as mediating variables were not significant. Results indicate that Media multitasking did not significantly predict anxiety and attention shifting (β = 0.001, p = 0.979; β = −0.081, p = 0.067), but media multitasking significantly and positively predicted negative information attention bias (β = 0.326, p < 0.001). Moreover, attention shifting significantly predicted negative information attention bias (β = −0.332, p < 0.001), and attention shifting and negative information attention bias significantly predicted anxiety (β = −0.133, p < 0.001, β = 0.468, p < 0.001). It can be seen that the path coefficient of media multitasking to attentional shifting was not significant. The results indicate that attention shifting and negative information attention bias had no significant serial mediating effect between media multitasking and anxiety.

Media multitasking–depression serial mediated analysis

Next, the study analyzed the mediating effect of attention focusing and negative information attention bias between media multitasking and depression. Multiple mediation analysis

TABLE 1 Mean, standard deviation, and correlation coefficient of each variable.

	M	SD	1	2	3	4	5	6
1. MMI	2.83	1.65						
2. AF	20.78	4.55	−0.303**					
3. AS	20.77	3.69	−0.076	0.602**				
4. ACS	41.56	7.39	−0.225**	0.917**	0.871**			
5. APNI-N	33.64	9.81	0.358**	−0.535**	−0.358**	−0.508**		
6. GAD-7	4.93	4.32	0.195**	−0.390**	−0.300**	−0.390**	0.521**	
7. PHQ-9	6.93	5.18	0.221**	−0.410**	−0.331**	−0.418**	0.515**	0.784**

MMI, Media Multitasking Inventory; AF, Attention focusing dimension of Attentional Control Scale; AS, Attention shifting dimension of Attentional Control Scale; ACS, Attentional Control Scale; APNI-N, Negative dimension of the Attention to Positive and Negative Information Scale; GAD-7, Generalized Anxiety Disorder Questionnaire-7; PHQ-9, Patient Health Questionnaire-9. **$p < 0.01$.

was conducted with media multitasking as the independent variable, attention focusing and negative information attention bias as mediating variables, depression as the dependent variable, and gender and age as covariates. The models with attention focusing and negative information attention bias as mediating variables were significant. The results are shown in Table 4. Results indicate that Media multitasking did not significantly predict depression (β = −0.004, $p = 0.913$), but significantly predicted attention focusing and negative information attention bias (β = −0.299, $p < 0.001$, β = 0.212, $p < 0.001$). In addition, attention focusing were negatively significantly predicted negative information attention bias (β = −0.469, $p < 0.001$), and depression significantly predicted by attention focusing and negative information attention bias (β = −0.184, $p < 0.001$, β = 0.411, $p < 0.001$).

Then we performed a bootstrap analysis using the bias correction non-parametric percentage test to further examine the significance of the serial mediating effects. The results revealed (see Table 5) that the direct effect of media multitasking on depression was not significant ($p = 0.913$) and that attention focusing and negative information attention bias mediated the relationship between media multitasking and depression. Specifically, this mediating effect consisted of three pathways, namely indirect pathway 1: media multitasking → attention focusing → depression; indirect pathway 2: media multitasking → negative information attention bias → depression; indirect pathway 3: media multitasking → attention focusing → negative information attention bias → depression. The effect values of the three pathways were 0.281, 0.444, and 0.296, respectively. The 95% confidence interval of the three paths did not contain 0, indicating that the serial mediation effect was significant (pathway model see Figure 3).

The models with attention shifting and negative information attention bias as mediating variables were not significant. Results indicate that media multitasking cannot significantly predicted depression and attention shifting (β = 0.028, $p = 0.471$; β = −0.081, $p = 0.067$), but

TABLE 2 Regression analysis of variable relationships in models.

Outcome variable	Predictor variables	*R*	R^2	*F*	β	*t*
AF		0.304	0.093	19.150***		
	Gender				0.012	0.141
	Age				−0.023	−0.569
	MMI				−0.299	−7.139***
APNI-N		0.574	0.329	68.977***		
	Gender				−0.007	−0.103
	Age				0.024	0.688
	MMI				0.212	5.634***
	AF				−0.469	−12.938***
GAD-7		0.542	0.293	46.552***		
	Gender				−0.132	−1.762
	Age				−0.026	−0.729
	MMI				−0.026	−0.651
	AF				−0.157	−3.696***
	APNI-N				0.441	10.181***

MMI, Media Multitasking Inventory; AF, Attention focusing dimension of Attentional Control Scale; APNI-N, Negative dimension of the Attention to Positive and Negative Information Scale, GAD-7, Generalized Anxiety Disorder Questionnaire - 7. ***$p < 0.001$.

TABLE 3 Mediating paths between media multitasking and anxiety.

	Effect	Boot SE	Boot LLCI	Boot ULCI	Relative effect (%)
Total	0.177				
Total indirect effect	0.203	0.026	0.153	0.255	1.147
Indirect effect 1	0.047	0.014	0.020	0.077	0.266
Indirect effect 2	0.094	0.019	0.057	0.131	0.531
Indirect effect 3	0.062	0.011	0.041	0.085	0.349

Relative effect (%) = Indirect effect/Total; Indirect effect 1: media multitasking → attention focusing → anxiety; Indirect effect 2: media multitasking → negative information attention bias → anxiety; Indirect effect 3: media multitasking → attention focusing → negative information attention bias → anxiety.

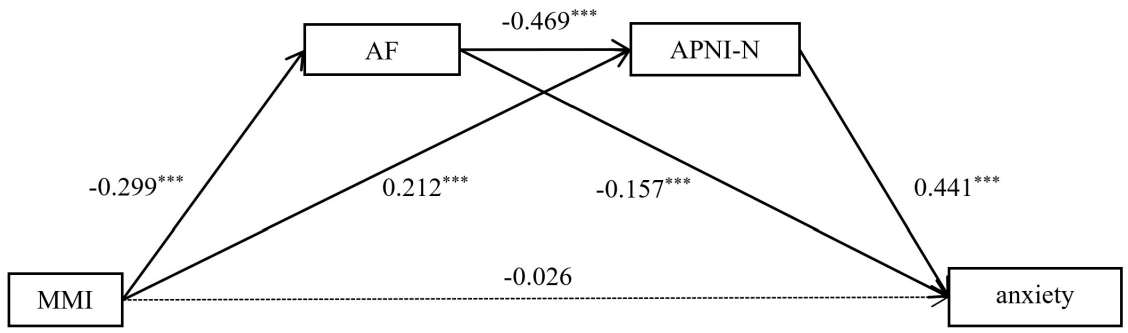

FIGURE 2
The mediating pathway of attention focusing and negative information attention bias in media multitasking influence anxiety. MMI, Media Multitasking Inventory; AF, Attention Focusing dimension of Attentional Control Scale; APNI-N, Negative dimension of the Attention to Positive and Negative Information Scale. ***$p < 0.001$.

media multitasking significantly and positively predicted negative information attention bias (β = 0.326, $p < 0.001$). Moreover, attention shifting significantly predicted negative information attention bias (β = −0.332, $p < 0.001$), and depression significantly predicted by attention shifting and negative information attention bias (β = −0.174, $p < 0.001$; β = 0.435, $p < 0.001$). It can be seen that the path coefficient of media multitasking to attentional shifting was not significant. The results indicate that attention shifting and negative information attention bias had no significant serial mediating effect between media multitasking and depression.

TABLE 4 Regression analysis of variable relationships in models.

Outcome variable	Predictor variables	*R*	R^2	*F*	β	*t*
AF		0.304	0.093	19.150***		
	Gender				0.012	0.141
	Age				−0.023	−0.569
	MMI				−0.299	−7.139***
APNI-N		0.574	0.329	68.977***		
	Gender				−0.007	−0.103
	Age				0.024	0.688
	MMI				0.212	5.634***
	AF				−0.469	−12.938***
PHQ-9		0.548	0.300	48.136***		
	Gender				−0.192	−2.577
	Age				−0.037	−1.050
	MMI				−0.004	−0.109
	AF				−0.184	−4.367***
	APNI-N				0.411	9.522***

MMI, Media Multitasking Inventory; AF, Attention focusing dimension of Attentional Control Scale; APNI-N, Negative dimension of the Attention to Positive and Negative Information Scale; PHQ-9, Patient Health Questionnaire-9. ***$p < 0.001$.

Discussion

Our study aimed to explore the function of attention-related cognitive factors while media multitasking influences individuals' anxiety and depression symptoms. In this study, media multitasking was significantly and positively related to anxiety and depression, and hypothesis (1) was verified; media multitasking, anxiety, and depression were significantly negatively related to attention focusing, significantly positively related to negative information attention bias, but media multitasking was not significantly related to attentional shifting, and hypothesis (2) was partially verified; attention focusing and negative information attention bias played a serial mediating role in the relationship between media multitasking, anxiety, and depression, but the serial mediating effect of media multitasking-attention shifting-negative information attention bias-anxiety/depression is not significant, and hypothesis (3) was partially verified.

The results show that frequent media multitasking behavior is associated with higher levels of anxiety and depression, which are consistent with previous research (12, 14). A more

TABLE 5 Mediating paths between Media multitasking and depression.

	Effect	Boot SE	Boot LLCI	Boot ULCI	Relative effect (%)
Total	0.196				
Total indirect effect	0.200	0.024	0.152	0.247	1.020
Indirect effect 1	0.055	0.014	0.029	0.084	0.281
Indirect effect 2	0.087	0.018	0.055	0.123	0.444
Indirect effect 3	0.058	0.011	0.038	0.080	0.296

Relative effect (%) = Indirect effect/Total; Indirect effect 1: media multitasking → attention focusing → depression; Indirect effect 2: media multitasking → negative information attention bias → depression; Indirect effect 3: media multitasking → attention focusing → negative information attention bias → depression.

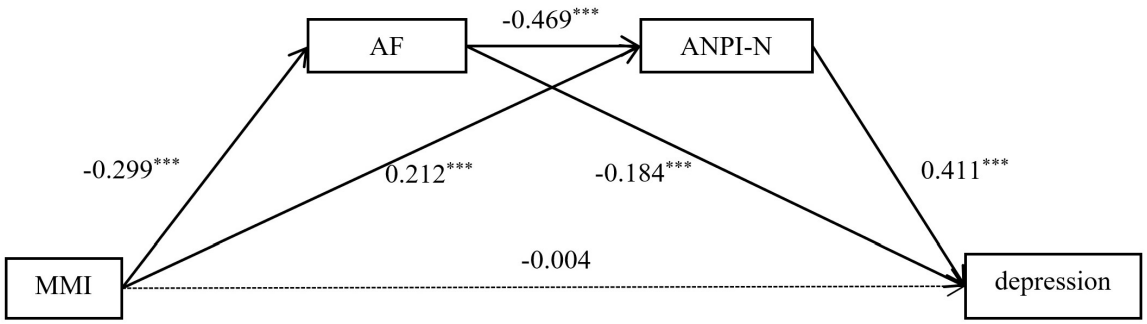

FIGURE 3
The mediating pathway of attention focusing and negative information attention bias in media multitasking influence depression. MMI, Media Multitasking Inventory; AF, Attention Focusing dimension of Attentional Control Scale; APNI-N, Negative dimension of the Attention to Positive and Negative Information Scale. ***$p < 0.001$.

important finding of this study was that after adding two mediating variables to the model, the direct effect of media multitasking on anxiety or depression was not significant, while the three indirect effects were significant, and the two cognitive factors played a serial mediating role. These results suggest that media multitasking may not directly influence anxiety and depression, but when considering attention focusing and negative information attention bias as the mediators, the serial effect is significant. The mediating effect found in this study could explain why some studies have found that media multitasking has no implications for mental health (50).

The present study found a significant positive association between media multitasking and negative information attention bias, and a significant positive association between negative attention bias and anxiety and depression. Negative information attention bias can partially mediate the relationship between media multitasking and anxiety and depression. As in a previous study, researchers simulated real-world media multitasking by asking participants to watch television news while paying attention to occasional tweets popping up on a tablet, the result showed that participants looked at negative tweets longer than at the positive ones, and participants tended to have more negative feelings (29). During the COVID-19 epidemic, learning and working remotely at home is becoming regular and promoting more media multitasking behaviors. Media multitasking may expose people to more negative or positive information on the Internet and induce greater negative emotions such as anxiety and depression if they have an attentional bias toward negative information (26, 51).

Furthermore, the present study found that attention focusing and negative information attentional bias played a serial mediating role in the relationship between media multitasking, anxiety, and depression. The more frequently individuals engaged in media multitasking had more significant decreases in attentional control and were more likely to attend to negative information, leading to increased levels of anxiety and depression. This is consistent with previous studies, which found that heavy media multitaskers perform worse in attentional control than light media multitaskers (2, 52). Previous study has also found that individuals with higher attentional control ability have lower levels of anxiety and depression (53). Therefore, attentional control may be a protective mechanism for the mediating role of negative attention bias mediating the relationship between media multitasking and anxiety and depression. Individuals with good attentional control ability can regulate top-down attention allocation and avoid bottom-up stimulus drive systems that are overly enhanced and more easily attracted to negative stimuli. However, the lower the attentional control, the more susceptible the individual is to the stimulus drive system, and the more attention is captured by negative stimuli, leading to anxiety and depression (54–56).

The two dimensions of attentional control were analyzed separately in this study, and the results indicated that different aspects of attentional control did not play the same mediating role. Remarkably, the serial mediation of attention focusing and negative information attentional bias was held, but the serial mediation of attention shifting and negative attentional bias was not. The above results suggest that media multitasking has different effects on attention focusing and attention shifting. A more consistent finding from previous studies revealed that media multitasking harmed attention focusing. For example, heavy media multitaskers tend to use breadth-biased attention allocation, are more likely to be inattentive, and get distracted by internal or external irrelevant stimuli (39). While the results of studies on the influence of media multitasking on attention shifting are inconsistent, some studies suggested that heavy media multitasker's switch cost was greater than light media multitaskers on shifting tasks (40, 41). However, others have found that heavy media multitaskers behave better when shifting among tasks (43, 57). The discrepancy in the

results of these studies may be due to the different effects of different media multitasking types on attention. Which previous scholars suggested can be defined as two different behaviors: simultaneous media multitasking and media task-shifting. It has been suggested that different types of media multitasking may have different effects on attention shifting (6, 58). The reason why media multitasking cannot insignificantly predict attention shifting in the present study may be that different types of media multitasking were not distinguished.

In this electronic age, mobile devices (PCs, tablets, smartphones, etc.) have become an essential part of our lives, which makes it hard to avoid the increase in media multitasking. An important practical implication of the present study is that the cognitive decline resulting from media multitasking may induce mental health problems. Several studies have proved the effeteness of attentional control training (59, 60). Thus, improving the attention control ability of heavy media multitaskers could be a possible way to prevent the harmful effect.

Limitation and prospects

The current study has several limitations. Firstly, because our data are cross-sectional, we cannot establish evidence of a causal relationship between media multitasking and anxiety and depression. Longitudinal designs should be considered in future research to test the causality. Secondly, the self-report method could introduce response bias, such as overestimating or underestimating their media use time and cognitive abilities. Further studies are needed to develop more objective methods to measure the occurrences of media multitasking, such as the experience sampling approach (61). Alternatively, observing the real-time changes in cognitive abilities and emotions in the lab could be considered in future studies. Finally, as recent research suggested, the different patterns of media multitasking could play a different role (3, 6). Future research should focus on the effect of subdividing media multitasking types on attention control and mental health.

Conclusion

In conclusion, this study found that media multitasking was significantly associated with anxiety and depression, but it did not directly predict them. The results implied that cognitive factors should be considered when examining the effects of media multitasking on anxiety and depression. We found that attention focusing and negative information attentional bias play serial mediating effects between media multitasking and anxiety/depression. In contrast, attention shifting did not play the same role as attention focusing. Specifically, individuals with more media multitasking behaviors have worse abilities in attention focusing, which will more frequently draw their attention to negative information, which then induces higher levels of anxiety and depression.

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

Author contributions

SL conceived the research idea and structured and drafted the manuscript. Both authors collected and analyzed the data, contributed to the article, and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Self-concept clarity and Internet addiction disorder among junior high school students: A moderate mediation model

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Introduction: As the epidemic spreads, the problem of Internet addiction disorder (IAD) stand out and getting serious. The present study aimed to investigate IAD among junior high school students during the spread of the COVID-19, and to explore the mediating role of cognitive failure between self-concept clarity and IAD, and the moderating role of mindfulness.

Methods: A sample of 1,153 junior high school students from two randomly selected junior high schools in Henan Province were surveyed anonymously with Self-concept Clarity Scale (SCCS), Cognitive Failure Questionnaire (CFQ), Mindfulness Attention Awareness Scale (MAAS) and Internet Addiction disorder Test (IAT). The sample was obtained through random cluster sampling, taking classes as the clusters and students as the elements.

Results: (1) Self-concept clarity was negatively correlated with Internet addiction disorder; (2) Self-concept clarity not only had a direct effect on Internet addiction disorder, but also indirectly affect Internet addiction disorder through cognitive failure; (3) Mindfulness moderates the relationship between self-concept clarity and Internet addiction disorder, as well as the relationship between cognitive failure and Internet addiction disorder. Compared with low levels of mindfulness, both the protective effect of self-concept clarity and the effect of cognitive failure on Internet addiction disorder were stronger among junior high school students who were at high levels of mindfulness.

Conclusion: This study constructs a moderated mediation model to explain the effect of self-concept clarity on Internet addiction disorder. It is effective to alleviate Internet addiction disorder by improving self-concept clarity and mindfulness level of the junior school students.

KEYWORDS

junior high school students, Internet addiction disorder, self-concept clarity, cognitive failure, mindfulness

Introduction

The Internet has played an important role in people's lives and work, especially during the COVID-19 pandemic. The Coronavirus disease 2019 (COVID-19) as a public health emergency brought about a sharp increase in the number of behavioral addictions (1). Behavioral addictions, especially Internet addiction disorder, have become more

prominent among adolescents during the COVID-19 pandemic (2). In order to deal with the spread of the virus, various countries and regions have launched different strategies, such as reducing aggregation, locking down cities, shutdown or home office, school suspension or e-learning. Although these measures are meant to protect people from the virus, they also bring new problems, especially Internet addiction disorder among teenagers. During the pandemic, they need to temporarily stop the traditional face-to-face learning and rely more on online distance learning. Since online learning is generally unsupervised, it is easy for teenagers to indulge in Internet surfing or games. Moreover, adolescents' self-awareness and personality have not yet developed well, and it has not been fully developed in their self-control ability. Coupled with the attraction of the Internet world, teenagers are always a high incidence group of Internet addiction disorder (3). At the same time, due to the fear of viruses and the depression and stress caused by uncertainty, junior high school students tend to seek sense of security from cyberspace (4). With the increasing number of minors using the network, Low age in the problem of Internet addiction disorder gets worse with each passing day (5). Previous researches provided a global internet addiction disorder prevalence of 7.02%, and the prevalence was 7.7% in Chinese middle school students (6).

Internet addiction disorder (IAD) is defined as the loss of control over Internet use (7, 8) leads to a series of physical and mental health and social adaptation problems in everyday life, such as decreased sleep quality, decreased academic performance, interpersonal tension and many other negative effects (9). In view of the negative effects of IAD, it is particularly urgent to solve the problem of IAD among teenagers. The society is paying much attention to the IAD of college students, many researches were done from different kinds of fields. In this context, it is necessary to explore the influencing factors and psychological mechanism of middle school students' IAD, which has practical significance to reduce and solve the problem of IAD.

Self-concept clarity is a structured self-concept, which refers to an individual's confidence and clarity in self-evaluation and self-knowledge (10). The influencing factors of IAD is still a topic ongoing and under investigation, and self-concept clarity is one of the most important factors. Previous studies with adult subjects have found that self-concept clarity is significantly and negatively associated with IAD. Specifically speaking, low level of self-concept clarity may result in Internet-dependent behaviors and eventually it becomes an addiction (11, 12). The reason is that individuals with low self-concept clarity usually show more inferiority and introversion, pay too much attention to the inner world, and do not have a comprehensive understanding of their own abilities. Therefore, they are more likely to indulge in alternative satisfaction through the Internet (13). It was found that the level of self-concept clarity of middle school students was slightly lower than the theoretical mean level (14). Some studies have found that adolescents with a low level of self-concept clarity typically have more negative coping styles, poorer interpersonal relationships, and exhibit more anxiety and depression (15). Evidence from relevant reviews have suggested that there is a significant correlation between self-concept clarity and IAD, but few studies have examined whether this relationship is the same for junior middle school students. Adolescents are more curious but lack mature cognitive control, self-regulatory, and more likely to suffer from environmental adjustment, and other life events. Based on this, this paper will take junior high school students as the research object to explore the impact of their self-concept clarity on IAD.

Mediating role of cognitive failures

Cognitive failure refers to perceptual, memory or motor lapses that occur in daily life, as well as multiple aspects of subjective cognitive failures—including decision-making, attention, and memory (16). Generally speaking, individuals with low self-concept clarity tend to experience more negative emotions and lower self-evaluation (17). According to Conservation of Resources Theory, individuals with low self-evaluations are inclined to accumulate negative emotions and thus consume more cognitive resources. Excessive self-concern and negative emotions also make it difficult for individuals to allocate cognitive resources effectively when dealing with daily life events, which leads to cognitive failure (18). The results of several empirical studies confirm the relationship between self-concept clarity and cognitive failure (19). For example, social anxiety is alleviated as adolescents' self-concept clarity improves. Hence, low self-concept clarity is significant factor in causing individual social anxiety (20), while social anxiety is widely recognized as one of the important causes of cognitive failure (21). Specifically, compared with high self-concept clarity, individuals with low self-concept clarity are unable to correctly deal with the negative effects of social anxiety and are prone to self-attrition, which caused ultimately cognitive failure (22). In addition, there is a distinct link between cognitive failure and IAD. Cognitive failure contribute to the reduction of cognitive resources, which results in competition between the needs of daily activities and the excessive use of the Internet, and IAD is easy to occur under competitive conditions (23). Unsworth et al. noted that individuals with cognitive failure have less working memory capacity and poorer cognitive control, which makes them more susceptible to the temptation of the Internet (24). Since individuals can compensate for their failure behaviors in daily life through the Internet (25), which will further promote the frequency and time of using the Internet and increase the likelihood of IAD.

Moderating role of mindfulness

However, not all the individuals with low self-concept clarity and high cognitive failure necessarily lead to serious psychological or behavioral problems. It has found that there are individual differences in the negative effects of self-concept clarity and cognitive failure on adolescents, that is, such effects may be moderated by individual characteristics and then affect individual behavior (26). Mindfulness as an individual trait refers to an open, accepting attitude in which individuals purposefully and non-judgmentally direct their attention to current experiences (27–29). Mindfulness may reduce the negative effects of cognitive failure (30). According to the two-factor model of mindfulness, mindfulness emphasizes the individual's ability to pay attention to current experiences non-judgmentally. It can help individuals perceive things more comprehensively and objectively (31). Moreover, A large number of studies have found that mindfulness has a relatively positive impact on individual self-development, physical health, cognitive, emotional and behavioral problems (30, 32), also confirmed the protective effect of mindfulness on addictive behaviors (33–36). Mindfulness may provide individuals the ability to self-regulate their emotional and reduce their responses to potentially emotional and stressful stimuli by improving awareness (37). For example, mindfulness intervention for college students can effectively reduce their mobile phone dependence (38). However, existing results are still controversial, with some studies suggesting that mindfulness does not always have "ideal" effects (39, 40). Dubow et al. examined the contribution of particular stressors and resources to children's adjustment and found that peer support not only did not alleviate but exacerbated the effect of stressors on behavioral maladjustment (41). Although mindfulness can positively influence individual behavior, its protective effect has some limitations. In other words, while positive traits such as mindfulness are protective, it is not known whether they can protect individuals against the negative effects of risk factors such as cognitive failure. The effect of mindfulness on self-concept definition and IAD needs further research.

The present study

In this study, we aimed to explore the association between self-concept clarity and IAD. Therefore, we constructed a moderated mediation model to test the mediating effect of cognitive failure on self-concept clarity and IAD, as well as the moderating effect of mindfulness (see Figure 1). Specifically, we proposed the following hypotheses:

Hypothesis 1 (H1): Self-concept clarity is negatively correlated with IAD.

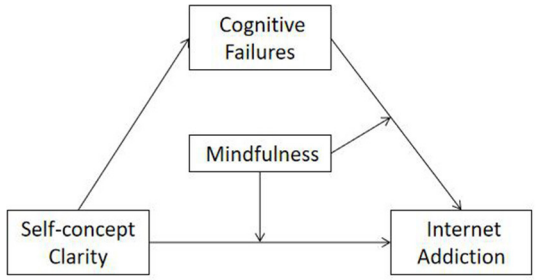

FIGURE 1
Proposed research model.

Hypothesis 2 (H2): Cognitive failures mediates the relationship between self-concept clarity and IAD.
Hypothesis 3 (H3): Mindfulness moderates the relationship between self-concept clarity and IAD, as well as the relationship between cognitive failure and IAD.

Methods

Participants and procedure

The participants are students from three grades in two randomly selected junior high schools in Henan Province. The sample was obtained through random cluster sampling, taking classes as the clusters and students as the elements. A total of 1,400 questionnaires were distributed, and the data from 1,153 (82.36%) participants were collected. Of these participants, 610 (52.9%) participants were female and 543 (47.1%) were male, 387 of them are first-year students, 274 of them are second-year students, 492 of them are third-year students. Participants' age ranged from 11 to 17 years, with a mean age of 13.84 ± 2.82 years. Informed consent was obtained from all participants and no compensation was provided to participants. Comparing the structures of the population and he sample, the main relevant indicators of the sample were consistent with the overall structure of the junior high schools population, indicating good sample representativeness.

The study was conducted in a classroom setting, and the entire process was conducted by a trained psychology student who used uniform instructions prior to administration, and the questionnaire was completed anonymously and collected on the spot upon completion.

Measures

Self-concept clarity

We used Campbell et al.'s Self-Concept Clarity Scale (10). This is a 12-item scale on the 5-point Likert scale ranging from

1 = strongly disagree to 5 = strongly agree. A sample item is "My beliefs about myself often conflict with one another." In this study, the internal consistency of the SCCS was 0.68.

Cognitive failures

The CFQ consists of 25 items assessing five dimensions of cognitive failures: distractibility, memory, interpersonal, blunders, motor coordination, and memory for names. Items are scores on a 5-point Likert scale ranging from 1 = never, to 5 = always. Higher scores indicate increasing

behavioral errors caused by cognitive distortions. Sample items include: "I found myself suddenly wondering if I had just worded it correctly"; "I don't know what I want to say"; and "Can't tell left from right when giving directions." In the present study, the Cronbach's α coefficient of this scale was 0.92.

Mindfulness attention awareness scale

The MAAS is a 15-item measure of mindfulness. Items are rated on a 6-point Likert scale ranging from 1 = almost always, to 6 = almost never. Sample items include: "I can't focus very well on what's happening at the moment"; "I always complete a task mechanically and without consciousness"; and "I would focus too much on the future or the past". Higher scores represent higher levels of mindfulness. In our study, the Cronbach's α coefficient of scores from this scale was 0.86.

Internet addiction disorder

In order to measure IAD, we used Young's (7) Internet Addiction disorder Questionnaire. This questionnaire has been widely used in various studies and has already been translated to other languages, such as Chinese, Norwegian and Italian. Respondents are asked to rank their responses on a 4-point Likert scale, ranging from 1, "completely untrue," to 4, "completely true." In the current study, the Cronbach alpha for the entire scale was 0.87.

Data analysis

All data analyses were conducted using SPSS 21.0. First, we computed descriptive statistics and performed correlation analysis of the variables. Second, a simple mediation analysis of cognitive failures mediating the relationship between role self-concept clarity and IAD was tested using Hayes's PROCESS macro for SPSS(Model 4). Third, a moderated mediation analysis was conducted using Hayes' PROCESS macro (Model 15) to test the moderating role of mindfulness in direct and indirect effects of cognitive failures on IAD in the mediation model. The indirect effect of mediation was tested using a bootstrapping method with 5,000 samples as recommended, with a significant effect indicated by a 95% confidence interval not including zero.

TABLE 1 Descriptive statistics and correlations among variables.

		1	2	3	4	5	6
1 Age	12.72 ± 2.82	1	-	-	-	-	-
2 Gender	1.53 ± 0.50	−0.04	1	-	-	-	-
3 Self-concept clarity	34.05 ± 5.94	0.11**	−0.01	1	-	-	-
4 Cognitive failures	69.17 ± 16.41	−0.05	0.11**	−0.25**	1	-	-
5 Mindfulness	53.50 ± 12.50	0.04	−0.01	0.28**	−0.64**	1	-
6 Internet addiction	18.17 ± 6.87	−0.11**	−0.12**	−0.28**	0.47**	−0.43**	1

**p < 0.01, two-tailed test.

Results

Common-method variance test

An explanatory factor analysis (EFA) including all variables using unrotated principal components factor analysis was performed to statistically verify the presence of CMV. The results revealed that 13 factors had eigenvalues >1, and the general factor accounted for only 23.48% of the total variance, which did not exceed the critical value of 40%.It concluded that CMV was not a concern.

Descriptive statistics and correlation analysis

Table 1 lists the means and standard deviation of the study variables and their correlations. The results indicate that IAD had significant positive correlations with cognitive failures, and had significant negative correlation with self-concept clarity and mindfulness. Cognitive failures had significant negative correlation with self-concept clarity. Besides, age and gender were significantly correlated with some variable. Therefore, both were treated as control variables in the subsequent analysis.

Testing for mediating effect

Table 2 shows the results of mediating effect of cognitive failures. Self-concept clarity had a significant negative effect on IAD ($\beta = -0.26$, $t = -9.52$, $p < 0.001$), and on cognitive failures ($\beta = -0.24$, $t = -8.60$, $p < 0.001$). When the mediating variable cognitive failures was added, the direct effect of self-concept clarity on IAD was still significant ($\beta = -0.16$, $t = -6.68$,

TABLE 2 Testing the mediation effect of self-concept clarity on IAD through cognitive failures.

	Model 1(IAD)		Model 2 (Cognitive failures)		Model 3 (IAD)	
	β	t	β	t	β	t
Age	−0.03	−3.00**	−0.01	−0.76	−0.03	−2.97**
Gender	−0.24	−4.36***	0.21	3.72***	−0.33	−6.68***
Self-concept clarity	−0.26	−9.52***	−0.24	−8.60***	−0.16	−6.15***
Cognitive failures					0.44	16.87***
R^2	0.1		0.07		0.28	
F	41.31***		30.48***		109.76***	
P	0.001		0.001		0.001	

Each column is a regression on model that predicts the criterion at the top of the column.
***P < 0.001.

TABLE 3 Testing the moderated mediation effect of mindfulness on the relation between self-concept clarity and IAD *via* cognitive failures.

	Model 1 (Cognitive failures)		Model 2 (IAD)	
	β	t	β	t
Age	−0.01	−0.76	−0.03	−2.90**
Gender	0.21	3.72***	−0.30	−6.15***
Self-concept clarity	−0.24	−8.60***	−0.14	−5.31***
Cognitive failures			0.34	10.41***
Mindfulness			−0.17	−5.14***
Self-concept clarity*Mindfulness			0.06	2.71**
Cognitive failures*Mindfulness			0.06	2.96**
R^2	0.07		0.30	
F	30.48***		71.16***	
P	0.001		0.001	

Each column is a regression model that predicts the criterion at the top of the column.
***p < 0.001.

$p < 0.001$), indicating partial meditation. Cognitive failures had a significant positive effect on IAD (β = 0.44, t = 16.87, $p < 0.001$).

Further bootstrapping results showed cognitive failures partially mediated the relationship between self-concept clarity and IAD, with an indirect effect accounting for 40.28% of the total effect.

Testing for moderated mediation

In our proposed moderation mediation model, we hypothesized that mindfulness would moderate direct and indirect effects of cognitive failures on IAD in the mediation model. Table 3 shows the results of such moderation mediation analysis using Model 15 of PROCESS macro by Hayes. After mindfulness was put into the model, self-concept clarity had a significant negative effect on cognitive failures ($\beta = -0.24$, $t = -8.60$, $p < 0.001$), cognitive failures had significant positive effect on IAD ($\beta = 0.34$, $t = 10.41$, $p < 0.001$), and self-concept clarity had a significant negative effect on cognitive failures ($\beta = -0.14$, $t = -5.31$, $p < 0.001$. In addition, the product of self-concept clarity and mindfulness had a significant positive effect on IAD ($\beta = 0.06$, $t = 2.71$, $p < 0.01$), and the product of cognitive failures and mindfulness had a significant positive effect on IAD ($\beta = 0.06$, $t = 2.71$, $p < 0.01$), indicating that social support moderated the direct effect of self-concept clarity and indirect effects of cognitive failures.

To better interpret the moderating effects of mindfulness, we examined the simple effects of both cognitive failures on IAD and self-concept clarity on IAD, at different levels of mindfulness (1 SD below the mean and 1 SD above the mean). Simple slope tests showed that the association between self-concept clarity and IAD was stronger for individuals with low mindfulness (β = −0.20, t = −5.71, $p < 0.001$) than for individuals with high mindfulness (β = −0.08, t = −2.25, $p < 0.05$) (see Figure 2). Similarly, the association between cognitive failures and IAD was stronger for individuals with high mindfulness (β = 0.40, $t = 9.81$, $p < 0.001$) than for individuals with low mindfulness (β = 0.28, $t = 7.54$, $p < 0.001$) (see Figure 3).

Discussion

This study explored the effect of self-concept clarity on IAD among junior middle school students during THE COVID-19 pandemic in China. The mechanism for this effects is briefly discussed. We found that self-concept clarity negatively predicted IAD, confirming the mediating role of cognitive failure and the moderating role of mindfulness.

Self-concept clarity predicted IAD

Consistent with hypothesis 1, the lower the self-concept of junior middle school students, the more serious the IAD

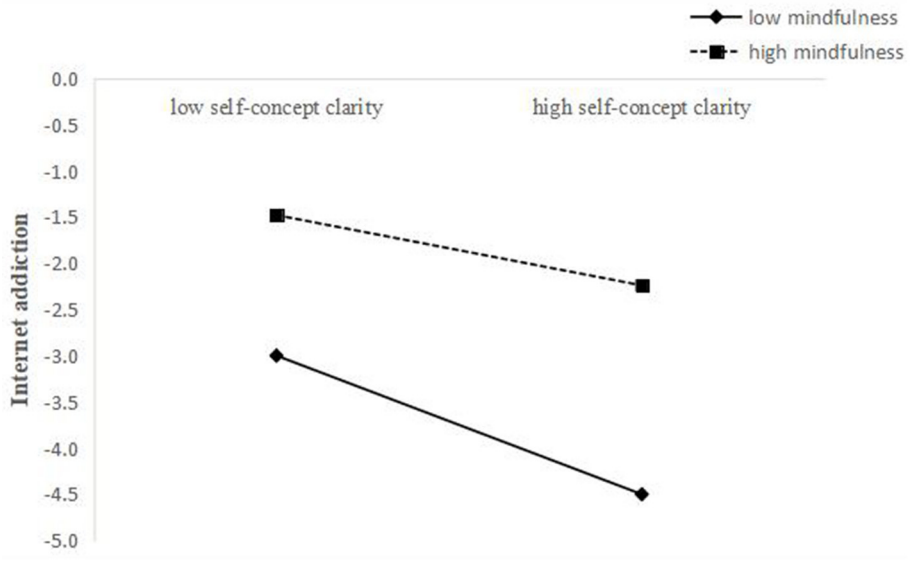

FIGURE 2
The interaction between self-concept clarity and mindfulness on IAD.

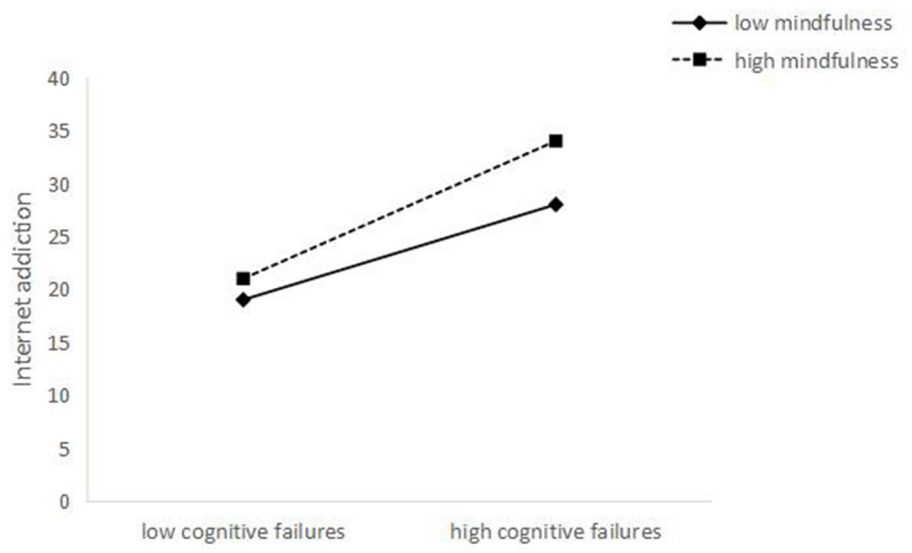

FIGURE 3
The interaction between cognitive failures and mindfulness on IAD.

behavior. In other words, Self-concept clarity can significantly negatively predict IAD of junior high school students, which is consistent with previous research conclusions (11, 42). According to uncertainty-identity theory, uncertainty about the self is aversive and uncomfortable, and that uncertainty can cause negative emotional and cognitive responses, so people always try to reduce, control, or avoid the occurrence of self-uncertainty (43). Previous research has pointed out that higher self-concept clarity is an important indicator of adolescents' social adjustment, and adolescents with higher self-concept clarity also generally have higher levels of wellbeing and lower levels of depression, anxiety, and loneliness (44). The presence of these negative Emotion make adolescents with lower self-concept clarity tend to find "safe havens" in the Internet. According to the compensatory Internet use hypothesis, it is known that the network allows them to experience a sense of

achievement or a sense of identity (25). Previous research has shown that instant gratification are important to individuals with low self-concept clarity and they are largely unwilling to delay gratification (45). In order to compensate for real life problems, junior high school students with low self-concept clarity tend to seek more internet resources such as online information, games or socialization (13, 25, 46). Couple with their own immature thinking and poor self-control, they have difficulty in resisting the temptation of the Internet. Compared to normal times, adolescents who use the Internet for long periods of time during the pandemic are more likely to develop addictive behaviors than in normal times (11). The results provide a new perspective to explain the Internet addictive behaviors of junior high school students in special periods, reveal the underlying causes of Internet addictive behaviors, and suggest that further attention should be paid to the negative effects of the lack of self-concept clarity on junior high school students.

The mediating role of cognitive failures

As expected, cognitive failures partially mediated the relationship between self-concept clarity and IAD, supporting our hypotheses 2. Junior high school students with lower self-concept clarity tend to be more prone to cognitive failure, which leads to IAD.

For the first path of the mediation process, we found that self-concept clarity was negatively linked to cognitive failure. On the one hand, if junior high school students have a clear understanding of self-concept, they will have higher self-evaluation and more positive emotional experience, which will help them allocate cognitive resources more rationally and effectively in the face of daily life events (46) and reduce cognitive failure in daily life. Conversely, negative self-evaluation enhances the activation of idiosyncratic failure episodes, leading to the preferential retrieval of this part of the individual's memory events. Therefore, individuals with lower self-concept clarity are less likely to take effective measures to cope with events, and ultimately leading to cognitive failure (18, 47). On the other hand, studies have shown that individuals' self-concept clarity is significantly negatively correlated with neuroticism (N) (48), while individuals with high neuroticism are more prone to cognitive failure, and they are more likely to ignore task-related information and be easily disturbed by task-unrelated information (49). According to the mental noise hypothesis of neuroticism, individuals with high neuroticism are more susceptible to psychological noise, which affects executive function and ultimately result in cognitive failure, than individuals with low neuroticism (50).

For the second path of the mediation process, this study indicated that cognitive failure was positively related to IAD, which supported the previous researches (51). The results, to a certain extent, validate the hypothesis of compensatory Internet use. According to this hypothesis, the junior high school students with high level of cognitive failure did not take the right way to cope with the failures they experienced in daily life in time, but re-experienced "compensatory success" through the pathological compensation of frequent Internet use (52). This undesirable cycle will eventually lead to IAD (25). Individuals with high cognitive failure are characterized by inefficiency of executive functioning and high trait impulsivity (53), which makes them more likely perform high-risk behaviors such as pathological gambling and risky sexual behavior (54). Besides, substance-related addictions is more severe and persistent in individuals with high cognitive failure (55). And there are many similarities between behavioral additions and substance-related addictions such as comorbidity, genetics, and neurobiological mechanisms (56). Studies have shown that individuals with high levels of attentional inattention and attentional lapses in daily life generalize this tendency to cell phone use, producing problematic cell phone use behaviors, such as using their phones for longer than they expect, continuously browsing for information without purposes, and repeatedly checking their phones (57). It not only supports the compensatory Internet use hypothesis of Conservation of Resources Theory, but also confirms the mediating role of cognitive failure between self-concept clarity and IAD.

The moderating role of mindfulness

A higher level of perceived stress of the COVID-19 pandemic might lead to a sharp increase in the number of mental health problem, such as post-traumatic stress symptoms, confusion and depression (58). At the same time, previous researches suggested that mindfulness training can play a significant role in relieving pain, improving cognition and regulating emotions by improving people's level of mindfulness (59, 60). It will help junior high school students respond to the outside world in a more flexible way, thus avoiding Internet addiction (61). Our study further found mindfulness moderated the indirect association between self-concept clarity and IAD among junior high school students through cognitive failure during the COVID-19 pandemic, supporting our hypotheses 3. To be specific, in terms of the direct effect, the protective effect of high self-concept clarity on IAD increased with the level of mindfulness, which is consistent with most previous studies (62, 63). Junior high school students with high levels of mindfulness are able to confront their own characteristics, and they are not obsessed by their deficiencies and focuses on current experiences. Therefore, junior high school students with high level of mindfulness can concentrate on their studies on their studies without interference, thus avoiding IAD (64). According to the mindfulness reperceiving model, "perception" helps individuals to accept life events in a more objective way

(65). Mindfulness is a significant protective factor of self-efficacy and sense of security (66), which will help students cope with the various stressors around them. If students are able to cope with stress effectively, the negative effects of IAD will be gradually mitigated accordingly.

The result also suggested Mindfulness moderated the relationships between cognitive failures and IAD. To be specific, compared with low levels of mindfulness, the effect of cognitive failure on IAD was stronger among junior high school students who were at high levels of mindfulness. There may be two reasons for this: First, the impact of cognitive failure is far-reaching. Junior high school students with high cognitive failure hardly experience "success" in their daily lives, and the "compensatory success" given by the online world makes them feel they can handle their own lives. Second, Individuals with cognitive failure generally have fewer cognitive resources, and mindfulness requires individuals to detach from their experience and accept the event objectively, which still takes up a lot of cognitive resources of junior high school students. In this way, the two processes compete for cognitive resources which increase the likelihood of cognitive failure (67, 68). While the results of this study not only provide some evidence that mindfulness is a protective factor for IAD, they also suggest that risk factors may undermine the positive effects of protective factors in the association between different factors (69). This result suggests that the interaction between mindfulness and other individual and social contextual factors should be taken into account when exploring the influence of mindfulness on IAD, so as to analyze the positive effects of mindfulness more comprehensively and objectively.

Implications

The findings of this study provide a new perspective for the prevention, intervention and treatment of junior high school student's IAD. Firstly, consistent with other research, our findings suggest that self-concept clarity is a significant factor for IAD. This result indicates that intervention targeting avoiding IAD should start with improving students' self-concept clarity, which may be realized through the discussion of self-concept. For example, teachers can set up an interactive platform for students to freely talk about the hot issues in the society and guide them to learn more about themselves. Schools can provide group psychotherapy to enhance students' sense of self-awareness. Secondly, given that cognitive failure is a significant mediator linking self-concept clarity and IAD, avoiding cognitive failure may be another helpful and efficient measure to avoid IAD. For instance, psycho-social interventions aimed at focusing limited cognitive resources on academic activities and preventing intrusions of task-irrelevant information may best serve the purpose of avoiding IAD. Finally, although the protective effect of mindfulness has some limitations, it can positively influence individual behavior. Improving the level of mindfulness may also greatly help junior high school students avoid IAD. Specifically, school activities can be implemented and improved to enhance junior high school students' mindfulness level. For example, schools can provide group psychotherapy for students to increase mindfulness levels in adolescents, improve their cognitive style. Teachers can also offer psychology classes for students to teacher them interventions such as mindfulness-based and cognitive behavioral training. Because the Coronavirus is strongly contagious, compared with face-to-face posttraumatic stress disorder (PTSD) treatment, Internet-delivered interventions have more advantages in the epidemic (70, 71). As an important part of Internet-delivered interventions, online mindfulness-based interventions could help people concern in the process of inner strengths and abilities and establish close relationships with others (72), which will help junior high school students avoid Internet addiction.

Limitations and future research directions

Although the present study advances our understanding of the mediating and moderating mechanism underlying the association between self-concept clarity and IAD among junior high school students, several limitations need to be acknowledged. First, this survey used a cross-sectional design, which leads to the inability to infer causality. Longitudinal studies could be carried out in the later study to further verify the moderated mediation model. Second, this study only measured individual variables of junior high school students; future studies could take into account environmental factors of junior high school students, such as parenting style and school climate. Third, we over-relied on self-report data, which is susceptible to social desirability bias. Future studies should collect information from multiple informants.

Conclusion

Although some studies attention has been directed toward understanding the effect of self-concept clarity on IAD, less attention has been paid to the mediation and moderation mechanisms underlying such an association among junior high school students. This study suggests that self-concept clarity was associated with IAD both directly and indirectly through cognitive failure, both were further moderated by mindfulness. A high level of mindfulness may increase the protective effect of high self-concept clarity on IAD and the negative predictive effect of cognitive failure on IAD.

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 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

YL and YW contributed to conception and design of the study. LC organized the database. WT performed the statistical analysis. YL and LC wrote the first draft of the manuscript. YW and WT wrote sections of the manuscript, contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

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

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Unraveling the effect of ambivalence over emotional expression on subjective wellbeing in Chinese college students in romantic relationships: A multiple mediation model

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The sudden and unpredictable outbreak of the COVID-19 pandemic has severely threatened young adults' physical and mental health and damaged the quality of relationships. As a critical stage of development, their well-being is more vulnerable to adverse environments which may lead to profound negative long-life mental health status. The current study aimed to investigate the mediation effects of fear of intimacy and attachment avoidance in the association between ambivalence over emotional expression and subjective wellbeing. A sample of 555 Chinese college students who are currently involved in romantic relationships (Mean age = 19.69, SD age = 1.36, 52% females) completed anonymous questionnaires regarding ambivalence over emotional expression, fear of intimacy, attachment avoidance, and subjective wellbeing. The findings revealed that ambivalence over emotional expression can predict negative subjective wellbeing of college students in romantic relationships significantly, and fear of intimacy and attachment avoidance played a sequentially mediating role in the association between ambivalence over emotional expression and subjective wellbeing. Surprisingly, when considering attachment avoidance independently, we found it had an inhibitory action on the link between ambivalence over emotional expression and subjective wellbeing. The present study contributes to a better understanding of how ambivalence over emotional expression can decrease subjective wellbeing, and also has implications for the intervention of students' subjective wellbeing and closeness during the period of COVID-19.

KEYWORDS

ambivalence over emotional expression, subjective wellbeing, fear of intimacy, attachment avoidance, COVID-19

Introduction

The global outbreak of Coronavirus disease 2019 (COVID-19) has severely threatened the psychological and physical wellbeing of people all over the world (1). Particularly, the long-term lockdown and isolation measures have negatively affected individuals' interpersonal security (2). As a critical developmental stage, young adults show high sensitivity to environmental influences (3), and previous studies have indicated that their subjective wellbeing significantly declined during the pandemic (4). Subjective wellbeing (SWB) is defined as an individual's general appraisal of their lives, which consists of cognitive judgments regarding their overall life satisfaction and emotional reactions including positive and negative emotions, and it reflects whether an individual lives a satisfied and desirable life (5) and is also an important indicator of positive psychological development and mental health. Previous studies have shown that individuals with higher SWB lead longer, healthier lives, together with a lower rate of suicide ideation (6). By contrast, the decline in SWB may lead to a higher incidence of depression, social anxiety, and insecurity (7, 8). Notably, for the youth, subjective wellbeing has been found to be particularly vulnerable to adverse social circumstances (2). For example, youths who fail in maintaining a supportive social environment usually lived in an isolating social environment which could seriously undermine their emotional or psychological wellbeing (9). Meanwhile, prior studies have found people who are unable to regulate their emotions tend to have trouble maintaining a supportive environment (10), and their improper expression of feelings may result in more unfulfilled needs (11). What is worse, based on the model of context-process-outcome (12), negative personal disposition might exacerbate the impact of the environment and lead to more severe psychological problems because people need more emotional support to mitigate distress in difficult times, such as COVID-19 period.

Besides, a decreasing trend could also be seen in college students' experience of romantic relationships during the COVID-19 period due to the lockdown policy which reduced the amount of time staying together (13), with Vigl and colleagues attributing this to limited time staying together under lockdown policy for non-cohabiting couples (college students). Moreover, under such stressful circumstances, positive emotions and expression of feelings might have a beneficial effect on individuals' attitudes toward their partners, which are highly correlated with their romantic experience and subjective wellbeing (14, 15). However, college students with poor emotional expressing ability may not only be awash with insufficient emotional expression but also distort their attitudes in relationships, leading to a negative influence on subjective wellbeing.

In a word, poor emotional expression may have a greater negative impact on the subjective wellbeing of students who involve in romantic relationships. Therefore, the present study aimed to investigate the relationship between a particular psychological risk factor called ambivalence over emotional expression and subjective wellbeing among college students in love during the COVID-19 pandemic. Given the serious effect of the pandemic, the present study could provide a more comprehensive insight into the adverse psychological impact of insufficient emotional expression and propound some practical and feasible interventions to mitigate that situation.

Ambivalence over emotional expression and subjective wellbeing

Ambivalence over emotional expression (AEE) refers to an internal conflict of expressing one's positive or negative feelings in fear of negative consequences from exhibiting such expression (16). Previous studies have shown that AEE is associated with high levels of psychological distress, and depressive and anxiety symptoms (17). More specifically, King and Emmons (16) stated that individuals with high AEE are likely to overread and overthink other's reactions in social interaction, and their rumination over potential negative feedback from others turn into a stressor in their minds. Furthermore, given their inability to express their feelings and emotions properly, they could not or hardly take self-disclosure as an effective coping strategy when experiencing negative moments in their lives (18), so that they are unable to use social support as a coping mechanism, which leads to a lack of effective strategies to manage stressful life events. On the other hand, some internalizing symptoms like depression and anxiety, which can trigger emotional problems, are also highly correlated with AEE (17). Therefore, it can be seen that people with high AEE are more likely to have both emotional and cognitive problems, both of which are the core components of subjective wellbeing (5). During the outbreak of the COVID-19 pandemic, college students tend to experience more stressful events in both economic and psychological aspects, such as decreasing family income, low living quality, and insecurity (8, 19), which means people with high AEE may struggle to find emotional support to deal with these stresses, which might cause a prominent decline in subjective wellbeing. As a result, it is important for recent studies to illustrate the underlying association between AEE and SWB in order to put forward related interventions.

Since AEE can reflect normative responses to negative experiences, it may also be influenced by local culture (20). For instance, emotional expression in East Asian cultures is generally considered to be a sign of weakness and lack of self-control in a social environment (21), whereas western cultures encourage self-disclosure (22). Based on the theory of person–culture fit, a match between one attitude/value and the prevailing attitude/value of the cultural environment in which he or she lives is beneficial to individuals' wellbeing (23).

Therefore, in the context of Chinese culture, the relationship between AEE and subjective wellbeing still remains inscrutable, which can be neutral or even positive. So, the present study aimed to investigate whether or not AEE can significantly predict a decline in subjective wellbeing among the population of Chinese college students.

The mediating role of fear of intimacy

Researchers suggested that AEE was also associated with marital dissatisfaction in couples (24), which provides new insight into how AEE influences the subjective wellbeing of college students through romantic relationship attitudes, as they are at a critical juncture of identity development and relationship exploration (25), and their attitudes toward romantic partners largely affect their life satisfaction in life span (14).

Given that the exploration and development of closeness is an important goal of college students (26), a major obstacle to achieving this goal is fear of intimacy (FOI). Fear of intimacy can be conceptualized as a limited ability or willingness to share personal feelings or emotions with someone who is highly valued (27). Prior work showed that fear of intimacy is usually significantly associated with a host of negative outcomes in relations (28). To be specific, various studies confirmed that fear of intimacy might give rise to various psychological disorders [e.g., anxiety, social phobia, depression, post-traumatic stress disorder, substance use, and hoarding symptoms; (29–31)], which eventually lead to the drop of subjective wellbeing. Although fear of intimacy is mostly limited to particular emotional suppression in romantic relationships, Toh et al. (32) found that people with a high level of FOI generally have decreased social connectedness, which would ultimately lead to a decline in perceived social support and an increase in loneliness in a more general relationship (33), resulting in the lower level of subjective wellbeing. Based on the studies mentioned above, it can be seen that fear of intimacy can contribute to a poorer assessment of individuals' lives, which may deteriorate people's subjective wellbeing, both in social and individual aspects.

On the other hand, it has been found that people with high AEE may develop emotional suppression as a strategy to deal with conflicting emotions, and such inhibition strategy has been wildly verified in general interpersonal interaction (18). However, as a primary and unique relationship in adulthood (34), romantic relationships can play a pivotal role in difficult or stressful times (35), so it is unclear whether or not the same suppression strategy resulting from AEE can be applied to romantic relationships. If so, it could be concluded that even when facing their important partners, they still tend to overestimate the possibility of rejection, wrongly believing that their partner would reject their expression and eventually hurt their feelings (16). Besides that reason, researchers also found that conflict over emotional expression might interrupt the processing and experience of emotions (11), which means people with high AEE may find difficulty in detecting emotions due to a lack of emotional awareness. However, whether or not AEE could lead to stronger fear of intimacy still need to be verified, as well as the mediating role of fear of intimacy between AEE and subjective wellbeing.

Taken together, we proposed that AEE positively predicts fear of intimacy, which in turn reduces subjective wellbeing, namely, fear of intimacy mediates the association between AEE and subjective wellbeing.

The mediating role of attachment avoidance

Another important factor contributing to SWB is insecure attachment. According to the classification by Bartholomew (36), adult insecure attachment types include anxious attachment and avoidant attachment. The latter tends to perform avoidant behaviors in interpersonal relationships and prevent themselves from a close individual (37). Previous studies have reported that attachment avoidance was negatively correlated with subjective wellbeing (38). Indeed, Kalkotan (39) found that college students with attachment avoidance could predict lower life satisfaction, which is the key component of subjective wellbeing. Additionally, there is a negative association between attachment avoidance and relationship quality or satisfaction in cross-sectional studies (40, 41) and longitudinal studies. For example, Fitzpatrick and Lafontaine (42) investigated 199 Canadian heterosexual couples by administering questionnaires for a period of 3 years, finding that attachment avoidance and anxiety predict lower relationship satisfaction, which could eventually lead to a decline in subjective wellbeing.

Additionally, people with high AEE usually experience conflicts and difficulties when longing for expressing negative or even positive emotions and feelings to others, because they are scared of negative feedback from others after expression. Also, it is important to be demonstrative and receive appropriate responses when maintaining a romantic relationship (33). So, such conflicts toward expressing emotions undoubtedly would undermine one's faith in forming or maintaining romantic relationships and reinforces their sense of incompetence. Feeney (43) asserted that attachment avoidance mainly results from the fear of one's own incompetence in a romantic relationship. Therefore, it can be assumed that people with high AEE usually feel incompetent in romantic relationships, which eventually tends to develop severe attachment avoidance.

Based on the preceding studies, we assumed that attachment avoidance mediates the association between AEE and subjective

wellbeing. Specifically, AEE positively predicts attachment avoidance, which in turn reduces subjective wellbeing.

The sequential mediation model

The interpersonal model of intimacy (44) highlights the importance of self-disclosure and partners' responsiveness in romantic relationships. From this perspective, individuals engage in disclosure of self-relevant feelings or emotions and then receive others' responses, which makes individuals feel understood, validated, or cared for. Such successful interaction may be viewed as a rewarding relationship (45). However, people with a fear of intimacy tend to suppress their emotional expression in romantic relationships, which means there is no satisfying self-disclosure related to emotions or feelings between romantic partners, let alone emotional support from partners. At this point, people tend to perceive such relationships as unrewarding, which eventually might lead to more avoidant behaviors in a relationship (46, 47). In addition, the effort to hide one's emotions may involve less sensitivity to another person's pain (48), so people who have great FOI might fail in supporting their romantic partners in the emotional field, which is important when forming an intimate relationship. Consequently, they might find difficulties in maintaining their relationships, which can also contribute to avoidant behaviors (43). Such difficulties may lead to a more severe consequence during the time of COVID-19 when people need to go through psychological and physical hardships. Therefore, it can be assumed that fear of intimacy and attachment avoidance play sequential mediating roles in how ambivalence affects subjective wellbeing.

However, when considering the relationships between fear of intimacy and attachment avoidance, some researchers hold the opposite view. Given attachment process can shape an individual's beliefs and interactions in interpersonal relationships, thus affecting the individual's overall evaluation of life (49), previous studies have also found that attachment avoidance could lead to emotional inhibition strategy in relationships (37, 50). More specifically, people with attachment avoidance tend to regard the experience/expression of emotions (both negative and positive) as a vulnerable indicator of interpersonal closeness, and hence they are inclined to suppress them (51). So, we attempted to further investigate the effects of fear of intimacy and attachment avoidance on subjective wellbeing, considering fear of intimacy as a mediator.

The present study

The current study aimed to test the following aspects: (a) whether AEE could negatively predict subjective wellbeing, (b) whether fear of intimacy mediated the relationship between AEE and subjective wellbeing, (c) whether attachment avoidance mediated the association between AEE and subjective wellbeing, and (d) whether fear of intimacy and attachment avoidance work as the sequential mediation between AEE and subjective wellbeing.

Materials and methods

Participants

After being approved by the Ethical Committee for Scientific Research at the authors' institution (Ethical Committee of Zhengzhou University), the current study was conducted at three universities in Zhengzhou City, Henan Province, China. A convenient sampling method was conducted, and a total of 555 students (268 men, mean age = 19.69 years, SD = 1.36, range from 17 to 23 years) who were involved in romantic relationships currently were able to join this survey. An item was asked to select the qualified participants ("How long have you been in current romantic relationships"), we excluded students who chose "0," and among the qualified students, 107 (19.3%) chose 1–3 months, 191 (34.4) chose 3 months - 1 year, 174 (31.4%) chose 1–3 years, and 83 (15%) chose more than 3 years. We assigned research assistants to each of the universities to organize the survey. They informed the students about the time and place of the survey and asked the students to start the measurement in their classrooms. After finishing the survey, all participants were provided with payments. The details of participants' characteristics are shown in **Table 1**.

Measurement

Ambivalence over emotional expression

Ambivalence over emotional expression was measured by the Chinese version of the AEQ scale (16), which consists of 28 items. It measures expressions of positive emotions, negative emotions, and intimacy (e.g., "I want to express my emotions honestly but I am afraid that it may cause me embarrassment or hurt."). Participants respond to items on a 5-point Likert scale ranging from 1 = never to 5 = frequently, indicating how often they feel what each statement suggests. The overall score was the summation of all items, with a higher score representing people feeling more conflict when they try to express their feelings. The AEQ has been used in Chinese samples with good reliability and validity (52). In the present study, the Cronbach's alpha coefficient for this scale was 0.906 [95 % CI (0.232, 0.282)].

Fear of intimacy

Fear of intimacy was measured by the Fear of Intimacy Scale [FIS; (27)], which is a 35-item scale that reports on the degree to which participants are uncomfortable with or

TABLE 1 Participants' characteristics (n = 555).

	Age	Gender		Grade			
		Male	Female	Freshmen	Sophomore	Junior	Senior
Mean or n	19.69	268	287	106	300	148	1
±SD or %	1.36	48.29%	51.71%	19.09%	54.05%	26.67%	0.18%

fear intimacy in their relationships [e.g., "I might be afraid to confide my innermost feelings to(the other person)]." Items are scored on a 5-point scale from 1 (not at all true of me) to 5 (extremely true of me) with higher scores indicating higher fear of engaging in behaviors that demonstrate vulnerability. The Fear of Intimacy Scale shows good reliability and validity in Chinese student samples (53). In the present study, the Cronbach's alpha coefficient for this scale was 0.871 [95 %CI (0.144, 0.183)].

Attachment avoidance

Attachment avoidance was measured by the Chinese revised version (54) of the Experiences in Close Relationships–Relationship Structures Questionnaire (ECR-RSQ; (55)). It is a seven-item self-report instrument that measures attachment dimensions (avoidance and anxiety) in different types of close relationships. The avoidance components in a romantic relationship of the revised version of ECR-RSQ were conducted in this survey, consisting of four items (e.g., "I usually discuss my problems and concerns with this person."). Each item is scored on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree), with higher scores on each item indicating higher avoidance. Peng (54) illustrated that the revised version of ECR-RSQ shows favorable psychometric characteristics in Chinese college students. In the present study, the Cronbach's alpha coefficient for this scale was 0.854 [95 %CI (0.555, 0.634)].

Subjective wellbeing

Subjective wellbeing was measured by two scales according to its definition (5), with positive/negative affect and life satisfaction, respectively. The positive and negative emotions were measured by The Positive and Negative Affect Scale [PANAS; (56)], which is a 20-item measurement of affect. Ten items evaluate positive affect (e.g., "interested"), and 10 items assess negative affect (e.g., "distressed"). Participants used a five-item Likert scale (from 1 "very slightly or not at all" to 5 "extremely") to rate their current mood. Higher scores on each sub-scale indicate greater positive or negative affect. In this study, Cronbach's alpha for positive and negative affects was 0.882 [95 %CI (0.394, 0.463)] and 0.912 [95 %CI (0.457, 0.543)], respectively.

Life satisfaction was measured by the Satisfaction with Life Scale [SWLS; (57)]. It is a five-item self-report measure of life satisfaction (e.g., "In most ways my life is close to ideal"). Respondents are required to rate the extent to which they agree with each item on a 7-point Likert scale (from 1 "strongly disagree" to 7 "strongly agree"). Scores for 5 items are added, with higher scores indicating greater life satisfaction. Cronbach's alpha for SWLS was 0.855 [95 %CI (0.504, 0.580)] in this study.

Based on previous studies (58, 59), we sum the scores of SWLS and PANAS (positive emotions and negative emotions) to evaluate an individual's whole subjective wellbeing.

Data analyses

The descriptive and correlational analyses were conducted in SPSS version 25.0. Mplus version 7.4 was used to analyze the hypothesized multiple mediating pathways and an alternative model, and 95% bias-corrected bootstrap confidence intervals based on 1,000 bootstrap samples were conducted to test the statistical significance of the hypothesized indirect pathways.

Results

Descriptive statistics and correlations

Mean values, standard deviations, and bivariate correlations among all the study variables are shown in **Table 2**. AEE was significantly positively associated with fear of intimacy, while significantly negatively associated with subjective wellbeing. Fear of intimacy was significantly positively associated with attachment avoidance, but significantly negatively associated with subjective wellbeing. Also, attachment avoidance was significantly associated with subjective wellbeing. However, attachment avoidance is not significantly correlated with ambivalence over emotional expression ($p > 0.05$). But, we still conduct a multiple regression model based on our hypothesis, since the bivariate correlations share different aims and functions with regression (60).

Mediation analyses

We further analyzed the mediating effects of fear of intimacy and attachment avoidance. We conducted a multiple

TABLE 2 Mean values, standard deviations (SD), and correlations among study variables (N = 555).

	M	SD	1	2	3	4	5	6
1. AEE	5.05	0.862	1					
2. FOI	2.64	0.508	0.176**	1				
3. AA	3.26	1.293	−0.078	0.499**	1			
4. SWB	5.22	2.470	−0.093*	−0.322**	−0.392**	1		
5. Age	–	–	0.041	−0.072	−0.108*	0.080	1	
6. Gender	–	–	−0.127*	−0.002	−0.050	−0.019	−0.131**	1

M, mean; SD, standard deviation; AEE, ambivalence over emotional expression; FOI, fear of intimacy; AA, attachment avoidance; SWB, subjective wellbeing; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

mediation model using Mplus code, with AEE as the predictor, fear of intimacy as the first mediator, attachment avoidance as the second mediator, subjective wellbeing as the dependent variable, and gender and age as control variables. According to the statistical indices (61), the results suggested that hypothesized multiple mediation model had an acceptable fit (χ^2/df ratio = 2.810, CFI = 0.975, TLI = 0.924, RMSEA = 0.057, SRMR = 0.030).

Results from the pathway analysis strongly supported our hypotheses. As shown in **Figure 1** and **Table 3**, there were three significant indirect pathways between the association of ambivalence over emotional expression and subjective wellbeing: the specific indirect effects of (a) fear of intimacy, (b) attachment avoidance, and (c) the chain indirect effect of both. Meanwhile, the direct effect of AEE on subjective wellbeing was significant when considering the above indirect effects. Notably, based on Wen et al.'s (62) classification of mediation effect, the pathway analysis of the mediator role of attachment avoidance independently showed a suppression effect, while the direct effect of AEE on subjective wellbeing was negative (β = −0.074) and the indirect effect of attachment avoidance was positive (β = 0.042), which means the negative effect of AEE on subjective wellbeing is suppressed by attachment avoidance.

Alternative model

Finally, we assessed the alternative mediation model, with attachment avoidance as the predictor, fear of intimacy as the mediator, and subjective wellbeing as the dependent variable. The results are shown in **Figure 2**, revealing that fear of intimacy could act as a partial mediator between the relationship of attachment avoidance and subjective wellbeing (χ^2/df ratio = 1.862, CFI = 0.993, TLI = 0.975, RMSEA = 0.040, SRMR = 0.016), showing an acceptable fit. Specifically, attachment avoidance had a significant direct effect on subjective wellbeing [β = −0.715, 95% CI (-0.958, -0.452)] and a significant indirect effect on subjective wellbeing through fear of intimacy [β -0.218, 95% CI (-0.340, -0.095)], with the total effect of attachment avoidance on subjective wellbeing [β -0.933, 95% CI (-1.127, -0.706)]. These results may point to multidirectional links among the variables studied. In the section "Discussion," this issue will be further discussed.

Discussion

The present study focused on a multiple mediation model which examined the relationship between AEE and subjective wellbeing with the mediating roles of fear of intimacy and attachment avoidance among Chinese college students who are involved in a romantic relationship in the context of the COVID-19 outbreak. First, we found that higher levels of AEE could predict a lower level of subjective wellbeing. Those consequences also verified that people with high AEE are likely to deteriorate their subjective wellbeing even in a culture that encourages emotional suppression, and similar results could be found where AEE was negatively associated with pain or stress symptoms (63), which implies that the negative influence of ambivalence over emotional expression might show cross-culture consistency.

The mediating role of fear of intimacy

Consistent with our hypothesis, the present study illustrated that fear of intimacy had a significant mediating effect between AEE and subjective wellbeing, which means AEE could negatively predict subjective wellbeing *via* the increasing of FOI among college students in love. To be specific, AEE was positively correlated with fear of intimacy and in turn decreased the evaluation of subjective wellbeing. Based on the theory of ambivalence over emotional expression (16), individuals with high AEE usually feel ambivalent when expressing their emotions because they are willing to express their feelings but scared of negative feedback from others. Such feelings are likely to turn into an internal conflict, so in order to mitigate that conflict, they tend to develop emotional suppression as a strategy in daily lives so that they would not be obsessed with the choice of whether or not to express their feelings (18). Also, such an emotional suppression strategy can also be applicable to other relationships, even for romantic relationships that serve as

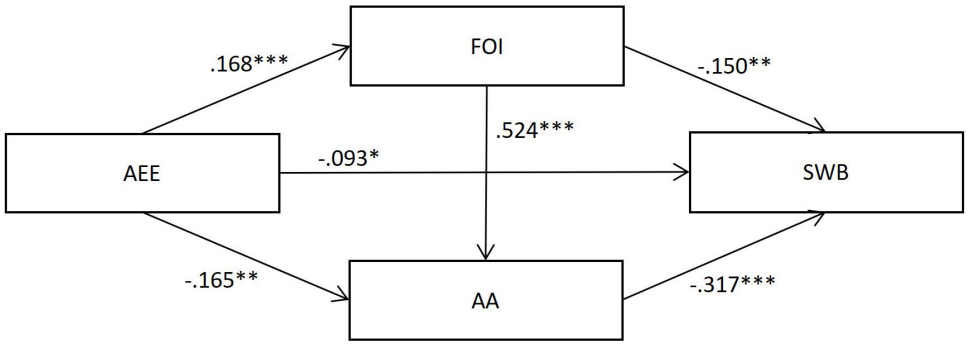

FIGURE 1
The structural equation model regarding the mediating effects of fear of intimacy and attachment avoidance on the association between ambivalence over emotional expression and subjective wellbeing. Standardized regression coefficients are presented after controlling for age and gender. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

important emotional support for the individual (64), leading to a stronger fear of intimacy.

Furthermore, intimacy is a dynamic relational process involving self-disclosure (44), and Aron et al. (65) emphasized the importance of self-disclosure to increase intimacy in relationship construction, so people with a high fear of intimacy resulting from strong AEE usually have dissatisfaction with romantic relationships. More importantly, such inhibition in romantic relationships triggered by AEE can also expand to a more general aspect, resulting in internalized symptoms such as depression, stress, and social connectedness problems (45), all of which are closely related to a decline in subjective wellbeing.

The mediating role of attachment avoidance

Although the present study found that the mediating effect of attachment avoidance is significant, it is unexpected that our statistical analysis results illustrated that attachment avoidance played an inhibitory role in the relationship between AEE and subjective wellbeing, suggesting that attachment avoidance could buffer the negative relationship between AEE and subjective wellbeing. This consequence can be explained by the theory of stress (66) and the importance of a romantic relationship (34). Stress occurs when people perceived their environment as problematic (67). Given people with high AEE find difficulties in attaining a sense of social connection *via* emotional expression (17), it is obvious that in the context of COVID-19, they might perceive their situation as highly problematic. But the longing for a social relationship is an eternal pursuit of human beings (68), and their romantic partner could play a pivotal role in times of difficulty or stress (35). Therefore, in order to fulfill their desire to be connected, people who have difficulty expressing their feelings but are in a romantic relationship may turn to their lovers. For example, Ratelle (64) found that a romantic partner was an important source of support, and college students' wellbeing was the highest when their romantic partner is perceived as highly supportive. What is more, Schacter et al. (69) indicated that high-quality relationships can compensate for rejection from peer groups. Based on these perspectives, it could be assumed that individuals' romantic relationships might make up for the negative experiences (e.g., stress) from individual normal social interaction, which means high AEE individuals are more likely to attach to their romantic partners rather than avoid them when they find it hard to get along with peers.

More importantly, such a result does not contradict the result of fear of intimacy, which indicated people with high AEE tend to inhibit their emotions in romantic relationships. According to the coping theory (70), there are two types of coping strategies for solving stresses: problem-focus and emotion-focus. The problem-focused approach attempts to alter the source of stress, while the emotion-focused approach aims to handle the emotions in stressful situations. To give an existing finding, people with high AEE still suppress their emotions and feelings in romantic relationships, and they are more likely to take problem-focused approaches, so they might tell negative

TABLE 3 Results of mediation analyses.

				Bias corrected	
	Estimate	S.E.	Est./S.E.	Lower 2.5%	Upper 2.5%
Total effect	−0.075	0.037	−2.028	−0.150	−0.004
Direct effect	−0.074	0.036	−2.059	−0.144	−0.003
AEE → FOI → SWB	−0.020	0.010	−2.028	−0.046	−0.005
AEE → AA → SWB	0.042	0.016	2.537	0.014	0.079
AEE → FOI → AA → SWB	−0.022	0.008	−2.852	−0.041	−0.011

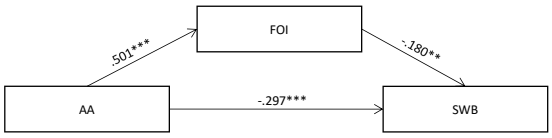

FIGURE 2
Mediating paths between attachment avoidance and subjective wellbeing *via* fear of intimacy. Standardized regression coefficients are presented after controlling for age and gender. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

facts to their partner instead of their feelings about it. However, indeed, the self-disclosure of emotions is a better predictor of relationships' quality compared with factual expression (71). It might be assumed that although their factual expression with partners may suppress the negative effect of AEE on subjective wellbeing in a short term, it could still impair their romantic relationships, which would eventually lead to a decline in SWB in the future. However, more studies are needed to prove this assumption.

The sequential mediation model

Findings from the present study revealed that AEE could also influence subjective wellbeing through serial mediation by fear of intimacy and attachment avoidance. Previous research has demonstrated that fear of intimacy is related to attachment difficulties (72). Based on the interpersonal model of intimacy (73), a romantic relationship that involves self-disclosure and responsiveness may feel rewarding. In contrast, those who choose not to express their feelings in romantic relationships were unable to perceive related responses from partners. As a result, they might perceive their partner's inability to understand their feelings, leading to more avoidant behaviors in relationships. Eventually, such feelings would contribute to dissatisfaction with relationships and even expand to a more general relationship (e.g., friends and classmates) in daily life (40, 47), which could directly deteriorate subjective wellbeing (15). Overall, AEE can exert a direct influence on college students' subjective wellbeing or indirectly influences subjective wellbeing through enhancing fear of intimacy and attachment avoidance sequentially.

Additionally, given that there are some conflicts about the relationships between fear of intimacy and attachment avoidance, which indicated that the FOI and AA might reciprocally influence each other, so the present study also investigated the mediating role of fear of intimacy in the relationship between attachment avoidance and subjective wellbeing. We found fear of intimacy mediated the influence of attachment avoidance on subjective wellbeing. More specifically, the results of the alternative mediation model confirm the hypothesis that greater attachment avoidance also predicted a higher level of fear of intimacy. Similar results could be seen in previous studies which also demonstrated that attachment avoidance could negatively predict fear of intimacy (74). To sum up, individuals with higher attachment avoidance dismiss the importance of interpersonal relationships and rely solely on themselves (37), leading to emotional distance from romantic relationships.

Limitations and implications

Because the outbreak of COVID-19 led to numerous psychological issues (1, 2, 4) without enough studies indicating the precaution against that disease, the present study particularly aimed to investigate some factors which might contribute to individuals' subjective wellbeing and find possible and related intervention based on our results. However, the results of this study should be interpreted in the context of its limitations. First, due to the cross-sectional design adopted in our study, we cannot indicate the causality of the relationships between COVID-19 and psychological factors. Therefore, more experimental and longitudinal studies should be adapted to clarify the direction of the effects of COVID-19 in the future.

Second, although we found the underlying relationships between AEE, attachment avoidance, fear of intimacy, and subjective wellbeing, it is hard to conclude the influence of COVID-19 on that relationship based on our results, so more studies, especially comparison studies, should be applied in the future. Third, because the participants of the present study were employed from three universities in Zhengzhou city and the three universities are located in the same city, some characteristics might be different. Future studies should pay attention to those characteristics. Last but not least, although attachment avoidance played the role of a suppressor in the relationship between AEE and subjective wellbeing, we could not illustrate whether or not that function is valid for a long period, so more longitudinal studies should be adapted. It also raised an interesting question of whether or not the romantic relationship could partly or fully replace the function of peer relationship in some aspects, or compensate for the loss in daily social interactions.

Despite its limitations, the present study still revealed the effects of AEE and the mediating roles of fear of intimacy and attachment avoidance on subjective wellbeing in the context of COVID-19. Due to our research design, we could not draw substantive conclusions about the pandemic influence, but we found that the underlying model could be meaningful when people want to intervene in the mental health of college students. These results provided a more comprehensive conceptualization of how emotional expression conflict is associated with college students' general evaluation of their lives and were helpful to understand the function of romantic relationships in those relationships. These results

point to potential intervention possibilities in promoting college students' subjective wellbeing and intimacy. In the ecological model of individual development, families and schools are the most basic units of analysis, and their interactions affect the development of youth (75). So, establishing a supportive circumstance that encourages students to express their feelings freely is imperative for their mental health or intimacy development when people are going through the challenges of a pandemic. Considering AEE is rooted in the fear of potential negative feedback in social interaction (16). It is also helpful to apply Rational Emotive Behavior Therapy (REBT) in order to cultivate students' abilities to prevent over-expectation of negative consequences in social interaction (76). For example, students can be guided to find objective evidence of rejection when getting along with others, and if they cannot find any cues of negative feedback, they may be aware of their cognition bias. Besides, the present study also indicated the function of fear of intimacy and attachment avoidance in the relationship between AEE and subjective wellbeing, and they could reciprocally influence each other, which means intervening in one of them can potentially improve the other. Some treatments could be applied, for example, studies on Functional Analytic Psychotherapy have found that the treatment is effective in reducing fear of intimacy (77). Overall, because of the lockdown policy, individuals' physical interactions and activities are largely restricted, and hence relevant departments and institutions should pay more attention to alleviating students' psychological difficulties *via* communication and fostering some protective factors (e.g., perceived social support and mindfulness).

Conclusion

In conclusion, despite its limitations, the current study contributed to a key point of understanding the multiple mediation model between AEE and the subjective wellbeing of Chinese college students. We found that fear of intimacy and attachment avoidance served as a potential mechanism in the relationship between AEE and subjective wellbeing, with fear of intimacy independently mediating that. Surprisingly, the analysis results showed that attachment avoidance played as a suppressor in such links. More importantly, the current study indicated fear of intimacy and attachment avoidance mediated the link between ambivalence over emotional expression and subjective wellbeing sequentially. We also illustrated that fear of intimacy and attachment avoidance could reciprocally affect each other, which means the fear of intimacy could also mediate the relationship between attachment avoidance and subjective wellbeing. Given that the COVID-19 outbreak seriously damaged college students' psychological health, our results could be meaningful for related intervention.

Data availability statement

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

Ethics statement

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

Author contributions

YW and ZZ designed the research and wrote the manuscript. XW performed the research. ZZ designed the structure and performed the calculations. YL reviewed the manuscript and supervised the project. All authors approved the submitted version.

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Conflict of interest

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

Publisher's note

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Does sleep disturbance predicts posttraumatic stress disorder and depression among college students during COVID-19 lockdown? A longitudinal survey

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Aim: To examine the cross-sectional and longitudinal associations between self-reported sleep disturbances, posttraumatic stress disorder (PTSD) and depression in a large cohort of Chinese adolescents experiencing the COVID-19 pandemic.

Methods: Participants were 67905 Chinese college students in the two-wave longitudinal web-based survey during early COVID-19 outbreak (Time1, T1: Feb 3rd to 10th, 2020) and initial remission period (Time2, T2: March 24th to April 3rd, 2020). The Youth Self Rating Insomnia Scale (YSIS), 6-Item Impact of Event Scale (IES-6), and 9-Item Patient Heath Questionnaire (PHQ-9) were used to assess adolescents' sleep, PTSD, and depressive symptoms, respectively, at T1 and T2.

Results: Self-reported PTSD and depression prevalence at T1 were 34.6% and 21.6% respectively. While depressive symptoms worsened as the lockdown time increased, while PTSD symptoms decreased. After adjusting for confounding factors, sleep disturbance and sleep deprivation at T1 were significantly associated with increased PTSD and depressive symptoms at T2. Furthermore, sleep disturbance and sleep deprivation also predicted the new onset and persistence of PTSD and depression.

Conclusion: Sleep disturbance predicts the development and persistence of PTSD and depression. Early assessment and treatment of sleep disturbance may be an important strategy for prevention and intervention of PTSD and depression in adolescents after experiencing the special public health emergency.

KEYWORDS

sleep disturbance, depression, posttraumatic stress disorder, college students, COVID-19

Background

COVID-19 pandemic outbreak and subsequent quarantine have adverse impact on mental health among public (1, 2). Results from the recent meta-analysis including studies from 17 countries indicated high level of depression (28%) during the pandemic (3). Another meta-analysis including 19 studies documented that the after the COVID-19 outbreak, the prevalence of depression in general population ranged from 14.6 to 48.3%, as well as the rate of PTSD ranged from 7 to 53.8% (4). Therefore, paying greater attention to individuals' mental health during the pandemic era is urgently needed. To decrease the risk of pandemic-related stress symptoms and depression, screening for PTSD, depression and research into factors related to this psychological distress is imperative.

Past studies also have highlighted how pandemic lockdown increases various sleep disturbances, such as insomnia, poor sleep quality, and decrease sleep duration (5–7). It is well established that sleep disturbance, a modifiable behavior, is strongly associated with increased risk of mental health problems. There is limited longitudinal research however that has examined the extent to which disturbed sleep predicts the development of PTSD and depression. One study examined insomnia and daytime sleepiness at 1 month of 102 victims of motor vehicle accidents, suggesting that these sleep disturbances significantly predicted PTSD at 12 months after the trauma (8). However, another study in 453 Dutch military service members has only established the association between the presence of predeployment nightmares with an increased risk for developing PTSD symptoms at 6 months postdeployment among, while predeployment of insomnia did not (9). Moreover, a one-year prospective study of 1,573 adolescent earthquake survivors reported that sleep disturbance could predict the development and persistence of PTSD and depression after controlling for demographics and earthquake exposure (10). Based on these studies, the temporary association between sleep disturbance and subsequent PTSD and depression appears to be inconsistent, which may be explained by differences in sample and traumatic events experienced.

Meanwhile, most of previous related studies evaluated sleep disturbance as a long-term risk factor (about a year and more) for PSTD and depression. In fact, clinical risk assessments are more focused on determining whether one would be affected by a disorder in the near future. Recognizing and treating sleep disturbances is of particular importance during stress provoking time such as the COVID-19. If an individual's sleep disturbance can be measured during the early period of a pandemic, it may predict the possibility of developing PTSD and depression during home-isolation. Therefore, understanding the degree to which disrupted sleep predicts short-term risk in necessary. Moreover, most of previous related studies involved a small sample size, suggesting sampling bias that can further obscure this relationship. There is also lack of epidemiological data from large samples on relationship between the sleep disturbance, PTSD, and depression.

Furthermore, studies have suggested that compared with general population, students are more susceptible to suffer from the psychological impact of the pandemic (11). To contain the spread of the pandemic, the Chinese government has announced the closure of schools, colleges/ universities, and other educational institutions in spring 2020 during which all students were asked to stay at home and pursue their studies online. The direct impact of the confinement includes physical inactivity, lack of academic schedule, and excessive digital use, all of which increased the risk of mental health issues among adolescents (12). For college students, the uncertainty of future career or academic opportunities due to the lockdown further increased their psychological stress (13). Accordingly, paying greater attention to college students' mental health during the pandemic era is urgently needed.

Collectively, the current study attempts to investigate PTSD and depression among college students during COVID-19, as well as to enhance understanding of sleep disturbance as a risk factor for the onset and persistence of PTSD and depression in a 2-month follow-up sample. This study aims to investigate: (a) the prevalence rates of PTSD and depression in Chinese college students during the pandemic; (b) whether sleep disturbance can be cross-sectionally associated with the current and follow-up PTSD and depression; and (c) whether baseline sleep disturbance can predict the change of PTSD and depression.

Methods

Participants and procedure

Using the repeated cross-sectional study design, we conducted a two-wave longitudinal web-based survey on mental health in college students from 22 colleges/universities in Guangdong provinces, Southern China. Since winter 2019, COVID-19 has rapidly spread across China, with the total number of confirmed cases increased to 80,905 by March 10, 2020. During this period of the COVID-19 outbreak (Time1, T1: from February 3 to February 10, 2020), 164,101 participants completed the online questionnaires. Since March 10, the pandemic in China has been brought basically under control, with the number of newly confirmed cases showing a consistent downward trend nationwide. The second wave of the survey was conducted in the same population during the remission period of COVID-19 (Time2, T2: from March 24 to April 3, 2020).

Participants in this study were home isolation during the study period. We push questionnaires to target colleges/ universities through our self-built information website and official WeChat account, and the questionnaires are distributed to college students through psychological counseling centers of each school. Participants scan the Quick Response (QR) code

on their mobile phone to complete an online survey at home. Participants needed to submit an online informed consent form before the survey and have a right to withdraw freely during test period. Through data integration, A total of 67905 college students (31.3% male) participated in all two web-based surveys and provided complete data on all measures. The details of the study design and sample procedures have also been described elsewhere (7, 14). Figure 1 shows the details of study design and sample procedures.

This study was supported by the local education bureau, and approved by the Human Research Ethics Committee of South China Normal University (SCNU-PSY-2020-01-001). We also opened a psychological hotline (the 'Xinqing' hotline) to provide free psychological assistance services to participants if they need during lockdown.

Measures

Sample characteristics

Sample characteristics included sex [1= Male; 2= Female], age, grade [1= Freshman; 2= Sophomore; 3= Junior; 4= Senior; 5= Graduate], residence location [1= Rural; 2= Urban], ethnicity [1= Han (the ethic majority in China); 2= Others], single child status [1= Yes; 2= No], history of physical illness [1= Yes; 2= No], and history of mental illness [1= Yes; 2= No].

COVID-19 related factors

COVID-19 related factors included the severity of the pandemic in the place of residence [1= Mild; 2= Moderate; 3= Severe], confirmed COVID-19 cases in the community or village [1= Yes; 2= No], and relatives or friends being infected with COVID-19 [1= Confirmed/ suspected; 2= No]. The severity of the pandemic in the place of residence was categorized according to the World Health Organization (WHO) guideline in early 2020 (15). Severe risk areas have more than 10,000 cumulative COVID-19 confirmed cases (e.g., Hubei province); moderate risk areas have 1,000 to 9,999 cumulative confirmed cases (e.g., Guangdong province); and the remaining provinces in China are mild risk areas with less than 1,000 cumulative confirmed cases (e.g., Sichuan province).

Sleep disturbance

Four items were drawn from the Chinese Version of Youth Self-Rating Insomnia Scale (YSIS) (16) to measure sleep status over the last two weeks at T1. Three items were used to assess insomnia symptoms, including difficulty initiating sleep, difficulty maintaining sleep, and early morning awakening. Participants had options to answer 1 = Never, 2 = < 1 times/week, 3 = 1-2 times/week, 4 = 3-5 times/week, or 5= 5-7 times/week. Meanwhile, one item - "How would you rate your overall sleep quality over past two weeks?" was used to assess subjective sleep quality, with response options of 1= very good, 2 = good, 3 = fair, 4 = poor, 5 = very poor. In the present study, sleep disturbance was defined as having any one of the following four sleep symptoms: difficulty initiating sleep (≥3 times/week), difficulty maintaining sleep (≥3 times/week), early morning awakening (≥3 times/week), or poor/very poor sleep quality. This definition has been used in previous publications using the similar question on sleep disturbance (7, 10). The Cronbach' s alpha of four items was 0.77 at T1. Sleep duration was asked as such, "how many hours of sleep did you get at night over past two weeks?" Responses to items were recorded: 1 ≤ 5 h, 2 = 5–6 h, 3 = 6–7 h, 4 =7–8 h, or 5 ≥ 8 h. Sleep time < 6 h per night was considered as sleep deprivation (17, 18).

PTSD

The 6-item Impact of Event Scale (IES-6) was used to assess PTSD over past one week in the form of two surveys (19). It was anchored to the COVID-19 pandemic in this study, and clustering into three dimensions: intrusion (e.g., I thought about the COVID-19 pandemic when I didn't mean to), avoidance/numbing (e.g., I tried not to think about the COVID-19 pandemic), and hyperarousal (e.g., I had trouble concentrating because of the COVID-19 pandemic). Each item was rated on a five-point Likert scale from 0- not at all to 4- extremely. The average score of 0–1.09 indicates normal, between 1.09 and 1.5 shows stress symptoms, 1.5 or greater may be diagnosed with PTSD (20). The Chinese version of IES-6 demonstrated satisfactory reliability, as well as be widely used in the Chinese population (21, 22). The Cronbach' s alpha was 0.80 at T1 and 0.82 at T2 in this study.

Depression

The nine item Patient Health Questionnaire (PHQ-9) was used to measure depression over past 2 weeks at two surveys (23). Each item included four choices: 0- not at all, 1- several days, 2- more than halt the days, and 3-nearly every day. The total score ranges from a scale of 0-27, with higher total score indicating more severe symptoms of depression. Psychometric properties of the PHQ-9 have been described in the Chinese population (24). A score of 7 was identified as the optimal cut-off point for detecting clinical level of depression in Chinese population (24). The Cronbach' s alpha was 0.87 and 0.91 in two surveys, respectively.

Data analyses

All data analyses were conducted using IBM SPSS Statistics version 23.0. The McNemar's test was used to examine the differences in the prevalence rates of PTSD and depression between T1 and T2. In the present study, we detect four

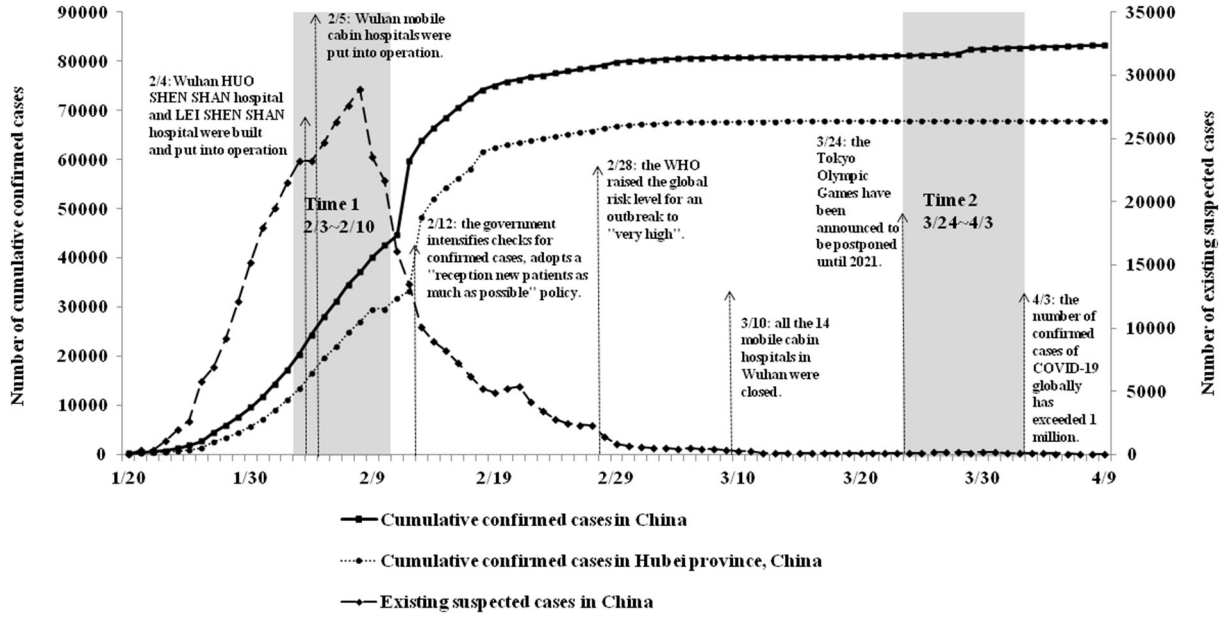

FIGURE 1
The details of study design and sample procedures.

trajectories of PTSD and depression that refer to previous studies (7, 25): Persistent group (both IES-6 average score ≥1.5/ both PHQ-9 score ≥ 7); Remission group (baseline IES-6 average score ≥1.5/ PHQ-9 score ≥7, the second IES-6 average score <1.5/ PHQ-9 score < 7); New onset group (baseline IES-6 average score <1.5/ PHQ-9 score < 7, the second IES-6 average score ≥1.5/ PHQ-9 score ≥7); and Resistance group (both IES-6 average score <1.5/ both PHQ-9 score < 7). A series of univariate logistic regression analyses were performed to determine the associations between each sleep variable and PTSD and depression. Further, sample characteristics and COVID-19 related factors were included to adjust for their potential confounding effects in the multivariate regression models. For all regression analyses, we excluded the one sleep-related item from PHQ-9 (Item 3: Trouble falling or staying asleep, or sleeping too much) to control the effect of collinearity. Odds ratio (OR) and 95% confidence interval (CI) were used to quantify the strength of the association.

Results

Description of the sample

The participants aged between 16.0 and 25.0 year-old, with the mean age of 20.23 (1.63) year-old. Among 67905 students, approximately two-third were female (68.7%, $n = 46{,}635$) and most were undergraduate (96.0%, $n = 65{,}200$). Meanwhile, 60.0% ($n = 40{,}713$) lived in urban areas, 98.0% ($n = 66{,}517$) were of Han ethnicity, 20.8 % ($n = 14{,}140$) were of the only child in their family. More detail characteristics have been reported elsewhere (7).

Prevalence of sleep disturbance, PTSD and depression

The prevalence of sleep deprivation (<6 h per night) and overall sleep disturbance were 2.9 and 8.5% at T1, respectively. The prevalence of PTSD was 34.6% at T1 and has significantly decreased at T2 (16.4%, $\chi^2 = 7{,}844.05$, $p < 0.001$). The prevalence of depression at T1 was 21.7% with significantly increase at T2 (26.3%, $\chi^2 = 732.54$, $p < 0.001$), see Figure 2. Table 1 depicts the relationship between demographics, COVID-19 related factors, PTSD and depression among college students.

Figure 2 illustrates the trajectory changes of PTSD and depression among colleges students during the pandemic. As shown in Figure 3A, 11.1% of college students who had PTSD at T1 continued to have PTSD at T2, these participants are classified as the persistent group. While 5.3% of those who only developed PTSD at T2, these participants are named as the new onset group. The other two trajectories included 23.5% participants in remission group, and 60.1% in the resistance group. As shown in Figure 3B, four trajectory changes of depression as follow: persistent (14.0%), remission (7.7%), new onset (12.3%), resistance group (66.0%). Figure 3C also showed four trajectory changes of depression base on the cut-off point of 7 after excluded the sleep-related item from PHQ-9.

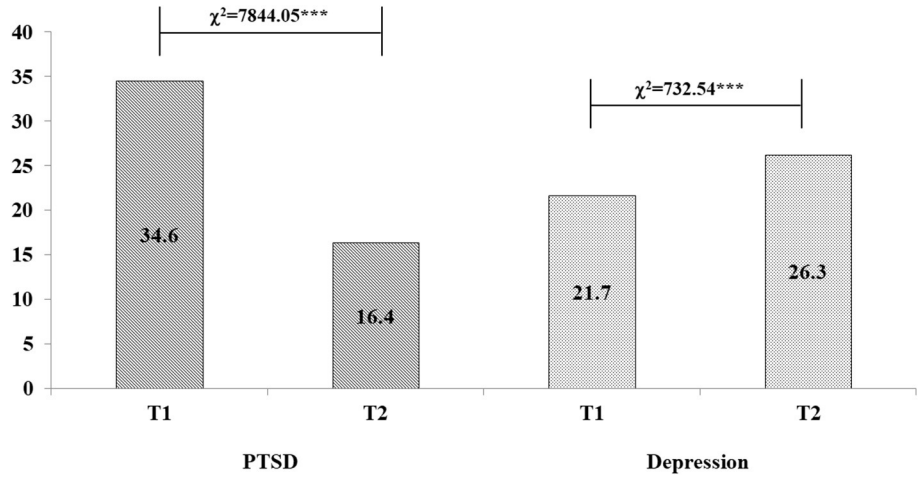

FIGURE 2
Prevalence rates of PTSD and depression at two follow-ups (%), ***$p < 0.001$.

Cross-sectional associations of sleep with PTSD and depression

The prevalence rates of PTSD and depression at baseline significantly increased in the presence of various sleep disturbances. College students who reported having sleep disturbance were more likely to have PTSD (52.3% vs 33.0%; OR = 2.23; 95% CI = 2.11–2.35) and depression (47.7 vs. 13.2%; OR = 6.01; 95% CI = 5.68–6.36). After adjusting for sample characteristics and COVID-19 related factors, difficulty initiating sleep (PTSD: OR = 3.05; 95% CI = 2.85–3.27; Depression: OR = 7.20; 95% CI = 6.83–7.59), difficulty maintaining sleep (PTSD: OR = 2.71; 95% CI = 2.47–2.97; Depression: OR = 5.20; 95% CI = 4.92–5.48), early morning awakening (PTSD: OR = 3.31; 95% CI = 2.93–3.74; Depression: OR = 6.50; 95% CI = 6.11–6.92)≥ 3 nights per week, poor sleep quality (PTSD: OR = 2.81; 95% CI = 2.56–3.09; Depression: OR = 12.10; 95% CI = 10.97–13.35), and overall sleep disturbance (PTSD: OR = 2.25; 95% CI = 2.13–2.37; Depression: OR = 5.78; 95% CI = 5.46–6.12) were all still significantly associated with increased risk of PTSD and depression. Sleep deprivation (PTSD: OR = 1.71; 95% CI = 1.56–1.87; Depression: OR = 3.55; 95% CI = 3.22–3.92) was also significantly associated with PTSD and depression (see Table 2).

Longitudinal associations of sleep with PTSD and depression

As shown in Table 3, the unadjusted odds of PTSD and depression at T2 have significantly increased with difficulty initiating sleep, difficulty maintaining sleep, early morning awakening, poor sleep quality, and with reduced sleep duration. After controlling for sample characteristics, COVID-19 related factors, and baseline PTSD or depression, difficulty initiating sleep (PTSD: OR = 1.82; 95% CI = 1.67–1.98; Depression: OR = 2.64; 95% CI = 2.51–2.78), difficulty maintaining sleep (PTSD: OR = 1.64; 95% CI = 1.46–1.83; Depression: OR = 2.08; 95% CI = 1.97–2.21), early morning awakening (PTSD: OR = 1.82; 95% CI = 1.58–2.09; Depression: OR = 2.22; 95% CI = 2.07–2.38)≥3 nights per week, poor sleep quality (PTSD: OR = 1.78; 95% CI = 1.59–1.99; Depression: OR = 2.72; 95% CI = 2.43–3.03), and overall sleep disturbance (PTSD: OR = 1.50; 95% CI = 1.39–1.60; Depression: OR = 2.16; 95% CI = 2.02–2.30) at T1 also remained significantly associated with increased odds for PTSD and depression at T2. Sleep deprivation (PTSD: OR = 1.69; 95% CI = 1.51–1.90; Depression: OR = 1.93; 95% CI = 1.73–2.16) was also a significant predictor for PTSD and depression.

Sleep disturbance predicting change of PTSD and depression

As shown in Table 4, sleep duration and sleep disturbances were used to predict changes in PLEs. sample characteristics and COVID-19 related factors were adjusted for their potential confounding effects. Compared with resistance group, adjusted OR of sleep disturbance was 1.71 (95% CI = 1.52–1.93) for new onset PTSD, as well as 2.68 (95% CI = 2.46–2.91) for new onset depression. Meanwhile, compared to the remission group, adjusted OR of overall sleep disturbance was 1.40 (95% CI = 1.30–1.52) for persistent PTSD, as well as 1.69 (95% CI = 1.54–1.85) for persistent depression. Sleep deprivation was also a significant predictor for new onset (PTSD: OR = 1.99; 95% CI = 1.67–2.38; Depression: OR = 2.24; 95% CI = 1.95–2.58) and

TABLE 1 Prevalence of PTSD and depression by demographics and COVID-19 related factors (n = 67,905).

Variables		Total [n (%)]	PTSD [a] [%]		Depression [b] [%]	
			T1	T2	T1	T2
Sex	Male	21,270 (31.3)	34.8	20.3	19.2	25.0
	Female	46,635 (68.7)	34.5	14.6	22.8	26.9
	χ^2		0.55	352.15***	110.40***	26.22***
Grade	Freshman	23,921 (35.2)	32.5	15.9	20.4	24.2
	Sophomore	20,533 (30.2)	34.7	16.6	21.8	26.0
	Junior	14,540 (21.4)	36.1	16.4	22.4	27.8
	Senior	6,206 (9.1)	37.1	17.2	25.2	31.8
	Graduate	2,705 (4.0)	38.9	16.2	20.3	26.6
	χ^2		101.90***	8.18	77.98***	167.81***
Residence location	Rural	27,192 (40.0)	35.6	17.3	20.9	25.7
	Urban	40,713 (60.0)	34.0	15.7	22.2	26.7
	χ^2		18.89***	31.50***	16.01***	9.22**
Ethnicity	Han	66,517 (98.0)	34.6	16.3	21.7	26.3
	Others	1,388 (2.0)	36.5	18.4	21.7	27.7
	χ^2		2.13	4.49*	0	1.49
Single child status	No	14,140 (20.8)	35.2	16.6	22.0	26.6
	Yes	53,765 (79.2)	32.5	15.3	20.3	25.1
	χ^2		34.41***	13.43***	21.08***	13.23***
History of physical illness	Yes	335 (0.5)	37.0	20.6	26.0	31.0
	No	67,570 (99.5)	34.6	16.3	21.6	26.3
	χ^2		0.86	4.41*	3.67	3.89
History of mental illness	Yes	534 (0.8)	35.8	19.3	49.4	52.6
	No	67,371 (99.2)	34.6	16.3	21.4	26.1
	χ^2		0.32	3.37	244.50***	192.16***
The severity of the epidemic in the place of residence	Mild	6439 (9.5)	34.7	16.1	20.8	25.8
	Moderate	61030 (89.9)	34.6	16.4	21.8	26.4
	Severe	436 (0.6)	39.4	18.1	22.0	27.5
	χ2		4.59	1.39	3.34	1.17
Confirmed COVID-19 cases in the community or village	Yes	4,679 (6.9)	39.2	20.1	29.4	34.8
	No	63,226 (93.1)	34.3	16.1	21.1	25.7
	χ2		47.52***	52.23***	175.32***	187.41***
Relatives or friends being infected with	Confirmed/suspected	735 (1.1)	45.3	25.2	34.7	37.8
COVID-19	No	67,152 (98.9)	34.5	16.3	21.5	26.2
	χ^2		38.32***	43.79***	75.71***	52.27***

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

[a] PTSD calculated using the IES-6, with a clinical cut-off score of 1.5.

[b] Depression calculated using the PHQ-9, with a clinical cut-off score of 7.

persistent (PTSD: OR = 1.53; 95% CI = 1.33–1.77; Depression: OR = 1.57; 95% CI = 1.33–1.85) PTSD or depression.

Discussion

This study is the first large-scale longitudinal study on the relationship between sleep disturbances, PTSD and depression among college students during the COVID-19 pandemic in China. Our findings showed that the prevalence of PTSD and depression was 34.6 and 21.6% during early COVID-19 outbreak, respectively. As the lockdown progresses in China, depressive symptoms seemed to increase but PTSD symptoms seemed to decrease. Meanwhile, sleep disturbance and sleep deprivation were cross-sectional and longitudinally associated with increased risk of PTSD and depression. In addition, our data also revealed four trajectories for PTSD and depression, namely resistance, persistent, new onset, and remission, among

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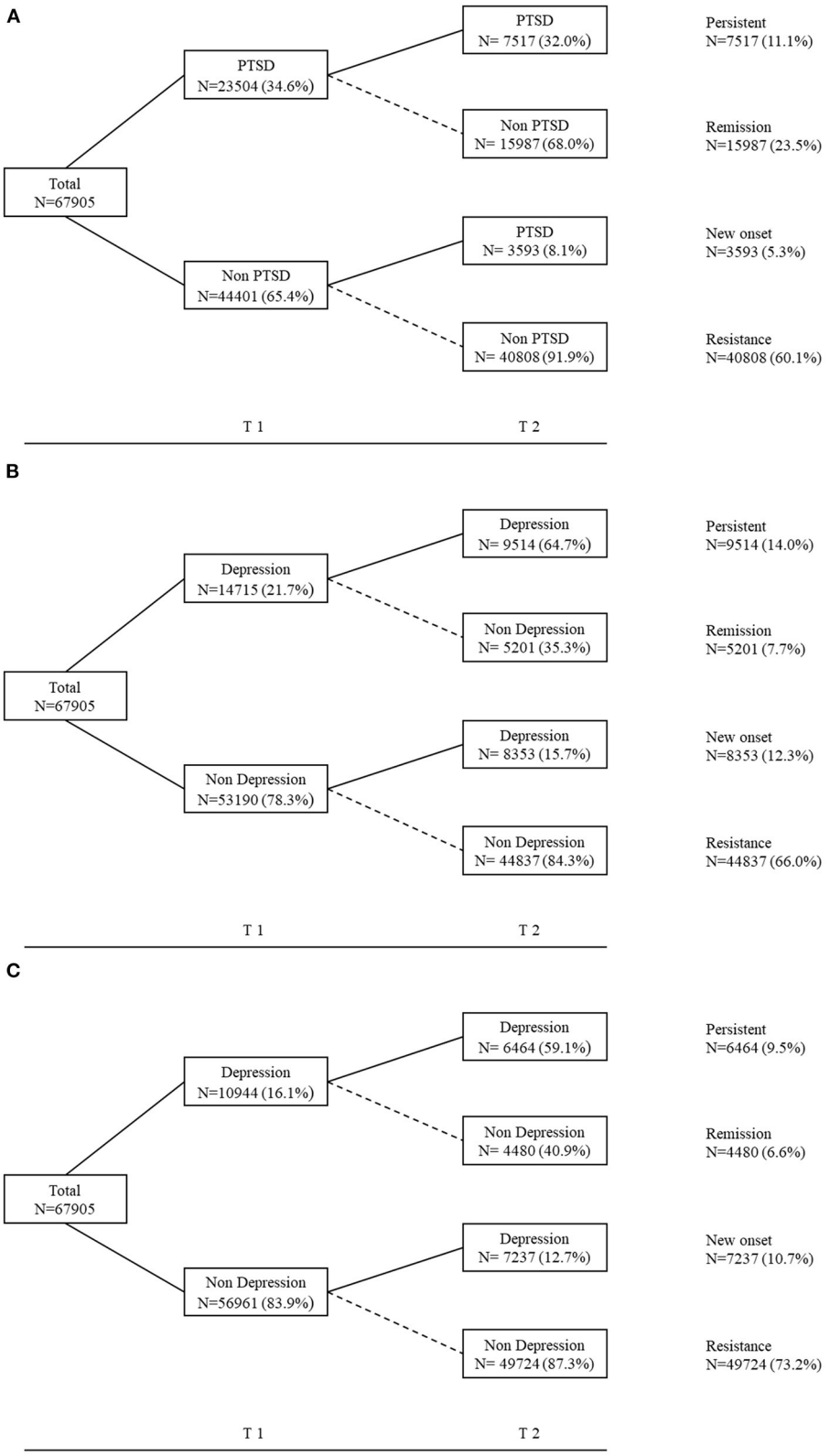

FIGURE 3
Trajectory changes of mental health problems among colleges students during the pandemic. **(A)** The trajectory of PTSD; PTSD calculated using the IES-6, with a clinical cut-off score of 1.5. **(B)** The trajectory of depression; Depression calculated using the PHQ-9, with a clinical cut-off score of 7. **(C)** The trajectory of depression; Depression calculated using the PHQ-8 (exclude the sleep-related item), with a clinical cut-off score of 7.

TABLE 2 Prevalence of PTSD and depression at T1 and their associations with sleep disturbance at T1.

		PTSD at T1			Depression at T1[#]	
Sleep at T1	**%**	**Crude OR (95% CI)**	**Adjust OR (95% CI)** [a]	**%**	**Crude OR (95% CI)**	**Adjust OR (95% CI)** [a]
Sleep duration						
>8 h	32.8	1.00	1.00	14.6	1.00	1.00
7–8 h	34.8	1.09 (1.05,1.13)***	1.09 (1.05,1.13)***	14.6	1.01 (0.96,1.06)	1.02 (0.98,1.07)
6–7 h	39.9	1.36 (1.29,1.44)***	1.36 (1.29,1.43)***	23.4	1.80 (1.69,1.92)***	1.82 (1.70,1.94)***
<6 h	45.7	1.73 (1.57,1.90)***	1.71 (1.56,1.87)***	38.2	3.63 (3.29,4.00)***	3.55 (3.22,3.92)***
Difficulty initiating sleep						
Never/<1 night/week	27.1	1.00	1.00	7.5	1.00	1.00
1–2 nights/week	42.8	2.01 (1.94,2.08)***	2.02 (1.95,2.09)***	18.5	2.81 (2.66,2.97)***	2.79 (2.64,2.94)***
≥3 nights/week	52.6	2.98 (2.79,3.19)***	3.05 (2.85,3.27)***	37.2	7.36 (6.99,7.75)***	7.20 (6.83,7.59)***
Difficulty maintaining sleep						
Never/<1 night/week	29.9	1.00	1.00	10.4	1.00	1.00
1–2 nights/week	44.2	1.86 (1.80,1.92)***	1.85 (1.79,1.91)***	22.6	2.52 (2.39,2.65)***	2.51 (2.38,2.64)***
≥3 nights/week	53.6	2.82 (2.48,2.98)***	2.71 (2.47,2.97)***	38.3	5.36 (5.08,5.65)***	5.20 (4.92,5.48)***
Early morning awakening						
Never/<1 night/week	30.6	1.00	1.00	11.2	1.00	1.00
1–2 nights/week	48.9	2.17 (2.09,2.26)***	2.15 (2.07,2.23)***	28.6	3.19 (3.03,3.36)***	3.18 (3.02,3.35)***
≥3 nights/week	59.5	3.34 (2.96,3.77)***	3.31 (2.93,3.74)***	45.6	6.67 (6.27,7.10)***	6.50 (6.11,6.92)***
Subjective sleep quality						
Very good/ Good	30.5	1.00	1.00	10.1	1.00	1.00
Normal	47.4	2.06 (1.98,2.14)***	2.07 (1.99,2.15)***	33.2	4.44 (4.23,4.64)***	4.38 (4.18,4.58)***
Poor/ Very poor	54.8	2.76 (2.51,3.03)***	2.81 (2.56,3.09)***	58.6	12.63 (11.46,13.92)***	12.10 (10.97,13.35)***
Sleep disturbance [b]						
No	33.0	1.00	1.00	13.2	1.00	1.00
Yes	52.3	2.23 (2.11,2.35)***	2.25 (2.13,2.37)***	47.7	6.01 (5.68,6.36)***	5.78 (5.46,6.12)***

***$p < 0.001$.

[a] Adjusting for age, sex, grade, residence location, ethnicity, only single child, history of physical/ mental illness, and COVID-19 related factors.

[b] Sleep disturbance = difficulty initiating sleep (≥3 nights/week), difficulty maintaining sleep (≥3 nights/week), Early morning awakening (≥3 nights/ week), or poor/very poor sleep quality.

[#] Depression calculated using the PHQ-8 (exclude the sleep-related item), with a clinical cut-off score of 7.

which sleep disturbances were significant predictors of distinct PTSD and depression trajectories.

In this study, we found that 8.5% of college students had experienced sleep disturbance during pandemic outbreak. Results of previous studies varied due to the differences in sampling, measures and cut-off points. For instance, Wang and colleagues investigated 3,092 Chinese college students' sleep status using the Self-Rating Scale of Sleep (SRSS) were reported that 5.3% participants had sleep problems during the outbreak of COVID-19 (5). Studies by Zhou et al., sleep was analyzed using the Pittsburgh Sleep Quality Index (PSQI), indicated a prevalence of clinically insomnia being 23.2% during pandemic (6). During the outbreak of pandemic, 2.9% of college students have reported sleep deprivation, which is consistent with previous studies with 2.7% of college students sleeping <6 h per night during outbreak of COVID-19 (26).

Meanwhile, our data showed that about 34.6% of participants had possible clinically significant PTSD during the COVID-19 pandemic outbreak period. The prevalence is similar to the results of previous studies with a larger sample. Previous studies with same measurement scales and similar sampling time found that about 32.7% of 304,167 college students had PTSD (21). We also found that 21.6% college students had clinical level depression, which was also similar to previous studies using the same measurement scale by Ma et al. (21.1%) (27). However, the rate of PTSD has significantly decreased between the two-wave assessment periods. The result was also in line with previous studies (28). This decrease in PTSD symptoms could potentially be explained by China's effective control of the COVID-19. As time elapsed, knowledge of reliable information on COVID-19, effective prevention and control measures, enhanced medical support and a public health service systems implemented by the Chinese government through trial and error, might have contributed in reassuring people and alleviating the initial worry and fear caused by the emergence of the pandemic. However, similar to prior research

TABLE 3 Prevalence of PTSD and depression at T2 and their associations with sleep disturbance at T1.

		PTSD at T2			Depression at T2[#]	
Sleep at T1	**%**	**Crude OR (95% CI)**	**Adjust OR (95% CI)** [a]	**%**	**Crude OR (95% CI)**	**Adjust OR (95% CI)** [b]
Sleep duration						
>8 h	15.1	1.00	1.00	18.7	1.00	1.00
7–8 h	16.3	1.10 (1.05,1.15)***	1.04 (0.99,1.09)	18.8	1.00 (0.96,1.04)	0.99 (0.95,1.04)
6–7 h	20.1	1.42 (1.33,1.52)***	1.25 (1.16,1.34)***	27.0	1.60 (1.51,1.70)***	1.33 (1.24,1.42)***
<6 h	26.8	2.06 (1.86,2.29)***	1.69 (1.51,1.90)***	40.9	3.00 (2.73,3.30)***	1.93 (1.73,2.16)***
Difficulty initiating sleep						
Never/<1 night/week	12.8	1.00	1.00	12.1	1.00	1.00
1–2 nights/week	20.0	1.71 (1.64,1.79)***	1.42 (1.35,1.48)***	23.2	2.19 (2.08,2.29)***	1.72 (1.63,1.81)***
≥3 nights/week	26.7	2.48 (2.30,2.69)***	1.82 (1.67,1.98)***	38.9	4.61 (4.41,4.83)***	2.64 (2.51,2.78)***
Difficulty maintaining sleep						
Never/<1 night/week	13.8	1.00	1.00	15.1	1.00	1.00
1–2 nights/week	21.6	1.72 (1.64,1.79)***	1.46 (1.39,1.53)***	26.6	2.05 (1.95,21.4)***	1.59 (1.51,1.67)***
≥3 nights/week	26.0	2.19 (1.97,2.43)***	1.64 (1.46,1.83)***	38.9	3.59 (3.41,3.78)***	2.08 (1.97,2.21)***
Early morning awakening						
Never/<1 night/week	14.0	1.00	1.00	15.9	1.00	1.00
1–2 nights/week	24.6	2.00 (1.91,2.10)***	1.59 (1.51,1.67)***	31.7	2.45 (2.33,2.57)***	1.73 (1.64,1.83)***
≥3 nights/week	30.4	2.68 (2.36,3.06)***	1.82 (1.58,2.09)***	44.5	4.24 (4.00,4.51)***	2.22 (2.07,2.38)***
Subjective sleep quality						
Very good/ Good	13.9	1.00	1.00	14.9	1.00	1.00
Normal	23.9	1.94 (1.85,2.03)***	1.55 (1.48,1.63)***	35.7	3.17 (3.03,3.30)***	2.05 (1.95,2.14)***
Poor/ Very poor	28.4	2.45 (2.21,2.72)***	1.78 (1.59,1.99)***	53.4	6.55 (5.96,7.20)***	2.72 (2.43,3.03)***
Sleep disturbance						
No	15.5	1.00	1.00	17.7	1.00	1.00
Yes	25.9	1.91 (1.80,2.04)***	1.50 (1.39,1.60)***	46.6	4.06 (3.84,4.30)***	2.16 (2.02,2.30)***

***$p < 0.001$.

[a] Adjusting for age, sex, grade, residence location, ethnicity, only single child, history of physical/ mental illness, COVID-19 related factors, and PTSD at T1.

[b] Adjusting for age, sex, grade, residence location, ethnicity, only single child, history of physical/ mental illness, COVID-19 related factors, and depression at T.

[#] Depression calculated using the PHQ-8 (exclude the sleep-related item), with a clinical cut-off score of 7.

(14, 29–31), depression increased from 21.7% at T1 to 26.3% at T2. Specifically, depressive symptoms have worsened as the lockdown time increased, which be explained by the chronic stress associated with unexpected changes in living patterns for college students (i.e., lacking in exercise, confinement for social distancing, and delay in returning to school) due to long-term lockdown (12), which led to increase the risk of depression.

The PTSD and depression trajectories showed that the majority of college students in the study (60.1% and 66.0 for resistance) exhibited no symptoms throughout the 2-month period post-pandemic. Meanwhile, a small percentage of the college students exhibited the trajectories of persistence, remission and new onset. This result showed that the overall PTSD and depressive symptoms is relatively low and very stable. We speculated that college students exposed to the COVID-19 pandemic exhibited acute stress responses only immediately after the public health emergency while maintained a stable trajectory of euthymia and healthy functioning. However, the presence or new onset of PTSD and depression might be related to secondary stressors during pandemic lockdown, such as lifestyle and economic disruptions (32). Having more time spent with family and reduced academic stress could contribute to symptoms remission (25).

Adjusting for socio-demographics variables and COVID-19 related factors, sleep disturbances have been cross-sectionally associated with PTSD and depression during the pandemic. Much literature has also identified that individual with sleep disturbances is at a higher risk of PTSD and depression than those without sleep complaints (33, 34). Meanwhile, different from the long-term risks identified in previous studies, this study also confirmed the strong associations between sleep disturbances and PTSD or depression within a shorter time-frame after the exposure to a special public health emergency. Specifically, these findings were expected

TABLE 4 Sleep disturbance predicting change of PTSD or depression during COVID-19.

Sleep at T1	PTSD				Depression[#]			
	New-onset v. resistance		Persistent v. remission		New-onset v. resistance		Persistent v. remission	
	Crude OR (95% CI)	Adjust OR (95% CI) [a]	Crude OR (95% CI)	Adjust OR (95% CI) [a]	Crude OR (95% CI)	Adjust OR (95% CI) [a]	Crude OR (95% CI)	Adjust OR (95% CI) [a]
Sleep duration								
>8 hours	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7-8 hours	1.04 (0.97,1.12)	1.01 (0.93,1.09)	1.09 (1.02,1.15)**	1.06 (1.00,1.13)	1.00 (0.95,1.06)	1.00 (0.94,1.05)	0.99 (0.91,1.08)	0.99 (0.91,1.08)
6-7 hours	1.36 (1.21,1.52)***	1.30 (1.16,1.46)***	1.25 (1.14,1.37)***	1.22 (1.11,1.33)***	1.34 (1.23,1.45)***	1.33 (1.22,1.45)***	1.32 (1.17,1.48)***	1.31 (1.17,1.48)***
<6 hours	2.12 (1.77,2.53)***	1.99 (1.67,2.38)***	1.59 (1.38,1.83)***	1.53 (1.33,1.77)***	2.28 (1.99,2.62)***	2.24 (1.95,2.58)***	1.60 (1.36,1.89)***	1.57 (1.33,1.85)***
Difficulty initiating sleep								
Never/<1 night/week	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1–2 nights/week	1.30 (1.20,1.41)***	1.98 (1.85,2.06)***	1.21 (1.13,1.30)***	1.31 (1.20,1.44)***	1.90 (1.79,2.01)***	1.90 (1.79,2.02)***	1.22 (1.10,1.35)***	1.22 (1.10,1.35)***
≥3 nights/week	1.72 (1.57,1.88)***	3.15 (2.96,3.35)***	1.50 (1.40,1.59)***	1.95 (1.79,2.12)***	3.02 (2.83,3.21)***	3.03 (2.84,3.22)***	1.86 (1.69,2.04)***	1.86 (1.69,2.04)***
Difficulty maintaining sleep								
Never/<1 night/week	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1–2 nights/week	1.37 (1.26,1.49)***	1.79 (1.69,1.90)***	1.29 (1.21,1.38)***	1.34 (1.24,1.46)***	1.72 (1.62,1.83)***	1.72 (1.62,1.83)***	1.28 (1.17,1.41)***	1.28 (1.16,1.40)***
≥3 nights/week	1.60 (1.44,1.78)***	2.52 (2.34,2.72)***	1.53 (1.42,1.64)***	1.73 (1.59,1.88)***	2.46 (2.28,2.64)***	2.44 (2.27,2.62)***	1.61 (1.46,1.76)***	1.58 (1.44,1.74)***
Early morning awakening								
Never/<1 night/week	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1–2 nights/week	1.61 (1.47,1.77)***	1.66 (1.51,1.83)***	1.41 (1.31,1.51)***	1.43 (1.34,1.54)***	2.01 (1.88,2.15)***	2.01 (1.88,2.15)***	1.27 (1.16,1.40)***	1.26 (1.15,1.39)***
≥3 nights/week	1.90 (1.67,2.17)***	1.92 (1.69,2.19)***	1.70 (1.56,1.84)***	1.72 (1.58,1.87)***	2.87 (2.62,3.14)***	2.83 (2.58,3.10)***	1.61 (1.45,1.78)***	1.58 (1.43,1.75)***
Subjective sleep quality								
Very good/ Good	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Normal	1.65 (1.52,1.79)***	1.66 (1.53,1.81)***	1.47 (1.39,1.56)***	2.83 (2.68,3.00)***	2.37 (2.41,2.51)***	2.37 (2.24,2.51)***	1.51 (1.39,1.63)***	1.50 (1.39,1.63)***
Poor/ Very poor	2.00 (1.63,2.44)***	1.99 (1.62,2.44)***	1.67 (1.47,1.90)***	4.25 (3.74,4.83)***	3.67 (3.13,4.29)***	3.59 (3.07,4.21)***	2.02 (1.76,2.33)***	2.00 (1.73,2.30)***
Sleep disturbance								
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.68 (1.49,1.89)***	1.71 (1.52,1.93)***	1.38 (1.27,1.49)	1.40 (1.30,1.52)***	2.71 (2.50,2.95)***	2.68 (2.46,2.91)***	1.70 (1.56,1.87)***	1.69 (1.54,1.85)***

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

[a] Adjusting for age, sex, grade, residence location, ethnicity, only single child, history of physical/ mental illness, and COVID-19 related factors.

[#] Depression calculated using the PHQ-8 (exclude the sleep-related item), with a clinical cutoff score of 7.

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and in line with several studies (8, 10, 35) that prospectively demonstrated the association of previous sleep disturbances with later onset and persistence of PTSD and depression. On the contrary, good sleep quality is a protective factor for PTSD and depression remission. Previous studies suggested that sleep disturbance following a trauma might amplify or prolong typical stress responses and increase the likelihood of PTSD development (36). Recent evidence has also suggested that college students with sleep disturbance are prone to maladaptive emotion regulation, resulting in the development of depressive symptoms during COVID-19 lockdown (37).

Moreover, our data also demonstrated significant cross-sectional and longitudinal associations between sleep deprivation, PTSD and depression. These results are consistent with findings prior to the pandemic, although most studies have been limited by cross-sectional design. For example, one cross-sectional study on American veterans demonstrated the significant association between sleep deprivation and increased odds of concurrent PTSD (38). Few prospective studies have shown that sleep deprivation at baseline predicted depression at 1 year later among adolescents, after adjusting for baseline depression (17). Longitudinal analysis further demonstrated that sleep deprivation could independently predict the new onset or persistence of PTSD and depression, after controlling for socio-demographics variables and COVID-19 related factors. However, the 12-month follow up by Fan et al. demonstrated that sleep deprivation could not independently predict the onset of PTSD and depression (10). The inconsistency of these results may be due to the difference in follow up time. The two surveys in this study were separated by only 2 months, and the effect of sleep deprivation was relatively stable. Another explanation could be that insufficient sleep among college students during pandemic lockdown could be related to their excessive media use at night, which could be their mean to acquire more COVID-19 related information. Indeed, exposure to media coverage of the COVID-19 was found may be a risk factor for individual mental health during outbreaks (27).

Finally, this study makes a unique contribution to the literature by examining the association between sleep disturbances, PTSD and depression in a college student sample during the COVID-19 pandemic. Our findings suggest that recognizing and treating sleep disturbance is especially vital during stress-inducing periods such as the pandemic. For groups in isolation at home, we can appropriately increase sleep duration and improve sleep quality through measures such as exercise training (39) or cognitive behavioral therapy for insomnia (CBT-i) (40). However, several limitations also should be noted. In this study, sleep, PTSD, and depression were all assessed by self-reported questionnaires rather than face-to-face clinical interviews, which may have led to reporting bias caused by participants various psychiatric states and recollection inaccuracy. In the form of web-based questionnaires, it is also difficult to answer participants' questions in a timely manner during the survey process, which might reduce the reliability of the data. Meanwhile, there is a significant sex imbalance in our data, which may bias the current results. Finally, some confounding factors such as negative life events were not considered in our study, which may also impact the current results.

Conclusion

This is the first study to survey both cross-sectional and longitudinal associations of sleep disturbance with PTSD and depression in a large cohort of college students exposed to COVDI-19. Our data showed that sleep disturbance was cross-sectional and prospectively associated with an increased risk of PTSD and depression. It also predicted changes of PTSD and depression. Furthermore, the current study shed light on the notion that assessing several simple symptoms related to sleep problems may be a quick and effective way to screen individuals at increased risk of PTSD and depression. Therefore, assessment and treatment of sleep disturbance as early as possible may be an important strategy for prevention and intervention of mental disorders in individuals after exposure to a public health emergency.

Data availability statement

Publicly available datasets were analyzed in this study. The raw data supporting the conclusions of this article will be made available by the authors.

Ethics statement

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

Author contributions

DW, JZ, and FF: conceptualization. DW: methodology, formal analysis, and writing—original draft. DW, JZ, HY, and LB: data curation. JZ, SZ, and FF: writing–review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Burnout, negative emotions, and wellbeing among social workers in China after community lockdowns during the COVID-19 pandemic: Mediating roles of trait mindfulness

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Objective: This study aimed to investigate burnout situation of social workers (SWs) who experienced the COVID-19 pandemic-related community lockdown 1 year before, and to assess the protective value of trait mindfulness (TM) in states of burnout.

Method: We surveyed the burnout, trait mindfulness, negative emotions (NEs) and wellbeing (WB) of 182 social workers provided services to Wuhan lockdowns community by COVID-19 one year before. Burnout were measured using the Maslach Burnout Inventory–Human Services Survey; TM using the Mindful Attention Awareness Scale; NEs using the Depression Anxiety and Stress Scale-21; and WB using the General Wellbeing Schedule. We also performed correlation regression analysis and mediation test for burnout, TM, NEs, and WB.

Results: Among the 182 respondents, 75 (41.2%) still suffered from severe burnout. TM was negatively correlated with burnout ($r = -0.623$), negatively correlated with NEs ($r = -0.560$), and positively correlated with WB ($r = 0.617$). Burnout had a significantly positive correlation with NEs ($r = 0.544$) and a significantly negative correlation with WB ($r = -0.666$). Further, WB had significantly negative correlation with NEs ($r = -0.758$). After controlling for age, gender, marital status, educational level, and years of employment, burnout had a significantly positive predictive effect on NEs ($\beta = 0.509$), whereas TM had a significantly negative predictive effect on NEs ($\beta = -0.334$). TM played a partial mediating role in the effect of burnout on NEs, with a mediating effect and effect ratio of 0.088 and 39.7%, respectively. Burnout had a significantly negative predictive effect on WB ($\beta = -0.598$), whereas TM had a significantly positive predictive effect on WB ($\beta = 0.299$). TM played a partial mediating role in the effect of burnout on NEs, with a mediating effect and effect ratio of −0.164 and 30.3%, respectively. WB had a significantly negative predictive effect on NEs ($\beta = -0.711$), and it played a partial mediating role in the effect of burnout on NEs, with a mediating effect and effect ratio of 0.185 and 83.3%, respectively.

Conclusion: The current levels of burnout among local SWs remained high 1 year after the community lockdowns. TM played a mediating role in the relationship between burnout, NEs, and WB. Concomitantly, WB played a mediating role in the relationship between burnout and NEs. Therefore, in the context of burnout, TM is a protective factor for reducing emotional stress and risks of developing psychiatric disorders through the enhancement of WB.

KEYWORDS

social workers, burnout, anxiety, depression, trait mindfulness, COVID-19, wellbeing

Introduction

Owing to its rapid societal developments, China has become increasingly reliant on SWs to address the welfare needs of the ever-growing grassroots societies. Correspondingly, the number of SW teams has grown rapidly over the recent years. However, the emergence of the coronavirus disease 2019 (COVID-19) resulted in a surge in the levels of occupational stress experienced by SWs. Even before the COVID-19 pandemic, SW teams in China had long been dealing with high levels of burnout and high turnover rates (1). In China, the issue of burnout among SWs has become one that requires urgent solutions. Various studies have emphasized on the crucial impact of social support on the levels of burnout among SWs (2, 3). However, the increasing lack of social support for SWs remains a major concern in Chinese societies (4). As a result, research aimed at enhancing stress tolerance among SWs is essential for ensuring sufficient levels of stress tolerance among such individuals for their protection. Therefore, this study aims to investigate the protective value of trait mindfulness (TM) in states of burnout to identify training interventions that can help in maintaining mental health among SWs in China.

Literature review

Burnout

Burnout is a state of physico-mental exhaustion associated with the work of providing care for others (5). The operational definition of burnout, as proposed by Maslach and Jackson (6) refers to a situation in which practitioners experience emotional exhaustion, cynicism, and low levels of self-efficacy. Burnout is a subjective feeling that arises when individuals detect significant levels of input–output occupational disparities (7). It is generally believed that various professionals, such as civil servants, teachers, and medical staff, belong to occupational groups at a high risk of burnout (8). For such individuals, burnout can be caused by increasing workloads and declining levels of work efficiency, onerous reporting systems, and burdensome paperwork, as well as various factors, such as weak organizational support structures and poor team cultures (9, 10). Current studies further show that modernized electronic health management records are becoming a new cause of burnout (11). Although burnout is yet to be classified as a mental disorder (12), an increasing number of surveys have confirmed that it is closely related to mental health issues, such as anxiety, depression, and substance abuse (13–15), thereby resulting in a corresponding deterioration in occupational wellbeing among practitioners (16).

Current burnout situation among social workers

The responsibilities of SWs are specifically related to providing care to community residents, and the tasks of such professionals involve giving residents the assurance of access to primary healthcare, maintaining order in the community, and using their actions to maintain a "just sense of wellbeing" that transcends their roles and environments (17). The meticulous and detailed work of SWs endows them with vital social responsibilities. As a result, similar to primary healthcare workers, these professionals are highly prone to burnout (18–20). Previous studies have shown that higher burnout rates often pose a range of physico-mental health risks to practitioners in professions that involve serving people (21), and burnout is often associated with increased levels of absenteeism, higher turnover rates, and negative work attitudes (22–24).

From 2019 to date, the global transmission of COVID-19 has been prolific, and according to the World Health Organization, COVID-19 is currently classified as a "public health event of international concern" (25). In various healthcare systems across the world, a variety of approaches aimed at combating the transmission of COVID-19 continue to be implemented. Controlled studies have concluded that actively sealing off and controlling communities as well as encouraging all residents

Abbreviations: SW, social worker; TM, Trait mindfulness; NEs, Negative emotions; WB, Wellbeing; COVID-19, Coronavirus disease-19.

to practice home isolation play a significant role in limiting the transmission of the virus at the individual level and without the situation escalating to a social malaise, thereby containing the pandemic rapidly and effectively (25). However, the actualization of this approach requires the mobilization of substantial numbers of SWs and public healthcare personnel.

In 2020, China imposed community lockdowns owing to the COVID-19 outbreak. Throughout this period, SWs provided multiple services, including health promotion, coordinating medical treatment, and providing residents with food, medicine, and daily necessities. SWs were also required to resolve familial and psychological problems among community residents. Such problems resulted from extended periods of isolation (26). Similar to medical staff, SWs were required to bear additional workloads within short notice, and this aspect resulted in many of them experiencing psychological stress owing to an overall lack of preparation (27, 28). Currently, with the COVID-19 outbreak having been controlled at lower levels nationwide, one question remains: what are the current burnout levels among SWs who worked through a year of community lockdowns? There is currently a lack of survey data on this topic. Community management work related to COVID-19 response continued even after community lockdowns had been lifted, and the tasks were ongoing throughout that year, meaning that additional new tasks targeting community security were imposed on the initial workload among SWs. Therefore, in this study, we speculated that burnout among SWs might persist, reaching severe levels.

Burnout, wellbeing, and negative emotions

With COVID-19 cases remaining prevalent across the world, there has been a continuous stream of reports on burnout among medical staff in many regions. These reports have indicated that burnout is often accompanied by negative emotions (NEs), such as anxiety and depression, as well as other mental health issues, including increased levels of stress, reduced wellbeing (WB), and traumatic experiences (29–31). Parallel research on burnout and various types of NEs has revealed overlapping effects between the two states, which include depression and emotional exhaustion, anxiety, and reduced professional efficacy (14). Anxiety and depression are currently included in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) diagnostic tool, and they are categorized under mental disorders (32). Additionally, there is a possibility that burnout resulting from persistently unfavorable workplace environments can result in increased incidences of mental illnesses, such as depression and anxiety, to a certain extent. Patients with mild to moderate levels of depression and anxiety disorders may not be at immediate risks of severe life hazards, such as suicide, and therefore, they can work and live independently. However, their burnout levels remain increasingly persistent, and the levels of stress they experience are highly significant compared to those of their colleagues in similar working environments (33).

Another major effect of burnout is a reduction in WB, whereby the individuals affected feel that their experience of WB in life has declined significantly (34). No link has been established between professional practitioners that serve people and those that suffer from reduced WB and increases in their occupational errors (34). However, burnout and low levels of WB have been observed as aspects resulting in reduced professional empathy and the appearance of empathy fatigue (35). In turn, professional efficiency is further hampered, thereby affecting the effective actualization of personal accomplishments (36). Some studies have established that improving WB through positive psychological interventions reduces the prevalence of depressive symptoms (37). Therefore, in this study, we speculated that WB may be a mediating variable affecting NEs when an individual is in a state of burnout.

Social support and burnout

Rapid developments in the social work sector in China have attracted increasing social attention to the problem of burnout. Consequently, scholars have attempted to examine the factors related to burnout among SWs, and one of the factors is social support (4). Some studies have suggested that the effective work performance levels among Chinese SWs depend on the support they receive from their family, friends, team members, and especially, leaders. This corresponds to the model of interpersonal relationships in Chinese culture, which is a hierarchical structure (38). Although a stable external environment is beneficial for ensuring physico-mental health among SWs, its dependence carries specific risks. Owing to the accelerating pace of change in Chinese society, the pragmatism of pursuing benefits has gradually weakened the efforts individuals previously made to maintain workplace relationships. Existing studies have confirmed that various factors, such as poor working conditions, the lack of social support, and work–family conflicts, have become vital precursors of burnout and high turnover rates among Chinese SWs (39–41). Despite contexts involving unfavorable levels of social support, there are always some individuals who can maintain satisfactory levels of physico-mental health, and significant attention should be paid to the psychological characteristics of such individuals.

Trait mindfulness and burnout

Mindfulness, which is a concept developed in the field of contemporary clinical psychology and healthcare, is a broad technical term related to attention and awareness. Kabat–Zinn

(42) defined mindfulness as "awareness that arises through paying attention, on purpose, in the present moment, non-judgmentally." Although scholars often describe mindfulness as a state, the pursuit of this state is not the purpose of mindfulness. Practicing the non-judgmental attitude of mindfulness and obtaining the effect of physico-mental healing is the process that guides an individual toward achieving that state (43). Such vague concepts confuse many practitioners and researchers focusing on mindfulness. Various studies on the application of mindfulness have established that the stability of the practice's long-term effects is affected by various factors among individual practitioners (44). These findings have inspired various scholars to further propose that mindfulness is akin to a psychological trait generally possessed by individuals, trait mindfulness (TM), which is jointly influenced by *a priori* endowment and *a posteriori* training (45).

Considering that the psychological characteristics of TM are something individuals may possess, the implication is that some SWs have high levels of TM, and therefore, they can maintain mild levels of burnout through self-empowerment, despite situations involving insufficient levels of external support, thereby preventing the encroachment of NEs. Previous studies related to this topic have also evaluated the impacts of psychological interventions containing elements of TM. Such interventions include enhancing participants' levels of empathy, WB, and burnout (36). TM also plays a mediating role in the relationship between social support and burnout. Various studies have concluded that TM plays such a role between perceived social support and sleep quality (46). Further, intervention projects involving TM aimed at mitigating burnout levels have established that TM, burnout, and NEs among various individuals all changed accordingly (47, 48). All the findings presented above further suggest that inter-correlations between different levels of TM, burnout, NEs, and WB exist. In this study, we further assumed that TM may play a mediating role between burnout-induced NEs and WB.

In this study, we used correlation research, regression analysis, and testing for mediating effects to verify the proposed assumptions. A survey was specifically scheduled to be conducted 1 year after the COVID-19-related community lockdowns were lifted. The purpose of this survey was to evaluate the levels of burnout among SW teams and their associated NEs and WB after they had provided a year of community services during and after the lockdowns. Meanwhile, the specific hypotheses proposed were as follows:

H1: Burnout levels among SWs are positively correlated with their NEs but negatively correlated with their WB.

H2: Burnout levels have a positive predictive effect on NEs but a negative predictive effect on WB, and TM has a negative predictive effect on NEs but a positive predictive effect on WB.

H3: TM plays a mediating role between burnout and NEs, and between burnout and WB, and WB plays a mediating role between burnout and NEs (Figure 1).

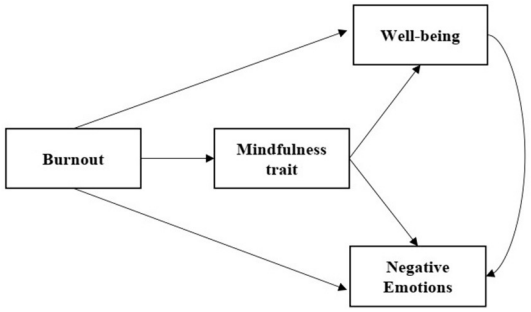

FIGURE 1
Mediating effects of TM on burnout, NEs, and WB.

H3a: TM plays a mediating role between burnout and NEs.
H3b: TM plays a mediating role between burnout and WB.
H3c: WB plays a mediating role between burnout and NEs.

Materials and methods

Data and samples

Data used in this study were obtained from SWs providing services to multiple communities in Wuhan, China. All the communities involved experienced lockdown enforcement during the COVID-19 outbreak in 2020. The SWs in these communities were invited to complete a questionnaire online through the support of the China Association of Social Workers in April 2021. A total of 213 questionnaires were distributed, and 182 valid questionnaires were returned, representing a response rate of 85%. There were 18 questionnaires that were not completed in time or did not meet the requirements. An informed consent procedure was implemented prior to the survey. All the respondents were informed that by responding, they would be contributing to the development of stress management services for SWs. Additionally, they were informed that their participation in the survey was voluntary and without compensation, and that they could decide to terminate their participation at their discretion.

Method

Burnout levels were assessed using the Maslach Burnout Inventory–Human Services Survey (MBI–HSS), which is applicable to all occupations that are of service to human beings, such as those involving medical personnel and SWs. The survey's reliability and validity have been proven to be satisfactory after being applied in different countries and industries (49). The original MBI–HSS comprises a total of 22 items. The Chinese version, which has been simplified to 17

items for clinical use, was applied in this study. It contains three dimensions: (i) emotional exhaustion (7 items, e.g., "At work, I feel that my emotions are that of exhaustion"); (ii) depersonalization (3 items, e.g., "I have become increasingly indifferent to other people ever since starting this job"); and (iii) personal accomplishment (7 items, e.g., "I can solve problems at work effectively").

A 7-point Likert scale, ranging from 0 (almost never) to 6 (almost always), was used for scoring. The dimension of personal accomplishment was reverse-scored. The higher the total score was, the more severe the individual's burnout level was. The Cronbach's alpha coefficient of the MBI–HSS (Chinese version) was 0.88 (50). The possible scores ranged from 0 to 102. For the score of 50 in demarcated burnout severity, a score <50 indicated mild burnout, whereas a score of ≥ 50 indicated severe burnout for which psychological intervention was necessary.

TM was assessed using the Mindful Attention Awareness Scale (MAAS), which was developed by Brown and Ryan (51). The 15 items cover only one dimension. The performance of TM over the immediate preceding week was measured using a 6-point Likert scale, ranging from 1 (almost always) to 6 (almost never). All the questions were reverse-scored: The higher the scores, the higher the individual's TM level. The Chinese version of the scale has been used widely, and it has high reliability and validity, with a Cronbach's alpha coefficient of 0.87 (52).

NEs were assessed using the Depression Anxiety and Stress Scale-21 (DASS-21). The scale's total number of items was reduced from the original 42 to 21 items, thereby covering three dimensions, each with seven items: (i) depression (e.g., "I cannot seem to experience any positive feelings at all."); (ii) anxiety (e.g., "I do not have any valid reason to be afraid."); and (iii) stress (e.g., "I find it difficult to relax."). A 4-point Likert scale was used for scoring, which ranged from 0 (never descriptive of me) to 3 (always descriptive of me). The higher the score, the more severe the individual's NEs.

The psychometric properties of the DASS-21 have been proven to be satisfactory through a comparative study of this scale using the Beck Depression Inventory (BDI) and the Beck Anxiety Inventory (BAI). The correlation between the DASS-21 and the BAI was 0.81, and that between the DASS-21 and the BDI was 0.74 (53). The DASS-21 has also been validated throughout its applications in China and Hong Kong (54). The Cronbach's alpha coefficients of the three dimensions in the Chinese version were 0.83, 0.80, and 0.82, respectively. The Cronbach's alpha coefficient of the total score was 0.92 (55).

WB was assessed using the General Wellbeing Schedule (GWB) (56), which is a short, reliable, and valid measure of WB. The GWB comprises 33 items covering six dimensions: (i) satisfaction and confidence in life, (ii) worries about health, (iii) energy level, (iv) depressive or happy moods, (v) control over emotions and behavior, and (vi) relaxation and tension. The scores for each item range from 0–3 to 0–10, with a higher overall score indicating higher levels of WB. The Chinese version of the GWB has satisfactory psychometric properties, with the Cronbach's alpha coefficients of the scale being 0.91 for males and 0.95 for females (57).

Analysis strategy

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) 26.0 software. First, descriptive analyses and correlation tests were performed on the total score of each scale. Next, the various variables were subjected to linear regression analysis. The MAAS scores were considered the independent variables. The total scores of the MBI-HSS, DASS-21, and GWB represented the dependent variables, and the control variables included gender, age, marital status, educational level, and years of employment. The SPSS-PROCESS plug-in was used to verify the mediating effect of the MAAS on the regression between the MBI-HSS and the DASS-21 and that between the MBI-HSS and the GWB.

Results

Data used in this study might have been subject to common method bias because these data were obtained from self-reports filled by the respondents. Harman's one-factor test revealed that three factors had eigenvalues >1. The first factor explained 31.98% of the variance, which was less than the critical value of 40%. Therefore, it was deemed that the data had significant levels of common method bias.

The respondents comprised 18 males (9.9%) and 164 females (90.1%). They were aged between 19 and 60 years. The median age was 42 years, and the mean $\pm$ standard deviation was 41.09 $\pm$ 9.41 years. In terms of marital status, 126 (69.2%) were married, 34 (18.7%) were unmarried, and 22 (12.1%) were divorced/separated. Regarding educational qualifications, 11 (6.0%) had completed high school/technical secondary school, 44 (24.2%) had attended a professional training college, 101 (55.57%) held bachelor's degrees, and 26 (14.3%) had a master's degree or above. More than half of the respondents had worked for more than a decade: 62 (34.1%) and 120 (65.9%) had ≤ 10 and >10 years of employment, respectively.

The average scores of the sample were as follows: 36.90 (SD = 12.54) for burnout, 51.52 (SD = 10.62) for TM, 34.14 (SD = 7.29) for NEs, and 71.74 (SD = 15.12) for overall WB. Taking the total MBI–HSS score of 50 as the demarcation point, it was established that 75 (41.2%) of the respondents suffered from severe burnout. The various descriptive statistics of the demographic characteristics and the key variables of the two groups of the sample with mild and severe burnout, as well as a comparison between the related factors, are listed in Table 1. The data indicated that SWs who were older and had been employed longer generally had milder burnout levels. In terms

TABLE 1 General characteristics of respondents in the mild vs. severe burnout groups and a comparison of related factors.

	Mild burnout (MBI–HSS < 50) ($n = 107$)	Severe burnout (MBI–HSS ≥ 50) ($n = 75$)	t/χ^2	p-value
Gender [N (%)]				
Male	9 (8.4)	9 (12.0)	0.637	0.425
Female	98 (91.6)	66 (88.0)		
Age (M ± SD)	43.11 ± 8.76	38.21 ± 9.60	3.568	0.000*
Marital status [*N* (%)]			6.398	0.041*
Married	77 (72.0)	49 (65.3)		
Not married	14 (13.1)	20 (26.7)		
Divorced/separated	16 (15.0)	6 (8.0)		
Educational level [*N* (%)]			3.244	0.356
High school/ technical secondary school	5 (4.7)	6 (8.0)		
Professional training college	30 (28.0)	14 (18.7)		
Bachelor's degree	59 (55.1)	42 (56.0)		
Master's degree or above	13 (12.1)	13 (17.3)		
Years of employment [*N* (%)]				
≤10	30 (28.0)	32 (42.7)	4.201	0.040*
>10	77 (72.0)	43 (57.3)		
TM (M ± SD)	56.19 ± 8.78	44.87 ± 9.42	8.304	0.000*
NEs (M ± SD)	31.47 ± 5.90	37.96 ± 7.42	−6.568	0.000*
WB (M ± SD)	78.60 ± 12.09	61.96 ± 13.58	8.681	0.000*

N = 182, *p < 0.05.

TABLE 2 Correlation matrix among the key variables of TM, burnout, NEs, and WB.

	Variable	Mean (SD)	1	2	3	4
1	TM	51.52 (10.62)	1			
2	burnout	49.19 (16.72)	−0.623*	1		
3	NEs	34.14 (7.29)	−0.560*	0.544*	1	
4	WB	71.74 (15.12)	0.617*	−0.666*	−0.758*	1

N = 182, *p < 0.01.

of marital status, the proportion of married respondents in the mild burnout group was significantly higher. The TM and WB scores were higher among the mild burnout group, and their NEs scores were lower.

The correlations among the key variables of TM, burnout, NEs, and WB are listed in Table 2. A Pearson's correlation test demonstrated that TM was negatively correlated with burnout ($r = -0.623$, $p < 0.01$) and NEs ($r = -0.560$, $p < 0.01$), but it was positively correlated with WB ($r = 0.617$, $p < 0.01$). Although burnout was positively correlated with NEs ($r = 0.544$, $p < 0.01$), it was negatively correlated with WB ($r =$-0.666, $p < 0.01$). WB was negatively correlated with NEs ($r = -0.758$, $p < 0.01$). Therefore, **H1** was verified.

Next, a regression analysis was conducted on burnout, TM, NEs, and WB while controlling for age, gender, marital status, educational level, and years of employment. Concomitantly, we examined whether TM played a mediating role between burnout, NEs, and WB. The results of the regression analysis and the mediating effects of TM on burnout and NEs are listed in Table 3.

Burnout had a positive predictive effect on NEs ($\beta = 0.509$, $p < 0.001$), even after the addition of TM as a mediating variable ($\beta = 0.307$, $p < 0.001$), whereas TM had a negative predictive effect on NEs ($\beta = -0.334$, $p < 0.001$). TM played a partial mediating role in burnout's impact on NEs, with a mediating effect of 0.088, 95% CI [0.102-0.305], and an effect ratio of 39.7%.

The mediating effects of TM on burnout and WB are listed in Table 4. Burnout had a significantly negative predictive effect on WB ($\beta = -0.598$, $p < 0.001$), and TM had a significantly positive predictive effect on WB ($\beta = 0.299$, $p < 0.001$). TM played a partial mediating role in burnout's impact on NEs, with a mediating effect of−0.164, 95% CI [-0.285-−0.090], and an effect ratio of 30.3%.

The mediating effects of WB on burnout and NEs are listed in Table 5. WB had a significantly negative predictive effect on NEs ($\beta = -0.711$, $p < 0.001$). Further, when WB was used as the mediating variable, the positive predictive effect of burnout on NEs was weakened ($\beta = 0.084$, $p > 0.01$). WB also played a partial mediating role in burnout's effect on NEs, with a mediating effect of 0.185, 95% CI [0.313–0.545], and an effect ratio of 83.3%. This mediating relationship is presented

TABLE 3 Mediating effects of TM on burnout and NEs.

	NEs			TM			Burnout		
	β	SE	*p*-value	*β*	SE	*p*-value	*β*	SE	*p*-value
Age	−0.204	0.062	0.012*	0.190	0.084	0.011*	−0.141	0.060	0.073
Gender	−0.012	1.531	0.847	−0.061	2.072	0.295	−0.033	1.465	0.588
Marital status	−0.121	0.677	0.064	0.051	0.916	0.404	−0.104	0.647	0.095
Educational level	−0.119	0.588	0.054	0.082	0.795	0.151	−0.092	0.564	0.122
Years of employment	0.092	0.503	0.238	−0.213	0.681	0.003**	0.020	0.492	0.788
Burnout	0.509	0.028	0.000**	−0.606	0.038	0.000**	0.307	0.034	0.000**
TM							−0.334	0.053	0.000**
R^2		0.343			0.433			0.406	
Adjusted R^2		0.320			0.413			0.382	
F value		$F_{(6,175)} = 15.212$**			$F_{(6,175)} = 22.266$**			$F_{(7,174)} = 16.985$**	

N = 182, *$p < 0.05$, **$p < 0.001$.

TABLE 4 Mediating effects of TM on burnout and WB.

	WB			TM			WB		
	β	SE	*p*-value	*β*	SE	*p*-value	*β*	SE	*p*-value
Age	0.320	0.112	0.000**	0.190	0.084	0.011*	0.263	0.108	0.000**
Gender	−0.011	2.753	0.845	−0.061	2.072	0.295	0.008	2.623	0.882
Marital status	0.077	1.217	0.176	0.051	0.916	0.404	0.061	1.158	0.254
Educational level	0.040	1.057	0.456	0.082	0.795	0.151	0.015	1.010	0.766
Years of employment	−0.121	0.904	0.074	−0.213	0.681	0.003	−0.057	0.880	0.387
Burnout	−0.598	0.050	0.000**	−0.606	0.038	0.000**	−0.417	0.060	0.000**
TM							0.299	0.095	0.000**
R^2		0.506			0.433			0.557	
Adjusted R^2		0.489			0.413			0.539	
F value		$F_{(6,175)} = 29.906$**			$F_{(6,175)} = 22.266$**			$F_{(7,174)} = 31.259$**	

N = 182, *$p < 0.05$, **$p < 0.001$.

intuitively in Figure 2. Based on the results presented above, **H2** and **H3** were verified.

Discussion

The issue of burnout among medical staff received widespread attention during the pandemic. However, relatively few reports have examined burnout among SWs, who are also at a significantly high risk of experiencing psychological stress in the workplace. Existing surveys have concluded that burnout levels among SWs are increasing globally (58, 59). The findings of this study indicate that SWs still had high levels of burnout 1 year later after serving in communities that were under lockdown measures to control the COVID-19 pandemic in 2020. Of the total survey population, 41.2% of the respondents had a severe level of burnout. Contrarily, according to a survey conducted by Peng Shiyue et al. (60) in March 2020, which involved 249 medical staff in Wuhan who were similarly involved in COVID-19 prevention and control work, only 24.9% of the surveyed population had burnout. This proportion was much lower than that in the data gathered in this study and certainly lower than that in the data collected in surveys involving medical practitioner counterparts in other countries during the same period (30, 61, 62).

The relatively low burnout levels among the medical staff in China might be related to the rapid control of COVID-19 in Wuhan owing to the lockdowns enforced. However, SWs did not benefit from any reduction in burnout levels as a result of those measures. Although medical staff had significant levels of direct contact with infected patients, they received sufficient prior training and proper protective equipment. Therefore, their risk of infection was relatively low, and their confidence to complete their tasks was high. Medical staff across China

TABLE 5 Mediating effects of WB on burnout and NEs.

	NEs			WB			NEs		
	β	SE	*p*-value	*β*	SE	*p*-value	*β*	SE	*p*-value
Age	−0.204	0.062	0.012*	0.320	0.112	0.000***	0.023	0.052	0.730
Gender	−0.012	1.531	0.847	−0.011	2.753	0.845	−0.020	1.210	0.691
Marital status	−0.121	0.677	0.064	0.077	1.217	0.176	−0.067	0.538	0.197
Educational level	−0.119	0.588	0.054	0.040	1.057	0.456	−0.091	0.465	0.064
Years of employment	0.092	0.503	0.238	−0.121	0.904	0.074	0.006	0.401	0.924
Burnout	0.509	0.028	0.000***	−0.598	0.050	0.000***	0.084	0.028	0.201
WB							−0.711	0.033	0.000***
R^2		0.343			0.506			0.592	
Adjusted R^2		0.320			0.489			0.576	
F value		$F_{(6,175)} = 15.212$***			$F_{(6,175)} = 29.906$***			$F_{(7,174)} = 36.117$***	

N = 182, $^{*}p < 0.05$, $^{**}p < 0.001$.

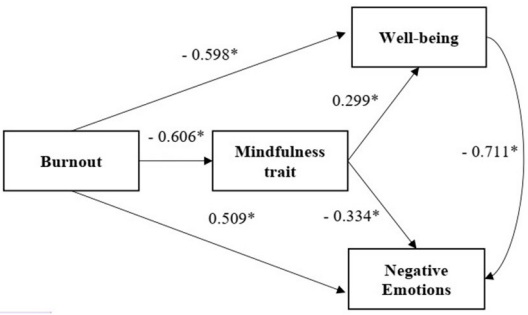

FIGURE 2
Mediating effect of MAAS on the impact of MBI–HSS on DASS-21 and GWB. Standardized *β*, *N* = 182, * *p* < 0.05.

has perennially managed heavy workloads and are often in a state of pessimism regarding their career prospects (63). They also suffer from significant levels of burnout owing to the persistent hazard of doctor–patient disputes and the long-standing negative evaluations that they face online and on social media (64, 65). Although the sudden outbreak of the epidemic has put enormous pressure on China's medical industry, the medical staff have received active publicity and social support, which has enhanced their sense of personal achievement and professional enthusiasm.

Although the sudden outbreak of the COVID-19 epidemic exerted enormous pressure on China's medical industry, the medical staff have received active publicity and social support, which has enhanced their sense of personal achievement and professional enthusiasm. This phenomenon of a high sense of personal achievement despite the pressure is also found in the Serbian doctor group (66). Since personal achievement is inversely proportional to emotional exhaustion, it is speculated that the level of burnout among Chinese physicians may have been offset to some extent by higher personal achievement, and may actually have been reduced.

Surveys conducted in Europe have indicated that professionals with non-medical backgrounds (e.g., psychologists, Pharmacists, SWs, et al.) might have faced additional stress levels compared to medical staff when undertaking work associated with COVID-19 prevention and control (66, 67). The tasks performed by medical staff in such situations were relatively specific, whereas those performed by SWs were highly complicated, menial, and nuanced (68). SWs also had to directly manage the actual difficulties, complaints, and mental health of community residents during the lockdown periods (69). These factors might have caused SWs to accumulate additional psychological pressure and trauma during the pandemic. In the 1 year since the pandemic was brought under control in China, long-term pandemic prevention and control work is still being conducted in the communities, which has significantly increased workload among SWs compared with their workload before the COVID-19 outbreak. Furthermore, most of them did not receive any prior training regarding stress reduction or recovery from psychological trauma. Therefore, we deduced that the aforementioned psychological problems they faced had not been alleviated effectively.

In addition to external work pressure, another source of burnout among SWs might be their personal characteristics, such as compartmentalization of their emotions and the inability to recognize the sources of such emotions and feelings of pressure. Using a cross-sectional survey as its basis, this study's focus was the impact of SWs' TM (a psychological quality) on their burnout, NEs, and WB. The findings indicate that TM is negatively correlated with both burnout and NEs in stressful contexts, whereas it is positively correlated with WB. A regression analysis further confirmed

that burnout promoted the generation of NEs and weakened WB, whereas TM still promoted WB and ameliorated the generation of NEs in the context of burnout. A similar phenomenon has been identified in various studies, such as those conducted by Sala et al. (70), Dillard and Meier (71), Trombka et al. (72), and Nadler et al. (73). When testing the mediating effects in this study, we established that burnout levels significantly reduced individuals' WB and correspondingly, increased their risk of NEs. TM played a partial mediating effect. When burnout levels were at severe levels, individuals with higher levels of TM had relatively better WB and fewer NEs. It is worth mentioning that WB was also found to have a partial mediating effect on burnout's impact on NEs.

Combining our findings with those of previous studies, the following psychological process of stress was inferred: When individuals experience an excessive stress load, their first response is physical and mental burnout as well as an instinctive resistance to the stressful occupational environment, which is followed by a decline in their levels of professional enthusiasm. If there is insufficient social support at this time and the individuals lack adequate self-support, their WB will decline, thereby resulting in increased levels of NEs, such as anxiety and depression. Individuals with low levels of TM tend to have lower self-compassion, thereby intensifying the physical and mental reactions of NEs (74). Eventually, their ability to function in social contexts will be affected, and their condition will satisfy the diagnostic criteria for mental illness. Some of the negative behaviors, such as complaints and impulsiveness, arising from the NEs will further affect the overall workplace experience and result in increased levels of burnout (75).

The core idea of TM involves having the self-awareness to truly experience the present moment consciously and non-judgmentally. Individuals with higher levels of TM are more focused on the awareness and self-acceptance of their physical and mental feelings, thereby reducing the risks of mental rumination and emotional dysregulation and enhancing their perceptions of social support (4), which results in an effective increase of WB in their minds (76). The occurrence of burnout can be prevented through the influence of various mediating effects. In the early burnout stages, these mediating effects can also protect individuals' WB and reduce their risk of developing anxiety and depression.

The inferences presented above are supported by the corresponding research data. For example, at the physiological level, individuals with high levels of TM have lower levels of cortisol and higher levels of parasympathetic nerve excitation. They also feel less burnout in stressful environments and have an increased tolerance to physical and mental discomfort (77, 78). At the psychological level, the non-judgmental attitude associated with TM makes individuals more inclined toward internal attribution. Previous studies have confirmed that such internal attribution improves self-efficacy among individuals (79), and it has been proven to be a protective factor against burnout (80). With a non-judgmental attitude, individuals with higher levels of TM are more likely to react by engaging in positive cognitive reconstruction and enhancing their subjective initiative when they deal with real stress in workplace environments (79). Therefore, such individuals can comprehend all their work-related problems from a new and highly macroscopic perspective, thereby attaining significant levels of WB (81). These findings indicate that TM is closely related to sufficient physical and mental health (70).

In this study, we focused on examining the practical value of TM in alleviating the negative physico-mental experiences resulting from burnout, and we constructed a mediating relationship model among the burnout, TM, NEs, and WB levels of SWs in China. The findings provide further insight into the current status of SWs' occupational stress when engaging in COVID-19 prevention and control, and they contribute to the literature supporting the examination of the value of TM among SWs' professional lives. Nevertheless, the findings have certain limitations. First, the results were based on data obtained from a cross-sectional survey. When communities in Wuhan were urgently locked down as a result of the COVID-19 pandemic, SWs had neither the time nor the conditions to participate in such surveys. Valuable data could have been obtained if such a survey was conducted a year earlier, and this is a regrettable situation. Second, the data were mainly collected through the subjective reporting of SWs, and the sample size was relatively small. The coverage was incomplete, and there might have been sampling bias. Despite the limitations mentioned above, this study highlighted the importance of individual intrinsic psychological qualities on mental health among SWs. The results serve as a reference for governments and the global society at large to work toward improving the occupational welfare of SWs. In our future studies, relevant training frameworks will be developed to enhance TM among individuals. We shall also further verify the actual effects of TM enhancement on reducing burnout levels through interventional research.

Conclusion

The findings of this study confirmed that the burnout levels among SWs in China remained relatively high 1 year after the enforcement of COVID-19 related community lockdowns. TM played a mediating role in the relationship between burnout levels, NEs, and WB, whereas WB played a mediating role between burnout levels and NEs. In states of burnout, TM, through the improvement of WB, acted as a protective factor that reduced emotional stress and the risk of developing psychiatric disorders among SWs in China.

Data availability statement

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

Author contributions

YWu was responsible for the design of the study, the processing and analyses of the data, and the writing of the paper. YWe and YL were responsible for technical guidance and the quality control of the study. JP and YS were in charge of data collection. All authors have read and approved the final manuscript.

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Conflict of interest

Author JP was employed by Guangzhou Juenian Consulting Co., Ltd. Author YS was employed by Hainan Mindfulness Education Technology Co., Ltd.

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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The adverse impact of excessive internet use during the COVID-19 pandemic on adolescents' coping skills: A case study in Hanoi, Vietnam 2021

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Introduction: The COVID-19 pandemic has created significant stressors in Vietnamese adolescents' lives. Coping skills play important roles in helping adolescents contend with stress. This study aimed to evaluate adolescents' coping skills during the COVID-19 pandemic and examine how those skills are impacted by excessive internet use during this pandemic.

Methods: The study used respondent-driven sampling and Google online survey forms to collect data. The study sample included 5,315 high school students aged 11- 17 years in Hanoi's rural and urban areas. The Kid Coping Scale was applied to examine adolescents' coping, and the coping score was compared among adolescents with different levels of internet use.

Results: The average coping score measured by Kid Coping Scale was 20.40 (std = 2.13). About half of adolescents often "avoid the problem or the area where it happened" when experiencing a hard time. One-third of adolescents often stopped thinking about the problem they faced. More than one-fourth of respondents stayed online for at least 8 h per day. The online time for learning/other activities showed a reverse dose-response relationship with the coping score; the longer the internet use duration, the lower the coping score.

Conclusion: The mean score of coping of Hanoi adolescents was moderate. Internet use has an adverse impact on their coping skills.

KEYWORDS

COVID-19, children, adolescent, mental health, pandemic effects

Introduction

Coronavirus disease 2019 (COVID19), which was declared a pandemic on March 11, 2020 (1), is currently causing thousands of deaths worldwide. Because of this situation, social confinement for the entire population, including adolescents, became mandatory in many countries.

Adolescents are a vulnerable population undergoing a challenging transition period (2). COVID-19 detention has impacted adolescents' physical, mental, and emotional

well-being (3). Lockdown due to the COVID-19 pandemic has obliged school children to stay at home, have e-classes from home, and increase the time of access to the internet and social media (4). School children see their family members too much while having too little interaction with friends (5). Apart from that, all plans are canceled or postponed quite often. Children worry about the economic future of their family and country, have felt less secure than in the past (4), and are uncertain about the future. All these things can make them stressed during a challenging time (6–9). The pandemic has affected children at different levels – health, social, family, and individual (10). They worried about their family, friends, and physical health; they also felt unfocused and anxious and had negative thoughts during the pandemic (11). The physical and mental impact of the COVID-19 epidemic on children and adolescents is a matter of fundamental importance both for governments and families (4).

One of the most potent risk factors for psychopathology during childhood and adolescence is exposure to acute and chronic stressful events and adversity. However, not all children and adolescents who face stress and adversity develop symptoms of psychopathology, raising the question of why some children and adolescents suffer while others are resilient. The ability to cope with stressful events and circumstances and regulate emotions in various situations may play an essential role in developing resilience and reducing the risk of psychopathology during childhood and adolescence (12, 13).

Coping is a complex concept that can protect against or increase the risk of adverse mental health outcomes during stressful life experiences. Coping was defined as "constantly changing cognitive and behavioral efforts to manage specific external and internal demands that are appraised as taxing or exceeding the person's resources" (14). Coping is important in considering how stressors affect children and adolescents because it emphasizes a child's active role in the transactional process of dealing with stressful situations in their lives while also bringing reflections about one's future development (13). The scope of coping has broadened with a growing emphasis on coping as the regulation of a broader range of functions, including emotion, behavior, cognition, physiology, and the environment, in response to stress (15).

During the COVID-19 pandemic, children are not allowed to go to school and must continue to study at home. This increases their internet usage during the day. In addition to using cyberspace for their studies, students access it for many other purposes, such as reading news, surfing websites, and joining social networks. Long internet use duration has been demonstrated to affect children's health, social competence, and behavioral competence (16). Understanding how the youth cope with such significant life upheavals will help ensure that youth support activities are appropriately targeted and successful. However, the literature on children's coping strategies during the COVID-19 pandemic is still limited. In October 2021, many new cases and deaths due to COVID-19 continued to be reported in Vietnam (17), and schools in many provinces (including Hanoi) were closed. Hanoi have been applied online teaching and learning.

This study, therefore, was conducted to investigate coping skills among adolescents in Hanoi and explore the association between the average time of their internet use per day and their coping skills.

Materials and methods

Study design and setting

This study employed a cross-sectional design conducted in Hanoi Capital, Vietnam. Hanoi consists of 12 urban districts, one district-leveled town, and 17 rural districts (18).

Study participants

The inclusion criteria for participants were children aged 11–17 years old, living in Hanoi, and accessing the internet to complete the form. No exclusion criteria were applied in the study.

Sample size and sampling method

The sample size was calculated based on a single population formula with absolute precision. We had no information about the proportion of children with coping issues in Vietnam, so we chose $p = 0.5$ to maximize the sample size and a small d of 0.03, 95% confidence level at $z = 1.96$, producing a sample size of 1,068 children. Since we want to provide estimation separately for male/female and urban/rural and estimated non-response rate of 25%, the estimated sample size was 5,340.

The respondent-driven sampling method was used, and data were collected using Google online survey forms. We started with a group of 100 core members selected representatives of different age from 11 to 17, male and female (50% was male and 50% was female), rural and urban (students was randomly invited from five rural districts and five urban districts). Each core member was asked to send the forms to five friends to complete and ask each of those friends to continue forwarding the link to the next five friends. The participants can forward the link through zalo, Facebook, or email. The study sampled 5,315 students aged 11–17 years attending some secondary and high schools in Hanoi's rural/urban areas. The secondary school students accounted for 55.94% of all respondents; the rest were high school students.

Data collection

Data was collected through a monkey survey in Google Forms. The electronic questionnaire's content and interface were designed and tested so that the audience could answer the survey on such media as smartphones, tablets, and computers. Respondents completed the online survey between October and December 2021. The survey included demographic factors, hardships during the COVID-19 pandemic, family care, family pressure, and coping strategies. The Kid Coping Scale (KCS) was applied to examine their coping skills.

Measurements

Coping scale

The studies based on the research work of Maybery et al. (19) on coping strategies for stressful situations (Kid Coping Scale-KCS) examined three main coping strategies: (1) Problem-focused coping (try to think the different way to solve the problem/*try the best to make things better/try hard to fix the problem/say sorry if it is your fault); (2)* Emotion-focused coping *(Distracting yourself from thinking about the problem/ avoid the problem or the area where it happened/ did something else to stop thinking about the problem); (3)* Seeking social support *(thought about what others might do/sought help from others)*. The KCS applied the Likert scale (with three levels: never, sometimes, and always).

Up to now, the Kid Coping Scale was not available in Vietnamese. The research team applied the following process to translate the tool: (1) two people translated the questionnaire into Vietnamese and compared their translation to make changes when necessary (2) back translation: the Vietnamese version was translated into English by a third person to make sure no contents of the questionnaire was lost during translation (3) pretest the translated Vietnamese version: 10 high school students were selected for the pretest, they provided comment on words that don't quite translate well, were ambiguous; and (4) finalizing translation. Internal consistency in the current sample was 0.81 for problem-solving coping, 0.79 for avoidant coping, and 0.90 for social support-seeking coping.

The scores for each component's total coping skills were calculated by taking all items/items in each element. The KCS had nine items, which entity would have a score range from 1 (never) to 3 (always), so the minimum score was nine and the maximum score was 27. The higher score represents a greater active/passive coping tendency. Besides that, the adolescent who has an issue with coping if they answered at least 1 question as never in the domain (emotion-focused coping, problem-focused coping, and seeking social support).

Internet use

Measuring the daily average online time of an adolescent. During Covid time, all the secondary high school children study online for an average of 3.5 h in the morning, and Jason et al. mentioned that the average time for kids using the internet was 8 h during Covid time (20). We consider more than 8 h was high, but we also want to look at a lower cut-off point. Internet use was categorized into four groups: <4 h, 4–6 h, 6–8 h, and 8 h and more.

Family care and family pressure

Family care and family pressure were measured by the Global School-based Student Health tool (21). This tool applied the Likert scale (with five levels, namely never, rarely, sometimes, often, and always). It consisted of seven items regarding the frequencies at which parents or guardians did during the past 30 days (four items for family care and three items for family pressure): (1) the parent/guardian checked if their child did homework, (2) the parent/guardian understood their child's problems and worries, (3) the parent/guardian knew what their child was doing in his/her free time, (4) the parent/guardian gave advice and guidance to their child, (5) the parent/guardian expected too much of their child, (6) the parent/guardian did not respect their child as a person, and (7) the respondent was involved in a physical fight during the past 12 months. The sum of the item score was used as the scale for family care and family pressure.

Other information included demographic information (gender, age), grade, and the person with whom the child lives (parents, a single parent, and neither mother/father).

Data analysis

In this study, research data were expressed as frequencies and percentages. Frequencies and means were used to identify the rates of coping strategies children used. Univariate and multiple linear regression models were applied to determine the relationship between independent factors and the coping score (dependent variable). We had a conceptual framework for the original study for all the related factors of children's psychological status like coping skills. The questionnaire (for related factors) was developed based on literature and the variables selected for the multiple regression model were chosen based on that. The univariate analysis was performed, and the results of these relations with a $p < 0.2$ were included in the multivariate linear regression. A p-value <0.05 was regarded as statistically significant. Statistical analyses were performed using STATA version 17.0.

Ethics

Ethical clearance, including confidentiality of the participants' consents and information, was approved by the Human Research Ethics Committee at The first author's institution with No. 382/2021/YTCC-HD3. No sensitive data that could identify the participants was collected. Informed consent was described in the instrument, with mandatory acceptance to proceed. There was also a contact for further clarification.

As the survey collected data through Google form, we anticipated it would be challenging to obtain parental and children's consent forms. Also, the 45 CFR § 46.104 - Exempt research stated that "*research subject to subpart D involving educational tests or the observation of public behavior when the investigator(s) do not participate in the activities being observed*" may have exempt of parental ethnics (22). We had sought the permission of the IRB the waive parental consent forms.

Results

Table 1 shows the sociodemographic characteristics of the study participants, including 5,315 children aged 11 to 17 years, with 2,177 boys (41.0%) and 3,138 girls (59%). Ninety-two percent of the children reported living with their parents, 7.6% living under one roof with a single parent, and 0.4% living alone. About 53% of the participants are from the rural area of Ha Noi. During the COVID-19 pandemic, about 27.3% of the participants lived in families that experienced difficulty in buying food. One-fourth of the children had at least one parent who became jobless due to COVID-19. About 12% had experienced domestic family violence during this pandemic. Children surfing the internet for at least 6 h a day accounted for 50% of all participants.

Table 2 shows that more than one-third (37.2%) of the participants had parents or guardians who often or always check their homework. According to nearly half of the participants, their parents or guardians often or always understood their problems/worries during the past 30 days. Moreover, half of the children reported that their parents or guardians knew what they did in their free time, and 53.5% often or always received advice and guidance from their parents or guardians during the past 30 days.

Regarding family pressure (Table 2), 60.9% of participants reported that their parents or guardians often or always expected too much of them. Nearly one-fourth of parents or guardians often did not respect their child as a person during the past 30 days. Children who reported being often and always involved in a physical fight during the past 12 months accounted for 5.5%.

Table 3 shows the respondents' self-reports of how they confronted a stressful situation during the COVID-19 pandemic. In the three groups of active coping strategies,

TABLE 1 Characteristics of the study sample.

Characteristics	Male; *n* (%) *n* = 2,177 (41.0)	Female; *n* (%) *n* = 3,138 (59.0)	Total; *n* (%) *n* = 5,315
Age			
Aged 11	138 (6.3)	195 (6.2)	333 (6.3)
Aged 12	147 (6.7)	221 (7.0)	368 (6.9)
Aged 13	232 (10.7)	260 (8.3)	492 (9.3)
Aged 14	305 (14.0)	342 (10.9)	647 (12.2)
Aged 15	609 (28.0)	877 (27.9)	1,486 (28.0)
Aged 16	432 (19.8)	741 (22.1)	1,173 (22.1)
Aged 17	314 (14.4)	502 (15.3)	816 (15.4)
Location			
Rural	1,055 (48.5)	1,739 (55.4)	2,794 (52.6)
Urban	1,122 (51.5)	1,399 (44.6)	2,521 (47.4)
Living with			
Parents	1,997 (91.5)	2,892 (92.2)	4,889 (92.0)
Single parent	170 (7.8)	235 (7.5)	405 (7.6)
Neither with mother/father	10 (0.5)	11 (0.3)	21 (0.4)
Living in a family that experienced difficulty buying food	548 (25.2)	905 (28.8)	1,453 (27.3)
Having at least one parent unemployed due to COVID	442 (20.3)	850 (27.1)	1,292 (24.3)
Experiencing domestic family violence during the COVID time	218 (10.0)	401 (12.8)	619 (11.6)
Average Online time per day			
Less than 4 h	987 (45.3)	1,241 (39.5)	2,228 (41.9)
4 to 6 h	182 (8.4)	260 (8.3)	442 (8.3)
6 to 8 h	475 (21.8)	708 (22.6)	1,183 (22.3)
8 h or more	533 (24.5)	929 (29.6)	1,462 (27.5)

"Saying sorry if it is your fault" was the most applied (57.4%), followed by "Thinking about what others might do" (50.6%), and "Trying your best to make things better" (48.6%). Only 3.8% reported trying hard to fix the problems they encountered. The average total score of coping was 20.40 (std = 2.13).

Figure 1 shows that the percentage of adolescents having issues with emotion-focused coping, problem-focused coping, and seeking social support was 25.0, 32.9, and 32.8%, respectively.

Table 4 shows that daily internet usage was negatively associated with the children's coping score ($p < 0.001$) in the

TABLE 2 Family care and family pressure during the COVID-19 pandemic.

Family care and family pressure during the COVID-19 pandemic	Frequency				
	Never *n* (%)	Rarely *n* (%)	Sometimes *n* (%)	Often *n* (%)	Always *n* (%)
Family care (Mean: 9.5; sd: 3.0)					
The parent/guardian checked if their child did homework during the past 30 days.	862 (16.2)	606 (11.4)	1,868 (35.1)	1,425 (26.8)	554 (10.4)
The parent/guardian understood their child's problems and worries during the past 30 days.	520 (9.8)	829 (15.6)	1,502 (28.3)	1,125 (21.2)	1,339 (25.2)
The parent/guardian knew what their child was doing in his/her free time during the past 30 days.	412 (7.8)	584 (11.0)	1,677 (31.6)	1,158 (21.8)	1,484 (27.9)
The parent/guardian gave their child advice and guidance during the past 30 days.	230 (4.3)	455 (8.6)	1,786 (33.6)	1,409 (26.5)	1,435 (27.0)
Family pressure (Mean: 4.8; sd: 2.1)					
The parent/guardian expected too much of their child (i.e., to perform better at school or to be a better person) during the past 30 days.	321 (6.0)	441 (8.3)	1,317 (24.8)	2,012 (37.9)	1,224 (23.0)
The parent/guardian did not respect their child as a person (i.e., not letting their child talk or favoring someone else more than their child) during the past 30 days.	2,824 (53.1)	956 (18.0)	355 (6.7)	427 (8.0)	753 (14.2)
The participant (i.e., the child) was involved in a physical fight during the past 12 months.	592 (11.1)	4,402 (82.8)	31 (0.6)	30 (0.6)	260 (4.9)

TABLE 3 Self–reports of coping with a stressful situation during the COVID-19 pandemic.

Kid cope scale	Never; *n* (%)	Sometimes; *n* (%)	Always; *n* (%)
Problem-solving			
Trying to think of a different way to solve the problem	138 (2.6)	3,654 (68.7)	1,523 (28.7)
Trying your best to make things better	93 (1.7)	2,640 (49.7)	2,582 (48.6)
Trying hard to fix the problem	1,785 (33.6)	3,329 (62.6)	201 (3.8)
Saying sorry if it is your fault	71 (1.3)	2,194 (41.3)	3,050 (57.4)
Avoidant			
Distracting yourself from thinking about the problem	67 (12.7)	3,753 (70.6)	886 (16.7)
Avoiding the problem or the area where it happened	160 (3.0)	2,674 (50.3)	2,481 (46.7)
Doing something else to stop thinking about the problem	888 (16.7)	2,616 (49.2)	1,811 (34.1)
Social support seeking			
Thinking about what others might do	717 (13.5)	1,907 (35.9)	2,691 (50.6)
Seeking help from others	264 (5.0)	2,965 (55.8)	2,086 (39.2)

multivariate model, with other factors being held constant. Staying online for about 6 to 8 h per day or at least 8 h led to a 0.45-fold decrease (95% CI: −0.29; 0.61) and a 0.62-fold decrease (95% CI: 0.47; 0.78) in the general coping score, respectively.

In addition, living in a rural area, having family care, having at least one parent unemployed due to COVID, living in a family that experienced difficulty buying food, and living alone were factors related to children's coping score ($p < 0.05$). Meanwhile, gender, family pressure, and experience of domestic family violence during COVID time had no significant association with their coping score ($p > 0.05$), with other factors being held constant.

Discussion

Kid coping

The present study reports on adolescents coping with challenging situations during the COVID-19 pandemic in Hanoi, Vietnam. Research on coping and emotion regulation in

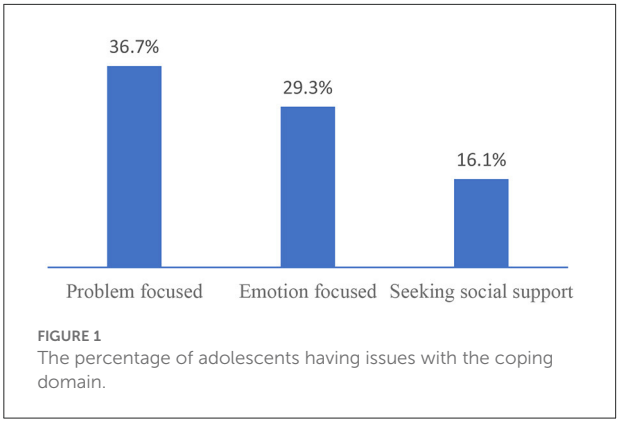

FIGURE 1
The percentage of adolescents having issues with the coping domain.

children and adolescents is critical for the field of developmental psychopathology and prevention science because of its potential to inform our understanding of risk, resilience, and intervention processes. Our findings from the analysis suggest that kid coping of children in Hanoi was quite low.

Coping strategies are related to symptoms of psychopathology (12). Avoidant coping is a risk factor for developing anxiety or depression in adolescents (7, 23, 24). In contrast, children with active coping, including problem-solving, predicted a lower risk of new-onset depression later (25–27). Adolescents who seek social support are less likely to develop depression and anxiety symptoms (12, 15, 28).

In our study, about 87% of adolescents reported "distracting yourself from thinking about the problem" this result was similar to the study of Campbell et al. (29), with 84.7% of adolescents reported "just tried to forget it" when they faced with a problem. There was 83.3% of adolescents reported "doing something else to stop thinking about the problem," and 66.4% of adolescents reported "trying hard to fix the problem" those results were higher than the results of Campbell et al. (29). The reason may be due to our research conducted in the context of the Covid-19 pandemic, and the culture in diffentce.

In line with the previous studies, children utilized a variety of strategies to cope with stress (28–31), reflecting a need for children to attempt to cope. Children most frequently reported using avoidant coping and social coping, findings that are consistent with the existing research (29, 30). Children do not use a single strategy to cope, supporting speculation presented by other studíe that children essentially "try out" a large variety of strategies before determining which are effective and/or feasible (28–30, 32, 33).

Although our study did not address children's assessment of effective coping strategies, many studies show that social support or emotional coping methods were partially effective and better than avoidance strategy (29–31, 33, 34). Zimmer et al. also pointed out that proactive coping, not avoidant, was related to better psychological well-being in children, but only in controllable situations/contexts (13). Future research should consider the effectiveness of coping strategies in adolescents.

Several adolescents still hide/avoidant the problems they face instead of thinking positively and solving them. This is dangerous because youths who engage in avoidant coping behaviors (such as distraction, self-blame, or behavioral disengagement) are more likely to experience emotional distress. In contrast, those who engage in active/adaptive coping strategies are less likely to experience negative mental health symptoms (24, 35, 36). However, in uncontrollable situations, for example, the COVID-19 pandemic, the secondary control strategies (i.e., avoidant) may be more effective (13, 37). Because of the global scale of the COVID-19 spread, young people may feel powerless to change the situation, resorting to secondary control strategies such as distraction to deal with the pandemic's effects.

Relationship between internet use and kid coping

Bach et al. indicated that COVID-19 restrictions increased the global internet use (38). The change in children's Internet use and their activities on the internet also directly affects how children face and deal with other risks. Internet use has been linked to loneliness and can provide short-term relief and relief from stress in response to the psychological distress of the pandemic. The literature also suggests increased Internet use is associated with poor psychological regulation (39).

The study results showed that the coping score decreased as the internet use duration increased. This result corresponds to Singh et al. (40); with increased internet usage, there was an increase in maladapted coping. This can be explained by the fact that children spend much time on the internet, so they do not have time to think and actively face stressful issues in life. The virtual world created by the internet offers children the opportunity to escape external stress and real-life difficulties through short-term joys and relief. However, this also reduces the child's ability to cope with reality and will affect the child's mental health capacity, making the child use the internet more and leading to internet addiction.

Strength and limitation

This study has some important strengths. As already underlined, this is one of the first studies conducted in Vietnam about children coping with stress and the relationship between internet use duration and the coping of the children. Another strength is the large sample size, with more than 5,000 Hanoian teenagers participating in our study.

Regarding limitations, and due to the characteristics of this current time of isolation, all the respondents answered an

TABLE 4 Regression model for the relationship of internet use duration with the coping of the children.

Characteristics	Univariate analysis		Multivariate analysis	
	Coeff	95%CI	Coeff	95%CI
Internet use duration per day				
Less than 4 h	Ref		Ref	
4 to under 6 h	−0.17	−0.4 to 0.06	−0.13	−0.36 to 0.09
6 to under 8 h	−0.61***	−0.77 to −0.45	−0.45***	−0.61 to −0.29
8 h and more	−0.86***	−1.01 to−0.72	−0.62***	−0.78 to −0.47
Gender				
Male	Ref		Ref	
Female	−0.07	−0.19 to 0.06	0.01	−0.11 to 0.13
Location				
Urban	Ref		Ref	
Rural	0.02	−0.04 to 0.09	0.06*	0.001 to 0.12
Living with				
Parents	Ref		Ref	
Single parent	0.07	−0.16 to 0.3	0.13	−0.09 to 0.36
No one	−1.31**	−2.28 to −0.33	−1.02*	−1.97 to −0.06
Family care	0.14***	0.12 to 0.16	0.11***	0.08 to 0.13
Family pressure	−0.04*	−0.07 to −0.01	−0.02	−0.05 to 0.01
Having at least one parent unemployed due to COVID.	0.25***	0.11 to 0.39	0.2**	0.06 to 0.34
Living in a family that experienced difficulty buying food	0.26***	0.12 to 0.4	0.25***	0.11 to 0.38
Experiencing domestic family violence during the COVID time	−0.46***	−0.65 to−0.27	−0.17	−0.37 to 0.03

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
A 1-unit increase in covariate corresponds to a b-increase in the total coping score (if the coefficient >0) or a b-decrease in a total coping score (if the coefficient <0).

online questionnaire using self-reported measures; hence, the accuracy of the answers and the potential influence of self-report bias on the results could not be determined. Second, a precise causal relationship between the variables cannot be established because this is a cross-sectional study. Third, the respondent-driven sampling technique was another limitation; the sampling process was non-random and could lead to potential sampling bias. Future research should employ face-to-face self-administered interviews and a probability sampling approach to select more representative respondents.

Conclusion

During the COVID-19 pandemic, Hanoi adolescents with a score of coping skills were moderate. Many of them use the internet for 8 h and more per day. Internet use has an adverse impact on their coping. Therefore, parents and family members should provide a supportive environment, which may improve adolescents' coping skills and, as a result, lower their risk of mental health. The future study should determine the effectiveness of coping strategies in adolescents and children's coping skills from a parent's perspective.

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 clearance, including confidentiality of the participants' consents and information, was approved by the Human Research Ethics Committee at Hanoi University of Public Health. No sensitive data that could identify the participants was collected. Informed consent was described in the instrument, with mandatory acceptance to proceed. There was also a contact for further clarification. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

QB and DP designed and conceptualized the paper. QB and CP analyzed the data. All authors interpreted the results, prepared and reviewed the manuscript, and contributed to the

critical revision of the manuscript for important intellectual content read and approved the final manuscript.

Conflict of interest

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

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The relationship between COVID-19-related restrictions and fear of missing out, problematic smartphone use, and mental health in college students: The moderated moderation effect of resilience and social support

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As one of the groups most affected by the epidemic, the mental health of college students during the epidemic is a focus of attention in multiple fields. Based on resource conservation theory, this study investigates the impact of COVID-19-related restrictions on college students' problematic smartphone use and mental health from two perspectives, students' individual factors and external environmental factors, and specifically explores the role of fear of missing out (FoMO), resilience and social support in this context. This study used a questionnaire method, and to control for common method bias, a multitemporal data collection strategy was used. The study used online questionnaire distribution, the final sample included 975 Chinese college students (497 males and 478 females), and of these, 10.3% were freshmen, 31.9% were sophomores, 31.6% were juniors, 12.3% were seniors, and 13.9% were postgraduates. The results of this study showed the following: (1) Perceived COVID-19-related strain was positively correlated with perceived FoMO, problematic smartphone use and mental health problems (depression, anxiety, stress) among college students. (2) FoMO partially mediated the relationship between perceived COVID-19-related restrictions and problematic smartphone use, and it fully mediated the relationship between perceived COVID-19-related restrictions and mental health problems. (3) Resilience and social support co-moderated the relationship between FoMO and problematic smartphone use or mental health problems (depression, anxiety, stress).

KEYWORDS

COVID-19-related restrictions, fear of missing out, problematic smartphone use, mental health, resilience, social support

Introduction

According to the 49th Statistical Report on the Development of the Internet in China, the number of China's internet users reached 1.032 billion, and the internet penetration rate reached 73.0%. Mobile phones account for 99.7% of internet users and are the main devices used for accessing the internet, and college students are one of the top three main groups, accounting for 17.3% of users. The popularity of the smartphone and the depth of connection users have with it has awakened concerns about its addictive potential (1). Excessive use of smartphones can lead to many undesirable problems, such as addiction-like symptoms and feelings of dependency, which is termed problematic smartphone use (2). Numerous studies have shown a strong link between problematic smartphone use and mental health, especially during the COVID-19 pandemic (3–5). As one of the groups most affected by the epidemic, students' mental health is a major focus of attention in multiple areas because their learning styles and lifestyles have been significantly altered by COVID-19-related restrictions during the COVID-19 pandemic. Therefore, it is necessary to explore the mechanisms underlying the rise in problematic smartphone use and mental health problems among college students during the epidemic and to identify the protective factors that exist between them.

As the COVID-19 pandemic continues to lengthen, the sense of panic caused by the unknown nature of the epidemic is diminishing, and countries are entering the post-epidemic era one after another. As a result, researchers have investigated whether COVID-19-related restrictions, such as home isolation, community closures, online working and public place closures, have had an impact on people's mental health (6). According to self-determination theory, human behavior is divided into self-determined and non-self-determined behavior with three basic psychological needs, autonomy, competence and relationship, and considers drives, intrinsic needs and emotions as sources of motivation for self-determined behavior (7, 8). COVID-19-related restrictions are force majeure measures arising from COVID-19, which are non-self-determined behaviors that undermine the social environment and, to some extent, the three basic needs that could have been met. However, the satisfaction of basic needs is a guarantee of a stable level of mental health. Studies have shown that during the epidemic, there was a significant increase in levels of anxiety and depression among the student population, and the amount of time spent on screens per day changed significantly from the pre-epidemic period (9–12). The reasons for this have been explored by numerous scholars, with students' lack of self-control, the use of online teaching and learning, and the adverse effects of unmet psychological needs and increased isolation of students due to COVID-19-related restrictions all being risk factors for increased problematic smartphone use among students (13). While the current post-epidemic era has seen researchers turn their attention to the range of effects of COVID-19-related restrictions, the underlying mechanisms are still less well-documented, and it remains to be seen how the lack of needs associated with COVID-19-related restrictions has led to more problematic smartphone use and mental problems.

How do COVID-19-related restrictions trigger problematic smartphone use and mental health problems? The problematic smartphone use associated with COVID-19-related restrictions may be different from avoidance-induced mobile phone addiction (13). The increased use of mobile phones during the COVID-19 blockade somewhat alleviated the lack of relational needs, as people used their phones frequently to socialize with friends and family and to obtain epidemic-related information and real-time news from the outside world, but while this alleviated the fear of lack of information, it also created more anxiety, which in turn exacerbated problematic smartphone use (11). Tandon et al. (14) suggests that frequent use of social media to access information about the outside world and others sometimes creates jealousy, and smartphone is one of the most important channels for social media use. That is, the contrast and disparity between the blocked restrictions of one's area and the freedom of others triggers fear of missing out (FoMO) and exacerbates problematic smartphone use. FoMO is a diffuse anxiety caused by an individual's fear of missing out on a novel experience or positive event for others (15). For example, it has been shown that during an epidemic, people are more likely to experience FoMO through online information because of the reduction in offline activities and the abundance of online content due to restrictions (16). Regarding the association between FoMO and problematic smartphone use and mental health problems, according to self-determination theory, individuals experience impaired self-regulation, or FoMO, when their basic psychological needs are not met (15). It has been shown that the lack of relational needs caused by the associated limitations of the epidemic negatively predicts FoMO (6). COVID-19-related restrictions break down people's autonomy, competence and relatedness, and spatial and social restrictions compromise these three basic needs, creating FoMO. In addition, a study by Koban confirmed that an increase in epidemic-related FoMO can affect a person's level of mental health and contribute to daytime fatigue (17). Thus, FoMO may mediate the relationship between COVID-19-related restrictions and problematic smartphone use or levels of mental health.

Although the stress associated with the perceived epidemic and FoMO can increase students' problematic smartphone use and affect their mental health, not all students are severely affected by COVID-19. Conservation of resources theory suggests that individuals have a tendency to strive to acquire, maintain, nurture, and protect the resources they value (18, 19). That is, people use the key resources they have to cope with stressful situations in their current environment while also actively constructing and protecting their existing resource reserves to cope with possible future stressful situations. In a study by Liu and others, resilience and social support were

identified as important protective factors for college students in coping with the epidemic after returning to school in the post-epidemic era (20).

Resilience is an individual characteristic that is both variable and stable, reflecting an individual's ability to cope positively with adversity and recover quickly. Resilience has been shown to improve students' environmental adaptability (21). The dynamic model of resilience suggests that resilience is a potential and that students have multiple psychological needs as they grow and that when these psychological needs are met, they develop psychological characteristics that can be transformed into internal resources for the individual (22). COVID-19-related restrictions are the inevitable pressures brought about by changes in the external environment. According to conservation of resources theory (18), people use the key resources they possess to cope with stressful situations in their current environment, and the resilience possessed by college students as they develop during their formative years is a collection of key resources. Resilience is one of the protective resources. Since the beginning of the epidemic, it has been empirically demonstrated that people with high resilience have more stable levels of emotional and mental health during the epidemic and have less problematic smartphone use (23, 24).

Raschke and Helen (25) suggest that social support refers to the care and support people feel from others. Social and emotional support and having good social relationships help to reduce depressive symptoms, control emotions, reduce behavioral problems and increase students' resilience (26). Because of COVID-19-related restrictions for college students, closure is the most immediate measure. According to Bronfenbrenner's ecosystem theory, the university campus is an important microsystem for students at this time. The school, as the main place of activity for college students during closure, and the social support felt on campus are important breakthroughs to compensate for students' psychological needs. In turn, according to the dynamic model of resilience and self-determination theory, social support is an important means of forming and enhancing students' resilience (22). Also, according to conservation of resources theory, social support from school, family, and friends completes the student's psychological protective resources and allows for a constant source of protection against COVID-19 crises, so it may work in tandem with resilience to collectively and directly reduce the impact of FoMO on mental health and problematic smartphone use.

Building on previous theoretical and research foundations, we attempted to extend previous research by constructing two moderated moderated-mediation models (Figure 1). Problematic smartphone use and mental health problems were two important research variables during the COVID-19, reflecting the negative effects of the COVID-19 on students from both the behavioral (extrinsic) and psychological (intrinsic) sides. The design of the two independent models allows for a more distinct presentation of the behavioral and psychological

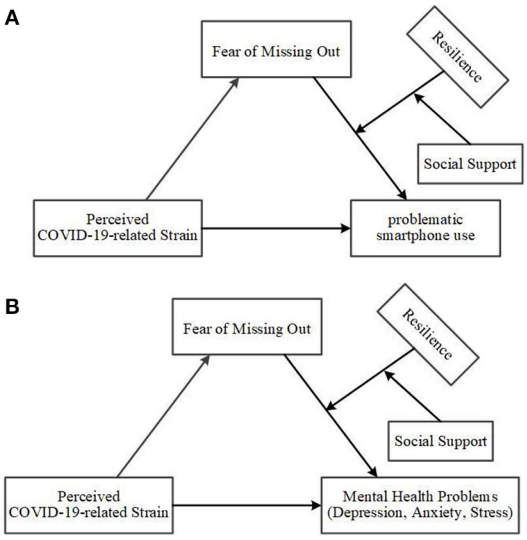

FIGURE 1
(A) The moderated moderated-mediation model of problematic smartphone use. **(B)** The moderated moderated-mediation model of mental health problem.

effects, and because of the dual moderator variable design, this also makes the model more concise and intuitive, better presenting the focus of this study. The model explores the relationship between COVID-19-related restrictions and problematic smartphone use and mental health among college students and its internal mechanisms and explores its moderating role between FoMO and problematic smartphone use or mental health among college students in terms of both the individual's own (resilience) and external forces (social support). This study aims to test the following hypotheses:

H1a: Perceived COVID-19-related restrictions is positively associated with problematic smartphone use among college students.
H1b: Perceived COVID-19-related restrictions is positively associated with mental health problems (depression, anxiety, stress) among college students.
H2: Perceived COVID-19-related restrictions is positively associated with FoMO.
H3a: FoMO mediates the association between perceived COVID-19-related restrictions and problematic smartphone use among college students.
H3b: FoMO mediates the relationship between perceived COVID-19-related restrictions and mental health problems (depression, anxiety, stress) among college students.
H4a: The resilience and social support levels of college students co-moderate the relationship between FoMO and problematic smartphone use; that is, the resilience and social support levels of college students can

effectively mitigate the effect of FoMO on problematic smartphone use.

H4b: The level of resilience and social support of college students co-moderates the relationship between FoMO and mental health problems (depression, anxiety, stress); that is, the level of resilience and social support of college students can effectively mitigate the effect of FoMO on mental health problems (depression, anxiety, stress).

Materials and methods

Sample

This study used a questionnaire method. To control for common method bias, a multitemporal data collection strategy was used, with data on perceived COVID-19-related restrictions, FoMO, resilience and social support collected at time point T1 (February, 2022) and data on problematic smartphone use and mental health problems collected at time point T2 (April, 2022). To ensure the validity of the measure, Osborne and Costello (27) suggested that the sample size should be 5–10 times the total number of question items. In this study the total number of question items was 97, therefore, we considered it appropriate to recruit about a thousand participants. And the study used online questionnaire distribution. Drawing on Elhai et al. (28), we used the popular Chinese social networking app WeChat to invite participants. We first arranged and recruited the heads of each year at several universities and invited their classmates through the heads. Prior to the survey, all students were informed that the study would be conducted anonymously and that their information would be kept confidential. Interested participants received an online informed consent form. Each participant receives a reward for completion in the amount of RMB 2.

In this study, a series of questionnaires were distributed to 1,003 college students from China. Of the participants, 28 did not complete the surveys and were excluded from the analysis. Thus, the final sample included 975 participants, of which 497 were from males and 478 were from females. In these students, 10.3% were freshmen, 31.9% were sophomores, 31.6% were juniors, 12.3% were seniors, and 13.9% were postgraduates. There were 13.44% participants reporting that they lasted for < 2 weeks of duration of closure during the epidemic of COVID-19, 26.46% were "half to one month," 26.15% were "one to one and a half months," 10.97% were "one and half to two months," 22.97% were "two months and over."

Measures

COVID-19-related restrictions

COVID-19-related restrictions data used the Perceived COVID-19-related Strain Scale developed by Wegmann and contains 12 questions divided into five dimensions: experienced strain due to social contact restrictions, restrictions in the working context, childcare restrictions, travel restrictions and health issues (6). Each of the restrictions and consequences were rated on a 5-point Likert scale (1 = "not at all burdensome" to 5 = "very burdensome"). The scale has good reliability and validity, as verified by the study by Wegmann et al. In the current study, the scale was modified to a more relevant expression for the experiences of college students depending on the research context, for example, "restrictions on campus life, such as the ban on delivery takeaways." The Cronbach's alpha in this study was 0.893.

Fear of missing out

FoMO was determined by one-dimensional scales containing 10 questions scored on a scale of 1–5, with 1 being "Not at all true of me" and 5 being "Extremely true of me" (29). The higher the score is, the higher the level of FoMO. The results of the analysis of data from adults and adolescents in the USA, Spain, China and Turkey showed that the reliability of the scale was good, with internal consistency coefficients above 0.83. The Cronbach's alpha in this study was 0.906.

Problematic smartphone use

Problematic smartphone use was measured using the Mobile Phone Addiction Inventory (MPAI), a 17-question scale (30). The scale consists of four dimensions: inability to control craving, anxiety and feeling lost, withdrawal and escape, and productivity loss. A 5-point Likert scale was used, with 1 = "not at all," 2 = "rarely," 3 = "occasionally," 4 = "often," and 5 = "always." The higher the scale score is, the higher the index of mobile phone addiction. In the current study, the overall Cronbach's alpha was 0.953, the inability to control craving was 0.902, anxiety and feeling lost was 0.868, withdrawal and escape was 0.774, and productivity loss was 0.840.

Resilience

Resilience was assessed using the Resilience Scale CD-RISC, a revision of the Connor-Davidson Toughness Scale (CD-RISC) by Xiao-Nan Yu of the Chinese University of Hong Kong, which consists of 25 items that are assessed on a 5-point Likert scale ranging from 1 to 5 corresponding to "not true at all" to "true nearly all of the time" (31). The scale consists of 3 dimensions: perseverance, self-improvement and optimism. The higher the scale score is, the stronger the resilience. In the current study, the overall Cronbach's alpha was 0.979, perseverance was 0.961, self-improvement was 0.941 and optimism was 0.870.

Social support

The Perception Social Support Scale (PSSS) was developed by Blumenthal in 1987 (32). The PSSS has 12 items and 3 subscales, including the dimensions of family support, friend support, and support from others. A seven-point Likert scale was used, from 1 = "extremely disagree" to 7 = "extremely agree." The higher the score is, the higher the perceived social support. In this study, the overall Cronbach's alpha was 0.977, family support was 0.940, friend support was 0.941 and other support was 0.938.

Mental health problems

The Depression Anxiety and Stress Scale (DASS-21), a short version of the DASS, was originally developed by Lovibond et al. in 1995, and the simplified version of the DASS-21, revised in 2010, was used in this study (33). The full scale consists of 21 items scored on a 4-point Likert scale from 0 to 3 corresponding to "not at all" to "always." The higher the score is, the lower the level of mental health. In this study, the overall Cronbach's alpha was 0.978, stress was 0.930, anxiety was 0.937 and depression was 0.941.

Statistical method

Data entry and analysis were conducted using SPSS 26.0 and PROCESS 3.3. First, descriptive statistics, independent samples *t* tests, one-way ANOVA and correlation analysis were conducted on the main variables. Second, we used the PROCESS 3.3(Model 18) in SPSS 26.0 to examine the mediating role of FoMO in the relationship between COVID-19-related restrictions and problematic smartphone use or mental health problem, as well as the moderated moderating role of resilience and social support in the relationship between FoMO and problematic smartphone use or mental health problem.

Results

Descriptive values and correlation analysis

To explore differences in student scores on problematic smartphone use and mental health problems by gender, age, grade, and duration of closure, differences tests were conducted (see Table 1). Independent sample *t* tests revealed significant gender differences in the following variables: problematic smartphone use ($t = 5.80$, $p < 0.001$), and mental health

TABLE 1 Difference test for gender, age, grade, and duration of closure ($M \pm SD$).

Variable	Group	Problematic smartphone use	Mental health problem
Gender	Male	3.63 ± 0.80	2.70 ± 0.81
	Female	3.30 ± 0.92	2.21 ± 0.86
	t	5.80***	9.14***
Age	18–20	3.42 ± 0.80	2.40 ± 0.81
	21–22	3.51 ± 0.90	2.49 ± 0.87
	23–24	3.45 ± 0.83	2.47 ± 0.87
	25 and over	3.32 ± 1.03	2.36 ± 0.98
	F	1.10	0.80
Grade	①Freshmen	3.54 ± 0.90	2.50 ± 0.91
	②Sophomores	3.49 ± 0.89	2.53 ± 0.85
	③Juniors	3.59 ± 0.79	2.57 ± 0.83
	④Seniors	3.41 ± 0.93	2.47 ± 0.89
	⑤Postgraduates	3.15 ± 0.89	2.00 ± 0.80
	F	6.69***	12.09***
	LSD	⑤ < ①②③④	⑤ < ①②③④
Duration of closure	①Less than two weeks	3.52 ± 0.98	2.56 ± 0.93
	②Half to one month	3.63 ± 0.78	2.70 ± 0.78
	③One to one and a half months	3.57 ± 0.79	2.61 ± 0.82
	④One and half to two months	3.38 ± 0.99	2.28 ± 0.91
	⑤Two months and over	3.18 ± 0.88	2.04 ± 0.79
	W	6.84***	25.85***
	Tamhane	⑤ < ①②③	⑤④ < ①②③

*p < 0.05, **p < 0.01, ***p < 0.001.
Due to heterogeneity of variance, it was reported as Welch values in duration of closure difference tests and as F values for the others.

problems ($t = 9.14$, $p < 0.001$). Problematic smartphone use, and mental health problems were significantly higher in men than in women. And one-way ANOVA revealed that grade level was significant difference for problematic smartphone use ($F = 6.69$, $p < 0.001$) and mental health problems ($F = 12.08$, $p < 0.001$), and *post hoc* analysis of multiple comparison results showed postgraduates scored significantly lower than other grades on problematic smartphone use and mental health problems. Moreover, the duration of closure was significant difference for problematic smartphone use (*Welch* $= 6.84$, $p < 0.001$) and mental health problems (*Welch* $= 25.85$, $p < 0.001$). Of these, *post hoc* analysis of multiple comparison showed that problematic smartphone use was significantly lower for "two months and over" than for "less than one and a half months" closure. "One and a half months and over" scored significantly lower than "less than one and a half months" on mental health problems. However, we also found no significant age differences in problematic smartphone use ($F = 1.10$, $p > 0.05$), and mental health problems ($F = 0.80$, $p > 0.05$).

To explore the correlations between the variables, this study used correlation analysis and the results are shown in Table 2. Perceived COVID-19-related restrictions were positively correlated with fear of missing out ($r = 0.59$, $p < 0.001$), problematic smartphone use ($r = 0.44$, $p < 0.001$) and mental health problems ($r = 0.27$, $p < 0.001$).

Moderated moderated-mediation analysis

To investigate the mechanisms and boundaries of the effects of perceived COVID-19-related restrictions on problematic smartphone use, this study used SPSS PROCESS 3.3 to construct a moderated mediation model (Model 18), and the results are shown in Table 3. Perceived COVID-19-related restrictions was positively associated with problematic smartphone use among college students ($\beta = 0.45$, $p < 0.001$), therefore H1a is accepted. Perceived COVID-19-related restrictions was positively associated with fear of missing out ($\beta = 0.60$, $p < 0.001$), and fear of missing out was positively associated with problematic smartphone use ($\beta = 0.58$, $p < 0.001$), thus H2 and H3a are accepted. At the meantime, the direct effect of perceived COVID-19-related restrictions on problematic smartphone use was significant under the influence of FoMO ($\beta = 0.09$, $p < 0.01$). It indicates that fear of missing out partially mediates the association between perceived COVID-19-related restrictions and problematic smartphone use among college students. Moreover, a 3-way interaction of FoMO, resilience and social support was positively associated with problematic smartphone use ($\beta = 0.10$, $p < 0.05$), which means that the resilience and social support levels of college students co-moderate the relationship between fear of missing out and problematic smartphone use, and H4a is accepted.

To further show the moderated moderating role of resilience and social support between FoMO and problematic smartphone use, this study referring to Hayes (34) categorized resilience, social support, and FoMO as higher group (M+1 *SD*) and lower group (M-1 *SD*) and plotted the moderated moderating effect diagram (see Figures 2A,B). When college students were at higher levels of FoMO, they had higher levels of problematic smartphone use under conditions with lower levels of both resilience and social support ($M = 4.61$, $SD = 0.82$), and lower levels of problematic smartphone use under conditions with higher levels of both resilience and social support ($M = 4.29$, $SD = 0.94$). It suggests that resilience and social support can effectively attenuate the effects of fear of missing out on problematic smartphone use.

To investigate the mechanisms and boundaries of the effects of perceived COVID-19-related restrictions on mental health problem, this study used SPSS PROCESS 3.3 to construct a moderated mediation model (Model 18), and the results are shown in Table 4. Perceived COVID-19-related restrictions was positively associated with mental health problem among college students ($\beta = 0.28$, $p < 0.001$), therefore H1b is accepted. Perceived COVID-19-related restrictions was also positively associated with fear of missing out ($\beta = 0.60$, $p < 0.001$), and fear of missing out was positively associated with mental health problem ($\beta = 0.36$, $p < 0.001$), thus H2 and H3b are accepted. At the meantime, the direct effect of perceived

TABLE 2 Correlations and means of study variables ($N = 975$).

	$M \pm SD$	1	2	3	4	5	6
1. COVID-19-related restrictions	3.81 ± 0.74	1					
2. Fear of missing out (FoMO)	3.59 ± 0.83	0.59***	1				
3. Resilience	3.49 ± 0.92	−0.06	−0.16***	1			
4. Social support	4.84 ± 1.54	−0.07*	−0.19***	0.49***	1		
5. Problematic smartphone use	3.47 ± 0.88	0.44***	0.69***	−0.19***	−0.23***	1	
6. Mental health problem	2.46 ± 0.87	0.27***	0.52***	−0.40***	−0.46***	0.60***	1

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

TABLE 3 The moderated moderated mediating tests of problematic smartphone use.

Outcome	Predictors	Fit Indices		Coefficients	
		R^2	F	β	t
Problematic smartphone use	COVID-19-related restrictions	0.26	67.90***	0.45	16.31***
	Gender			−0.14	−5.05***
	Age			0.03	0.93
	Grade			−0.08	−2.06*
	Duration of Closure			−0.15	−5.25***
FoMO	COVID-19-related restrictions	0.38	121.25***	0.60	23.61***
	Gender			−0.08	−3.15**
	Age			0.06	1.83
	Grade			−0.11	−3.31**
	Duration of Closure			−0.11	−4.11***
Problematic smartphone use	COVID-19-related restrictions	0.51	82.34***	0.09	2.96**
	FoMO			0.58	17.76***
	Resilience			−0.04	−1.18
	Social support			−0.08	−2.31*
	FoMO × Resilience			−0.02	0.46
	FoMO × social support			0.02	0.48
	Resilience × social support			−0.12	−3.24**
	FoMO × resilience × social support			0.10	2.17*
	Gender			−0.08	−3.43***
	Age			−0.01	−0.36
	Grade			−0.004	−0.14
	Duration of closure			−0.08	−3.35***

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

COVID-19-related restrictions on mental health problem was not significant under the influence of FoMO ($\beta = 0.02$, $p > 0.05$). It indicates that fear of missing out fully mediates the association between perceived COVID-19-related restrictions and mental health problem among college students. Moreover, a 3-way interaction of FoMO, resilience and social support was positively associated with mental health problem ($\beta = 0.14$, $p < 0.01$), which means that the resilience and social support levels of college students moderate the relationship between fear of missing out and mental health problem, and H4b is accepted.

To further show the moderated moderating role of resilience and social support between FoMO and mental health problem, this study referring to Hayes (34) categorized resilience, social support, and FoMO as higher group (M+1 *SD*) and lower group (M-1 *SD*) and plotted the moderated moderating effect diagram (see Figures 3A,B). When college students were at higher levels of FoMO, they had higher levels of mental health problem under conditions with lower levels of both resilience and social support ($M = 3.82$, $SD = 0.42$), and lower levels of mental health problem under conditions with higher levels of both resilience and social support ($M = 2.34$, $SD = 1.12$). It suggests that resilience and social support can effectively attenuate the effects of fear of missing out on mental health problem.

Discussion

Impact of COVID-19-related restrictions on problematic smartphone use and mental health among college students

In this study, we constructed two moderated moderated-mediation models based on self-determination theory and conservation of resources theory as a way to explore potential mechanisms between COVID-19-related restrictions and problematic smartphone use and college students' mental health levels. The results showed that perceived COVID-19-related restrictions is positively associated with problematic smartphone use and mental health problems among college students, thus supporting our hypothesis, which is consistent with previous findings. COVID-19-related restrictions may contribute to a lack of specific needs, triggering problematic smartphone use and consequently emotional stress changes (6). In our preliminary analysis, we found that men had higher levels of problematic smartphone use and mental health problems than women. This is similar to previous research findings that men are more likely to use social media than women when faced with FoMO (15). In terms of grade level, postgraduate

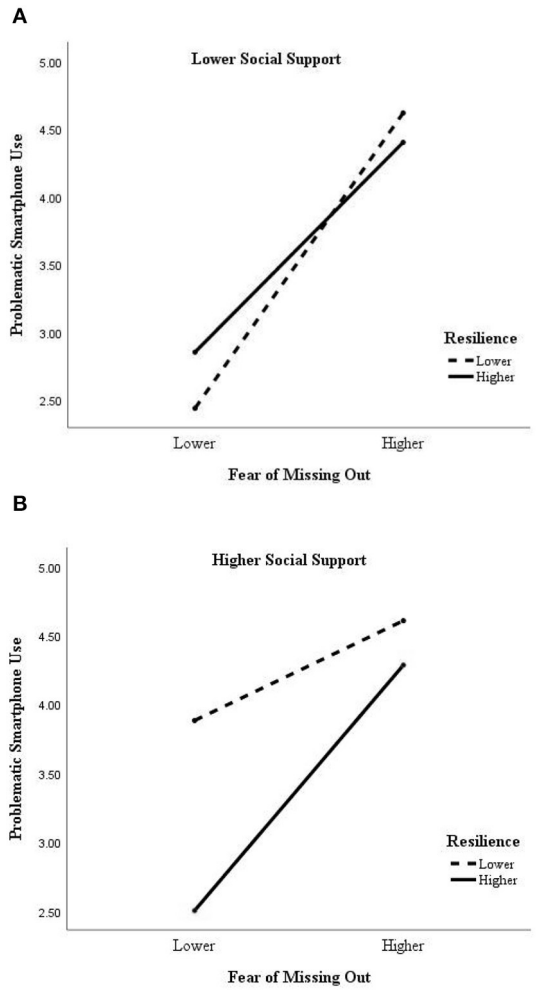

FIGURE 2
(A) The moderating effect of resilience between FoMO and problematic smartphone use under lower social support. **(B)** The moderating effect of resilience between FoMO and problematic smartphone use under higher social support.

students scored significantly lower than undergraduate students on problematic smartphone use and mental health problem levels. This may be because postgraduate students are more resilient and more self-determined than undergraduate students after the entrance exams and the postgraduate study life. For the duration of closure, the reason for the lower score on problematic smartphone use and mental health problems of "two months and over" is perhaps because of the students' adaptability to the environment and the fact that as time passes (35), the supporting measures of the school as well as the government will become more and more complete compared to the sudden situation at the beginning, which reduces the impact of the COVID-19-related restrictions on college students.

The mediating effect of FoMO

In problematic smartphone use model, FoMO partially mediated the relationship between perceived COVID-19-related restrictions and problematic smartphone use. The results supported that perceived COVID-19-related restrictions is positively associated with FoMO, FoMO mediates the association between perceived COVID-19-related restrictions and problematic smartphone use among college students, and indicated that FoMO had an important influence on problematic smartphone use during the epidemic closure, which is consistent with previous research (17). According to self-determination theory, epidemic closure disrupts the rhythm of students' lives, and college students are fundamentally different from junior and senior high school students in that junior and senior high school students are subject to certain restrictions in their daily lives even if they do not undergo epidemic closure (36). Research has shown that individuals with high levels of FoMO desire to satisfy their basic psychological needs through excessive smartphone and social media use (37). The greater the perceived stress caused by the restrictions of the epidemic, the greater the level of basic needs missing, and the more individuals experience impaired self-regulation, i.e., FoMO. Thus, FoMO is a significant predictor of the association between COVID-19-related restrictions and problematic smartphone use.

In mental health problems model, FoMO fully mediated the relationship between perceived COVID-19-related restrictions and mental health problems. The results support our hypothesis that FoMO significantly mediates the relationship between COVID-19-related restrictions and mental health problems such as anxiety, depression and stress, meaning that for college students during the epidemic, the more stressful the perceived COVID-19-related restrictions are, the more likely they are to lead to FoMO, which indirectly leads to mental health problems. This is similar to previous research findings that FoMO, as a subtype of anxiety, can lead to mental health problems (38). According to Wortham, FoMO is a source of negative emotions such as depression, as individuals with FoMO are always anxious about missing out on novel experiences or other things. The COVID-19-related restrictions have deprived college students of many enjoyable experiences, such as outings, parties and friendships, making them more susceptible to this particular anxiety, which Chai et al. suggest makes them more sensitive to stressful events in their daily lives based on the social selectivity hypothesis (15). The results of the study are consistent with the finding that FoMO often fully mediates the relationship between variables related to psychological needs (39, 40).

TABLE 4 The moderated moderated mediating tests of mental health problem.

Outcome	Predictors	Fit Indices		Coefficients	
		R^2	F	β	t
Mental health problem	COVID-19-related restrictions	0.21	52.57***	0.28	9.82***
	Gender			−0.23	−7.70***
	Age			0.11	2.92**
	Grade			−0.13	−3.51***
	Duration of closure			−0.21	−6.96***
FoMO	COVID-19-related restrictions	0.38	121.25***	0.60	23.61***
	Gender			−0.08	−3.15**
	Age			0.06	1.83
	Grade			−0.11	−3.31**
	Duration of closure			−0.11	−4.11***
Mental health problem	COVID-19-related restrictions	0.50	79.84***	0.02	0.51
	FoMO			0.36	11.16***
	Resilience			−0.20	−5.62***
	Social support			−0.27	−7.99**
	FoMO × resilience			−0.05	−1.19
	FoMO × social support			0.02	0.52
	Resilience × social support			−0.02	−6.39***
	FoMO × resilience × social support			0.14	3.10**
	Gender			−0.14	−5.89***
	Age			0.05	1.54
	Grade			−0.06	−2.06*
	Duration of Closure			−0.14	−5.56***

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

Moderated moderating effects of resilience and social support

The results show that the study supported that resilience and social support play a significant moderated moderating role between FoMO and both problematic smartphone use and mental health problems. See Figure 2, in problematic smartphone use model, resilience and social support had a significant interaction with FoMO. Students with high resilience had lower scores for problematic smartphone use when FoMO was high, and according to the results, scored lowest with higher levels of both resilience and social support. That is, these students used their resilience and social support as resources to alleviate the stress caused by FoMO and avoid problematic behavior. This result validates the scientific validity of resilience as a protective factor, and therefore, for future planning and setting up of mental health education on university campuses, enhancing students' resilience should be incorporated as an important component in the teaching design to improve resilience to frustration and environmental adaptability as a way to resist the subsequent changing epidemic environment.

See Figure 3, in mental health problems model, resilience and social support had a significant interaction with FoMO, which is consistent with previous research and our hypothesis. Even though the social support received during the epidemic closure was low, the previous personal upbringing had created and possessed a high level of resilience, i.e., protective resources. Therefore, when there is a change in the environment and higher anxiety is felt, it is still possible to maintain a better state of mind. And according to the results, scored lowest with higher levels of both resilience and social support. This accurately provides evidence to support the role of social support as a psychological protective factor during an epidemic (41). As an important formative factor of resilience, social support can work in tandem with resilience to reduce the impact of FoMO collectively and directly on mental health problems and problematic smartphone use. Social support can compensate for the lack of relational, autonomy and competence needs caused by FoMO, for example, by increasing the number of social and recreational activities such as recreation and sports in schools to enhance students' sense of competence and communication needs and by increasing students' freedom of choice in their closed lives to compensate for their autonomy needs.

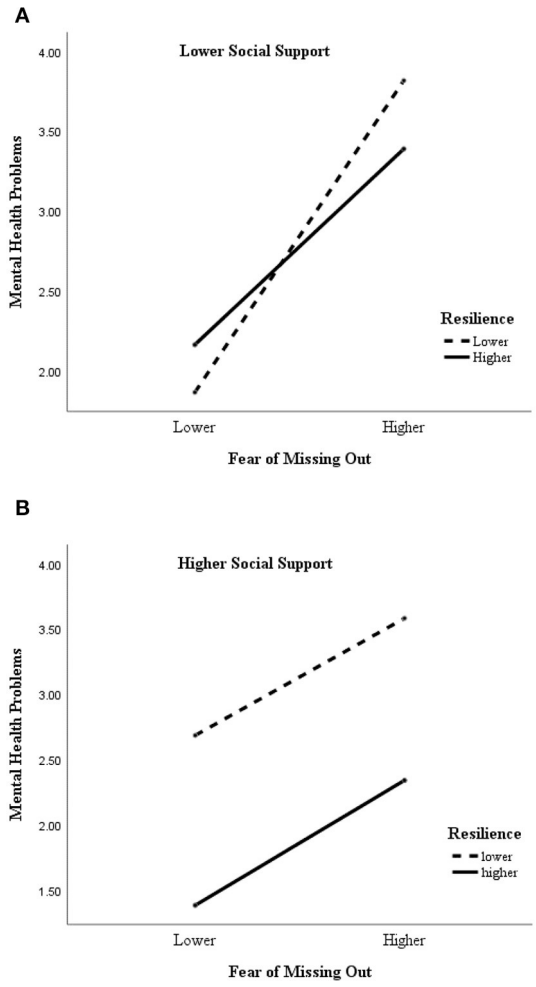

FIGURE 3
(A) The moderating effect of resilience between FoMO and mental health problem under lower social support. **(B)** The moderating effect of resilience between FoMO and mental health problem under higher social support.

Limitations and future directions

The present study has some limitations. First, although we emphasized in the guideline that question responses are not right or wrong and are confidential, there may still be a social approval effect for the self-report scale, and follow-up studies could develop more objective measures of the relevant variables, including experimental methods. Second, this study is a cross-sectional study. In the future, a follow-up study could be used to examine the long-term benefits of resilience and social support on the mental health of college students during the epidemic. Finally, follow-up research could be conducted across cultures, and we can test whether the positive effects of resilience and social support on the mental health of college students in the context of the epidemic are consistent across cultures.

Conclusion

This study investigates the effects of COVID-19-related restrictions on problematic smartphone use and mental health among college students. The perceived COVID-19-related restrictions may have influenced the development of problematic smartphone use and mental health problems among college students by triggering individual FoMO. FoMO is an important factor in triggering problematic smartphone use and mental health problems during the current epidemic, which provides an important entry point for the development of student mental health intervention strategies under the regular management of the epidemic in the future. This study explored how to alleviate the negative effects of individuals' FoMO triggered by the current COVID-19-related restrictions by constructing two moderated moderated-mediation models. This study found that resilience is a key individual resource for individuals to mitigate the negative effects of loss anxiety, while social support is an important environmental condition for individuals to mitigate the negative effects of loss anxiety. Therefore, nurturing students' resilience and creating an environment with a high level of social support are conducive to the psychological health development of college students under the regular management of the epidemic 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 Institutional Review Board, Normal College, Qingdao University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ZG, YL, and XJ designed, performed, analyzed the research, and wrote the research. QQ critically reviewed and edited the

manuscript. JL and YS made substantial revisions. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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How does growth mindset affect mental health of high school students during the COVID-19 epidemic? The role of grit and coping strategies

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Background: The outbreak of COVID-19 epidemic continues to unfold globally, which harms the public's mental health. Adolescents' mental health is affected by social isolation and lockdown during the COVID-19 epidemic. The implicit theory of thoughts-emotion-behavior states that individuals with a growth mindset believe that thoughts, emotions, and behaviors can be changed through effort and tend to persist in pursuing higher goals and maintain enthusiasm as well as cope with stress resiliently, thus having higher gritty and levels of mental health. This study aimed to explore the role of grit and coping strategies in the influence of the growth mindset on adolescents' mental health during the COVID-19 epidemic period.

Methods: A total of 1564 participants (M_{age} = 17.02, 760 boys, 804 girls) from three high schools in China were recruited to complete The Self-report Questionnaire-20, The Growth Mindset Scale, The Short Grit Scale, and The Coping Style Scale to evaluate mental health, growth mindset, grit, and positive coping strategies, respectively.

Results: The results showed that growth mindset has no significant indirect effect on mental health through grit but has a significant indirect effect on mental health through coping strategies. The results of chain mediation analysis showed that grit and coping strategies play chain mediating roles between growth mindset and adolescents' mental health.

Conclusion: The findings suggest that cultivating a growth mindset, developing grit, and teaching adolescents to adopt positive coping strategies can improve adolescents' mental health.

KEYWORDS

growth mindset, grit, cope strategies, mental health, adolescents, COVID-19

Introduction

The COVID-19 epidemic has swept the globe in recent years (1). Blockade measures prevent the spread of COVID-19 and benefit physical health, but ensuing social isolation also had a negative impact on mental health (2). Since the first emergence of the neo-crown virus in 2019, how to stop the spread of the virus while maintaining a healthy level of psychological wellbeing in people become a hot research topic in recent years.

Growth mindset and mental health

The Implicit Theories of Intelligence (ITI) divided mindset into a growth mindset and fixed mindset (3). Based on the ITI, a new model called the implicit theory of thoughts, emotions, and behaviors (TEB) combines TEB, which are closely connected to mental health (4). Based on exploratory factor analysis (5) and confirmatory factor analysis (6), TEB were found as three independent but related factors. Existed study also demonstrated that a fixed mindset of TEB among adolescents in grades 6–8 was associated with an increase in their mental health problems (5). Specifically, a growth mindset can reduce the impact of family stress on externalizing behavior (4). To date, there are few studies on the implicit theory of TEB, but research on it is promising, more research is needed.

The growth mindset is a capacity for adaptation and change (7), which not only facilitates academic progress (8), but also plays a crucial role in overcoming social adversity, improving students' social skills, and buffering adolescents from externalizing problems caused by family pressure (9). Research has shown that growth mindset can reduce adolescents' depression caused by cyberbullying (10). Even for people with illnesses, enhancing growth mindset during treatment can increase their wellbeing (11). Research manifested that people with a growth mindset are committed to pursuing challenges, value effort, and are able to cope with setbacks in a positive way, thereby maintaining their mental health (12), thus moving forward by affirming the possibility of their future development and success. These conclusions indicate that growth mindset can, to some extent, reduce the negative emotions and improve adolescents' mental health. Therefore, this study hypothesized that H1: growth mindset has a positive effect on the mental health of Chinese adolescents.

Grit

Positive psychology states that individuals who follow a meaningful life exhibit higher levels of grit, which is a future-oriented effort and persistence of interest. Grit supports individuals' pursuit of long-term goals, and it has two meanings, namely, perseverance and consistency of interest (9). Grit has also been shown to have a beneficial effect on mental health by reducing loneliness in life during the COVID-19 epidemic (13).

On the one hand, as a personality and basic psychological characteristic, grit predict an individual's subjective wellbeing. An intervention study found that motivating college students' grit enhance their satisfaction with realistic needs as well as their subjective experience (14). On the other hand, grit has the quality of responsibility, which enables individuals to become resilient in the face of adversity and failure (15), more importantly, keep the enthusiasm to be progressive (16, 17).

In addition, a study of Chinese children found that growth mindset predicted grit positively (18). Cultivating growth mindset may be particularly relevant to preventing or reducing mental health problems in adolescents' development. Therefore, this study hypothesized H2: growth mindset has a positive impact on the mental health of the Chinese adolescent during the COVID-19 epidemic through the mediating role of grit.

Coping strategy

Coping strategies is the individuals' cognitive assessment of the stressful situation, and the relationships between individuals and the stressful situations are constantly changing in response to changes in the individuals' behaviors (19). Positive coping strategies is solution-focused, aiming to do something to change the source of stress. Negative-coping strategies, focusing on emotions to avoid direct confrontation with stress situation and indirectly reducing emotional tension (20).

Researcher noted that United States undergraduate students who apply positive coping strategies and view stressors as potential challenges rather than threats, have lower perceptions of stress (21). Likewise, a Chinese study revealed similar results that mature, positive coping strategies can alleviate Chinese graduate students' abnormal psychological symptoms arising in stressful situations (22). A study of disease groups found that people with multiple sclerosis who used positive problem-solving coping strategies had a higher level of mental health (23).

Adolescents are inevitable to take online teaching due to the lockdown during the COVID-19 epidemic. Negative-coping strategies resulting by lack of contact with peers and teachers, as well as low frequency physical activity are associated with poor mental health conditions (24). Researchers noted that as important predictors of mental health, positive coping strategies contribute to cope with the deterioration of mental health status due to the COVID-19 epidemic (25). Those who use negative coping strategies, such as emotion-focused strategies, tend to use alcohol, tobacco, and drugs (26) to relieve stress, which is at greater risk for adverse outcomes and can cause significant harm to mental health than those who rely on positive coping strategies (27).

In light of this, the present study hypothesized that H3: growth mindset has a positive impact on Chinese adolescents'

mental health during the COVID-19 epidemic through the mediating effect of positive coping strategy.

Grit and coping strategy

The perception of uncontrollable stressful events triggers higher stress and negatively affects emotional wellbeing (28). Existing research indicated that people with higher grit tend to adopt effective coping strategies to reduce perceived stress (29), which is benefit to alleviate fear and anxiety, thereby, maintain high levels of mental health (30). Based on TEB, this study hypothesized that H4: grit and coping strategy play a chain-mediated role in the influence of growth mindset on Chinese adolescents' mental health. The theoretical model is shown in **Figure 1**.

Materials and methods

Participants

In this study, 1,596 students were recruited from three high schools in China. In total, thirty-two students were missing since they were absent on the day of data collection, or other undisclosed personal reasons. As a result, 1,564 students (760 men; 804 women; M_{age} = 17.02 years, *SD* = 1.05) were identified as final participants of this study, which resulted in an effective rate of 97. 99%. These include 539 senior students, 523 sophomores, and 502 juniors. There were 640, 406, and 518 students from urban, suburban, and rural areas, respectively. The questionnaires were distributed in the classes and would be collected after the survey was completed. This study was approved by the Ethics Committee of North China University of Science and Technology. All the participation in this study was voluntary and informed consent was obtained from parents in advance.

Measures

Self-report questionnaire 20

The mental health was evaluated by the self-report questionnaire 20 (SQR-20) which was published by WHO (31). The Chinese revision of this scale has stable reliability and validity (32). In developing countries, SRQ-20 is a simple rapid screening tool for mental disorders, each item is scored on a two-point scale for "yes" or "no." Higher scores indicate more prominent symptoms of psychiatric disorders. When the score is higher than 8, the individual is in a stressed state should be concerned. The Cronbach's α coefficient of the scale was 0.916 in the present study.

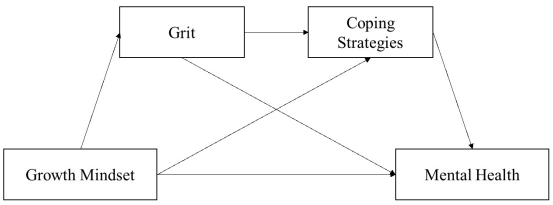

FIGURE 1
Hypothetical indirect pathways between growth mindset and adolescents' mental health.

Growth mindset scale

The Growth Mindset Scale (GMS) developed by Brock and Hundley (33) was used in this study to assess students' growth mindset. GMS consists of 10 items and was rated on 2-point scale (–1 = "yes," 1 = "no"). Higher scores of the total score indicates higher of growth mindset, conversely, lower score indicates higher fixed mindset. The Cronbach's α coefficient of the scale was 0.744 in the present study. Confirmatory factor analysis showed that the construct validity of the GMS was good in this study, χ^2/df = 7.285, CFI = 0.950, TLI = 0.931, RMSEA = 0.063, SRMR = 0.040.

The short grit scale

The Short Grit Scale (Grit-S) (34) was used in this study to evaluate the grit of participants, which included two dimensions, namely consistency of interest and perseverance of effort. Grit-S consists of eight items on a 5-points scale, with internal consistency reliability assessed between 0.73 and 0.83 in the previous studies (35). Due to there were high correlation between the total score of grit and the two dimensions' score, only the total score of grit was performed in the subsequent analysis. Higher scores indicate higher levels of grit. The Cronbach's α coefficient of the scale was 0.720 in the present study. Confirmatory factor analysis showed that the construct validity of the Grit-S scale was good in this study, χ^2/df = 5.664, CFI = 0.988, TLI = 0.981, RMSEA = 0.055, SRMR = 0.020.

The coping style scale

The coping strategies was evaluated using the coping style scale (TCSS) developed by Xie based on ways of copingquestionnaire (36, 37). TCSS is scored on a 4-point scale, with the positive-coping subscale consisting of 12 items and the negative-coping subscale consisting of 8 items. The positive-coping score minus the negative-coping score is the individuals' coping propensity score. A higher score indicates that an individual has adopted more positive coping strategies. The Cronbach's α coefficient of the scale was 0.869 in the present study.

Data analysis

First, the Harman's single factor test was used to validate for common method variance (38). Second, descriptive statistics for the variables were presented, followed by the Pearson correlation analysis between these variables, and gender difference tests for each variable. Third, the bootstrapping resampling method was used to analyze the mediating model in this study, which was a robust method for obtaining CIs for specific indirect effect under most conditions through taking a sample of size n cases with replacement from the original sample (39). All the statistical analyses were carried out using SPSS 28.0 (SPSS Inc., Chicago, Illinois, United States), of which PROCESS was used to analyze the chain mediating model by bootstrapping with 5,000 resamples to derive the 95% CIs.

Common method biases

Since growth mindset, grit, coping strategies, and mental health were measured by self-report, which may cause potential common method bias in the study. The Harman's single factor analysis manifested that the first factor in our data explained only 19.13% of the variance. As this value was lower than the critical cut-off point of 40% (40), indicating that the common method bias was negligible.

Results

Descriptive statistics of variables

The gender differences test in growth mindset, grit, coping strategies, and mental health were shown in Table 1. The results showed that there were significant gender differences in grit and mental health. Levels of grit and mental health in boys were significantly higher than those of girls. Mental health scores were grouped with a cut-off point of 8. It was found that 681 individuals (43.54%) were in a stressful state (289 boys, 392 girls) and 883 non-stressed individuals (471 boys, 412 girls). The results of the χ^2-tests showed that the stress level has significant gender differences, with girls having a significantly higher proportion than boys.

The preliminary analyses of the study variables were shown in Table 2. The results indicated that there was a significant negative correlation between growth mindset, grit, coping strategies, and mental health (rs = –0.467 ∼ –0.273, $p_s < 0.01$), and also a significant positive correlation between growth mindset, grit, and coping strategies (rs = 0.296 ∼ 0.374, $p_s < 0.01$).

Analysis of direct and indirect pathways of growth mindset and adolescents' mental health

As can be seen in Figure 2 and Table 3, the chain mediation model evaluated the direct and indirect pathways of growth mindset and adolescents' mental health during the COVID-19 epidemic after controlling for the covariates of age and gender. In Model 1, the results revealed that growth mindset significantly predicted mental health negatively (β = –0.36, $p < 0.01$). In Model 2, the results revealed that growth mindset significantly predicted grit positively (β = 0.33, $p < 0.01$), growth mindset (β = 0.19, $p < 0.01$), and grit (β = 0.31, $p < 0.01$) significantly predicted coping strategies positively. In Model 3, the results revealed that growth mindset (β = –0.23, $p < 0.01$) and coping strategies (β = –0.39, $p < 0.01$) significantly predicted mental health negatively, and grit was not a significant predictor of mental health (β = –0.05, $p < 0.01$).

The mediating effect was measured by Bootstrapping for 5,000 resamples. As represented in Table 4, the total indirect effect of growth mindset on mental health was significant [β = –0.128,95%CI = (–0.155, –0.103)]. The indirect effect of growth mindset on mental health through grit was non-significant [β = –0.013, 95%CI = (–0.030, 0.0004)]. The indirect effect of growth mindset on mental health through coping strategies was significant [β = –0.075, 95% CI = (–0.097, –0.054)] accounting

TABLE 1 The gender difference in the key variables.

Variables	Boys (N = 760)	Girls (N = 804)	t/χ^2	p	*Cohen d*
Growth mindset	0.57 ± 5.54	0.2 ± 5.21	1.355	0.176	0.069
Consistency of interest	12.34 ± 3.92	11.99 ± 3.96	1.751	0.080	0.089
Perseverance of effort	12.44 ± 3.99	12.04 ± 4.08	1.970	0.049	0.100
Grit	24.78 ± 5.35	24.02 ± 5.39	2.766	0.006	0.140
Coping strategies	14.94 ± 7.71	15.39 ± 7.81	–1.143	0.253	0.058
Mental healthy	6.46 ± 5.76	7.81 ± 5.8	–4.601	<0.001	0.233
Non-stressed state	471	412	18.297	<0.001	–
Stressed-state	289	392			

M, mean; SD, Standard Deviation.

TABLE 2 Bivariate correlations for study variables.

	1	2	3	4	5	6	7	8
1. Gender (boys = 0, girls = 1)	1							
2. Age	0.060*	1						
3. Mental healthy	0.116**	0.039	1					
4. Growth mindset	−0.034	−0.029	−0.363**	1				
5. Grit	−0.070**	−0.031	−0.273**	0.330**	1			
6. Consistency of interest	−0.044	0.011	−0.112**	0.248**	0.664**	1		
7. Perseverance of effort	−0.050*	−0.052*	−0.255**	0.197**	0.684**	−0.091**	1	
8. Coping strategies	0.029	−0.097**	−0.467**	0.296**	0.374**	0.096**	0.405**	1

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

for 21.13% of the total effect. The chain mediated effect of growth mindset on mental health through grit and coping strategies was significant [β = −0.040, 95%CI = (−0.051, −0.029)] accounting for 11.27% of the total effect. The statistical results showed that grit and coping strategies play mediating roles in the chain of growth mindset influencing adolescents' mental health.

Discussion

Because of the blockade during the COVID-19 epidemic adopted by various countries and regions, people were socially distanced, hindering the need for social interaction (41) and thus affecting the levels of mental health (42). For adolescents during the COVID-19 epidemic, the blockade strategy made it necessary to participate in online classes without face-to-face interaction with teachers and peers, which put a lot of stress on the psychological level and may even damage social confidence (43), at the same time, they are also under a tremendous psychological pressure.

Data from this study revealed that the Chinese adolescents who hold a growth mindset have fewer mental health problems and higher levels grit. At the same time, adolescents applying more coping strategies could reduce their mental health problems.

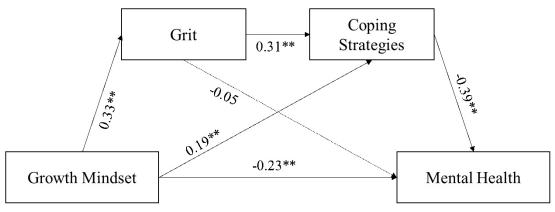

FIGURE 2
Estimates from chain mediation model testing the direct and indirect pathways between growth mindset and mental health. Estimates are standardized coefficients. The dashed line is the non-significant path. **$p < 0.01$.

TEB theory states that a growth mindset is more beneficial to adolescents' mental health than a fixed mindset (44). More importantly, a longitudinal study has shown that growth mindset is a negative predictor of adolescents' mental health problems after 2 years (45), which means that the impact of growth mindset on adolescents' mental health is stable over time. In the face of adversity, individuals with a growth mindset tend to believe that their abilities will develop over time, that effort is effective, and to be more active and flexible in applying the process of reaching achievement. Results of this study are consistent with previous research findings that growth mindset predicts greater grit in the face of social exclusion or victimization (46). As found in this study, Chinese adolescents who hold growth mindset adopt more coping strategies in facing difficulties and have less mental health problems. Meanwhile, in the process of overcoming various challenges, they will continue to improve the level of grit, therefore, they have higher levels of grit to apply more coping strategies to reduce mental health problems.

TEB implicit theory suggests that growth mindset aims to shape individuals' thoughts, emotion, and behavior (4). Existed study demonstrated that negative coping strategies plays a negative role in regulating students' mental health (47), which is negatively associated with mental health (48).

Growth-mind predisposes Chinese adolescents to maintain enthusiasm for pursuing goals and become gritter in the learning process, while there is a negative correlation between grit and depression and anxiety (49). In particular, during the COVID-19 epidemic, individuals with moderate and high levels of grit experienced less loneliness and academic stress resulting from social isolation (50), this is because they will exhibit more cognitive coping and actively seek support. Growth mindset makes Chinese adolescents more resilient when faced with challenges in life and academic. They refuse to give up and are willing to invest time and effort in trying various methods to overcome challenges and enjoy the joy of achieving success. Even if they fail, they will keep the same attitude to face the next challenge, while growth mindset makes individuals have more self-efficacy and maintain a high

TABLE 3 The chain mediating model analysis between growth mindset and mental health.

	Model 1		Model 2				Model 3	
	Mental health		Grit		Coping strategies		Mental health	
	β	t	β	t	β	t	β	t
Constant	−0.313	−4.211**	0.171	2.241*	−0.182	−2.483*	−0.35	−5.221**
Age	0.023	0.964	−0.018	−0.759	−0.086	−3.742**	−0.014	−0.632
Gender	0.102	4.339**	−0.058	−2.404*	0.063	2.720**	0.117	5.425**
Growth mindset	−0.358	−15.272**	0.327	13.710**	0.193	7.947**	−0.230	−9.946**
Grit					0.312	12.854**	−0.045	−1.872
Coping strategies							−0.387	−16.377**
*R*2	0.143		0.113		0.184		0.289	
F	86.479**		65.934**		87.839**		126.815**	

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

TABLE 4 Standardized direct and indirect paths between growth mindset and adolescents' mental health during COVID-2019.

Paths	β	SE	LLCI	ULCI	Percentage of effect size
Total effect	−0.355	0.023	−0.400	−0.309	–
Direct effect					
Growth mindset– > mental health	−0.227	0.023	−0.272	−0.182	–
Total indirect effect	−0.128	0.013	−0.155	−0.103	–
Growth mindset– > grit – > mental health	−0.013	0.008	−0.030	0.0004	3.66%
Growth mindset – > coping strategies – > mental health	−0.075	0.011	−0.097	−0.054	21.13%
Growth mindset – > grit– > coping strategies – > mental health	−0.040	0.006	−0.051	−0.029	11.27%

level of mental health. Meanwhile, growth mindset facilitates Chinese adolescents to regulate their emotions, adjust their behavior, and self-motivate to maintain a high level of mental health when facing and solving difficulties in life and school. Positive and flexible coping strategies brought by the growth mindset plays a great significance in improving the Chinese adolescents' mental health. Therefore, the role of growth mindset in enhancing the Chinese adolescents' mental health by improving grit and positive coping strategies should be emphasized.

This research contributes to future theoretical research and practical applications.

First, this study explores the impact of a growth mindset on the mental health among Chinese adolescents, and identifies the role of grit and coping strategies. In the future, based on the TEB and the results of this study, researchers can not only explore the influence of more thoughts, emotions and behaviors to enrich the research results of TEB, but also explore the relationship and impact pathway of growth mindset, grit, coping strategies, and mental health in different time period. It is worth noting that different ethnic groups of adolescents are necessary to research.

Second, in the future, more attention should be paid to the impact of growth mindset on the mental health of Chinese adolescents in school education, as well as the role of individuals' grit and positive coping strategies. Along with teaching academics, school education should focus on and strengthen the growth mindset of students to keep high development levels while reducing the incidence of mental health problems in schools. Furthermore, our study also supports related psychological interventions studies.

Third, in addition to school education, this research also provides practical application values for parents and their children in the family environment. In daily life and family education, parents should realize that the importance of their children's mental health and the cultivation of flexible cogitation of their children. Their children should be guided to solve life problems with flexible and diverse approach. For adolescents, fully understand the implication of growth mindset is conducive to improve their levels of grit, put forward a variety of solutions when facing problems, and thus maintaining a high level of mental health.

In addition, several limitations also exist. First, self-reported scales used in the present study cannot completely avoid social approval effects and common method bias. Therefore, so on-site observation and video

recording may be considered in the future. Second, based on the current spread of the COVID-19 epidemic, we should consider exploring the long-term effects of growth mindset on adolescents' mental health. Thus, longitudinal studies could be applied in the future research. It is worth mentioning that because the participants were randomly selected from three schools, caution was maintained in generalizing the results of the study. The samples could be further expanded to improve the validity of the results in future studies. Finally, the COVID-19 epidemic is now concentrated in some regions, while in counties and cities without the epidemic, normal work and life have resumed in each area. Therefore, in future studies, samples from areas with outbreaks can be compared with those from areas without outbreaks to explore whether the impact of the COVID-19 outbreak on adolescents' growth mindsets is more profound in areas with concentrated epidemics.

Conclusion

During the COVID-19 epidemic, adolescents faced tremendous psychological and adaptive stress. Those adolescents with growth mindset were able to maintain grit to pursue their goals, constantly adjust their ways of coping with the effects of the COVID-19 epidemic, and then maintain a healthy psychological level through positive coping strategies to handle the stress from school, life, and family.

Data availability statement

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

Ethics statement

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

Author contributions

LZ: conceptualization, data—analysis and visualization, writing—original draft and review, and writing—editing. HQ: investigation, resources, data curation, methodology, and writing—original draft. CW and TW: writing—review and writing—editing. YZ: writing—review, supervision, and project administration. All authors contributed to the article and approved the submitted version.

Conflict of interest

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

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The influence of college students' academic stressors on mental health during COVID-19: The mediating effect of social support, social well-being, and self-identity

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COVID-19 caused harmful mental consequences to the public, and mental health problems were very common among college students during the outbreak of COVID-19. Academic stressors were the main stress for college students, and social support, social well-being, and self-identity were widely known as protective factors for mental health. Therefore, the study aimed to investigate the influence of academic stressors on mental health and the mediating effect of social support, social well-being, and self-identity among college students during the outbreak of COVID-19. With 900 college students as subjects, using the college students' academic stressors questionnaire, social support questionnaire, social well-being scale, self-identity scale, and depression anxiety stress scales (DASS-21), the results showed that: (1) academic stressors had a significantly negative correlation with social support, social well-being, and self-identity while having a significantly positive correlation with mental health; (2) academic stressors could positively predict mental health; (3) this effect was mediated by social support, social well-being, and self-identity; (4) work stressor was an important stressor during COVID-19, and had the same role as academic stressors in the structural equation model. The results of this study suggested that adjusting the academic stressors or work stressors of college students and enhancing social support could improve social well-being and self-identity, and might effectively protect their mental health under the COVID-19 pandemic environment.

KEYWORDS

academic stressors, mental health, social support, social well-being, self-identity, work stressor

Introduction

College was an important turning point and the critical period for individuals from adolescence to adulthood in psychology. Mental health problems were very common in this period (1). A large number of mental state investigations showed that COVID-19 spoke common mental health issues, such as stress, anxiety, and so on (2–5). As COVID-19 broke out, it swept across many countries and even the world, causing damaging effects on the mental health of the public (6). For college students, the accompanying results of a pandemic like lockdown and taking online courses had already led to negative consequences and more stressors (7–9). Most existing studies focused on mental health for general populations (10) or health care workers (11), whose results might not be applicable to college students. So it was important and necessary to explore the protective factors in the relationship between stressors and mental health under the context of COVID-19 among college students.

The mental health of college students and their academic stressors

Various mental health challenges ranging from excessive stress and anxiety to severe depression had emerged (12). Cumulative stressors were the cause of anxiety, depression, and mental problems (13, 14). Anxiety was a common kind of negative emotion generated when faced with unpleasant events or a challenge that was too difficult to deal with (15). After COVID-19, the ratio increased up to 24.9% (16). Depression produced severe persistent sadness, unhappiness, mood swings, behavior, and mental disorders (17). Everyone lived with depression and the prevalence was even higher (18).

It was known that stressors or pressure were associated with individuals' mental health (19–21). Researchers proved that academic stressors had the main pressure on college students (22, 23). They would experience a variety of academic stressors on campus, such as giving a class presentation, solving problems against the clock, and dealing with tests and examinations. Those stressors aroused in an educational environment were called academic stressors (24). According to previous studies, academic stressors were associated with the rise of anxiety and depression (25–27) and had a positive correlation with mental health (28, 29).

The effects of the COVID-19 pandemic on mental health and academic stressors of college students

COVID-19 as a natural disaster could have strong effects on individuals' mental health (30, 31). It swept across the world, causing damaging effects on the mental health of the public (6). The pandemic embodied many overwhelming stressors, such as losing employment, financial insecurity, and isolation from others (32), increasing adverse psychological consequences on individuals, like depression (7, 8). There was reason to be concerned about the rapid and possibly sustained negative impact of the COVID-19 pandemic on mental health (33). College students were an important group who was in the process to get into society. In a recent study, approximately two-thirds of participants reported anxiety and depression symptoms in the moderate to severe range, and about one-third reported suicidality (34). The accompanying results of the pandemic, such as lockdown and taking online courses, led to negative consequences and more stressors for college students (7–9). Many students reported high academic stressors (35, 36), and this situation was even more severe during the pandemic. Home-study initiatives caused disruption of course in person and uncertainty of back to campus, which made college students experience poor mental health (37). Also, research showed that disruptions of research projects and internships would jeopardize the process of study, delay graduation, and undermine competitiveness in the job market, which in turn fuel anxiety among college students (9).

The role of social support, social well-being, and self-identity

Social support was the general or specific social resources that an individual obtained from others that could help to cope with difficulties and crises in life (38). As mental problems are widely encountered among college students, it was important to give them support from family, university, or friends (39), which was beneficial for reducing mental problems during COVID-19 (40). The negative correlation between academic stressors and social support reflected that someone who had lower support would suffer more academic stressors (41, 42). Social support had been long established as a mediator in buffering the impact of stressors (41, 43–46), and as a protective psychological factor, it would reduce the effect of academic stressors on mental health (47). Therefore, hypothesis 1 was put forward: Academic stressors directly positively predicted mental health, and social support played an indirect mediating role.

Social well-being referred to the individual's feelings toward the quality of relationships between himself, others, societies, and also self-assessment of their living environment and social functioning (48, 49). Research showed that social support played a significantly positive predictor of social well-being (44), which meant that if an individual received enough support from families, friends, or any others, they would have a higher level of well-being. In a time when students faced uncertainty and a continually changing environment, COVID-19 lowered individuals' well-being (50). Research showed that academic stressors were significantly negatively correlated with well-being, and social support mediated the relationship (42, 51–53). Thus, hypothesis 2 was put forward: Academic stressors directly negatively predicted social well-being, and social support played an indirect mediating role.

Self-identity was proposed by Erikson (54) as the maturity, continuity, and integration of individual personality development, mainly formed in youth. Previous research on social cognition suggested that emphasizing self-identity was key to changing a person's behavior and it would be effective in changing intentions and behaviors under the situation of the COVID-19 outbreak (55). Palsane (56) concluded that self-incongruence was related to a high level of stress, and poor physical and mental health. A common assertion about the relationship between social support and self-identity was that social support provided reassurance to the individual that esteemed and valued; that boosted the individual to believe that he could cope with or adjust to life's exigencies (43, 57, 58). In addition, many studies provided evidence that social support and well-being were associated with mental health benefits (59, 60). Therefore, it was reasonable to propose hypothesis 3: Social support negatively predicted mental health with social well-being and self-identity mediating the effect.

The chain mediating effect of social support, social well-being, and self-identity

According to the Stress-Buffering theory, the negative impact of stressors exposure was weakened when there were enough coping resources. Previous studies had demonstrated that social support and self-esteem were coping resources to reduce stressors (61). Receiving social support, such as care, attention, and being valued by others could serve as an effective buffer to challenging life events and enhance mental well-being (62). And self-identity had important self-aspects as self-esteem (63), which might have a stress-buffering role. Therefore, social support, social well-being, and self-identity all could be considered as stress-buffer factors and had positive functions to protect mental health (41, 43–46, 50, 55, 59, 60). Hong et al. (64) pointed out that related stressors in life would first affect individual emotional response and attitude toward life, and then ultimately affect mental health through positive or negative emotions as suggested. As there were few studies about stress-buffering effects on mental health, so it was of great value to consider social support, social well-being, and self-identity, underlying the following study and specific measurements. It was reasonable to give the hypothesis that social support, social well-being, and self-identity had a chain mediation effect.

The purpose of the present study

Combining hypothesis 1, hypothesis 2, and hypothesis 3, a model consisting of academic stressors, social support, social well-being, self-identity, and mental health was conducted, in which academic stressors had a direct influence on mental health, social support, social well-being, and self-identity playing as mediators under the COVID-19 environment. Specifically, mental health was negatively associated with social support, social well-being, and self-identity, while positively correlated with academic stressors. In addition, social support, social well-being, and self-identity were negatively associated with academic stressors. And those three variables positively correlated with each other. See Figure 1 for details.

Materials and methods

Participants

The survey began in July 2020, about 6 months after the first outbreak of COVID-19. By distributing online questionnaires among Chinese college students, a total of 900 participants were collected using random sampling. There were 900 valid questionnaires with no missing data. Participants in this study consisted of 290 male students and 610 female students. There were 588 (65.33%) undergraduate, 268 (29.78%) master students, and 44 (4.89%) doctoral students. Among them 34 (3.78%) were in Grade one, 136 (15.11%) in Grade Two, 224 (24.89%) in Grade Three, and 506 (56.22%) in Grade Four. The average age of the participants was 21.95 with a standard deviation of 3.36.

Ethics statement

The study involving human participants was reviewed and approved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Academic Board of Tianjin Normal University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The participants voluntarily completed the questionnaire. All were asked to sign a consent form.

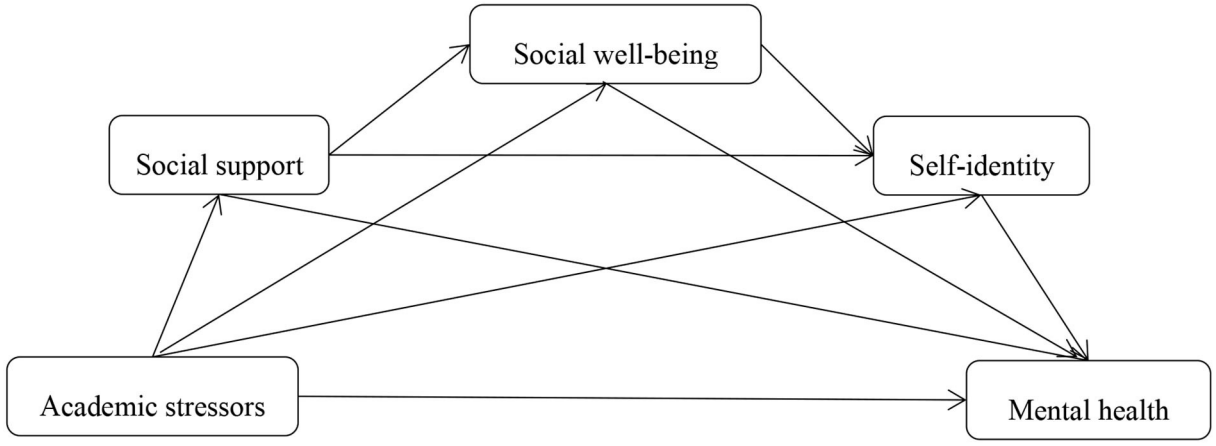

FIGURE 1
The hypothesis of mediating effect of academic stressors on mental health of college students.

Measures

College students' academic stressors questionnaire

The academic stressors of college students were measured by the College students' academic stressors questionnaire revised by Chen (65). The questionnaire consisted of 49 questions in 8 factors (work stressor, goal stressor, task stressor, competitive stressor, obstacle stressor, parental stressor, others' expectation stressor, and environmental stressor). Each item was scored from 1 (no stress) to 5 (high stress). The higher the total score was, the more academic stressors suffered. The reliability of the questionnaire in this study was good (Cronbach's $\alpha = 0.973$). The structural validity of the questionnaire in this study was acceptable ($RMSEA = 0.056$, $CFI = 0.906$, $TLI = 0.896$, $SRMR = 0.044$).

Social support questionnaire

The social support questionnaire was developed by Xiao (66). There were 10 questions in total, which were divided into three dimensions: subjective support, objective support, and utilization degree of support. In the questionnaire, items 1–4 and items 8–10 were scored between 1 and 4. Item 5 had four options, each of which was scored from 1 (none support) to 4 (full support). Items 6 and 7 were designed to investigate the sources of support received, scoring a point for each item selected. The total score was calculated as the social support score. The higher the score, the better the situation of social support. The Cronbach's alpha of the questionnaire in this study was 0.814. The structural validity of the questionnaire in this study was good ($RMSEA = 0.054$, $CFI = 0.910$, $TLI = 0.901$, $SRMR = 0.042$).

Social well-being scale

The social well-being scale, revised by Miao y Wang (67), consisted of 15 questions and was divided into five dimensions: social acceptance, social actualization, social integration, social coherence, and social contribution. A 7-point score was adopted, with the score from obviously not applicable at all to obviously very applicable being 1–7, respectively. The higher the score, the better the situation of social well-being. In this study, the Cronbach's alpha of the scale was 0.847. The structural validity of the scale in this study was good ($RMSEA = 0.069$, $CFI = 0.963$, $TLI = 0.952$, $SRMR = 0.045$).

Self-identity scale

The self-identity scale was developed by Oakes y Prager based on Erickson's theory (68). The scale consisted of 19 items, scoring from 1 (not applicable at all) to 4 (very applicable). After the reverse score of the reverse questions, the total score of the questionnaire was calculated. The higher the score was, the better the self-identity. The Cronbach's alpha coefficient of this scale in this study was 0.833. The structural validity of the scale in this study was good ($RMSEA = 0.056$, $CFI = 0.918$, $TLI = 0.901$, $SRMR = 0.054$).

Depression anxiety stress scales (DASS-21)

Mental health was measured by the simplified version of self-assessment lists of depression–anxiety–pressure (Depression Anxiety Stress Scales, DASS). DASS first was put forward by P. F. Lovibond y S. H. Lovibond (69). This research adopted the DASS-21 scale assessment survey participants 1 week before the survey of psychological state, with each participant scoring between 0 and 3 points: "0" for "never," "1" means "sometimes,"

TABLE 1 Descriptive statistics for main variables.

Variables	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Academic stressors	49.00	245.00	137.30	34.32	−0.19	−0.06
Social support	22.00	58.00	39.06	6.30	−0.03	−0.27
Social well-being	21.00	105.00	75.40	13.89	−0.26	0.01
Self-identity	30.00	72.00	53.61	6.89	−0.23	0.13
Mental health	42.00	168.00	64.08	20.28	1.33	2.06

TABLE 2 Correlation analysis results of all variables.

Variables	1	2	3	4	5
1 Academic stressors	1				
2 Social support	−0.20***	1			
3 Social well-being	−0.24***	0.46***	1		
4 Self-identity	−0.44***	0.46***	0.54***	1	
5 Mental health	0.40***	−0.38***	−0.43***	−0.69***	1
$M \pm SD$	137.30 ± 34.32	39.06 ± 6.30	75.40 ± 13.89	53.61 ± 6.89	64.08 ± 20.28

***$p < 0.001$.

"2" means "often," and "3" means "always." The sum of the scores was multiplied by 2 as the final score. The Cronbach's alpha coefficient was 0.939 in this study. The structural validity of the scale in this study was good ($RMSEA = 0.071$, $CFI = 0.916$, $TLI = 0.903$, $SRMR = 0.040$).

Data analysis

Harman's one-factor test was used to analyze the common method bias. The results showed that the cumulative interpretation of the first factor was 19.49, <50%, suggesting that there was no common method bias (70). SPSS 24.0 was used to conduct Pearson correlations, and Mplus 7.0 was used for mediation analysis.

Results

Descriptive statistics

The descriptive statistics of other variables are shown in Table 1. The statistical values of skewness and kurtosis of the variables in this research were normal distribution. The mean of academic stressors was 137.30 and the standard deviation was 34.32 in this study, much higher than the criterion provided by Chen (65). The corresponding mean and standard deviation values in Chen (65) were 131.76 and 31.77, respectively. T-test was conducted using the mean and standard deviation from the original article with the results in this study. A significant difference was found ($t = 3.31$, $p < 0.05$), suggesting COVID-19 did cause high academic stressors among college students.

Correlation analysis

The correlation analysis for academic stressors, social support, social well-being, self-identity, and mental health was conducted in this study. Results in Table 2 showed that academic stressors were positively correlated with mental health ($r = 0.40$). And academic stressors was negatively correlated with social support ($r = -0.20$), social well-being ($r = -0.24$), and self-identity ($r = -0.44$). In addition, social support, social well-being, and self-identity were positively correlated with each other ($r = 0.46$–0.54). Furthermore, there were eight different stressors in academic stressors: work stressor, goal stressor, task stressor, competitive stressor, obstacle stressor, parental stressor, others' expectation stressor, and environmental stressor. To investigate their roles, a partial correlation was conducted. The partial correlation results are shown in Table 3. It could be seen that only the work stressor was significantly correlated with social support, social well-being, self-identity, and mental health, after controlling the other seven stressors.

Mediation model results

Take academic stressors as the independent variable, social support, social well-being, and self-identity as mediation variables to conduct four structural equation models (SEM),

TABLE 3 Partial correlation analysis results.

Variables	Social support	Social well-being	Self-identity	Mental health
Work stressor	−0.116***	−0.122***	−0.165***	0.138***
Goal stressor	−0.037	0.048	0.016	−0.011
Task stressor	0.006	−0.022	0.065	−0.036
Competitive stressor	−0.027	−0.071*	0.025	−0.087**
Obstacle stressor	−0.023	−0.007	0.022	−0.082*
Parental stressor	−0.020	−0.012	−0.009	0.002
Others' expectation stressor	−0.320	−0.098**	0.058	−0.015
Environmental stressor	0.130***	0.144***	−0.044	0.113***

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

TABLE 4 Model fit results of the four SEMs.

Dependent variables	*RMSEA*	*CFI*	*TLI*	*SRMR*
Depression	0.070	0.909	0.884	0.038
Anxiety	0.071	0.907	0.882	0.039
Stress	0.070	0.910	0.885	0.038
Mental health	0.066	0.920	0.901	0.038

because there were depression, anxiety, and stress scores included in DASS-21 (71, 72). So four SEMs results are shown in Table 4, with depression, anxiety, stress, and mental health as the dependent variable, respectively. It could be known that the model fit results of mental health were slightly greater than the other three, and Zanon et al. (73) suggested that the DASS-21 could be used as a unidimensional scale, so the total score of DASS-21 was used in the following analysis. The path coefficients are shown in Figure 2, and the corresponding intermediatory effects and their confidence intervals of the model are shown in Table 5.

As shown in Table 5, the confidence intervals of the three paths: academic stressors → social well-being → mental health, academic stressors → social support → mental health, academic stressors → social support → social well-being → mental health included 0, so the mediating effects were not significant. Instead, confidence intervals of four paths: academic stressors→ self-identity → mental health, academic stressors→ social well-being → self-identity → mental health, academic stressors → social support→ self-identity → mental health, academic stressors → social support → social well-being → self-identity → mental health did not include 0, so the mediation effects were significant. The total mediating effect accounted for 62.44% of the total effect. The simple mediating effect of self-identity accounted for 56.91% of the total mediating effects. Generally, the results suggested that social support, social well-being, and self-identity could mediate the impact that academic stressors on mental health, and self-identity was the most important mediation variable.

It could be known from the partial correlation results that work stressor was the most important dimension. To explore the work stressors subdimension of academic stressors, introducing it as the independent variable, mental health as the dependent variable, social support, social well-being, and self-identity as intermediatory variables, conduct the mediation analysis. Model fit results: $RMSEA = 0.055$, $CFI = 0.953$, $TLI = 0.931$, $SRMR = 0.031$. The corresponding intermediatory effects and confidence intervals of the model are shown in Table 6, and the corresponding mediation figure is Figure 3. The total mediating effect accounted for 68.66% of the total effect. The simple mediating effect of self-identity accounted for 51.98% of the total mediating effects. The SEM in which work stressor was introduced as the independent variable and the SEM in which academic stressors was considered as the independent variable had significant paths, suggesting social support, social well-being, and self-identity could mediate the impact that work stressors had on mental health. Work stressor was the important factor during COVID-19 among academic stressors.

Discussion

The mediating role of social support

This study supported that academic stressors directly impacted mental health, in which social support played a mediating role. Social support had a negative prediction for COVID-19 anxiety, and results showed that it was needed to release the fear and anxiety of college students caused by COVID-19 (74, 75). And it was also negatively associated with academic stressors and work stressors, playing as a protective factor for the mental issue (41, 43, 44, 46). During COVID-19, effective support from friends and family could decrease the academic stressors of disturbed face-to-face study and worry about performance or work opportunities, according to the Stress-Buffering Hypothesis (76). In contrast, lacking social

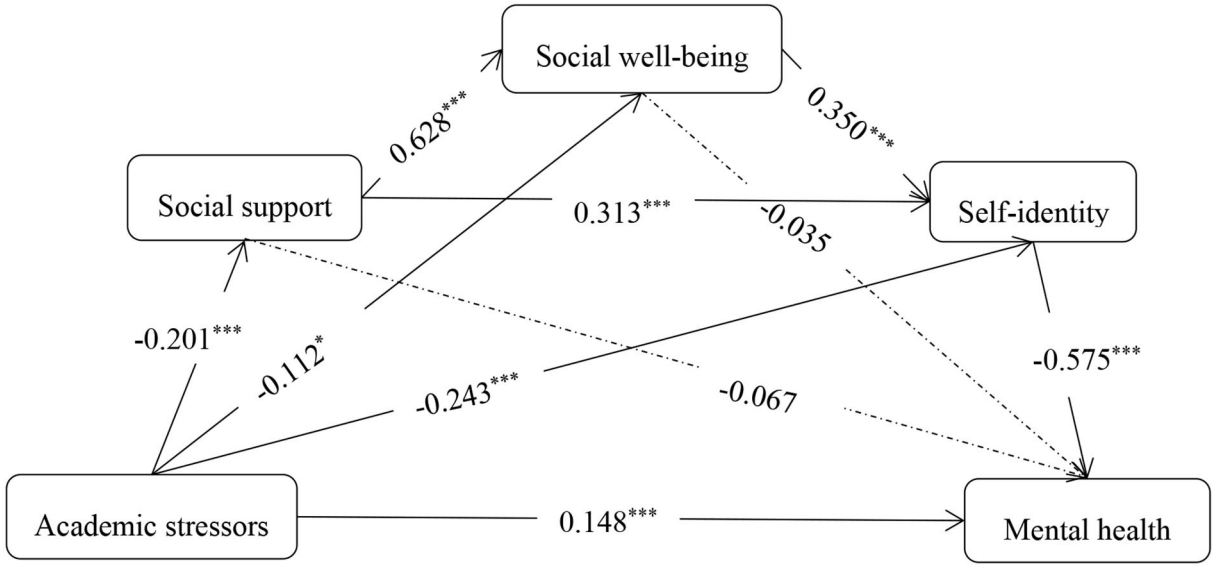

FIGURE 2
The mediation model of college students' academic stressors on mental health. *$p < 0.05$, ***$p < 0.001$.

TABLE 5 The chain mediating effect of social support, social well-being and self-identity between academic stressors and mental health.

Path	Effect	Boot SE	Boot LLCI	Boot ULCI
Direct effect	0.148	0.027	0.098	0.197
Academic stressors→ self-identity → mental health	0.140	0.020	0.104	0.184
Academic stressors→ social well-being→ mental health	0.004	0.006	−0.006	0.018
Academic stressors→ social support→ mental health	0.013	0.014	−0.015	0.046
Academic stressors→ social well-being→ self-identity→ mental health	0.023	0.009	0.007	0.042
Academic stressors→ social support→ self-identity→ mental health	0.036	0.010	0.020	0.062
Academic stressors→ social support→ social well-being→ mental health	0.004	0.007	−0.009	0.018
Academic stressors→ social support→ social well-being→ self-identity→ mental health	0.025	0.006	0.015	0.040
Total mediating effect	0.246	0.025	0.200	0.297
Total effect	0.394	0.030	0.328	0.448

support would cause greater symptom severity in mental health disorders, such as depression, anxiety, and bipolar disorder (77).

Usually, a person who could not get in touch with others or get support from others would suffer more negative emotions or moods (42, 51–53, 59). However, the effect of social support on mental health in the SEM was not significant. There were three intermediary variables included in the current SEM and only the effect of self-identity on mental health was significant. It could be inferred that social support was not a direct or important factor for mental health in this SEM and self-identity was the most important one. Many researchers discovered that identity could be enhanced by social support (78–81). Gleibs et al. (79) also found that social support contributed to the construction of identity. That was consistent with Haslam et al. (82), which suggested an "upward spiral" involving identity and social support whereby social support increased social identification. It was reasonable that the social support enhanced self-identity, weakening its own effect on mental health at the same time.

The mediating role of social well-being

Social well-being was one of the outcomes of positive mental health and an important factor for it (50, 83). The stressors of the public were severe during COVID-19, and some students also were concerned about their employment (84). A high level of academic stressors might result in a poor mental state, like worrying too much about the academic career or graduation, and employment causing a low level

TABLE 6 The chain mediating effect of social support, social well-being and self-identity between work stressors and mental health.

Path	Effect	Boot SE	Boot LLCI	Boot ULCI
Direct effect	0.115	0.027	0.063	0.166
Work stressors→ self-identity → mental health	0.131	0.019	0.097	0.172
Work stressors→ social well-being→ mental health	0.004	0.006	−0.006	0.019
Work stressors→ social support→ mental health	0.014	0.07	−0.020	0.049
Work stressors→ social well-being→ self-identity→ mental health	0.023	0.010	0.005	0.043
Work stressors→ social support→ self-identity→ mental health	0.043	0.012	0.026	0.073
Work stressors→ social support→ social well-being→ mental health	0.005	0.008	−0.010	0.022
Work stressors→ social support→ social well-being→ self-identity→ mental health	0.031	0.007	0.020	0.048
Total mediating effect	0.252	0.024	0.204	0.300
Total effect	0.367	0.030	0.303	0.420

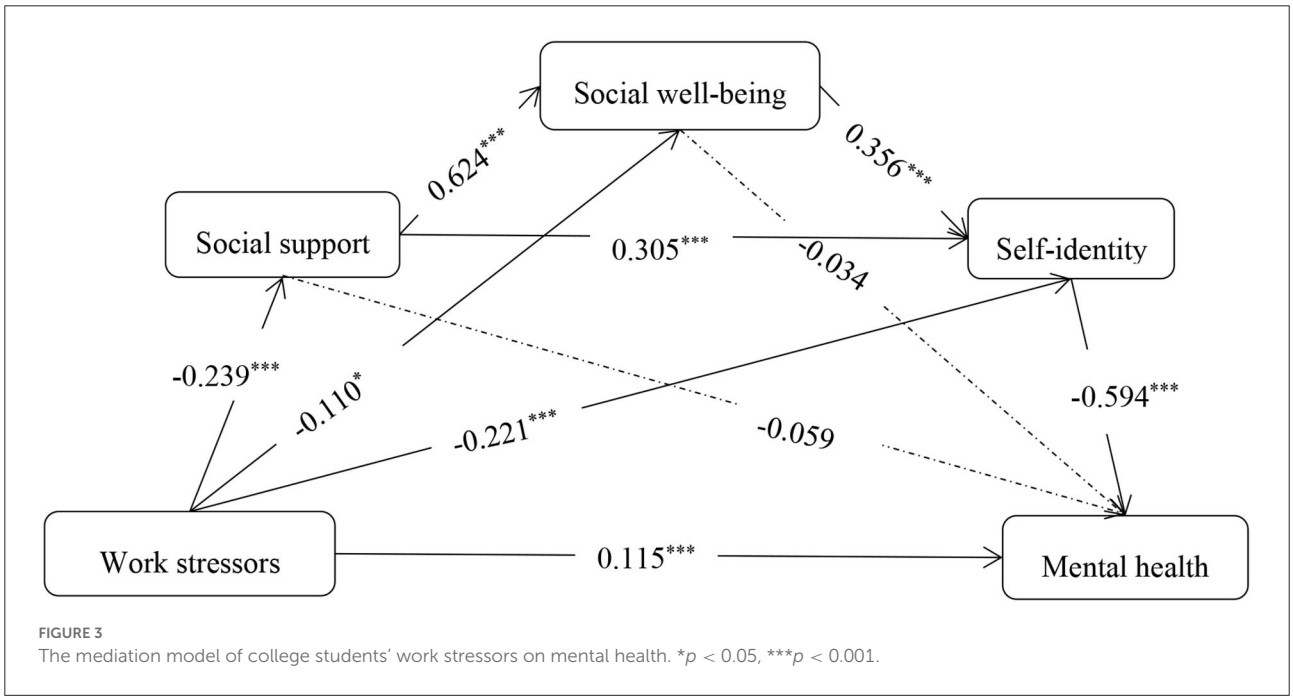

FIGURE 3
The mediation model of college students' work stressors on mental health. *$p < 0.05$, ***$p < 0.001$.

of well-being, and further launching a negative effect on mental health in the COVID-19 environment. So, well-being could be considered as a protective role between academic stressors and mental health (85). Research about the mediating effect of well-being showed that well-being played a mediating role in the relationship between social support and mental health (64, 86). Receiving social support, such as care and attention, and being valued by others could serve as an effective buffer to challenging life events and enhance mental well-being (62). Additionally, social well-being also had a close relationship with self-identity (87). Especially, the sense of personal continuity through time was related to better well-being.

Liu et al. (88) discovered that well-being could directly influence mental health. As the impact of COVID-19 was gradually expanding, many scholars and social welfare agencies warned that the measures to defeat COVID-19, such as lockdown, would have long-lasting adverse effects on individuals' social well-being and mental health (89–91). This research showed that social well-being was significantly predicted by academic stressors and work stressors, similar to Poots and Cassidy (42), indicating that the more stressors are experienced, the worse will be the mental state and the lower sense of well-being. But the path from social well-being to mental health was not significant, different from the previous research (88), which might be due to the fact that well-being and

identity had a close linkage, and some conceptual overlap was there between them (92).

The mediating role of self-identity

This study showed that academic stressors, work stressors, social support, and social well-being had a strong correlation with self-identity, and self-identity further predicted mental health. Self-identity protected against health risks among college-aged populations (63). College students who were at a low level of self-identity would worry too much about their performance in social, resulting in social anxiety (93, 94) and poor mental health (54). Besides, self-identity was indicated as the crucial factor to gain new identities (78–81). Especially, in the situation where the public was suffering from the devastating impact of COVID-19, the self-identity helped them retain confidence and positive cognition about themselves, and was the main factor predicting mental problems (95).

It was widely known that social support could release the suffering and negative consequence generated from general stress according to the Stress-Buffering Hypothesis (76). Self-identity had important self-aspects as a stress-buffering factor, having the same effect as social support and well-being (63). This might suggest that individuals' social support and social well-being enhanced their self-identity, and further reduced negative emotions or psychological disorders. People's self-conceptions were always closely linked to their psychological states. For example, if an individual felt a failure at work or encountered challenges, they always de-emphasized the importance of hard work, so as to protect his self-evaluation. So, if identity was successfully made less central to the self, ongoing problems in the identity domain or even the loss of the identity should have a less psychological impact (96).

The psychological mechanism between academic stressors and mental health

This study gave evidence that academic stressors paid a direct impact on mental health and an indirect impact on mental health through social support, social well-being, and self-identity during the outbreak of COVID-19. The direct effect that academic stressors on mental health were significant, but the mediation path through social support to mental health was not significant, partially conformed to hypothesis 1. Some studies discussed those variables, respectively (29, 44, 97). So, there might be other important variables in the model like self-identity, which burdened more effect from academic stressors to mental health, comparing social support and social well-being. Another recent study discussed the relationships among academic stressors, social support, and well-being (42), which found that social support mediated the relationship between academic stressors and well-being. In this study, we found that academic stressors could impact social well-being directly and also indirectly through social support, which supported hypothesis 2.

Self-identity was strongly correlated with anxiety, which was the main expression of mental health (94). Lacking identity would decrease individual well-being (98). It was widely known that social support and well-being strongly positively correlated with mental health (59, 60), reflecting that an individual who had resources of support and a good state of well-being, would have less psychological problems. Among college students, academic stressors were their main problems encountered, which had a strongly negative relationship with mental health (29). All those variables were important to mental health and had their own work. Taking them into the SEM model, the results showed that academic stressors not only could directly impact mental health, but also predict mental health through social support, social well-being, and self-identity; hypothesis 3 was partially supported. And work stressor in academic stressors was important, and they might have a similar effect as academic stressors. In sum, the results partially confirmed the hypothetical model and provided new evidence to explain the psychological mechanism of the effect of academic stressors on mental health during the outbreak of COVID-19.

The work stressor of college students under the COVID-19

College students had lots of unique stressors during the COVID-19 pandemic, and many of them were future oriented; concerns about campus closures, delays in degree completion, and, as the economy continued to decline, worry about future job prospects (16, 86). According to this study, work stressor was the important stressor and had a great impact on mental health, in line with the previous studies (19–21). In addition, there were not enough studies about the work stressor of college students. This might be due to the real situation that college students did not have a fixed job or were not ready to get into the job market. Even though, it also existed in college students. Yang et al. (99) showed that the non-graduating students had higher work stressors than the graduating students. So, it was necessary to expand the study about work stressors among college students.

Limitations and implications

Considering the mediation model results, self-identity was the most important factor for mental health comparing social support and social well-being. It might be an "upward spiral"

involving identity and social support whereby social support increased social identification. So, in-depth research can be conducted by manipulating the social support level to verify this effect in the future. Studying the concrete relationship between social support and social well-being had empirical evidence for future studies about social support and self-identity.

In addition, this was a cross-sectional study that could not explain the development of college students' mental health and how its causes played their roles. It would be better to conduct longitudinal research on college students' mental health, so as to expand this study and get a more accurate conclusion. It was important in real life to study deeply and further. The results of this study could be the base for establishing mental health protection measures, by providing more social support to make them have less stressors and more well-being, then further increasing the self-identity of college students.

Overall, the results in this study could not be generalized to the public to some extent, due to the focused group and special study time. The focused group was college students that had their own characteristics, such as age, understudying, and sitting in the transition to adults. The context of the outbreak of COVID-19 was very different from the situation before the pandemic, causing different mental states of the college students. So, it is necessary to include more extended people in the study samples, and use the corresponding data before COVID-19 to test the generalization of the mediation results.

Conclusion

In sum, in the context of the outbreak of the COVID-19 pandemic, social support, well-being, and self-identity could partially mediate the effect of academic stressors on mental health. Academic stressors could positively directly predict mental health, while self-identity negatively directly predicts mental health. Social support and social well-being played as mediators, which could not directly impact mental health. Work stressor was an important stressor during COVID-19, and had the same role as academic stressors in the model in this study.

Data availability statement

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

Author contributions

Study conception and design and draft manuscript preparation: PL, JY, ZhZ, ZiZ, and TL. Data collection: PL, JY, and ZhZ. Analysis and interpretation of results: PL, JY, and TL. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

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

Publisher's note

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University freshmen's excessive smartphone use and psychological safety during the COVID-19 pandemic

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Although excessive smartphone use has been confirmed as being associated with specific representations of mental health (e. g., anxiety, depression, wellbeing, etc.) throughout the COVID-19 pandemic, the relationship between excessive smartphone use and cognitive representations of mental health (i.e., psychological safety) is not yet fully understood. This study aimed to identify the association between excessive smartphone use and psychological safety among university freshmen during the COVID-19 pandemic; in addition, we examined the mediation effects of hardiness and interpersonal distress in this relationship. In this study, 1,224 university freshmen were selected at random from several universities in Guizhou Province of China. The Psychological Safety Scale was used to evaluate the mental health of university freshmen; the Mobile Phone Dependence Scale was used to evaluate excessive smartphone use; the Hardiness Questionnaire was used to evaluate hardiness; and the Interpersonal Relation Synthetic Diagnose Test was used to evaluate interpersonal distress. The findings showed that: (1) the greater the degree of excessive smartphone use, the more serious respondents' interpersonal distress and the lower their hardiness; (2) excessive smartphone use was not only directly related to the psychological safety of university freshmen but also indirectly related to their psychological safety through the independent mediation of hardiness and interpersonal distress, as well as through the chain mediation of hardiness and interpersonal distress. In general, excessive smartphone use in university freshmen could lead to a decline in their psychological safety. Also, hardiness and interpersonal distress play a complex role in this relationship. During the COVID-19 pandemic, interventions on the mental health of college freshmen should not only provide guidance on how to use their smartphone responsibly but also to provide them with support and guidance for the enhancement of their hardiness and improvement of their interpersonal relationships.

KEYWORDS

excessive smartphone use, psychological safety, hardiness, interpersonal distress, university freshmen

Introduction

For over 2 years, the entire world has struggled with the global COVID-19 pandemic. During this time, many households have faced isolation, fear, violence, drug abuse, and anxiety. The pandemic has affected not only physical health but also mental functioning (1). A recent study conducted among undergraduates in a Chinese college reported that 24.9% of the participants experienced psychological distress due to the COVID-19 pandemic (2). In another cross-sectional survey conducted in Iran, 99.0 and 69.6% of the participating medical students reported suffering from extremely severe anxiety and depression, respectively, due to commuting restrictions and fear of contracting the virus (3). These findings suggest that the pandemic has indeed had a negative impact on people's mental health.

To control the rapid spread of COVID-19, home quarantine and altered teaching styles for college students have been enforced in most colleges and universities. However, these policies may have led to an important unintended consequence, as time spent studying online may be a potential risk factor for excessive smartphone use, which could further result in negative psychological disorders. Relevant empirical findings have also provided support for this view. For example, a recent national survey of 746,217 Chinese college students showed that the risks of developing depression and anxiety disorders increased with their exposure time to smartphone use (4). Another study of 31,425 American college and graduate students also showed that problematic use of smartphones was demonstrably associated with certain mental health diagnoses (especially ADHD, anxiety, depression, and PTSD) (5).

Numerous related studies have been done on the relationship between excessive smartphone use and mental health (4, 5). However, the mechanism underlying this relationship during the COVID-19 pandemic has been inadequately explored. Moreover, previous research on the relationship between excessive smartphone use and mental health has focused on the analysis of representations (e.g., anxiety, depression, etc.) in mental health, but the analysis of cognitive representations (i.e., psychological safety) is still lacking. During the COVID-19 pandemic, psychological safety has been considered as an important indicator of mental health (6, 7). Therefore, the current study focused on the association between excessive smartphone use and psychological safety among college students during the COVID-19 pandemic. According to social cognitive theory, not only is people's behavior a response to the external environment and internal psychology (e.g., cognition, emotion, etc.), but also their behavior also has a direct effect on the external environment and their internal psychology (8). Based on this theory, the current study also intended to investigate the association mechanism of excessive smartphone use with psychological safety from both the external environment (interpersonal distress) and internal psychology (hardiness).

During the pandemic, many schools have shifted to online teaching for safety concerns. Smartphones have become an important tool for students when learning online (9). The selection of college freshmen for the current study was based on two considerations. First, college freshmen in general have recently been relieved of the pressure of the college entrance examination, and want to relax in college to compensate for their lack of time seeking entertainment in high school (10). Second, during the transition from high school to university, college freshmen generally face a variety of pressures including adapting to new environments, dealing with new interpersonal relationships, and embracing new ways of learning. These pressures often lead college freshmen to use their smartphones more to alleviate their burden of stress (11). These factors are likely to contribute to their excessive smartphone use. Therefore, it was determined that college freshmen would be a suitable demographic for this study.

Excessive smartphones use and psychological safety

Excessive smartphone use (also referred to as smartphone addiction or smartphone dependence) refers to people's inability to control the amount of time they spend using their smartphones, leading to excessive smartphone use which negatively impacts their physical and mental health (12). According to media dependency theory, the more an individual relies on a particular medium to meet their needs, the greater the influence of that medium on them (13). Numerous studies have examined the relationship between excessive smartphone use and specific representations of mental health problems (e.g., anxiety, depression, etc.) during the COVID-19 pandemic, and have identified a positive relationship between smartphone use and poor mental health (4, 14). However, few studies have focused on the relationship between excessive smartphone use and psychological safety, and the mechanisms at play between them. Psychological safety can be used as a positive indicator reflecting mental health during the pandemic (6, 7).

Psychological safety is an internal need for stability, expressed primarily as a sense of certainty and control over people or things in one's environment. It is measured by a two-factor structure, composed of the interpersonal security and the certainty in control (15). According to Maslow's hierarchy of needs theory, psychological safety is one of the basic human needs, and the satisfaction of this need determines the healthy growth and development of an individual (16). On the behavioral level, psychological safety is mirrored by actively participating in social activity and developing peer relationships, positively exploring the external world, and exerting reasonable

control over one's behavior in the face of setbacks and pressures (17). In fact, many human behaviors are designed to maintain a sense of psychological safety (15). Some researchers have considered psychological safety as an important factor in characterizing mental health (18). Others have even treated psychological safety and mental health as synonymous (6). There are two main sources of psychological safety: one is the perception of a safe environment; the other is the judgment of one's ability to cope with change (19). During the COVID-19 pandemic, while most people were in quarantine at home, many worked from or found entertainment through their smartphone (20). This led to more time and opportunity for people to use their smartphones. Excessive smartphone use will often cause individuals to experience loss of control (12), thus leading to them blocking sources of psychological safety. Therefore, as a starting point, the current study hypothesized that:

Hypothesis 1: Excessive smartphone use is negatively associated with psychological safety.

The affecting mechanism of hardiness

In positive psychology, hardiness is seen as a set of personal resources that appear to protect individuals from the adverse effects of stress (21, 22), which is usually defined as a generalized style of functioning characterized by a high level of commitment, control, and challenge. Hardiness is considered by many to be a stable personality trait (23). However, some studies emphasize the variability in hardiness due to either extrinsic or intrinsic influences, and have regarded hardiness as a state trait, arguing that it shows not only relative stability similar to personality traits but also variability (21, 24). In fact, hardiness represents one's sustained effort and consistent focus on goal-pursuing processes, during which an individual will regulate their thoughts, emotions, and behaviors based on daily events or experiences (25), thus exhibiting variability during such a period of time. Relevant empirical findings have also provided support for this view. For example, Wong et al. found that hardiness changes dynamically due to daily self-concept clarity (25); Dymecka et al. showed that fear of COVID-19 would lead to the variability of hardiness among Polish people (26); Yu et al. also identified that students' mathematics anxiety weakened their hardiness in math learning (27). The current study therefore regarded hardiness as a state trait that can be affected by internal and external factors during a period of time.

Some consider hardiness to be a form of self-control in the face of stress or adversity (28). Studies have also found that hardiness is closely associated with brain regions related to self-control (29). Using resting-state functional magnetic resonance images (rs-fMRI), researchers have found that the more severe one's excessive smartphone use, the more pronounced the decline in the altered connectivity of an individual's right inferior frontal gyrus, and the poorer their self-control (30). According to the strength model of self-control, behaviors such as information processing, interpersonal interaction, and impression management all consume an individual's limited psychological resources. The depletion of psychological resources below a certain level leads to a failure in self-control (31). Browsing websites, socializing online, and self-presentation are all common smartphone usage behaviors. Therefore, excessive smartphone use can deplete an individual's limited mental resources, leading to a failure in their self-control (32), which in turn leads to a decrease in their level of hardiness. Therefore, the current study hypothesized the following:

Hypothesis 2: Excessive smartphone use is negatively associated with hardiness.

In the face of environmental changes or risks, hardy individuals have strong insight and self-control and believe that they are able to adapt to environmental changes, and that their abilities can be improved through their efforts to change unfavorable conditions or solve crises (21), thereby making their lives more fulfilling and safe. Empirical studies have shown that hardiness is negatively associated with loneliness and depressive symptoms, and that it has played a core role in protecting the mental health of individuals during the COVID-19 pandemic (33). That is, the higher one's level of hardiness, the higher their level of mental health; conversely, the lower one's level of hardiness, the more likely they are to suffer from mental health problems (34). Another empirical study has found a positive correlation between hardiness and psychological safety (21). As proposed by the Hypothesis 2, excessive smartphone use is likely related to hardiness, and as hardiness is shown to be closely related to psychological safety (21), we inferred that hardiness might play an indirect role in the relationship between excessive smartphone use and psychological safety. Therefore, the current study hypothesized the following:

Hypothesis 3: Hardiness is positively associated with psychological safety.

Hypothesis 4: Hardiness mediates the relationship between excessive smartphone use and psychological safety.

The affecting mechanism of interpersonal distress

Interpersonal distress refers to the inability to communicate and interact with people normally, while exhibiting various symptoms including not being understood by others or appearing reserved and anxious when dealing with others (35). It can be divided into three types: interpersonal conversation distress, interpersonal communication distress, and heterosexual communication distress (36). College freshmen end or change their existing relationships when transitioning from high school to university, and are more likely to encounter interpersonal distress (10). Interpersonal distress

has attracted research attention specifically as an important indicator of interpersonal environmental health (37). Excessive smartphone use has also been linked with interpersonal distress. Some studies have found that excessive smartphone use can easily lead to individuals ignoring interactions with people around them, thus negatively impacting interpersonal relationships (38, 39). Interpersonal relationships are often regarded as a reflection of an individual's abilities, and they affect all aspects of individual's life and learning (40). An individual who cannot handle interpersonal relationships well will face interpersonal distress as a result, which will likely become a serious stress on their mental health (41). Interpersonal distress destroys an individual's internal control and trust, making them feel their life is meaningless and affecting their mental health (42). According to the theory of emotional security, interpersonal distress induces adverse effects on an individual's psychological safety (43). Related studies have also found that good interpersonal relationships contribute to psychological safety (44). Therefore, the current study hypothesized the following:

Hypothesis 5: Excessive smartphone use is positively associated with interpersonal distress.

Hypothesis 6: Interpersonal distress is negatively associated with psychological safety.

Hypothesis 7: Interpersonal distress mediates the relationship between excessive smartphone use and psychological safety.

According to the hardiness model, hardiness is considered to be an important protective factor for mental health which reduces physical and psychological distress by attracting social support (22). In other words, hardy individuals generally have good interpersonal relationships. Empirical studies have also found that higher levels of hardiness are associated with lower levels of interpersonal distress (21). Therefore, the current study hypothesized the following:

Hypothesis 8: Hardiness is negatively associated with interpersonal distress.

Hypothesis 9: Hardiness and interpersonal distress play chain mediating roles between excessive smartphone use and psychological safety.

The current study

To better understand the impact of excessive smartphone use on the mental health of university freshmen and the mechanisms at play during the COVID-19 pandemic, and guided by media dependence theory and social cognitive theory, the current study looked at university freshmen as the subject, and assessed their mental health using psychological safety as an indicator. The mechanisms were explored through the mediating effects of both internal psychology (hardiness) and the external environment (interpersonal distress). The hypothesized model is depicted in Figure 1. To ensure the reliability of the results, we controlled for variables that might influence the relationship between excessive smartphone use and psychological safety. Previous studies have found gender differences in excessive smartphone use (20), as well as differences relating to both gender and age with regard to hardiness (45). Therefore, we controlled for demographic variables including gender and age.

Materials and methods

Participants and procedure

The research group elected to use freshmen studying in Guizhou Province during September and October 2021 as the survey population. First, two universities, Guizhou Normal University and Zunyi Normal University, were selected at random from a list of 21 public universities in Guizhou Province. Then, 1,317 freshmen (out of a total of 10,022 freshmen at these two universities) were selected, also at random, as the survey subjects out of the 10,022 freshmen from Guizhou Normal University and Zunyi Normal University. A total of 93 incomplete or identical responses were removed. After data cleaning, 1,224 questionnaires were considered to be valid to use with an effective rate of 92.938%. The mean age of the subjects was 19.910 years old ($SD = 0.873$ years). Among these, female students accounted for 55.310% of the total. Detailed demographic data of the studied sample is presented in Table 1.

During the investigation process, the researcher conducted group training for the members of the investigation team, ensuring standardized instruction procedures during the investigation. Before the survey, each investigation team member completed a questionnaire independently to familiarize themselves with the full questionnaire. All questions related to the survey were distributed to participants in a classroom setting using a paper form, and were collected anonymously on the spot. Investigators were present to respond to any problems encountered by participants during the study process. After the questionnaires were collected, invalid questionnaires were removed. The remaining valid questionnaires were encoded. Random checks were conducted after data entry to reduce entry errors. The study was approved by the Academic Committee of Zunyi Normal University, and written consent was obtained from each participant.

Measures

Mobile phone dependence scale

The Mobile Phone Dependence Scale, edited by Huang (46), evaluates excessive smartphone use. The questionnaire comprises of 17 items in total measuring four dimensions:

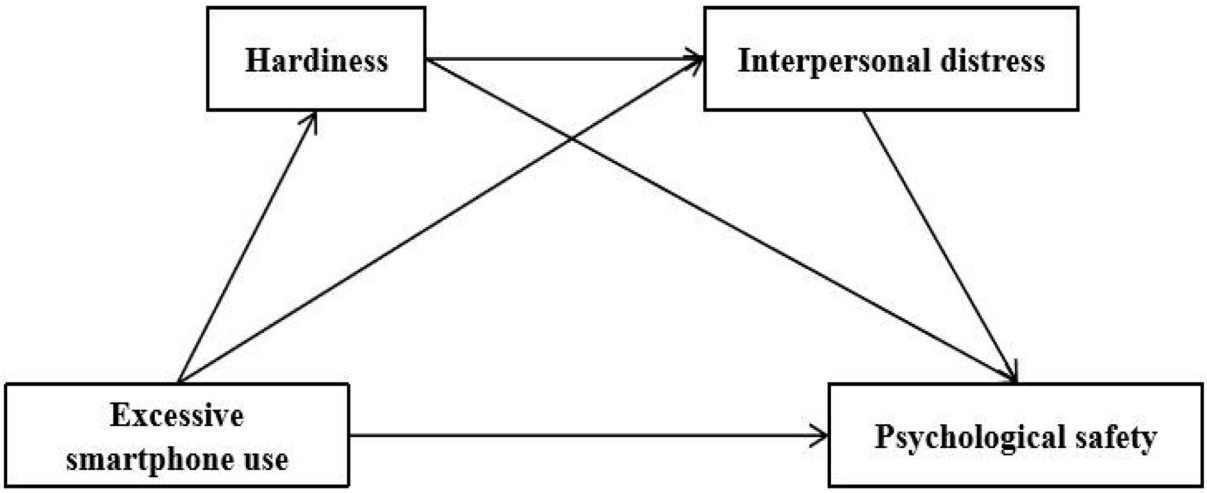

FIGURE 1
Proposed model of excessive smartphone use as a predictor of psychological safety mediated by hardiness and interpersonal distress.

TABLE 1 Demographic information of the study sample ($N = 1,224$).

	M	*SD*	Min	Max
Age				
All participants	19.910	0.873	17	24
Female	20.060	0.673	19	24
Male	19.730	1.043	17	24
		N		**%**
Sex				
Male		677		44.690
Female		547		55.310
Annual family income				
<10,000 yuan		316		25.817
10,000–30,000 yuan		422		34.477
30,000–60,000 yuan		264		21.568
60,000–100,000 yuan		147		12.009
More than 100,000 yuan		75		6.127
Number of siblings				
Only child		121		9.885
Non-only child		1,103		90.115
Residential location				
Rural		1,100		89.869
Urban		124		10.131

loss of control, withdrawal, avoidance, and ineffectiveness. Each item is rated on a five-point scale ranging from 1 (never) to 5 (always). The higher the total score, the more severe one's excessive smartphone use. It has been widely used and proven to have good validity and reliability for Chinese students (47). The internal consistency reliability coefficients in this study were 0.783 for the uncontrolled sub-scale, 0.859 for the withdrawal sub-scale, 0.751 for the avoidance sub-scale, 0.777 for the ineffectiveness sub-scale, and 0.901 for the total scale.

Hardiness questionnaire

The Hardiness Questionnaire, edited by Lu (48), evaluates hardiness. There are 27 items in total measuring the four dimensions: resilience, control, engagement, and challenge. Each item is rated on a four-point scale, with scoring options of "unsuitable", "somewhat suitable", "suitable", to "very suitable". The higher the one's total score, the stronger their personality hardiness. The reliability and validity of this questionnaire have been fully verified (49). The internal consistency reliability coefficients in this study were 0.757 for the resilience sub-scale, 0.834 for the control sub-scale, 0.805 for the engagement sub-scale, 0.791 for the challenge sub-scale, and 0.942 for the total scale.

Interpersonal relation synthetic diagnose test

The Interpersonal Relation Synthetic Diagnose Test evaluates interpersonal distress and was edited by Zheng (50). There are 28 items that measure a total of four dimensions: talking, socializing, dealing with people, and dating someone of the opposite sex. A score of 1 is given for "yes" and 0 for "no". The higher the total score, the more serious one's interpersonal distress. The Chinese version of Interpersonal Relation Synthetic Diagnose Test has been confirmed to be reliable and valid among adolescents and adults (51). The internal consistency reliability coefficients in this study were

0.728 for the talking sub-scale, 0.779 for the socializing sub-scale, 0.648 for the dealing with people sub-scale, 0.711 for dating the opposite sex sub-scale, and 0.902 for the total scale.

Psychological safety questionnaire

The Psychological Safety Questionnaire was edited by Cong (15) and is used to evaluate psychological safety. There are 16 items in total measuring two dimensions: interpersonal security and certainty in control. Each item is rated on a five-point scale from 1 ("very suitable") to 5 ("very unsuitable"). The higher the total score, the stronger one's psychological safety. It has been used widely and proven to have good validity and reliability for Chinese students (52). The internal consistency reliability coefficients in the current study were 0.877 for the interpersonal security sub-scale, 0.879 for the certainty in control sub-scale, and 0.933 for the total scale.

Covariates

In this study, the socioeconomic characteristics of the subjects were treated as covariates. This included age, sex (1 = male; 2 = female), annual family income (1 = <10,000 yuan, 2 = 10,000–30,000, 3 = 30,000–60,000 yuan, 4 = 60,000–100,000 yuan, 5 = more than 100,000 yuan), siblings (1 = only child, 2 = non-only child), and household registration (1 = rural, 2 = urban).

Data analysis

A total of 93 incomplete or identical response results were removed. After data cleaning, 1,224 questionnaires were considered to be valid for use. Data analysis was performed using SPSS 26.0. First, we checked the bias degree of the common method in this study. Second, descriptive analysis and correlation analysis were adopted to test the mean and standard deviation of each variable and their correlation coefficients. Third, model six of SPSS macro PROCESS 3.5 (53) was used to test the mediation effect of hardiness and interpersonal distress in the relationship between interpersonal stress and psychological safety, and the significance of the mediation effect was further determined by generating the bias-corrected bootstrap confidence interval (using 5,000 bootstrapping samples). In addition, all variables, such as age, gender, family income, birth, and whether they were an only child, were treated as covariates.

Results

Common methodological bias

An unrotated exploratory factor analysis of all variables showed that there were 17 factors with characteristic roots >1. The amount of variation explained by the first factor was 18.323%, which did not exceed the critical criterion of 40%. Therefore, it can be concluded that there was no serious common methodological bias in the variables involved in this study.

Descriptive and correlation analyses of each variable

As shown in Table 2, excessive smartphone use showed a positive correlation with interpersonal distress, as expected ($r = 0.341$, $p < 0.001$), and a negative correlation with hardiness ($r = -0.101$, $p < 0.001$) and psychological safety ($r = -0.327$, $p < 0.001$). Hardiness showed a negative correlation with interpersonal distress ($r = -0.209$, $p < 0.001$) and a positive correlation with psychological safety ($r = 0.361$, $p < 0.001$). Interpersonal distress showed a negative correlation with psychological safety ($r = -0.615$, $p < 0.001$).

Mediating effect test

Table 3 shows that excessive smartphone use had a negative effect on hardiness ($\beta = -0.091$, $p < 0.05$). When excessive smartphone use and hardiness simultaneously predicted interpersonal distress, excessive smartphone use had a positive predictive effect on interpersonal distress ($\beta = 0.314$, $p < 0.001$), and hardiness had a negative effect on interpersonal distress ($\beta = -0.173$, $p < 0.001$).

TABLE 2 Mean, standard deviation, and correlation coefficient (*r*; 95% CI) of the main variables.

	Mean	*SD*	1	2	3	4
1. Excessive smartphone use	2.511	0.688	1			
2. Hardiness	2.445	0.461	−0.101*** (−0.164, −0.034)	1		
3. Interpersonal stress	0.297	0.221	0.341*** (0.283, 0.398)	−0.209*** (−0.265, −0.154)	1	
4. Psychological safety	3.253	0.771	−0.327*** (−0.388, −0.265)	0.361*** (0.303, 0.417)	−0.615*** (−0.652, −575)	1

N = 1,224; ***p < 0.001.

TABLE 3 Regression analysis between variables.

Regression Equation		Overall fit index		Significance of regression coefficients		
Outcome variable	**Predictive variable**	***R***	***R*²**	***F***	***β***	***t***
Hardiness		0.189	0.036	7.571***		
	Gender				−0.321	−5.445***
	Age				0.034	1.039
	Family annual income				−0.024	−0.986
	Only child				−0.023	−0.228
	Household registration				0.02	0.761
	Excessive smartphone use smartphone use smartphone use				−0.091	−3.181*
Interpersonal Distress		0.396	0.157	32.408***		
	Gender				0.052	0.936
	Age				0.022	0.703
	Family annual income				−0.064	−2.692**
	Only child				0.164	1.726
	Household registration				0.096	1.012
	Excessive smartphone use				0.314	11.792***
	Hardiness				−0.173	−6.463***
Psychological Safety		0.671	0.449	124.127***		
	Gender				−0.001	−0.033
	Age				0.036	1.433
	Family annual income				0.001	0.075
	Only child				0.001	0.008
	Household registration				0.069	0.901
	Excessive smartphone use				−0.125	−5.491***
	Hardiness				0.239	10.843***
	Interpersonal distress				−0.523	−22.548***

N = 1,224. *p < 0.05,**p < 0.01,***p < 0.001.

When excessive smartphone use, hardiness, and interpersonal distress simultaneously predicted psychological safety, excessive smartphone use had a negative effect on psychological safety ($\beta = -0.125$, $p < 0.001$), hardiness had a positive effect on psychological safety ($\beta = 0.239$, $p < 0.001$), and interpersonal distress had a negative effect on psychological safety ($\beta = -0.523$, $p < 0.001$).

Using the bias-corrected bootstrapped confidence intervals method, the sample was repeated 5,000 times at 95% confidence intervals (CI) to calculate the mediation effect. If 95% CI did not contain 0, it indicated a significant mediating effect. As shown in Table 4, the total mediating effect value was 0.193, accounting for 60.691% of the total effect of excessive smartphone use on psychological safety (0.318). First, we tested the mediating effect of hardiness between excessive smartphone use and psychological safety. It was found that the indirect effect of hardiness was −0.021 (95% CI = [−0.037, −0.006]), which indicates a significant mediating effect of hardiness, with the mediating effect accounting for 6.604% of the total effect. Second, we tested the mediating effect of interpersonal distress between excessive smartphone use and psychological safety. It was found that the indirect effect of interpersonal distress was −0.164 (95% CI = [−0.196, −0.131]), which indicated a significant mediating effect of interpersonal distress and the mediating effect accounted for 51.572% of the total effect. Third, we tested the chain mediating role of hardiness and interpersonal distress between excessive smartphone use and psychological safety. It was found that the indirect effect of hardiness and interpersonal distress was −0.008 (95% CI = [−0.015, −0.002]), which indicated a significant chain mediating effect of hardiness and interpersonal distress, with the mediating effect accounting for 2.515% of the total effect. The corresponding pathways are shown in Figure 2.

Discussion

Among the effects of the COVID-19 pandemic, people began to use their smartphones more often (20), and the influence of excessive smartphone use on mental health has

TABLE 4 Direct and mediating effects of excessive smartphone use on mental health.

Effect	Path	Effect value	95% CI	Effect amount
Total effect		−0.318	−0.001, −0.371	100%
Direct effect	Excessive smartphone use → Psychological safety	−0.125	−0.001, −0.169	39.308%
	Excessive smartphone use → Hardiness → Psychological safety	−0.021	−0.037, −0.006	6.604%
Mediating effect	Excessive smartphone use → Interpersonal distress → Psychological safety	−0.164	−0.196, −0.131	51.572%
	Excessive smartphone use → Hardiness → Interpersonal Distress → Psychological safety	−0.008	−0.015, −0.002	2.515%
Total mediating effect		−0.193	−0.231, −0.155	60.691%

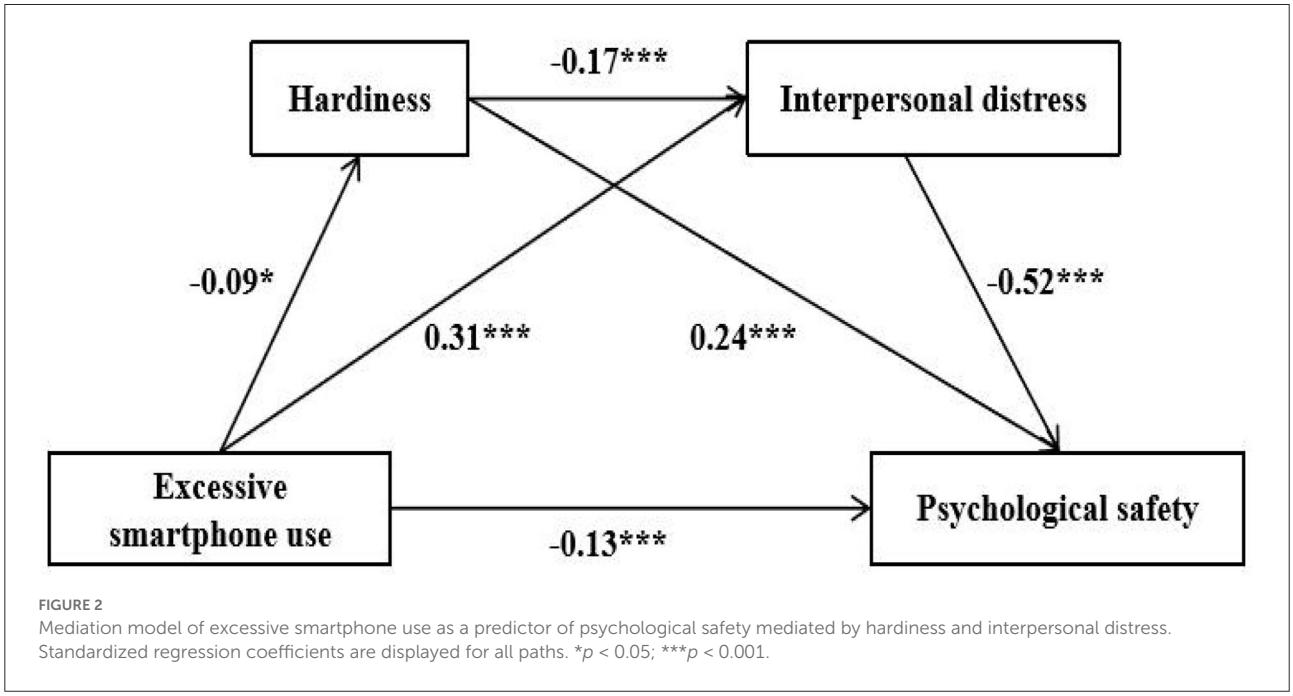

FIGURE 2
Mediation model of excessive smartphone use as a predictor of psychological safety mediated by hardiness and interpersonal distress. Standardized regression coefficients are displayed for all paths. *$p < 0.05$; ***$p < 0.001$.

received increasing attention from researchers. Previous studies have found that excessive smartphone use can lead to mental health issues such as anxiety, depression, and attention deficit. The current study extends our understandings of the effect of excessive smartphone use on mental health with regard to psychological safety, exploring the mechanisms of hardiness and interpersonal distress in the relationship between excessive smartphone use and psychological safety. All hypotheses were supported and some meaningful findings were revealed. First, excessive smartphone use was negatively associated with psychological safety. Second, both hardiness and interpersonal distress independently mediated the relationship between excessive smartphone use and psychological safety. Third, hardiness and interpersonal distress acted in a chain mediating role between excessive smartphone use and psychological safety. These findings provide further evidence for the theory of media dependence (13), while also pointing out the mechanism underlying the effect of excessive smartphone use on psychological safety in considering the mediating role of hardiness and interpersonal distress.

Association of excessive smartphone use with psychological safety

This study found that excessive smartphone use was negatively associated with psychological safety. That is, the higher one's degree of excessive smartphone use, the lower their psychological safety. This finding supports the theory of media dependence in that the greater the degree of media dependence, the more severe its adverse effects (13). Previous studies have tended to analyze these effects with regard to negative emotions (54) or interpersonal distress (55). The present study focused on the cognitive dimension, i.e., psychological safety. Thus, this study expands our understanding of the effect of excessive smartphone use on mental health from the emotional and interpersonal levels to the cognitive level. We can understand the adverse effect of excessive smartphone use on psychological safety in this way: psychological safety is a manifestation of an individual's sense of control over themself and their environment (21), and the higher the degree of one's excessive smartphone use, the easier it is for them to lose control of

themselves (12), thus resulting in a decline in their psychological safety. However, it is important to note that the problem of psychological safety in this study could not be attributed entirely to excessive smartphone use as we did not collect data regarding excessive smartphone use and psychological safety at a pre-pandemic timepoint. Some of these effects on mental health are likely to have arisen from the effects of the COVID-19 pandemic itself. Some longitudinal studies or meta-analysis studies comparing changes in mental health before and after the COVID-19 outbreak have found that the pandemic has induced more serious mental health problems (56, 57). Although these studies did not directly compare changes in psychological safety between the pre-pandemic period and during pandemic, they did provide inspiration for this study as the pandemic is likely to impair people's psychological safety. From this, we can speculate that in this study, part of the decline in psychological safety is likely due to the pandemic itself. Furthermore, we can also understand this phenomenon in this way: the special environment and conditions caused by the COVID-19 pandemic have given individuals the opportunity to use their smartphones excessively (20), which in turn has led to a decline in their psychological safety. Excessive use of smartphones is likely to be an indirect way that the COVID-19 pandemic has affected psychological safety, that is, as a mediator variable. However, this view does need to be further verified by further research.

The mediating role of hardiness

Our findings show that excessive smartphone use was related to psychological safety through the mediation of hardiness. That is, excessive smartphone use can be related to psychological safety both directly and indirectly through hardiness. This finding supports the view of the relationship model between psychological quality and mental health (58), which describes psychological quality (e.g., hardiness) as an endogenous factor that determines one's level of individual mental health, with extrinsic risk factors playing a role in mental health through psychological quality. In the current study, this played out in two ways. First, excessive smartphone use was negatively associated with hardiness, which is consistent with previous findings that college students with more mobile phone addiction were less hardy (59). According to the strength model of self-control (31), individuals who overuse smartphone consume psychological resources (60) and, as these psychological resources are consumed, they become less likely to be able to actively engage in self-control and cope with stress and frustration, thus inducing cognitive failure (61), which then leads to a decrease in their level of hardiness. Second, the present study found that hardiness was positively associated with psychological safety. This is consistent with the findings of related studies that have found that hardiness was positively associated with the psychological safety of the elderly (62). This could be understood as hardiness, as a positive coping trait for individuals, provides the resources and conditions to solve difficulties and resolve stress in stressful situations, and facilitates individual self-efficacy (63). Hardy individuals are more likely to pursue meaning and purpose in life (64), and are more inclined to believe that their capabilities can be enhanced through their own efforts (65). Moreover, hardy individuals are more likely to receive social support (62), resulting in a more fulfilling and secure life. The present study found that excessive smartphone use is related to psychological safety through the mediation of hardiness. To some extent, these findings enrich and extend media dependence theory, that is, that greater media dependence will deplete an individual's positive psychological resources (e.g., hardiness) and have adverse effects on psychological health.

The mediating role of interpersonal distress

The present study found that interpersonal distress mediated the relationship between excessive smartphone use and psychological safety in two ways. First, excessive smartphone use was positively associated with interpersonal distress, which supports the theory of media dependence (13). This result is also consistent with the empirical results that mobile phone addiction can lead to interpersonal distress in college students from Guangxi Province of China (39). According to social displacement theory, individuals who spend a lot of time and energy in the virtual world lack realistic opportunities to engage and interact with others in person (66), thus resulting in poorer interpersonal relationships. Second, interpersonal distress was negatively associated with psychological safety. This result supports the theory of emotional security, which states that poor relationships tend to impair psychological safety (43). Moreover, the results of this study are also consistent with related research findings which have found that the lower the degree of interpersonal distress in the elderly, the higher their psychological safety (44). According to self-determination theory, the satisfaction of the need for belonging is a basic prerequisite for one's healthy growth and development (67). If an individual encounters interpersonal distress, such as being rejected or neglected, their sense of belonging cannot be satisfied. This sense of belonging is very important for Chinese people in particular who are collectivist-value-oriented (68), meaning that a lack of a sense of belonging will lead to a decline in their level of psychological safety.

The current study found that excessive smartphone use was associated with psychological safety through the mediation of interpersonal distress. The findings of this study enrich and extend media dependence theory in that media dependence can disrupt the real interpersonal environment (i.e., cause

interpersonal distress) and have adverse effects on one's mental health. It is worth noting that, in this study, we included interpersonal distress as a consequence variable of excessive smartphone use. However, some studies have viewed interpersonal distress as an antecedent variable influencing excessive smartphone use (69). Causal inferences between interpersonal distress and excessive smartphone use cannot be drawn in this study. We hypothesize that there could be a bidirectional relationship between excessive smartphone use and interpersonal distress (i.e., excessive smartphone use affects interpersonal distress while interpersonal distress also affects excessive smartphone use). Future research should further explore this relationship from the perspective of bidirectional causality through longitudinal design.

The chain mediating role of hardiness and interpersonal distress

The present study found that hardiness and interpersonal distress mediated the relationship between excessive smartphone use and psychological safety. That is, excessive smartphone use was associated with interpersonal distress through hardiness, which led to a decrease in psychological safety. This result indicates that there is a close relationship between hardiness and interpersonal distress, which supports the view of the hardiness model. This is also consistent with previous findings that an adverse parent–child relationship is negatively related to predicting the level of hardiness in college students (70). This can be interpreted as individuals with a high level of hardiness have more positive perceptions of interpersonal relationships (71) and, as such are more likely to tolerate others' faults and respond positively to interpersonal conflicts and problems, thus reducing interpersonal distress and improving interpersonal relationships (72). In contrast, individuals with a low level of hardiness are more intolerant of others' faults and are prone to having conflict with others, thus leading to interpersonal troubles.

Overall, the association of excessive smartphone use with psychological safety likely has multiple pathways. Excessive smartphone use could be directly related to psychological safety, or it could be indirectly related through the independent mediating effects of hardiness or interpersonal distress, or even through the chain mediating effect of hardiness and interpersonal distress. These findings help further our understanding of the mechanism of excessive smartphone use on psychological safety and provide insight into how to improve people's psychological safety particularly during the COVID-19 pandemic. We can consider interventions from three aspects: smartphone use, hardiness, and interpersonal distress. In terms of smartphone use, this can be reduced by restricting smartphone usage time and increasing activities with family members or peers. In terms of hardiness, this can be increased by improving coping styles and focusing on increasing university freshmen's motivation (73). As for interpersonal distress, this can be decreased by teaching university freshmen interpersonal skills and organizing group activities to build their interpersonal communication skills and connection. It should be noted that the mediating effect analysis found that the effect sizes of the independent mediating effect of hardiness and the chain mediating effect of hardiness and interpersonal distress between excessive smartphone use and psychological safety were only 6.60 and 2.52%, respectively, which are insignificant. Meanwhile, the effect sizes of the direct effect of excessive smartphone use and the independent mediating effect of interpersonal distress were 39.31 and 51.57%, respectively. In other words, the effect of excessive smartphone use on psychological safety was shown to work primarily through direct and indirect paths through interpersonal distress. This suggests that future interventions for psychological safety should focus on limiting smartphone usage time and improving interpersonal relationships.

Limitations of the study

Although valuable findings have been revealed in this study, some limitations cannot be denied. First, this study investigated the association of excessive smartphone use with psychological safety and its mechanism with cross-sectional design during the COVID-19 pandemic, so only inter-variate correlations can be described and no causal inferences can be made. The stresses induced by the COVID-19 pandemic can also have affected psychological safety (74). Because of not being able to access pre-pandemic data, we were unable to separate the effects of excessive smartphone use on psychological safety from that of the COVID-19 pandemic itself. In other words, the effect of psychological safety in this study is likely to be driven by both excessive smartphone use and the COVID-19 pandemic. Moreover, some studies have suggested that there may be reciprocal causation between excessive smartphone use and mental health in that excessive smartphone use affects mental health while mental health status also affects excessive smartphone use (75). Longitudinal and experimental studies are needed to further explore the association of excessive smartphone use with psychological safety. Second, this study explored the association of excessive smartphone use with psychological safety and its mechanism, and the total effect was 0.318, which is not a high value. This implies that other factors have also affected psychological safety during the COVID-19 pandemic that were not addressed in this study, such as one's degree of exposure to the COVID-19 pandemic circumstances, their available coping resources, and present conditions, all of which have been found to be important factors affecting psychological safety during the COVID-19 pandemic (76). Future studies should further explore the influence of these factors and their mechanisms. Third, this study was

conducted among university freshmen and did not include other groups as university freshmen were identified as having special characteristics in interpersonal settings (10). Whether the results of this study can be generalized to other groups requires further study.

Conclusion

This study focused on the association of university freshmen's excessive smartphone use with psychological safety and its mechanism in the context of the COVID-19 pandemic. The findings confirmed that there are multiple pathways in the association. Specifically, excessive smartphone use could be directly related to psychological safety. Meanwhile, hardiness, interpersonal distress, and the combination of hardiness and interpersonal distress together also mediated the relationship between excessive smartphone use and psychological safety. The effect of excessive smartphone use on psychological safety appears to work through both direct and indirect paths through interpersonal distress. Future attention should focus on how to control smartphone use and improve interpersonal relationships in order to improve the psychological safety of university freshmen.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Review Committee, School of Teacher Education, Zunyi Normal University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

QY conceived and designed the study. MS and PX contributed to data collection. LZ analyzed the data. QY, MS, and PX wrote the paper. All authors reviewed and approved 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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The relationship between perceived social support with anxiety, depression, and insomnia among Chinese college students during the COVID-19 pandemic: The mediating role of self-control

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Object: We aimed to investigate the associations between perceived social support and anxiety, depression, and sleep disturbance *via* self-control among Chinese college students during the COVID-19 pandemic.

Materials and methods: The Perceived Social Support Scale, Self-control Scale, Self-rating Anxiety Scale, Self-rating Depression Scale, and Insomnia Severity Index Scale were used to survey 1,997 college students during the COVID-19 pandemic, who submitted valid questionnaires (M_{age} = 19.93, SD_{age} = 1.47, Range = 18–24 years, 62% female).

Results: The perceived social support and self-control were significantly positively correlated, and they were significantly and negatively associated with anxiety, depression, and insomnia. Further analysis found that self-control partially mediated the relationships between perceived social support with anxiety, depression, and insomnia.

Conclusion: During the COVID-19 pandemic, Chinese college students' self-control played a partial mediating effect in the relationships between perceived social support and anxiety, depression, and insomnia. This study provides new insights and inspiration for improving college students' mental health in the context of the pandemic.

KEYWORDS

COVID-19, college students, perceived social support, self-control, mental health

Introduction

The COVID-19 pandemic has been spreading worldwide since its outbreak in December 2019. Up till now, many countries have been experiencing the second or third wave of the COVID-19 pandemic. The repeated and constant pandemic has greatly disturbed people's daily life and threatened their physical and mental health (1). For college students, they have to change their lifestyles and reduce their social activities during the COVID-19 pandemic (2). In the context of social isolation, the reason for the limitations of their living environment, and the pressure from online learning, they are more likely to suffer from mental health problems (3, 4), including anxiety, depression, and insomnia. Zhang et al. (5) reported that the prevalence rates of anxiety and depression among Chinese college students were 10.3 and 25.1% during the COVID-19 pandemic, respectively. Additionally, research evidence showed that 16.9% of students once suffered insomnia in varying degrees during the pandemic (6). Therefore, it is necessary and urgent to detect the college students' mental health hit by the COVID-19 pandemic and help them effectively alleviate anxiety, depression, and insomnia.

Perceived social support refers to individuals' subjective feelings and judgments of the support from society, which includes material support, psychosocial support, and emotional guidance (7). Some studies have certified the association between perceived social support and mental health from both theoretical and practical aspects. As an important external factor, social support is beneficial to individual's mental health and can alleviate their anxiety, depression, and sleep disturbance (8, 9). Moreover, some studies have proved that social support plays a positive role in predicting individuals' mental health during the COVID-19 pandemic (10–12). Individuals with higher levels of perceived social support face fewer mental health problems, such as anxiety, depression, and insomnia (11, 12). Therefore, in this study, we speculated that the perceived social support of Chinese college students was negatively correlated with anxiety, depression, and insomnia during the COVID-19 pandemic.

Self-control refers to the ability of individuals to regulate, manage, and control their impulsive ideas, emotions, and behaviors (13). It is helpful in better regulating individuals' behaviors and emotions and guiding them in making rational decisions between desired goals and pleasurable responses (13–15). A large body of evidence has shown the importance of self-control for people's life adaptation. For example, individuals with higher levels of self-control generally reported higher levels of subjective wellbeing and a better state of health (16, 17). Self-control, as an internal factor, is closely related to individual's mental health. Individuals with higher levels of self-control tend to have greater perseverance and better emotional regulation, and thus are able to adapt more successfully to different situations and ultimately have the opportunity to experience more positive emotions (18, 19). In contrast, previous studies have demonstrated that self-control has negative associations with anxiety and depression (20, 21). In addition, self-control is regarded as an important internal factor that influences individuals' sleep. Self-control can help individuals resist various disturbances from the external environment and cultivate sound sleep habits and improve sleep quality (22).

Furthermore, there is a close link between perceived social support and self-control. Social support, as an external factor, can supply the cognitive resources needed for self-control, which in turn increases the level of self-control (23). The past study provided evidence that people would show high levels of self-control when they experience more social support among Chinese college students (24). Moreover, the buffering effect model of social support proposes that social support can buffer the effect of negative life events on individuals based on the internal cognitive system, thus promoting individuals' mental health (25). In this process, self-control is an important factor supporting the cognitive system, which can restrain impulsive responses and ensure that the cognitive process complies with intended goals (13).

Some studies have found that self-control can mediate the association between social support and life adaptation, such as the indirect predictions of social support on problem behavior and subjective wellbeing (24, 26). As mentioned earlier, both perceived social support and self-control are closely related to individual's mental health, and social support can promote individual's ability of self-control. Therefore, we speculated that self-control might play a mediating role in the relationships between social support and anxiety, depression, and insomnia of college students during the COVID-19 pandemic.

Although many studies have discussed the association between perceived social support and mental health, there is still a lack of study on the underlying mechanisms of the relationships between social support and anxiety, depression, and insomnia among college students during the COVID-19 pandemic. As a kind of external positive resource, social support can directly provide emotional support, understanding, and encouragement to college students during the COVID-19 pandemic, thereby alleviating their negative mental states, such as anxiety, depression, and insomnia, and also enhancing their self-control, which in turn can improve emotional wellbeing and sleep quality. Due to the outbreak of the COVID-19 pandemic, college students have to change their learning styles and living habits. Various coping measures preventing the novel coronavirus, such as social isolation, online learning, and increased time alone, make it more likely for college students to have mental health problems, which may require more social support and objectively challenge their self-control.

Therefore, this study aimed to examine the prediction of social support for mental health *via* self-control among Chinese college students during the COVID-19 pandemic. Perceived

social support might directly predict anxiety, depression, and sleep insomnia during the pandemic. Furthermore, perceived social support might also indirectly predict anxiety, depression, and insomnia *via* the mediating role of self-control. The hypothesis model of this study is shown in **Figure 1**.

Materials and methods

Participants

G*Power version 3.1.9.7 was used to conduct an *a priori* power analysis calculation for the adequacy of sample size (27). This result suggested that detecting a medium effect size (D = 0.3, α = 0.05) with a power (1 − β) of 99% needed a sample size of 188. This research was conducted in seven colleges and universities in Lanzhou City, the capital of Gansu Province, in China on October 2021. During the period, China was experiencing the second wave of the COVID-19 pandemic, and people infected with the Novel Coronavirus had been detected in Lanzhou for the first time. All colleges and universities in Lanzhou had taken emergency measures against the pandemic, with students being quarantined on campus and taking online learning. In terms of sampling principal in our study, we aimed to explore the impact of social environment and atmosphere under the pandemic on mental health instead of the direct effect of being infected by the virus. Therefore, we made three criteria to recruit the participants of college students: first, the colleges and universities had been identified as in severity level of the COVID-19 pandemic, students were not allowed in close contact with others, and limited the scope of activity in the period of the pandemic. Second, the students themselves and their close friends and family members, were not infected by the virus. Third, the students had no physical illnesses or psychological problems that appeared before the COVID-19 outbreak. We adopted the convenience sampling method to collect information *via Questionnaire Star* which is a popular online survey platform in China. The study design was approved by the ethics review board of Northwest Normal University. All participants were asked to provide informed consent and completed all questionnaires anonymously in the period between 15 and 22 October 2021. And an online shopping coupon worth 2 Yuan was provided to each of the participants for thanking them for answering the questionnaires. A total of 2,369 college students took part in the survey. However, 372 college students were excluded from the analysis because they did not fill in the informed consent form, did not complete all items of the questionnaires, or did not meet the recruiting criteria. Finally, a total of 1,997 valid questionnaires provided by the participants (M_{age} = 19.93, SD = 1.47, Range = 18–24 years old, 62% female) were included in the analysis.

Measures

Perceived social support

The Chinese version of the Perceived Social Support Scale (PSSS) was used to evaluate perceived social support (28). The scale contains 12 items, and each item is rated on a 7-point Likert scale ("1 = complete disagree"; "7 = complete agree"). A higher total score on the scale indicates that an individual can perceive more social support. The previous study has proven the validity and reliability of this scale in China (10). In this study, the Cronbach's α coefficient was 0.95.

Self-control

Self-control was evaluated with the Chinese version of Tangney and colleagues' Self-Control Scale (SCS) (29). The scale contains 19 items, and each item is rated on a 5-point Likert scale ("1 = strongly disagree"; "5 = strongly agree"). Fifteen items are reversed so that a higher total score indicates stronger self-control. This scale has been used in Chinese college students, showing good reliability and validity (30). In this study, the Cronbach's α coefficient of this scale was 0.89.

Anxiety

The Self-Rating Anxiety Scale (SAS) was used to evaluate the participants' anxiety symptoms (31). The scale has 20 items, rated on a 4-point Likert scale ("1 = rarely"; "4 = always"). Five items were reversed so that the higher total score on the scale indicated more severe symptoms. The scale has been used by Chinese college students and showed good reliability and validity (32). In this study, the Cronbach's α coefficient of this scale was 0.76. In addition, the standard of the severity of anxiety can be assessed by transforming it into an index score by multiplying the sum of the raw score of 1.25. The index score has two types: no anxiety ($<$50) and anxiety ($\geq$50).

Depression

The SAS was used to assess the participants' symptoms of depression (33). This scale contains 20 items (10 positive and 10 negative). Each item is rated on a 4-point Likert scale ("1 = rarely"; "4 = always"). After the positive items were reversed, the higher total score on the scale indicated more severe symptoms. This scale has been used in Chinese college students and demonstrated good reliability and validity (32). The Cronbach's α coefficient of this scale in this study was 0.86. The standard of the severity of depression can be assessed by transformation to an index score by multiplying the sum of the raw score of 1.25, and divided into two types: no depression ($<$53) and depression ($\geq$53).

Insomnia

The Insomnia Severity Index Scale (ISI) was used to assess the severity of insomnia (34). The scale contains

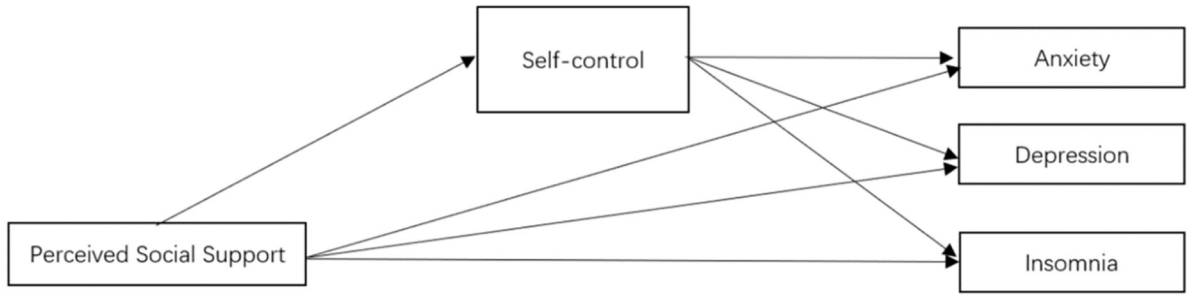

FIGURE 1
The conceptual model, social support as the independent variable, self-control as the mediating variable, anxiety, depression, and insomnia as the dependent variables.

seven items, rated on a 5-point Likert scale ("1 = rarely"; "4 = always"). A total score ranges between 0 and 28, with higher total scores indicating more severe insomnia, where 0–7 indicates the absence of insomnia, 8–14 subthreshold insomnia, 15–21 moderate insomnia, and 22–28 severe insomnia. This scale has been used in Chinese college students, showing good reliability and validity (35). In this study, the Cronbach's α coefficient of this scale was 0.87.

Data analysis

SPSS 24.0 was used to deal with the data analysis. First, a common method bias was tested by the Harman single test. Second, descriptive statistics and correlation analyses were conducted for exploring the relationships between variables in this study. An independent samples *t*-test was conducted to check the gender differences between variables. Finally, Model 4 of the PROCESS 3.4 was used to examine the mediating effects of self-control on the relationships between perceived social support, anxiety, depression, and insomnia. The test of mediating effect was based on a linear regression model and bootstrap analysis of 5,000 samples. Effect estimates and bias-corrected 95% confidence intervals (BC 95% CIs) were obtained.

Results

Common method bias test

A common method bias is likely to occur due to using a series of self-report questionnaires to collect data (36). Therefore, Harman's one-factor test was performed and showed 12 factors with the eigenvalues above one. The analysis showed that the first factors presented 20.66% of the variance, which did not reach the criterion of 40%. Therefore, there was no serious common method bias in this study.

Descriptive and correlation analysis

According to the diagnostic index scores, the prevalence rates of anxiety and depression among participants in this study were 12.61% (252/1997) and 29.89% (597/1997), respectively. And a total of 29.64% (592/1997) of participants had moderate insomnia and 8.51% (170/1997) had severe insomnia.

Means, standard deviations, and Pearson correlation coefficients of the variables were shown in **Table 1**. The result suggested that perceived social support had significant and negative correlations with anxiety, depression, and insomnia. Self-control was significantly and negatively related to anxiety, depression, and insomnia. Moreover, perceived social support was significantly and positively related to self-control. Additionally, the results revealed that age was significantly correlated with self-control, anxiety, depression, and insomnia.

An independent samples *t*-test was conducted to examine the gender differences in research variables. The results revealed that gender differences were significant in anxiety, depression, and insomnia. Female students reported higher scores in anxiety ($t = -5.313$, $p < 0.001$) and depression ($t = -3.448$, $p < 0.01$) compared to their male peers, while lower score in insomnia ($t = 2.024$, $p < 0.05$). Additionally, the gender differences were not significant in perceived social support ($t = 0.768$, $p = 0.443$) and self-control ($t = -1.875$, $p = 0.061$).

The mediating effect of self-control

This study further detected whether self-control mediated the relationships between perceived social support and anxiety, depression, and insomnia. Model 4 of PROCESS 3.4 (37)

TABLE 1 Descriptive statistics and correlations of perceived social support, anxiety, depression, and insomnia (N = 1,997).

Variable	*M (SD)*	1	2	3	4	5	6	7
(1) Gender	–	–						
(2) Age	–	−0.034	–					
(3) Perceived social support	4.87 (1.08)	0.042	0.062	–				
(4) Self-control	3.40 (0.56)	−0.017	0.116**	0.364**	–			
(5) Anxiety	1.65 (0.30)	0.118**	−0.089**	−0.371**	−0.408**	–		
(6) Depression	1.89 (0.42)	0.077**	−0.088**	−0.532**	−0.468**	0.716**	–	
(7) Insomnia	1.92 (0.79)	−0.045*	−0.051*	−0.286**	−0.360**	0.487**	0.429**	–

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

was used to perform three mediation analyses with gender and age as the controlled variables, perceived social support as the independent variable, self-control as the mediating variable, and anxiety, depression, and sleep insomnia as the dependent variables, respectively. The integrated mediation model was shown in Figure 2. Perceived social support positively predicted self-control (β = 0.36, $p < 0.001$) and negatively predicted anxiety (β = −0.26, $p < 0.001$), depression (β = −0.42, $p < 0.001$), and insomnia (β = −0.18, $p < 0.001$), respectively. Moreover, self-control negatively predicted anxiety (β = −0.31, $p < 0.001$), depression (β = −0.31, $p < 0.001$), and insomnia (β = −0.30, $p < 0.001$), respectively.

First, when anxiety was the dependent variable in the model, the total effect of perceived social support on anxiety was −0.3725 (LLCI = −0.1140, ULCI = −0.0917). The direct effect was significant, with the effect size being −0.2622 (LLCI = −0.0838, ULCI = −0.0610). The meditating effect on self-control was significant, with the size of meditating effect of −0.1103 (LLCI = −0.0366, ULCI = −0.0248), accounting for 29.61% of the total effect of perceived social support on anxiety, as shown in Table 2.

Second, when depression was the dependent variable in the model, the total effect of perceived social support on depression was −0.5325 (LLCI = −0.2220, ULCI = −0.1932). The direct effect was significant, with the effect size −0.4209 (LLCI = −0.1786, ULCI = −0.1495). The meditating effect on self-control was significant, and the size of the meditating effect was −0.1116 (LLCI = −0.0523, ULCI = −0.0353), accounting for 20.96% of the total effect of perceived social support on depression. As shown in Table 3.

Finally, when insomnia was the dependent variable in the model, the total effect of perceived social support on insomnia was −0.2820 (LLCI = −0.2365, ULCI = −0.1750). The direct effect was significant, with the effect size −0.1756 (LLCI = −0.1598, ULCI = −0.0965). The meditating effect of self-control was significant. The size of the meditating effect was −0.1064 (LLCI = −0.0951, ULCI = −0.0617), accounting for 37.73% of the total effect of perceived social support on insomnia, as shown in Table 4.

All in all, the results showed that self-control played a partially mediating effect in the relationships between perceived social support and anxiety, depression, and insomnia. Therefore, our hypothesis was supported.

Discussion

This study examined the relationships between perceived social support and anxiety, depression, and insomnia, especially the mediating effects of self-control among Chinese college students during the COVID-19 pandemic. We found that the prevalence rates of anxiety and depression were 12.61 and 29.89%, and of moderate and severe insomnia were 29.64 and 8.51%, respectively. All the results are higher than the prevalence of non-pandemic situations, which indicates that the pandemic has caused more serious mental health problems (32, 35). The long-term lasting of the COVID-19 pandemic has disturbed the normal life and study style of college students. Offline classes were switched to online learning in dormitories to avoid face-to-face contact between teachers and students and between students, so as to cut down the spread and infection of the pandemic. This situation is likely to adversely affect college students' mental health and cause them to suffer from anxiety, depression, and insomnia (4, 38, 39).

We found that perceived social support had a significantly positive correlation with self-control while significant negative correlations with anxiety, depression, and insomnia. These results supported our hypotheses. Our findings are consistent with prior studies (8, 9). Perceived social support of college students during the COVID-19 pandemic can significantly and negatively predict their anxiety, depression, and insomnia. Due to suffering more pressure of study and living during the COVID-19 pandemic, college students urgently needed the material and emotional supports provided by significant others to help them overcome these difficulties. If they could perceive adequate and effective

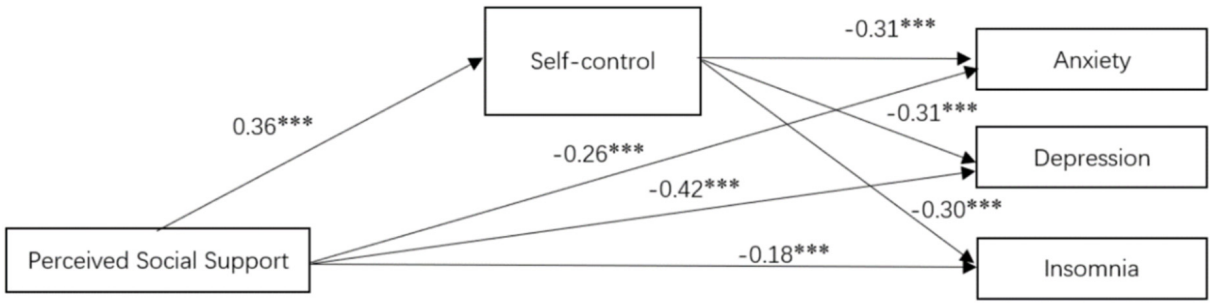

FIGURE 2
The integrated mediation model. ***$p < 0.001$.

TABLE 2 The mediating role of self-control in the relationship between perceived social support and anxiety.

Effect type	Effect size	Boot SE	95% CI		Proportion of effect size
Total effect	−0.3725	0.0057	−0.1140	−0.0917	
Direct effect	−0.2622	0.0058	−0.0838	−0.0610	70.39%
Indirect effect	−0.1103	0.0030	−0.0366	−0.0248	29.61%

TABLE 3 The mediating role of self-control in the relationship between perceived social support and depression.

Effect type	Effect size	Boot SE	95% CI		Proportion of effect size
Total effect	−0.5325	0.0074	−0.2220	−0.1932	
Direct effect	−0.4209	0.0074	−0.1786	−0.1495	79.04%
Indirect effect	−0.1116	0.0043	−0.0523	−0.0353	20.96%

TABLE 4 The mediating role of self-control in the relationship between perceived social support and insomnia.

Effect type	Effect size	Boot SE	95% CI		Proportion of effect size
Total effect	−0.2820	0.0157	−0.2365	−0.1750	
Direct effect	−0.1756	0.0161	−0.1598	−0.0965	62.27%
Indirect effect	−0.1064	0.0086	−0.0951	−0.0617	37.73%

support, their negative mental health would be improved. The results showed that college students with greater perceived social support usually suffered less from anxiety, depression, and insomnia during the COVID-19 pandemic. It reminds that college students should actively acquire and perceive available social resources to effectively prevent and alleviate their mental health problems arising during the COVID-19 pandemic.

Furthermore, the results also showed that self-control could play a partial mediating role in the relationships between social support and anxiety, depression, and insomnia of college students. Previous studies indicated that individuals' ability to self-control significantly and negatively predicted anxiety, depression, and sleep disturbance (20–22). During the COVID-19 pandemic, maintaining the normal style of study and living has been challenged. In this case, college students with stronger self-control are more possible to keep healthy living habits, better regulate their emotions, and experience more happiness, than buffering anxiety and depression caused during the COVID-19 pandemic (19, 40). In addition, better self-control ability can also help college students keep good sleep habits during the pandemic and avoid sleep-related problems (41). On the other hand, previous research has provided evidence that social support can positively predict the self-control of college students (23). When various social supports from significant others are perceived by college students, it is likely to enhance their sense of control over their life and study, and thus improve their self-control. In line with the energy model of self-control, social support is beneficial for college students to compensate for limited cognitive resources consumed by self-control during the COVID-19 pandemic (23) so that they can better restrain their impulsive behaviors and irrational ideas related to mental health problems. Therefore, perceived

social support is not only directly associated with college students' anxiety, depression, and insomnia during the COVID-19 pandemic but also indirectly connected with these variables of mental health *via* self-control. It suggests that college students can maintain and promote their mental health by actively perceiving external social support and improving internal self-control.

The results of this study have significant implications for preventing the risk of psychological problems. When providing support for vulnerable people such as college students, self-control should be fully considered. Students should be encouraged to actively use their psychological strength to solve their problems instead of passively waiting for support from others and universities. Self-control as a powerful adaptive ability can be improved through constant practice or promoted by cognitive adjustment, which cannot only directly help students overcome difficulties but also indirectly transmit the beneficial effect of social support to students in trouble. Therefore, healthcare providers and researchers should consider how to effectively integrate both self-control of internal resources and social support of external resources into a set of comprehensive counseling strategies for the mental health of college students in the context of unexpected social events. And it also suggests that future studies on mental health during the COVID-19 epidemic should not only examine the independent influence of external factors or internal factors but also pay more attention to the possible link between internal and external factors.

Limitations and future research

First, all data of this study were obtained based on the psychometric model. The scale scores reflect the general characteristics and trends of the sample group, but lack attention to special phenomena, and cannot present complete and detailed individual information. Some case studies and in-depth interviews may be used to outline a deep and specific psychological state and behaviors related to our research variables in the pandemic. Future study is suggested to consider the combination of measurement, case study, and in-depth interview method to explore the impact of the COVID-19 pandemic on college student's mental health.

Second, we did not collect more demographic information in this study. To respect personal privacy and relieve the participants' burden and worry of answering the questionnaires, we advised the participants to respond to the information about the demographic characteristics to their own will, but gender and age were required. When we analyzed the data, we found that few participants filled all optional items, so we only reported their gender and age. However, family background and socioeconomic status have potential effects on research variables, especially for social support. Therefore, we suggest that future researchers should measure these demographic variables.

Third, although a large number of cross-sectional data have been collected, our study only provided evidence of correlation rather than causal relationship when exploring the potential risk of the COVID-19 pandemic. We did not conduct follow-up studies and did not collect retrospective data, so this study could not comprehensively reveal the psychological changes of college students. Future research is expected to investigate the effect of the pandemic on mental health using experimental design or longitudinal study design.

Finally, although this study examined the inverse influence of the COVID-19 pandemic, we should realize that people in difficulty have been attempting to adapt to such dramatic social change. The vast majority of studies have been focusing on the dark side, ignoring the positive strength of human beings. Although we had emphasized the role of self-control, we did not connect it with other positive variables, such as happiness. Therefore, future research should pay more attention to positive psychological factors and explore how people actively adjust themselves to the stress caused by major social events.

Conclusion

During the COVID-19 pandemic, Chines college students' mental health is associated with the social support of external factors and self-control of internal factors, and self-control mediates the relationship between social support and mental health. It implies that the internal positive force of an individual is beneficial to transmit the positive effect of external support on health to individuals.

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 Commission of the School of Psychology, Northwest Normal University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

GZ and FX designed this study and wrote the manuscript. SL, YD, and XL recruited the participants and collected the data. FX performed the data analyses. All authors contributed to the study conception, design, read, and approved the final manuscript.

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Conflict of interest

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

Publisher's note

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Sleep quality and creativity in Chinese college student during the COVID-19 pandemic: The mediating role of executive function

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Background: COVID-19 has impacted adolescents' interpersonal relationships, life attitudes, and mental health during the past 3 years. However, previous studies predominantly focused on negative problems, while few studies assessed the situation of teenagers from the perspective of positive psychology. Therefore, this study explores the creativity level of Chinese college students during the COVID-19 pandemic, the relationship between sleep quality and creativity, and the mediating role of executive function.

Method: A cross-sectional study was conducted across six colleges in Heilongjiang in China, with a sample of 4,258 college students recruited *via* stratified cluster sampling. Data were collected through an online survey. A mediation model was constructed, and SPSS PROCESS macro was used to analyze the data.

Results: The creativity score of Chinese college students during the COVID-19 pandemic was 106.48 ± 13.61. Correlation analysis demonstrated that sleep quality correlated negatively with creativity ($r = -0.08$, $P < 0.01$) but positively with executive function (r=0.45, $P < 0.01$), whilst executive function correlated negatively with creativity ($r = -0.10$, $P < 0.01$). Moreover, the mediation model revealed that executive function partially mediated the relationship between sleep quality and creativity in college students (indirect effect $= -0.017$, $SE = 0.004$, 95% $CI = [-0.025, -0.008]$). Executive function accounted for 48.6% of the variance in college students' creativity.

Conclusion: School administrators should implement measures such as sleep education to enhance students' sleep quality. Concurrently, curriculum and assessment implementation should enhance executive function. Such measures can contribute to improved student creativity, thus helping students overcome the negative emotional impact of the COVID-19 pandemic.

KEYWORDS

COVID-19, creativity, sleep quality, executive function, mediation, college student

Introduction

The COVID-19 outbreak disrupts people's lives and adversely impacts individuals physical and mental health (1). College students have attracted much attention as a group of interest during the pandemic. Long-term isolation from studying at home impedes college students' social and communication skills development, produces several negative psychological burdens (such as loneliness, anxiety, depression, fear, etc.), and hinders brain and personality development (2). Creativity is the ability to generate novel and useful schemes, ideas, or inventions, and it is of great significance to individual development and social progress (3). Humanism and positive psychology suggest that creativity is closely related to happiness and that creativity is an important means to psychological happiness and self-realization (4). Related research noted that individuals with high creativity during the COVID-19 outbreak cultivated more positive emotions, thus leading to lower perceived stress and better coping with the pandemic's negative effects (5). Hence, enhancing college students' creativity is an effective method to increase psychological adjustment and psychological coping ability (6), which is conducive to enhancing college students' positive emotions to deal with the negative emotions generated during the pandemic.

Studies have shown that sleep correlates with two different types of memory and that this association is fundamental to creativity and problem-solving (7). A survey showed longer bedtimes or wake times, more sleep disorders, and poorer sleep quality compared to the pre-pandemic baseline, albeit individuals' sleep duration increased (8, 9). Studies have shown that adolescents and young adults are the groups whose sleep was most severely affected by the pandemic (8). Distance learning and pandemic prevention and control measures increase college students' screen time while decreasing the frequency of outings and physical activity, which may disturb sleep quality and biological rhythm (10), thereby impeding replenishment of cognitive resources consumed during the day, inhibiting divergent thinking activities and negatively affecting creativity (11). Out of several literature studies, the majority focus on the abnormal psychological state of college students during the pandemic. However, few studies have explored the relationship between sleep status and creativity among college students during the pandemic. Hence this study employs positive psychology to explore whether sleep quality is significantly correlated with college students' creativity during the pandemic period, as well as the potential mechanism of this relationship, in order to provide practical recommendations for college students to cope with negative emotions during the pandemic period.

Sleep quality refers to the overall subjective satisfaction of individuals in sleep activities (12). It is a significant physical and mental resource (13). For students and workers, sleep contributes considerably to the recovery of psychological resources essential for self-regulation (14). According to studies on the ego depletion theory in the context of sleep (15, 16), after individuals complete their daily tasks, their ability to control their resources decreases; conversely, good sleep quality contributes to the restoration of control over resources depleted during daytime work, resulting in more efficient dedication of physical and mental resources to work (17). The creativity component theory posits that individuals express creativity in response to external environmental pressure (18), which can result in resource depletion. Depleted self-control resources may be detrimental to the generation of creative behaviors. High-quality sleep replenishes individuals' self-control resources, enhances their positive emotional experience and thinking fluency, and is conducive to active and creative problem-solving. Conversely, impaired sleep quality negatively impacts psychological, physiological, and brain functions, especially attention and divergent thinking (19). Therefore, we hypothesize that sleep quality is positively correlated with creativity.

Numerous scholars have verified the relationship between sleep quality and creativity, but the underlying mechanisms of this relationship require further exploration. Executive function is a complex cognitive process in which individuals implement targeted behaviors flexibly and coordinate the activities of multiple cognitive subsystems (20), including three major components, namely cognitive flexibility, working memory, and inhibitory control (21). COVID-19 has placed tremendous psychological pressure on people (22), leading to alterations in adolescents' emotions, behaviors, and other daily activities (23, 24). Studies have shown that chronic and acute stress affect individual cognitive processes controlled by the prefrontal cortex (PFC) (25), thereby impacting processes and functions within the executive system, including working memory, emotional self-regulation, cognitive flexibility, etc. (26). Sleep quality can have a major impact on the neural activity of the prefrontal cortex; hence sleep conditions may affect executive function.

Numerous cross-sectional studies have examined the relationship between sleep problems such as insufficient sleep duration and sleepiness in adolescents and academic performance, mental health, and cognitive functioning, and reported significant correlations between the two (27, 28).

In individuals who continuously engage in highly energy-consuming behaviors, timely replenishment of their resources is not achieved, causing a decline in executive functions; as a result, such individuals engage in shallow cognitive processing (29). Harrison and Home found that the executive function of the sleep-deprived group was significantly lower than that of the control group (30). Another study also confirmed that sleep deprivation affected executive function, wherein increasing sleep deprivation correlated with worsening task performance (31). A study examining the effects of working memory in adolescents following sleep deprivation demonstrated that sleep restriction for 5 consecutive days significantly decreased response speed

in working memory tests. Concurrently, fMRI revealed brain function inhibition similar to that observed with complete sleep deprivation (32). Therefore, sleep quality may correlate positively with executive function.

Research shows that executive function is essential for generating creative thinking (33, 34). According to Norlander et al., the prefrontal cortex plays a central role in creativity (35). Thus, executive function and creative thinking share a common biological basis and are closely related (36). Benedek et al. demonstrated a positive correlation of creativity with cognitive control, whereby flexible adjustment of cognitive control contributes to creative performance (37). The literature also provides evidence that inhibition positively correlates with divergent thinking (38). Other studies have shown that individuals with high working memory ability are more likely to successfully overcome external interference and generate new ideas and strategies in creative thinking tasks (39). Vananina and Ansburg experimentally found that interfering information processing tasks (Hick task) were negatively related to creative potential, whereas for tasks requiring the suppression of interfering information (negative priming task and overall priority task), reaction times correlated positively with creativity (40, 41). Therefore, individual executive function enhancement can broaden creative thinking ability, enabling college students to improve their psychological coping ability in the face of pandemic changes, thereby ameliorating their physical and mental health. Therefore, we hypothesized that executive function is positively correlated with creativity and that executive function mediates the relationship between sleep quality and creativity.

The present study

Based on the literature review, this study proposed the following hypotheses (Figure 1):

Hypothesis 1. Sleep quality is negatively correlated with the creativity level of college students.
Hypothesis 2. Executive function is positively correlated with sleep quality and negatively correlated with creativity.
Hypothesis 3. Executive function mediates the relationship between sleep quality and creativity.

Methods

Participants and procedure

In December 2021, an online questionnaire survey was conducted among 4,500 college students from six universities in Heilongjiang Province, China, using a random cluster sampling method. Before the survey, consent was obtained from all participating college students. 4,258 valid questionnaires were collected (M_{age} = 19.88, SD_{age} = 1.87, $Range_{age}$ = 17–26) for completion of the anonymous survey, with an effective rate of 94.62%. The survey included questions on demographic variables, sleep quality, executive function, and creativity levels. Among the total samples, 1,736 (40.8%) were male students, and 2,522 (59.2%) were female students. There were 2,367 (55.6%) single-child and 1,891 (44.4%) non-single-child family participants.

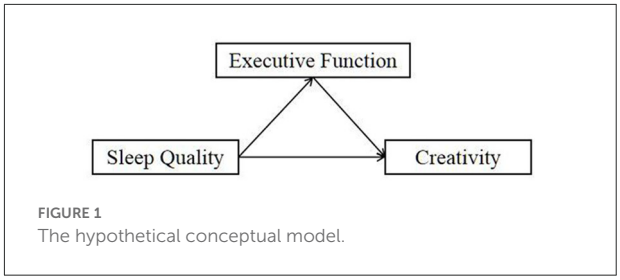

FIGURE 1
The hypothetical conceptual model.

The online questionnaire used in this study contained uniform instructions to protect the informed consent of the subjects and ensure confidentiality of the content so as to improve the authenticity of the participants' responses. The survey system was set up prior to the survey. To preserve the accuracy of survey results, the questionnaire could only be filled in and submitted once from the same IP address to prevent multiple submissions by the same respondent. After the questionnaire was collected, the questionnaires with logical inconsistencies and evident irregularities were removed while valid questionnaires were retained.

Measures

Sleep quality

The sleep quality of college students was measured using the self-rating sleep status scale (42). High total scores indicated poorer sleep quality. The scale consists of 10 items, divided into 5 grades. Participants rated each item on a five-point scale that ranged from one (never) to five (always). Chinese researchers recognize the self-rating sleep status scale as possessing good reliability and validity (43–45). In this study, Cronbach's α = 0.863, and the confirmatory factor analysis results (χ^2/df = 90.511, CFI = 0.985, TLI = 0.924, RMSEA = 0.045) were within the acceptable range.

Executive function

The adolescent executive function scale was used as a measurement tool (46). The scale was composed of 21 items divided into 3 grades, with Cronbach's α = 0.972. The total score was the sum of each item's score. High total scores were indicative of subpar executive function; conversely, low

TABLE 1 Basic situation and creativity score of college students.

Variables	Number of cases	Composition (%)	Creativity score	*F/t*	*P*
Gender					
Male	1,736	40.77	106.94 ± 14.76	3.321	>0.05
Female	2,522	59.23	106.16 ± 12.76		
Age					
17–20	3,001	70.48	107.61 ± 13.60	2.414	<0.01
21–23	991	23.27	104.45 ± 13.36		
24–26	266	6.25	101.28 ± 12.66		
The only child in a family					
Yes	2,367	55.59	107.19 ± 14.28	14.608	<0.01
No	1,891	44.41	105.59 ± 12.68		
Registered residence					
Urban	2,453	57.61	107.57 ± 14.22	−6.129	<0.05
Rural	1,805	42.39	104.99 ± 12.60		
Subjective socioeconomic status					
Low	581	13.64	104.06 ± 12.06	1.850	<0.01
Middle	2,936	68.95	106.33 ± 13.48		
High	741	17.41	108.99 ± 14.84		

total scores indicated better executive function. The reliability and validity of this scale have been authenticated by Chinese researchers (47, 48). Confirmatory factor analysis results (χ^2/df = 46.859, CFI = 0.871, TLI = 0.857, RMSEA = 0.048) were within the acceptable range.

Creativity

The creativity of college students was measured with the Williams Creativity Tendency Scale (49). High total scores indicated a higher propensity for creativity. Total scores of more than 135 points, 120–134 points, 90–119 points, and less than 90 points represent excellent, good, average, and poor creativity, respectively. This scale consists of 50 items, each graded between 1 (completely inconsistent) to 3 (completely consistent), Cronbach's $\alpha = 0.972$. The reliability and validity of this scale have been demonstrated in studies on college students in China (50, 51). Confirmatory factor analysis results (χ^2/df = 129.73, CFI = 0.973, TLI = 0.940, RMSEA = 0.025) were within the acceptable range.

Data analysis

All analyses were performed using SPSS 26.0 software. Analytic methods included descriptive statistics, regression analysis, correlation analysis, etc., and PROCESS macro analysis (Model 4) was employed to assess the mediating effect of executive function. The sample size in the model was set as 5,000, and the confidence interval (CI) was set as 95%. If the confidence interval did not contain zero, the effect was significant, and vice versa.

Results

Preliminary analysis

In this study, the average score generated by 4,258 students was (106.48 ± 13.61), which was representative of average creativity level. 107 (2.5%) participants had excellent creativity, 705 (16.6%) had average creativity, 3,217 (75.6%) had good creativity, and 229 (5.4%) had poor creativity. Descriptive analysis revealed that the creativity level of college students varies with age, single-child family status, registered residence, and subjective socioeconomic status ($P < 0.05$). See Table 1.

Correlation analysis

The sleep quality score was (20.95 ± 6.27), the executive function score was (34.57 ± 9.18), and the creativity score was (106.48 ± 13.61). Correlation analysis showed that sleep quality was negatively correlated with creativity ($r = -0.08$, $P < 0.01$) but correlated positively with executive function ($r = 0.45$, $P < 0.01$), while executive function was negatively correlated with creativity ($r = -0.10$, $P < 0.01$). Specific results are shown in Table 2.

TABLE 2 Correlations among variables.

Variables	(1)	(2)	(3)	(4)	(5)
(1) Age	1				
(2) Sex	0.02	1			
(3) Sleep quality	−0.08***	0.03	1		
(4) Executive function	−0.10***	−0.03	0.45***	1	
(5) Creativity	−0.15***	−0.03	−0.08***	−0.10***	1

***P < 0.01.

Testing for mediation effect

Our results showed that sleep quality was negatively correlated with creativity ($\beta = -0.035$, $t = -5.291$, $P < 0.001$) and that the better the quality of sleep, the higher the level of creativity, supporting hypothesis 1. Process model 4 was used to test hypotheses 2&3, according to which executive function would mediate the relationship between sleep quality and creativity. As shown in Table 3, sleep quality was significantly positively correlated with executive function ($\beta = 0.316$, $t = 33.228$, $P < 0.001$) and significantly negatively correlated with creativity ($\beta = -0.053$, $t = -4.952$, $P < 0.001$), which implies that better executive function pairs with higher creativity level in college students. Executive function partially mediates the relationship between sleep quality and creativity (indirect effect $= -0.017$, $SE = 0.004$, 95% CI= [−0.025, −0.008]), accounting for 48.6% of the total effect value (see Table 4). This supports the validity of hypotheses 2 and 3.The final confirmed mediation model was seen in Figure 2.

Discussion

Relevance of study results

The theory of two continuous models and the tenets of positive psychology posit that individuals also manifest positive changes when confronted with adversity (52, 53). Findings from this study aim to complement positive psychology reports on the physical and mental health of adolescents impacted by COVID-19. Firstly, we observed that the creativity level of Chinese adolescents during the pandemic was very low. Secondly, we found a significant correlation between sleep quality and creativity. Lastly, the executive function was identified as a mediator of this relationship.

The Chinese college students surveyed in this pandemic period study obtained medium creativity scores. Significant differences existed across individuals based on the comparison of creativity by grade, single-child status, household registration location, and subjective socioeconomic status. However, there was no significant difference across genders. As students progress in their studies, their development may be inhibited by practical considerations, resulting in lower creativity (54). Individuals from single-child households grow up with high-quality educational resources in an environment conducive to self-development. More opportunities to develop their creative potential are available to them than to individuals with siblings; hence, the former possess superior creative tendencies (55). In addition, there are significant geographical differences in the creativity levels of college students, whereby urban students are more creative than rural students. This indicates that the allocation of educational resources in China is uneven, while the environment strongly influences the development of creativity (56). There are also differences in the creativity of college students based on subjective socioeconomic status. In families with high socioeconomic status, parents are more educated, show more respect and understanding toward their children, often communicate with them, and allow them to express their own opinions, which facilitates the development of creativity (57). Conversely, families with low socioeconomic status experience more economic hardship, and family stress theory suggests that family economic stress increases parents' psychological stress, which leads to poor parenting behaviors such as low warmth and harsh punishment, which are not conducive to the development of creativity (58).

Sleep quality was found to be significantly negatively correlated with creativity. Poorer sleep quality in college students was associated with worsening creativity, consistent with previous research conclusions (59–61). According to the complementary learning system model, problem-related memories are transferred to the neocortex during sleep. When confronted with the problems again after sleep, neocortex activity is stronger while hippocampus activity is weakened, and memory reorganization is manifested in behavior, such that creative problem-solving ability is improved after sleep (62). According to the self-control depletion model, individuals will consume self-control resources when completing daily behavioral tasks, and lack of sleep hinders recovery of the consumed resources, thereby affecting the enthusiasm and creativity of individuals during daytime behavioral activities, resulting in a vicious cycle (13). High-quality sleep increases creativity by boosting individuals' willingness to invest resources and take risks when proposing new and useful ideas (17). The COVID-19 outbreak brought consequential disruptions to

TABLE 3 Summary of hierarchical regression analyses predicting creativity.

	Model 1 Y (Creativity)			Model 2 M (Executive function)			Model 3 Y (Creativity)		
	β	*t*	*P*	*β*	*t*	*P*	*β*	*t*	*P*
X (Sleep quality)	−0.035**	−5.291	<0.001	0.316**	33.228	<0.001	−0.018**	−2.480	<0.001
M (Executive function)	–	–	–	–	–	–	−0.053**	−4.952	<0.001
R^2	0.007			0.206			0.012		
	$F_{(1, 4258)} = P < 0.001$			$F_{(1, 4258)} = P < 0.001$			$F_{(2, 4257)} = P < 0.001$		

N = 4258; **P < 0.01.

TABLE 4 Direct and indirect effects of sleep quality on creativity.

	Effect size	Boot *SE*	Boot CI lower limit	Boot CI upper limit	Relative effect size
Total effect	−0.035	0.007	−0.048	−0.022	100%
Direct effect	−0.018	0.007	−0.033	−0.004	51.4%
Indirect effect	−0.017	0.004	−0.025	−0.008	48.6%

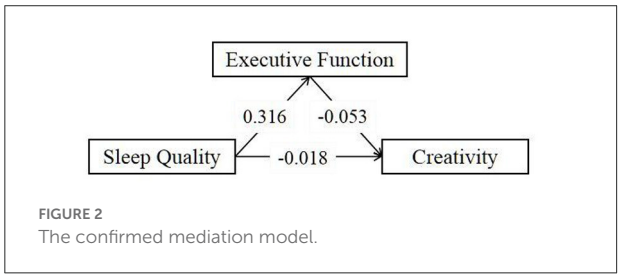

FIGURE 2
The confirmed mediation model.

college students' daily life as remote studying from home became imperative (63). Among undergraduates with less constraint, there is a possibility of developing addictions to network gaming or entertainment programs which consume a large amount of physical and mental resources over time, thus affecting sleep patterns and quality (64), resulting in reduced daytime distribution of physical and mental resources. The inability to generate positive emotions to expand and regain self-control resources negatively impacts psychological (19), physiological and brain functions, especially attention and divergent thinking. The resulting reduction in the mental agility of college students during creative activities prevents them from reaching their full creative potential (11).

This study also examined the mediating role of executive function in sleep quality and creativity in college students. The results demonstrated a significant positive correlation between sleep quality and executive function as well as a significant negative correlation between executive function and creativity. Executive function partially mediated the relationship between sleep quality and creativity. A decline in sleep quality impedes replenishment of the individual's limited resources, thereby weakening inhibition ability and executive function in learning and life while reinforcing superficial cognitive processing (29). Studies have shown that short-term sleep deprivation can interfere with normal prefrontal cortex function (65, 66), while prefrontal cortex development is essential for the development of executive function (67, 68). Therefore, executive function is remarkably sensitive to alterations in sleep quality.

Although distance learning and pandemic prevention and control measures have provided increased opportunities for improving sleep quality, college students' prolonged video screen time and reduced outdoor activities may disrupt sleep quality and biorhythm (8), resulting in decreased cognitive flexibility during daytime activities, reduced ability to control thoughts and actions, and weakened creative thinking.

Creative thinking necessitates the contribution of executive function. These mental processes are related to the activity of the prefrontal cortex (36, 69). Neuroscience research also reveals involvement of the frontal lobe, posterior brain regions (70), and subcortical structures (71) in the creative process. Reduced executive function decreases thinking flexibility, weakens self-regulation and self-control, and limits the generation of novel ideas. Limitations in problem-solving capacity reduce creativity to a certain extent (72). During the pandemic, college students faced pressure from a disrupted pace of life with irregular work, rest hours, and sleep quality. This new irregularity impacts college students' remote learning, capacity for self-regulation and self-control, and thinking flexibility. Consequently, students become prone to negative emotions, with less incentive to partake in creative activities. Such students are also at risk of psychological disorders due to the strain on mental health during the pandemic. Creativity and executive function share a common physiological basis, and the development of creativity requires the strengthening of prefrontal cortex function.

Impaired executive function can affect the performance of college students for tasks dependent on creativity (73). Working memory is an important component of executive function, and research indicates that sleep quality and working memory are interconnected (74). Research on rapid eye movement (REM) sleep and non-rapid eye movement (non-REM) sleep indicates that the REM sleep stage is principally responsible for memory reorganization by enhancing inter-memory connections and generating new connections, while the non-REM sleep stage contributes to rule extraction, formation of relational memory and memory integration, thereby complementing memory reorganization (75). During the pandemic, college students' sleep patterns were disrupted, and both REM and non-REM sleep were adversely affected to varying degrees; thus, executive function and creative problem-solving were impaired.

Implications

This study expanded our understanding of the impact of sleep quality on college students' creativity in the face of public health emergencies by linking sleep quality to creativity. Unlike previous studies conducted in a controlled setting, data collection in this study occurred during the COVID-19 pandemic; hence, the results are more reflective of the real world. Furthermore, the present study analyzed the mediating role of executive functioning among college students. The results revealed that poor sleep quality affects executive function and negatively impacts students' creativity.

Applying measures based on the relationship between these three variables may enable teachers and school administrators to foster students' creativity and mental health more efficiently after the pandemic. Varying degrees of negative emotions in students seem inevitable after an pandemic stretching beyond 2 years. At such times, sleep education for college students should be enhanced, while curricula should pay attention to executive function training such that students can improve their adaptive skills, nurture their creativity and achieve more significant personal development.

Limitations and future direction

Although all the hypotheses in this study have been verified, this study also contains limitations. Firstly, this study adopts a self-report method for the questionnaire survey. In the future, in addition to self-reports, other methods of data collection, such as evaluation of others, could be adopted to reduce deviation caused by a single research method. Secondly, this study adopted a cross-sectional research method which precludes the determination of a causal relationship between variables. Therefore, alternate methods such as longitudinal tracking should be applied in subsequent studies.

Conclusion

In conclusion, this study revealed that Chinese college students' creativity level was average during the COVID-19 pandemic. This suggests that a joint contribution from educational institutions, families, and individuals may be warranted to improve the creativity level of college students during the pandemic. First and foremost, schools should be attentive to the sleep quality and mental health status of students compelled to study from home during the pandemic, adequately schedule time for learning and extracurricular activities, reinforce sleep education, ameliorate the psychological support system, and promptly intervene to treat students with serious psychological problems. Concurrently, educational institutions should train students' executive function *via* appropriate curricula and assessment measures. Furthermore, college students should adjust their mentality, sufficiently engage in outdoor sports, develop regular work and rest habits, and enhance their psychological coping ability by establishing and cultivating intimate relationships and maintaining emotional connections, with the aim of maintaining a state of good 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 Ethics Committee of Harbin Medical University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

BG, YS, and LZ wrote the main manuscript text. XC and HM prepared figures and tables. YY and JZ supervised the manuscript. XY, XQ, and ZQ investigated data. EZ and TB rewrote the manuscript. BG, JY, and RM revised the manuscript. All authors reviewed the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.987372/full#supplementary-material

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Impact of COVID-19 on the lives and mental health of children and adolescents

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Student mental health is an integral part of the fight against disease, and health was an evolving concern during the spread of COVID-19. As the COVID-19 pandemic unfolds, physical distancing and social restrictions were introduced, and because of these, it was found a great impact on students' lives and their mental health. Adolescent mental health is focused on prevention, early detection, therapeutic innovation, and service development. In these circumstances, service providers can expand telemedicine Digital services that may help provide future mental health services to young people, particularly students. This study collects and analyzes data from students on the impact of these new online learning techniques, and by collecting and analyzing the challenges and issues faced by college students during the COVID-19 pandemic. The questionnaire was based on and extended the European Students' Union Survey and targeted higher education students concerning what student life looked like during the pandemic, including teaching and learning, their social contacts, habits/routines, as well as how they were coping with the situation emotionally and financially. The case of universities and distance learning education units in higher education during the COVID-19 pandemic process. This article highlighted the impact of COVID-19 on students of all ages and their time schedules such as online learning and reflection, study environment, sleep habits, routines, and outcomes. It was found that the students generally require greater self-discipline and motivation to complete online classes. It was also reflected that the pandemic adversely affected student mental health, leading to an increased prevalence of Major Depressive Disorder (MDD) and Generalized Anxiety Disorder (GAD). This may have a significant impact on their mental health issues such as frustration, stress, and sadness. This will significantly lead to cooperation between various local authorities and the private sector.

KEYWORDS

COVID-19, higher education, social life, anxiety, lockdown

Introduction

Psychosocially, COVID-19 disproportionately affects young people. The stresses and restrictions make college students more likely to develop mental health problems that may affect their academic success, social intelligence, future careers, and personal opportunities. Both short-term and long-term factors affecting young people were social

isolation, changes in the provision of treatment services, and the near-total loss of all structured professions (e.g., School, work, education). The World Health Organization declared COVID-19 a global pandemic, forcing many higher education institutions to take steps to promote student safety. Although there is no systematic review of the effects of COVID-19 on mental health, however some studies related to pandemics (including bird flu and SARS) have shown adverse effects on the mental health of affected people. Therefore, the development of COVID-19 was predicted to cause general psychological reactions such as tension, fear, anxiety, and mental disorders such as acute stress disorder, post-traumatic stress disorder, depression, and suicide. Interestingly, students who reported at least one effect showed a higher level of resilience and a self-reported health score, but with less need for support. Concerning exercise, those who exercised constantly had lower levels of depression and anxiety, higher quality of life, and higher self-assessed health scores than those who did not exercise occasionally (1–3).

Liquor utilization was not related to any of the choice factors, but tobacco utilization was altogether related to five choice factors, appearing to be higher uneasiness and misery, lower life quality of life, self-reported well-being, and higher back needs (4). These factors were significant impacts on children's health and well-being. The educational network takes serious efforts to seriously preserve the continuity of training during this period, while children and universities were to rely on their resources to study remotely through the internet, television, or radio. Teachers had to adapt to a new educational concept and delivery method so that they would not be able to do anything more than new educational concepts (5). This disaster revealed several disadvantages and disadvantages from whether the broadband and computer systems needed to support online education as well as the environment necessary to change the availability, assets, and requirements of computer systems.

Traditional education was violated due to the clogging of COVID-19 (6). Despite the considerable efforts of the education network to maintain the continuity of training for this period, college children and students were to rely on resources to learn remotely through the Internet, television, or radio. Teachers were to adapt to new pedagogical ideas and teaching methods they were never taught before. Newcomers from underserved group lack resilience and motivation to learn, as well as access to virtual learning resources. The universities gradually return to their previous educational levels, and the slow rise of today's college students' skills shortages will only be seen in the long run. However, it is important when considering the impact of this period.

In other words, if the educational system is recovered before the productivity preparation, the state will continue to fight low socioeconomic welfare. Some groups may be more vulnerable to the psychosocial effects of the COVID-19 pandemic than others (7–9). Because they were in a critical period of development, with half of all mental health disorders developing before the age of children and adolescents must be provided with adequate support. Factors associated with mitigation measures such as social distancing, family discord, school closures, fears about the future, and quarantine are disrupting young people's lives (10, 11).

These disruptions include changes in routine, a break in the continuity of learning with the closure of schools, a break in health care missed significant life events, and the loss of a sense of security and safety.

It was examined that the student's psychological well-being and well-being in higher education are among the broader predictors of COVID-19 (12, 13). Perhaps the most striking finding was that levels of distress and discomfort were high, with more than half of the students exceeding clinical limits. This suggests that they are likely to be in clinically significant distress and/or discomfort at the time of the study.

Despite the rapid replacement of the lecture on the facial lectures of online learning, such closure was influenced by training and testing and experienced international security students, international security students, and criminal reputation in host countries. In addition to academic content, this case is most concerned about the value of college education with network and social opportunities. If digitization is to grow and deepen relationships between students, coaches, and others, universities will need to rethink the learning environment. The addition of positive cases once again shows that there are still not yet been isolated, that there is still an infection due to close contact, and that no one is conscientious about washing hands with soap. Citizens are responsible for implementing various government-issued guidelines to break the COVID-19 infection chain, such as staying at home, maintaining a physical distance of at least 1 m, and washing hands with soap. It is a great need to exercise discipline such as the policy of the Ministry of Health of Indonesia applies to public health (14, 15).

The COVID-19 pandemic affects people psychologically; because the spread of it continues, death rates increase day by day, life comes to a halt and its control time is unpredictable. Similar to the traumatic experiences that have caused many psychological problems in humans throughout history, COVID-19 will have a negative psychological effect on every person. Scientific research on COVID-19 is of great importance to prevent its destructiveness of it in social, political, psychological, educational, and economic dimensions. After the COVID-19 epidemic is controlled over time, the psychological effects on people will be clearer. It is estimated that its effect will cause many problems in the short and long term (16–18).

In this study, the possible psychological effects of COVID-19 on children, youth, elderly people, and healthcare staff were discussed considering theoretical information

TABLE 1 The distance education learning statistics performed in the 2019–2020 spring pandemic.

	Data
The total number of used equipment	13.244
Online lectures	2.985
live class participation of students	35.620
Number of accesses to asynchronous resources	171.372
Number of attendances during lectures	34.350
Watched live lecture	73.308
Number of teachers and staff	855
Number of students included in the distance education system	27.039
Uploaded visual program size	180 GB
Total number of files upload size	214 GB

(19, 20). To minimize negative psychological effects, some recommendations were also presented. Since the government caused the spread of illness, the sanitary crisis is a major financial disaster that is expected to load society for many years because the hygiene crisis is deactivated the financial system.

According to the Current Economic Prediction of the OECD, even the most optimistic scenarios, forecasts a harsh economic downturn. According to the OECD, even if secondary infections are avoided, global economic activity is expected to contract by 6% in 2020. According to the statistics in Table 1, universities have conducted effective and successful educational courses during the pandemic. However, it is very important to consider the current location of distance learning students. The purpose of this study was to determine students' knowledge and views on distance learning between education and training pandemics in the spring semester of 2019–2020.

In this case, the most important thing is learning must occur even at home. Without teachers, the target must be that the curriculum must be achieved. Not move the school at home but choose essential materials that children need to do at home. Second, the teaching staff or teacher must provide education to children about life skills, namely education that is contextual following the conditions of each home, especially the understanding of COVID-19, regarding the characteristics, how to avoid it, and how to prevent someone from contracting (21).

On the other hand, government investments are often violated in response to external shocks because the government requests investment. The slowdown in economic growth caused by the spread of viruses also affects public investment in OECD and colleagues' education, and tax income of autumn and emergency and emergency budgets is aimed at helping health spending and welfare (22–24).

Public investment in education should not be encouraged by multiple members, as there is no guarantee that the market will provide fair access to education. In 2017, public spending on education accounted for 11% of total costs in OECD countries. However, according to data from the OECD and related countries, this ratio fluctuates between about 7% and about 17% in Greece (Figure 1).

The previous economic crisis put a heavy burden on the national budget. This reduced public spending on education in some countries. Cross-country and other comparisons do not show a strong link between education spending and academic performance across European countries, but the overall school system performance is so different that spending without improving grades. Reducing the pleasure of learning and the risk of injury. It can also take time to assess how disasters affect education spending. The previous economic crisis put a heavy burden on the national budget (25–27).

As a result, the cost of public education has fallen in some countries. The performance of the education system does not change much because the performance of the education system is very different. Therefore, there is no need to undermine the strong relationship between counterpoint and academic performance. It can take some time to assess how depreciation affects training costs. Despite severe fiscal cuts in all OECD countries since the last economic disaster, most OECD countries increased government spending on education between 2008 and 2009 and 2010, with 2010 being the most effective (28).

In April 2020, the support package for the highest level of education was presented. As a result of the investment in the Australian government, this package reduces the cost of short online processes and is not only released from mortgages in the house of young people that began in May but as well as investment for home college students (29). International students were particularly affected early in the blockade because they struggled with how the closure of the university affected their reputation on campus and in the host country. Students were to choose between returning with little information about when they could return or staying in a host country with limited employment and education opportunities while waiting for a visa to be issued. In some countries, such as Canada and the United Kingdom, students are exempt from visa requirements and are allowed to stay on campus, but this is no longer the case everywhere. Higher education institutions are using technology to offer online courses and student ratings as an elegant alternative to ensuring continued education despite the blockade (30, 31).

Before the pandemic, many higher education institutions made online guides available, but few students saw this as the only way to physically characterize. The countries that rely heavily on international college students to pay various fees, such as Australia, Canada, the United Kingdom, and the United States, will be hit hardest. For example, in

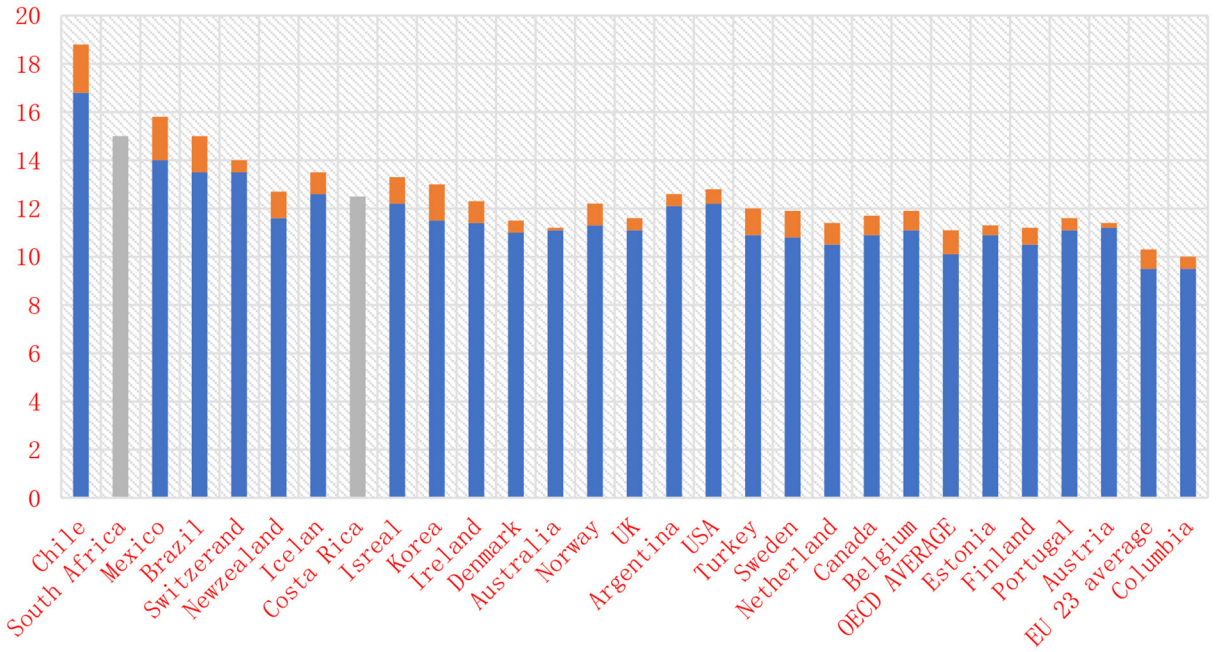

FIGURE 1
Total public expenditure on education as a percentage of total government expenditure (2017).

2017/18, public universities in Australia, Canada, and the United States charged international students more than the US $ 13,900 per year at the same level as undergraduate or domestic students.

The three main challenges are related to technical problems and online learning challenges as summarized in Figure 2:

(a) Information and work overload.
(b) Difficulty adapting and unfamiliarity with the new online learning environment.
(c) Personal health challenges related to stress and anxiety problems.

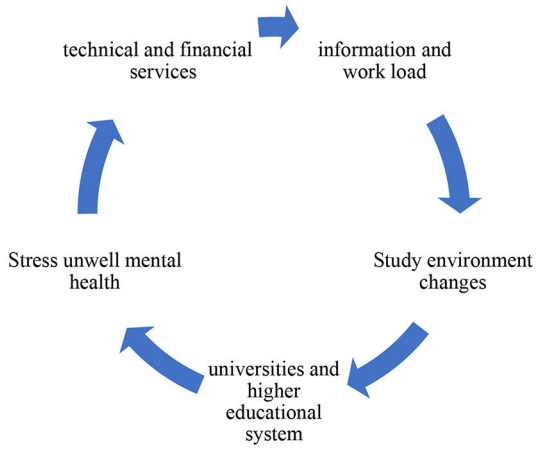

FIGURE 2
Summary of challenges due to the COVID-19 pandemic on university students.

Materials and methods

The main goal of this paper is to highlight the major results of a global survey on the impacts of the COVID-19 pandemic on the life of higher education students that was carried out by an international consortium of universities, other higher education institutions, and students' associations, and what they were expecting by way of support measures from various institutions, e.g., universities, the government, banks, etc. (32, 33). To understand the ways that the COVID-19 pandemic has impacted a range of aspects of student lives, the following research questions were addressed:

A1: How have students around the world been satisfied with different aspects and elements of student life during the COVID-19 pandemic and how have they perceived them?
A2: Are there any socio-demographic and geographic differences in:

- Students' satisfaction with and perception of selected elements of academic work and academic life due to the transition from onsite to online lectures.

- Students' perception of the COVID-19 pandemic's consequences on their social and emotional life, personal circumstances, and habits.
- students' satisfaction with the role of selected institutions and their measures during the COVID-19 pandemic.

This study will lead to focus on the COVID-19 Pandemic in the lives of Students and their intellectual health through the demographic information of the participant.

The method of investigation is defined as "precautionary measures taken on the entire universe, or on a sample or group of samples taken from it to reach a general judgment about the universe." During the COVID-19 pandemic, survey methods were used to gather student opinions on distance learning (34).

According to the data, the socio-demographic and other characteristics of the study population are shown in Table 1. Approximately two-thirds of the sample of 40,385 higher education students (75%) and more than half of children (55%) of the population fall in the age range of 10–15 and number are 350 and a total of 30% are affected. Most of the respondents were domestic (95%), full-time (88.1%), and first level (81%) students. A little over one-third of the participants (37.0%) were studying social sciences, followed by applied sciences (31.1%) and natural and life sciences (21.7%). A scholarship was not held by 70.8% of the respondents in 2019/2020 and just over half of them (52.6%) were able to pay the overall costs of their study before the COVID-19 pandemic (11).

During the 2019-2020 pandemic, the research was conducted with the support of university students. Participants were selected based on the principles of autonomy and availability. The survey received 1.10 responses, of which 712 boys (70.5%) and 399 girls and women (39.5%) participated. As shown in Table 2.

When asked which device they prefer for distance learning, participants found that they used 566 computers (56.1%) and 530 mobile phones (55.4%) as devices. "Even if you have access to the distance learning system over the phone, do you have a computer that you can use individually?" 551 (54.5%) responded positively.

The analysis moves from descriptive to interpretive. The process consists of first categorizing each transcript into broad themes and through continued review of the data into more specific data about students. The Public Health and the subjective lived experiences of people, and therefore, the researchers demonstrate reflexivity and the behavior changes effects and Depression/Anxiety among young people throughout the study (see Table 3).

To elaborate, reflexivity encourages the researchers to consider how their subjective worldviews may impact the research process. This approach benefits this research's quality, particularly concerning the data analysis as it buffers against personal experiences and biases impacting the research findings.

TABLE 2 Demographic information of the participants.

Gender	Participation	Percentage (%)
Under age 0–15	350	30%
Number of male	712	70%
Number of female	399	39%
Device used in distance learning education		
Computer	566	56%
Phones	530	55%
Tablets	13	13
Urban location	8/10	8%
Computer and social status		
Yes	661	61.5
No	490	49.5
Internet connection except for telephone		
Yes	636	63.5
No	440	40.5

TABLE 3 The referral and percentage of qualitative data.

Subjective	Referral out of 48	Percentage
Children appearance	25	55%
Social isolation	36	80%
Stress over home-schooling	32	69%
Behavioral changes	18	35%
Difficulty being confined in the household	21	48%
Depression/anxiety among young people	14	29%

The data about the "Distance Education System," "Lecture / Lecture Notes," and "Individual Evaluation," was designed to explore the student's perspective on distance education. The scale is created using a 5-point Likert scale and has a Cronbach's alpha reliability factor of 0.909.

The method of Means, standard deviations, and tests were calculated using the SPSS (Statistical Package for the Social Sciences) program. Responses to scale items were evaluated using mean, standard deviation, frequency, percentage, and *t*-test analysis. The 5-point Likert scale is a rating scale ranging from 1 to 5. As shown in Table 4.

In a crisis such as the COVID-19 pandemic, many questions emerge, and students need the support of various services. The survey results show that the students, regardless of the continent, studying from home commonly require greater self-discipline and motivation to follow through with online lessons, particularly in the earlier period when students were getting used to the new system, which might affect their feeling of an increase

TABLE 4 Scale options and score ranges.

Options	Range	Score range
Completely agree	5	4.30–5.00
Agree	4	3.50–4.20
Not sure	3	2.70–3.30
Not sure	2	1.80–2.50
Refuse	1	1.00–1.99

in study obligations. On the other hand, lecturers unfamiliar with the new mode of delivery could overload their students with study materials and assignments. Therefore, the students were asked to compare their workload before the onsite classes were canceled with the new circumstances after the lockdown (35).

Results and discussion

When the world tackled the outbreak of the COVID-19 pandemic, higher education was a significant impact on its core students. For them, time was undoubtedly unprecedented and extremely stressful, with face-to-face events being moved online, semesters postponed, and exams being coordinated. Therefore, there is an urgent need for detailed research on how the pandemic crisis affected the lives of students around the world. After providing a comprehensive review of the current literature, our treatise is the first large-scale global survey of students from a variety of research perspectives since the outbreak of COVID-19 (36). This study was conducted between 5 May and 15 June 2020 and found that student life during the COVID-19 pandemic was academically, socially, emotionally, economically, and otherwise. The author tried to explain what it was like. In this regard, it provides valuable and unique detailed insights into student life during the blockade (World Health Organization).

The 21-item survey conducted as part of this survey was represented by three elements: "Distance Education Module," "Lectures and Lecture Notes," and "Individual Evaluation," and the results are shown under these headings. In addition, a test analysis of the participant's computer and internet conditions was performed. In the first attempt to stop the spread of the virus, many countries-imposed blockades, and closed faculties and/or universities in OECD and partner countries for several months. In response to the COVID-19 pandemic, the People's Republic of China was the first of the 38 educated countries and other partner countries to close their faculties in 2020. On 16 February 2020, school closures were imposed in some parts of China when the planned spring semester began early and was extended nationwide about a week later. As the pandemic spread, other countries began to close their faculties (final school buildings without completely closing coaching and learning). Preliminary data from various sources (refer below) show how people react during this ongoing and evolving pandemic. By the end of March 2020, all 46 educated countries had immediate school closures of varying degrees. The United States and other 41 countries have closed their schools and five (Australia, Iceland, the Russian Federation, Sweden, and the United States) as can be seen in Figure 2. However, not all pandemic-affected countries are forced to close all schools. For example, if the elegant size is <20, it will continue to be available to the top teachers in Icelandic.

Most elementary and junior high schools in Sweden remained open, but high schools switched to distance learning in mid-March (UNESCO, 2020). It is difficult to estimate the number of weeks of education affected in each country, as individual faculties and local governments in some countries have autonomy over time.

By the end of June 2020, grade and school reopening employers will have several diplomas in two countries (4%) for up to 7 weeks, six countries (13%) for 812 weeks, and 12–16 weeks enacted, 1618 weeks (28%) in 24 countries (52%), 1618 weeks (28%) in 13 countries, and 18 weeks or more in China (UNESCO, 2020).

First, the student's academic work and academic life aspects were studied. Due to the physical closure of higher education institutions, the majority of teaching and learning processes went online, i.e., 89% of all respondents claimed that their onsite classes were canceled and substituted with online lectures in the form of real-time video conferences, sending presentations to students, video recordings, and written communication (forums and chats) (37).

The overall effect may not be so dramatic, as some of these times coincided with the planned faculty leave. Easter and/or spring break in April and early May reduced the impact of teacher closures by up to 2 weeks in many countries in Europe and the Southern Hemisphere. For example, in Japan, there was a 2-week spring break at the end of March refer to Figure 3 (25, 38). In addition, some countries reorganized their academic year to make up for the lack of coaching time. For example, in some jurisdictions of Australia and Chile, cold teacher holidays were carried forward. The summer season was shortened in South Korea.

Measures to continue students learning during school closure

Countries used a variety of resources to guide students' learning when they were unable to return to school. In the OECD and partner countries, online platforms were the most prominent tool used during school closures (39). Their homeschooling was available to all college students in elementary and junior high school (national level of the Ministry of Education). Greek teachers used real-time digital education

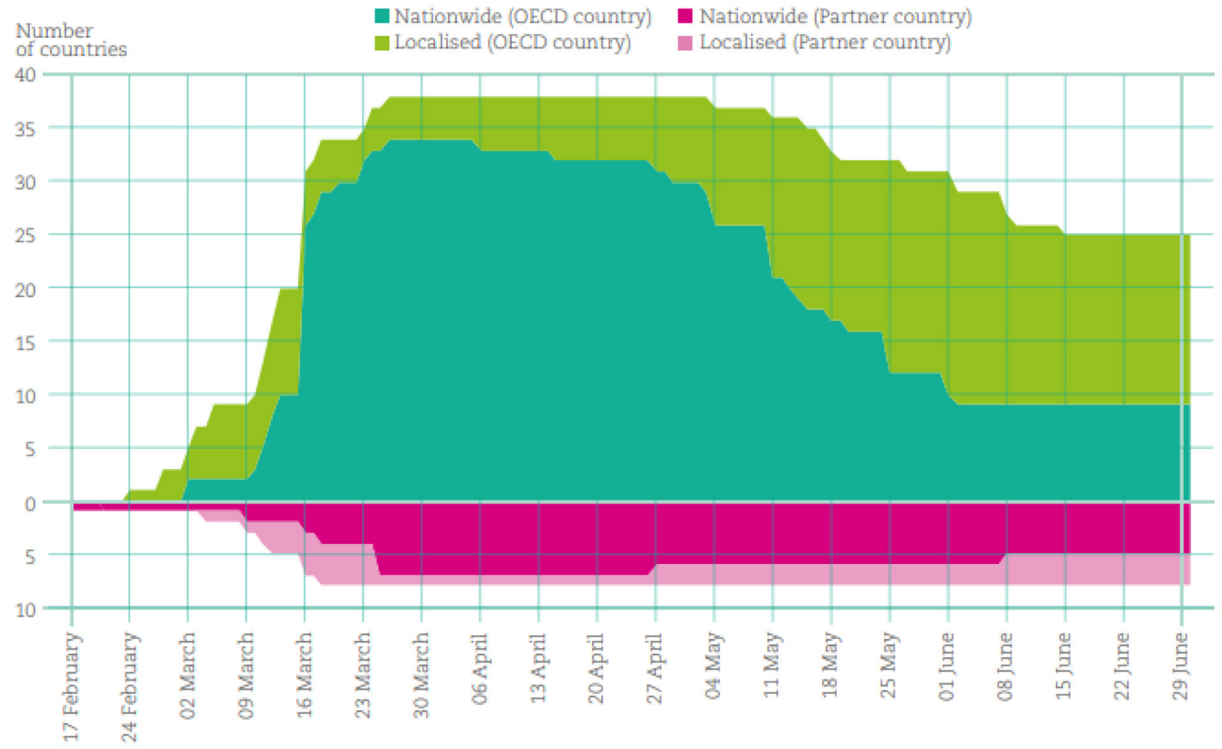

FIGURE 3
Number of countries with school closures due to COVID-19 Data covers the period between 17 February 2020 and 30 June 2020 (UNESCO, 2020).

TABLE 5 Universities and all higher education systems and faculties are uploading courseware to student information systems.

No	Conceptual elements	Effects
1	"LIVE Lectures" within the distance and doorstep education system	3.10 /1.5
2	Access the "LIVE subject lesson" within the distance education system with easy access	2.82/ 1.5
3	The records of the "LIVE COURSE" that I could not attend later and do it again	4.1/1.5
4	"REGISTERED SUBJECT OF STUDENTS	3.2/1.4
5	access the "REGISTERED COURSES" within the distance education system to students	3.10/ 1.5
6	"UPLOAD DOCUMENTS COURSES" in the Student Information System	3.60/ 1.4
7	Complete access "COURSE DOCUMENTS" in the Student Information DEPARTMENT	5.9/1.4
8	The quality of sound Audio of the live lessons	2.3/1.3
9	Satisfaction with the VIDEO quality of the system during live classes	2.4/1.4
10	"TECHNICAL SUPPORT" system and a good command of solving problems	2.6/1.4
11	the satisfaction of the work quality and intelligibility	2.6/1.4
12	I am satisfied with the compliance of the Instructors with the system and the "LIVE COURSE" narrations	3.4 /1.4
13	"COURSE DOCUMENTS" in the Student Information System and their content	3.2/1.5
14	"LIVE COURSE PROGRAM" and "COURSE HOURS" within the distance education system	2.7/ 1.5
15	"LIVE COURSES DURATION" within the distance education system	3.4/1.5

with a variety of online learning tools (Ministry of Education). As shown in Table 5.

Television testimony was likewise a powerful manner to attain college students who do now no longer presently have sufficient assets for online classes.

The time restriction of 1 h (40) 2020; Schleicher and Reimers) other techniques were broadly utilized in Mexico to guide college students in accomplishing home studies and moms who guide homeschooling.

College Students' Guidance (41) was completed *via* way of means of government with inside the majority of OECD and associated countries, with the energetic participation of character faculties (39).

Distance education module

Before the start of the spring semester 2019–2020 pandemic period, the university and all higher education systems uploaded research documents to the research information system. Guides for scientists and students were created and published on the university's website to provide technical information on the handling of distance learning. All courses with links to live courses were edited as distance learning courses according to the 2019–2020 spring semester syllabus, and the taught courses were classified as category registration courses so that students may access the course again.

Lectures and lecture notes

Researchers have uploaded four live lecture questionnaires and four lecture script questionnaires to the student information system. Participants stated that the instructor was in compliance with the system and was satisfied with the description of the "live course" (a = 3.44) and the duration of the live lesson (a = 3.40).

Teachers' willingness to support digital learning

Figure 4 expressed a sturdy preference for practice withinside the use of records and communique technology. Seventy-seven percent of instructors acquired specialized ICT training, and 23% indicated a want for extra ICT training.

Distance learning has become the lifeblood of education during the pandemic, but the potential of virtual technology extends far beyond the temporary nature of the crisis. Bridging time and space with multiple codecs, this technology Teachers and students to have access to specialized content that goes well-beyond textbooks. An intelligent virtual learning system works with teachers to challenge not only science students' learning styles but also their efforts, hobbies, boredom, or difficulty. In this way, study and work at the same time (42) This structure accommodates the learning experience of healthy college students with incredible granularity and accuracy. In this way, digital labs allow students to design, implement, and investigate experiments instead of conducting preliminary research for undergraduates.

Additionally, the Trainer's ability to contribute acquired expertise and act as a collaborator, coach, mentor, and expert evaluator diminishes over time. According to the 2018 OECD Teaching and Learning International Survey (TALIS), only 53% of teachers allow students to use facts and communications.

Data on international, global and regional public goods, grant commitments from the OECD Creditor Reporting System will be attributed to these categories (about 15% for global public goods and 15% for regional public goods) and other traditional ODA (official development assistance), with the remaining 70%) (43). The best control programmers depend often on stable troubles and curriculum content material substances that contain collaborative and energetic gaining knowledge of talents (41). Total government consumption is also related to the ODA/GDP ratio, which could also be interpreted as the fact that larger governments are associated with stronger altruism. Of the other indicators selected, only public spending on education is significantly correlated with the share of ODA in GDP. By contrast, the combined spending on health, education, and defense is correlated with the share of GPG in total ODA. This supports the hypothesis that the total public spending on education, health, and defense is associated with the relative preference of donors for public goods Trainers, on the alternative hand, are ways much more likely to wait for guides and seminars than different collaborative professionals.

Across OECD data of countries, 76% of secondary school teachers favor private involvement in guides and seminars, and 44% recognize peering, self-discovery, and being part of the broader university system (Figure 5). Participation of ICT talent is critical, especially given the unusual shift to online education at many international OECD sites during the COVID-19 lockdown. Even before the crisis, the educator made it clear that she preferred ICT-related schooling. This was the second

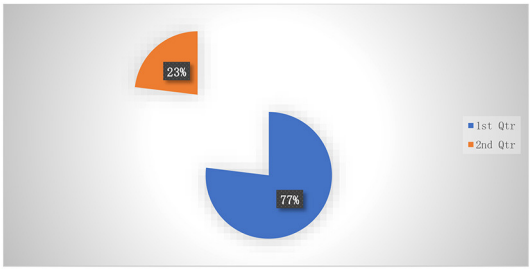

FIGURE 4
Preparedness to support digital learning.

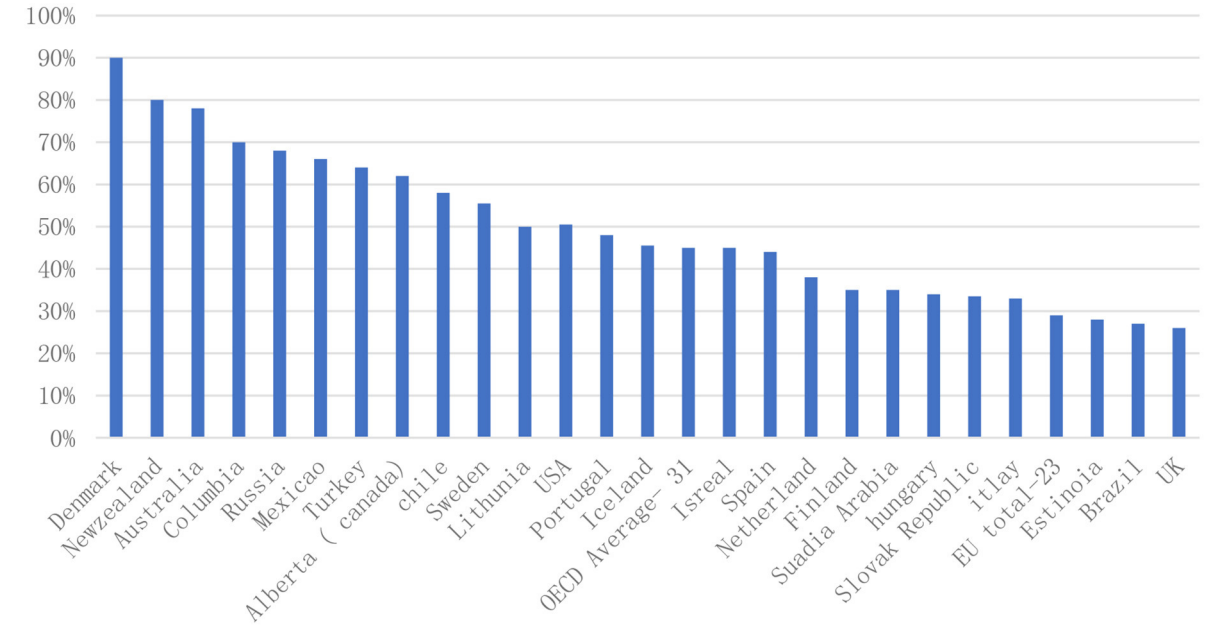

FIGURE 5
Percentage of secondary education teachers who "frequently" or "always" have students use ICT for projects and classroom tasks.

most important school preference after the students' personal educational aspirations, not uncommonly diagnosed as using teachers. On the other hand, the trainer does not simply report her ICT training needs. It also does not rely on distance learning or professional development.

According to professional development records, 36% of a small number of secondary teachers in international OECD countries supported collaboration in an online guide or seminar. Although that was genuine in lots of international locations, there were some exceptions, consisting of Korea and Shanghai (People's Republic of China), in which >90% of teachers pronounced assignment online professional development withinside the preceding year as shown in Table 5.

One of the most effective ways to avoid the COVID-19 epidemic was to keep a social distance. In the faculty context, this means maintaining a safe distance between scientists and staff at 12 m and limiting contact between youth organizations. The level of virus containment achieved determines the term protection in several international locations. For example, in Japan, faculty members must stay within 1 m in low-impact areas (level 1) and faculty members, not in high-impact areas (level 2 or 3). Many countries recommend reducing or halving aspects of education to maintain the required distance between college students (Table 6).

The above-mentioned quick and radical changes in teaching and learning processes have produced significant consequences for students' mental health, i.e., feeling specific emotions and worries. The analysis of the emotions felt by the students showed they were frequently feeling bored, anxious, and frustrated, but also hopeful and joyful, this may be the response and attributed to the fact that the start of the pandemic coincided with the beginning of the 2020 academic year, whereas in the northern hemisphere the academic year was nearing its end, i.e., students in the Southern Hemisphere may be more worried about course delivery and assessment throughout the academic year, rather than just the end of the program. A similar ranking of continents for anxiety was found for frustration as the second-most devastating emotion.

On the other hand, when analyzing positive emotions, North America appeared to be the continent with the most joyful students and Asia with the most hopeful students. To protect students' mental health as effectively as most countries' governments, health professionals, higher education institutions, student organizations, and NGOs should all collaborate intensively on the process of designing timely and efficient psychological and financial support services for students, and maintaining a safe distance between students and teachers depend on several factors, including study room size, availability, and the number of students per class. In countries with small fashionable sizes, sufficient space to safely accommodate college students may make it easier to comply with the new social distance expansion regulations. France and the UK have the same cap on the number of children after first elegance, but the average elegance size of French public schools was 23 college students, compared to the UK with an average post-elegance of 27 college students. This is also getting smaller.

TABLE 6 Shows OECD data of countries and online school percentage by students attended class size and parameters for re-opening of schools.

Countries	SUBJECTS / Seminars attended by the person	Coaching with peers and/or introspection as part of a formal school arrangement	Online school /Seminar	Formal qualification programmer
Lithuania	97%	70%	48%	20%
Latvia	95%	60%	29%	18%
Slovenia	94%	59%	31%	10%
Australia	93%	70%	71%	11%
Austria	90%	30%	18%	15%
Estonia	88%	51%	38%	11%
Netherland	85%	49%	17%	19%
Belgium	83%	35%	15%	12%
Alberta	83%	40%	40%	9%
New Zealand	80%	78%	33%	11%
Turkey	76%	20%	48%	32%
Russia	77%	77%	70%	10%
Iceland	78%	23%	35%	10%
Czech Republic	78%	55%	47%	15%
Israel	79%	25%	35%	25%
USA	76%	45%	25%	18%
Italy	74%	65%	52%	15%
OECD Average	76%	72%	55%	16%
Chinese Taipei	76%	48%	55%	20%
UK	76%	32%	54%	10%
China	75%	55%	35%	19%
Sweden	78%	18%	24%	8%
Norway	74%	75%	35%	25%

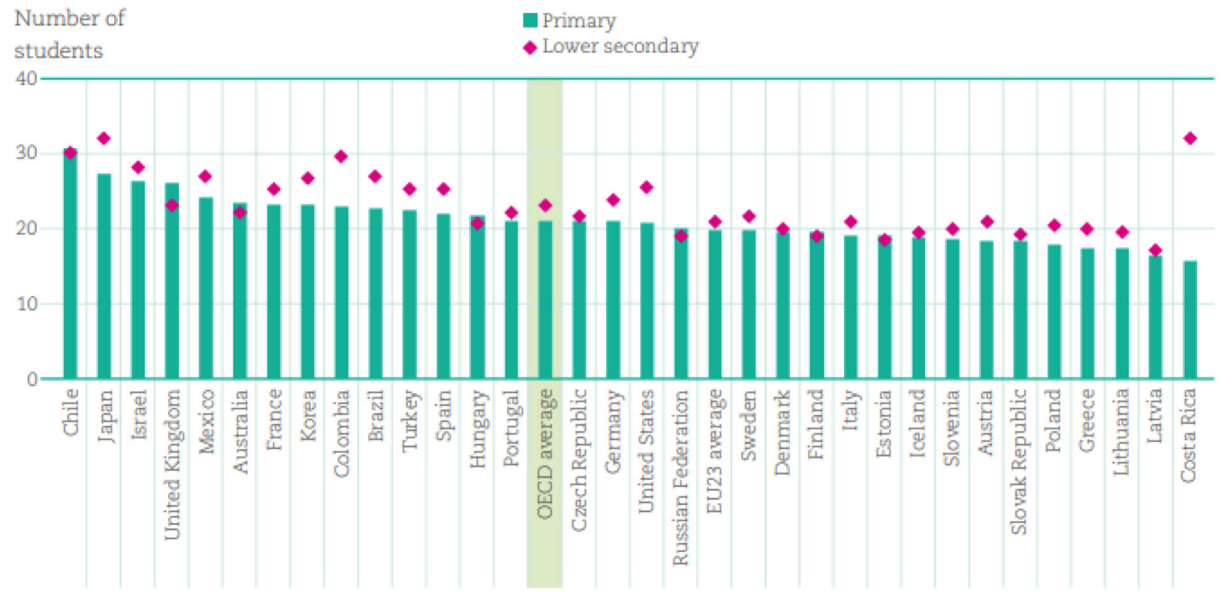

FIGURE 6
Average class size, by the level of education (2018).

TABLE 7 Crowding-out effect of GPGs and the dependent variable.

	ODA per capita	GPG per capita
GDP per capita	−1.99 × 104	1.68 × 105
	2.99 × 10	2.55 × 10

Due to the elegance of the education system, there were more than 30 students (Figure 6).

Although most OECD countries require students of the target age group or a certain level of education (excluding sick college students or students with vulnerable or sick circles of their relatives) to return to high school. Attendance was optional in Canada, the Czech Republic, France, and Spain. There were remote classes and online classes for students who want to live at home. These hybrid measures aim to consistently support teacher resumption while optimizing their ability to extend social distance (39).

Finally, this study addresses another donor concern. This means that greater global provision of public goods could lead to lower levels of aid for the poorest countries. However, the empirical analysis above shows the countries' response that the link between recipient countries' per capita GDP and per capita aid levels is already weak. If development aid was weakly linked to the income of recipient countries, it was unlikely that the countries with the lowest incomes were able to systematically reduce the provision of global public goods.

Table 7 shows the results and the limitations are obtained by regressing total aid and her GPG aid expenditure on income and pooling all donors (all variables are measured in her per capita calculation). The GDP per capita of recipient countries was negatively related to ODA/per capita, whereas the GPG-related ODA per capita was positively related, but the income coefficient is not significant in either regression. Of course, it is still possible that certain beneficiaries decided to give another country (perhaps wealthier) more aid in the form of GPG, thus shortening the aid that certain beneficiaries receive. However, this paper did not confirm the substantial displacement of aid in poor countries was caused by the provision of global public goods by ODA.

The results of our survey further demonstrate that on the global level, students were quite satisfied with the organization of all three segments of the pedagogical process: Lectures, tutorials/seminars, and mentorships. When comparing the workload before the transition from onsite to online, somewhat less than half of the respondents reported that in the new learning environment their workload had become larger or significantly larger-the biggest increase reported in Oceania and Europe and the smallest in Asia and Africa, both most probably due to the underdeveloped internet network and a lack of computer skills in higher educational unit.

Conclusion

The purpose of the study was to shed light on the ways the COVID-19 crisis has impacted student life and to design a set of recommendations for policymakers and higher education institutions concerning how students can be supported during the crisis created by the COVID-19 pandemic.

COVID-19 and the educational structure in developing resilient companies are most likely, especially in the mirror of vocational training. Candidates were exposed to a global fitness catastrophe and watched out for class disruptions. This helped to regain the respect of those who expressed opposition during the economic preservation period. The future can be very uncertain. A pandemic, on the other hand, highlights the sensitivities of the crisis and shows how much of the economy was built. The magnitude of the turmoil that was just witnessed includes not only pandemics but also natural, political, financial, and environmental turmoil. As with education and the definition of the school board, we need to develop the ability to respond appropriately, and the economic systems and skills needed to support it.

This study concluded that the distance learning modules, lectures, scripts, and individual assessments of distance learning. All governments intervene in education to maintain, direct, or change the scope of the proposal. Governments need to invest in educational opportunities because there is no guarantee that the market will provide equal access to educational opportunities.

Mental health problems of patients suffering from epidemics, front-line health workers, and the social and psychological impact on society as a whole show striking similarities between our experience with the virus diseases and COVID-19. However, the scale impact of COVID-19, duration, and uncertainty of future developments led to the intensity and its effects hitherto unprecedented in other viral pandemics. So is the rapid spread of COVID-19, the effect of the biology of the virus as evidenced to close connections in international travel and levels of immigration. At the same time, the impact on the global economy shows complex the way humanity is interdependent and connected through its various communities, institutions, and global infrastructure.

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

FL contributed to the motivation, the interpretation of the methods, the data analysis and results, provided the draft

versions and revised versions, references, and provided related concepts, and minor recommendations, and extracted the conclusion and discussion.

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Conflict of interest

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

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Distance learning during COVID-19 lockdown: Impact on adolescents with specific learning disorders and their parents

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Background: The transition of teaching from in-person to Distance Learning (DL) due to the COVID-19 pandemic led to negative effects on students' psychological wellbeing and academic achievement. The worst consequences have been experienced by students with so-called *special educational needs*, as well as by their parents. However, very little emphasis has been placed on the effects of DL in students with Specific Learning Disorders (SLD). The present work aimed to evaluate the effects of DL during the COVID-19 lockdown in Italian students with SLD and in their parents.

Methods: An online survey was administered to 92 students with SLD and their parents after the COVID-19 lockdown. The survey consisted of four sections: participants' demographic information; perceived stress related to general aspects (i.e., social and family determinants) as well as specific aspects related to DL; attitudes and feelings toward DL; and academic grades before and after DL.

Results: Students with SLD perceived stress mainly from social isolation/distancing and DL (p always $\leq$ 0.0001), especially from online classes and oral exams (p always $\leq$ 0.0001). Students who did not benefit from appropriate accommodations (i.e., individualized teaching and learning methods) during DL perceived 3 times more DL-related stress than those who used them as in-person learning (OR = 3.00, CI 95%: 1.24–7.28, p = 0.015). Girls perceived more stress from online lessons (OR = 0.40, CI 95%: 0.16–0.96, p = 0.04) and use of devices (OR = 0.33, CI 95%: 0.14–0.80, p = 0.015) than boys. Negative feelings (less motivation, reduced ability to understand lessons, interact, and stay focused) and positive feelings (less anxiety and more self-confidence with its own rate of learning) toward DL emerged. Higher academic grades also was observed after DL (p $\leq$ 0.0001). Lastly, strong and positive correlations emerged between students' and parents' perceived stress during DL (p always $<$ 0.001).

Implications: The present study prompts special considerations for students with special educational needs not only when providing conventional instruction, but especially when it is necessary to suddenly modify teaching approaches.

KEYWORDS

SARS-CoV-2, quarantine, stress, academic achievement, dyslexia, dyscalculia, education

Introduction

Starting from early 2020, governments in most countries introduced drastic and restrictive measures to reduce the spread of COVID-19 infection. The restrictions disrupted social, relational, working, and economic lives of people around the world—inevitably marking an epoch. Since that time, the detrimental consequences in terms of psychosocial wellbeing and mental health, largely due to prolonged social isolation (1) and forced cohabitation (2), have been widely documented.

Most of all, children and adolescents have suffered the worst consequences of the COVID-19 pandemic (1, 3, 4). The radical transformation of education was among the most challenging issues for young people and, consequently, their parents. As reported by the United Nations Educational Scientific and Cultural Organization, starting from March 2020, 107 countries have imposed school closures due to COVID-19 pandemic, affecting 862 million children and adolescents worldwide (5). School closures forced the disruption of in-person lessons, interfering with the daily routines of students and families with the activation of distance learning (DL). The move from in-person learning into online DL is unprecedented, and this transition has led to a readjustment of teaching methods using online platforms and videoconferencing tools to compensate for impossibility of in-person learning.

Generally, evidence documented that the experience of DL is usually associated with negative consequences in children and adolescents in terms of psychological wellbeing (5–8), learning outcomes and academic consequences (9–13). The findings also highlighted that the presence of associated medical conditions (14, 15), disabilities (16, 17), or neurodevelopmental disorders (18–20) in children and adolescents has markedly amplified the detrimental effects of DL—probably because of these already existing pre-conditions.

Surprisingly, little importance has been given to the effects of DL in children and adolescents who already have learning problems, such as specific learning disorders (SLD).

With a prevalence rate of 5%-15% worldwide, SLD are probably the most well-recognized neurodevelopmental conditions characterized by severe and enduring difficulties in the acquisition of reading (i.e., dyslexia) and/or math (i.e., dyscalculia) and/or writing (i.e., dysorthographia) in presence of adequate instruction and intellectual abilities (21). Such difficulties usually increase levels of stress and frustration at school and affect self-esteem with the onset of emotional and behavioral difficulties (22–25). During in-person learning, core difficulties of children and adolescents with SLD are mitigated to some extent by the implementation of individualized teaching and learning methods. In several countries, in order to provide the best conditions for learning and performing at school, students with SLD may benefit from specific regulatory prescriptions (e.g., Special Educational Needs and Disability Act, United Kingdom, 2001; Individual with Disabilities Education Act, USA, 2004; New regulations on Specific Learning Disorders in the school context, Italy, Law.170/2010). These prescriptions call for the application of appropriate accommodations, which include: the possibility of recording classroom explanations to facilitate home study, avoiding reading aloud and long dictations in class, using calculators and tables both at home and at school, scheduling oral exams specifying the content that will be required, the opportunity to consult visual maps during oral or written tests, and many others (New regulations on Specific Learning Disorders in the school context, Italy, Law.170/2010).

The DL imposed by the COVID-19 pandemic forced adjustments in teaching methods, especially for students with SLD, who already needed special supports and instruction tailored to their specific needs.

Only a few studies have focused on the impact of DL during the COVID-19 pandemic in students with SLD, particularly with dyslexia, examining the scenario in some European countries such as Italy (20, 26), Poland (27) and Spain (28, 29) considering personal and family emotional consequences (28, 29), perceptions of teaching quality (20, 27, 28), and consequences on academic achievement (26, 27).

Similar to findings on general population, when considering the emotional-behavioral consequences of DL, the little existing evidence on students with SLD highlighted a worsening of psychological wellbeing, with an increment of stress, anxiety, and depressive symptoms (28, 29).

The move from in-person learning into online DL has also posed additional challenges for families. Evidence generally documented that the experience of DL is usually associated with

negative consequences for parents (28–31). In particular, studies have reported increased stress and difficulties in managing DL in parents of children and adolescents with pre-existing conditions such as Autism Spectrum Disorder [ASD; (19)], Attention Deficit Hyperactivity Disorder [ADHD; (18)], and Intellectual Disabilities [ID; (16)]. One possible reason for the increased parental stress during DL may lie in the absence of specialized care generally provided during school hours and the increased involvement of parents in the management of school activities. As well, parents of children and adolescents with SLD often feel overwhelmed during DL, with increased levels of stress, anxiety, and frustration also due to the reduced study autonomy of the children (28, 29, 32).

Considering perceptions of teaching quality, students with SLD seemed to have more difficulties in organizing and carrying out school activities during DL, experiencing a decrease in learning opportunities, greater difficulties in learning organization (e.g., adjusting the rate and time of work to their own need, ease of contact with the lectures), and a lack of support from teachers (20, 27–29).

With regard to academic achievement, students with dyslexia have been shown to have greater difficulty achieving their educational goals during DL regardless of school-grade (26, 27). Specifically, the study by Baschenis et al. (26) documented that around 61% of 65 Italian children and adolescents with dyslexia did not reach the level of reading speed generally achieved at the end of the school year [0.30 syllables/seconds for words; 0.15 syllables/seconds for non-words; (33)]. The availability of adequate accommodations or support services and the presence of a tutor during DL also did not positively influence the reading level achieved. Similarly, the study on Polish undergraduate students (27) observed that more students with dyslexia or self-reported reading difficulties failed at least one exam after the DL period compared to typical readers. Similarly, although it is difficult to compare with due to different parameters, studies on general population showed a learning loss of about 3 percentile points or 0.08 standard deviations in reading, maths and writing during the COVID-19 pandemic in about 60% of students (11, 13).

In the literature briefly summarized above, the heterogeneity of SLD manifestations (e.g., dyscalculia; dysorthography; dyscalculia and dyslexia; etc.) has been overlooked, while only dyslexia has been considered. Therefore, a comprehensive overview on the effects of DL, including a sample composed by different combinations of SLD, should be considered. In addition, the application of specific regulatory prescriptions in SLD and also the DL consequences on parents have been underestimated.

In light of this, the aim of the present study was to provide an integrated perspective of students with SLD and their parents regarding the experience of DL during the Italian COVID-19 lockdown, taking into consideration multiple aspects (e.g., stress, emotional state and self-efficacy, performance). Specifically, the present study aimed to address the following Research Questions (RQs):

RQ1: (a) What COVID-19-related factors (i.e., forced cohabitation, social distancing, DL) were most challenging for students with SLD? (b) Could sociodemographic variables (i.e., gender and age) and school compliance with prescriptions for SLD have influenced perceived stress associated with COVID-19-related factors in students with SLD?

RQ2: (a) What DL-related factors (i.e., homework, online lessons, written tests, oral exams, and use of devices in support to DL) were most challenging for students with SLD? (b) Could sociodemographic variables (i.e., gender and age) and school compliance with prescriptions for SLD have influenced perceived stress associated with DL-related factors in students with SLD?

RQ3: What were the attitudes and feelings of students with SLD toward DL?

RQ4: What were the academic grades before DL vs. after DL?

RQ5: (a) What DL-related factors (i.e., supporting students during online lessons, during homework, concomitant daily home activities and/or smart-working) were most challenging for parents? (b) Could students' age and parents' sociodemographic variables (age and educational levels) have influenced parental perceived stress associated with DL-related factors?

RQ6: Is there a relation between students' and parents' perceived stress during DL?

Materials and methods

Participants

Adolescents were retrospectively selected from a broad database of the Child and Adolescent Neuropsychiatry Unit of the Bambino Gesù Children's Hospital (Rome), upheld by the direction of the Head of the Unit (S.V.), consisting of several hundred patients who were evaluated at the hospital according to the good clinical practices per international guidelines for neurodevelopmental disorders by experienced developmental psychiatrists, neuropsychologists, and speech therapists.

All the adolescents included in the study received a diagnosis of SLD (dyslexia and/or dysorthography and/or dyscalculia) according to the Fifth Edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5) criteria (21), developmental history and a comprehensive clinical and neuropsychological examination.

In particular, adolescents met the criteria for dyslexia and/or dysorthography and/or dyscalculia when the performance (i.e., accuracy and/or speed level) was at least 1.5 standard deviations below the mean for school-age in the norm-referenced reading

measures (34, 35) and/or norm-referenced writing measures (34, 36), and/or norm-referenced arithmetic measures (37).

Adolescents were also assessed for potential neurodevelopmental or neuropsychiatric comorbidities. The presence of developmental coordination disorder and/or dysgraphia was assessed throughout an extensive neuropsychological evaluation with appropriate norm-referenced tests (36, 38). Moreover, others neurodevelopmental (e.g., ADHD, Tic Disorders) and eventually psychopathological comorbidities (e.g., anxiety and mood disorders) were clinically ascertained according to developmental history, extensive clinical examination, and Kiddie-Sads present and lifetime version—Diagnostic and Statistical Manual of Mental Disorders 5 (39).

Criteria for inclusion in the study were as follows: (1) having a diagnosis of SLD (dyslexia and/or dysorthography and/or dyscalculia); (2) attending secondary schools (age range between 11 and 19 years old); (3) non-verbal Intelligence Quotient (nvIQ) $\geq$ 70 ($\pm$5 points allowing for measurement error).

The exclusion criteria were as follows: (1) a diagnosis of ASD or ID; (2) having received the first diagnosis of SLD after the COVID-19 lockdown; (3) non-participation in DL despite school closures (e.g., lack of electronic devices, inadequate internet connection, or school difficulties with organizing DL).

Procedures

The survey began after the conclusion of the Italian COVID-19 lockdown, at the end of May 2020, and was addressed to adolescents who had performed the DL and their parents. After selecting potential participants and their families based on inclusion/exclusion criteria, research assistants informed adolescents as well as their parents about the ongoing project. When both agreed to participation, the research assistants sent them *via* email a link through which they would have access to the self-report online survey. A total of 171 families were contacted, with a return rate of 96 students with SLD (56.14%) and 106 parents (61.99%).

The web-based survey included two questionnaires, one version for adolescents (students' version) and one for parents (mothers or fathers; parents' version). To ensure data privacy, an access code was provided for each participant. Each students' version was coded by "even" number while their respective parents' version with "odd" number. This method allowed the research assistants to combine the two versions of the survey (students' and parents') without tracking any sensitive data (e.g., first or last name, date of birth, etc.) of the respondents.

Adolescents as well as their parents provided consent and assent, respectively, before proceeding to the survey. The information collected was used in anonymous and aggregated form, in compliance with the EU General Data Protection Regulation n. 679/2016 (D.gls. n.196/2003 modified by D.gls. n. 101 del 10.08.2018). All procedures were consistent with the Declaration of Helsinki ethical principles for research involving human subjects.

Online survey

The students' version was composed of 28 multiple and non-multiple-choice questions. It consisted of four sections that investigated:

- *Sociodemographic information* (age, gender, residential area, presence and number of siblings, order of parentage, and educational level).
- *General Perceived Stress*. Adolescents were asked to rate the level of stress experienced during Italian COVID-19 lockdown (from March to May 2020) in three different life contexts (family, school, and social). Likert-scale responses ranging from 0 (no stressful) to 10 (very stressful) were used.
- *Perceived Stress during DL*. Adolescents were asked to rate the level of stress experienced during Italian COVID-19 lockdown (from March to May 2020) in five school activities during DL: homework, online lessons, written tests, oral exams, and use of devices in support to DL (e.g., laptops). Likert-scale responses ranging from 0 (no stressful) to 10 (very stressful) were used.
- *Attitudes and feelings*. Adolescents were asked to indicate their attitudes (e.g., attention, motivation, relationship with teachers) and feelings (e.g., sadness, loneliness, anxiety) in relation to DL experience compared to in-person learning. "True or false" responses were used.

The parents' version was composed of 18 multiple and non-multiple-choice questions. It consisted of five sections investigating:

- *Sociodemographic information* (age, gender, marital status, educational level, and occupation of both parents).
- *Adolescents' need for help during DL*. Parents were asked to indicate whether their children needed support for DL activities as well as who (such as mother, tutor, psychologist, speech therapist, etc.) provided support for DL. Multiple and non-multiple choice responses were used.
- *Application of regulatory prescriptions for SLD*. Parents were asked to indicate whether during DL, appropriate accommodations for SLD (New regulations on Specific Learning Disorders in the school context, Italy, Law.170/2010) have been applied as occurred during in-person learning. Multiple and non-multiple choice responses were used.

- *Perceived Stress during DL*. Parents were asked to indicate perceived stress in relation to supporting children during online classes and during homework as well as in relation to concomitant daily home activities and/or smart-working. Likert-scale questions ranging from 0 (no stressful) to 10 (very stressful) were used.
- *Adolescents' Academic Grades*. Parents were asked to indicate adolescents' grades before (from September to February 2020) and after (from March to May 2020) Italian COVID-19 lockdown in the following subjects: Italian, Math, and first foreign language (i.e., English).

For more details on the survey, see Supplementary materials.

Statistical analyses

Since the assumptions of normality and homogeneity of variance were not met, non-parametric analyses were conducted.

In students with SLD, Friedman's ANOVAs were run within each of the following sections: General Perceived Stress (RQ1a), Perceived Stress during DL (RQ2a), and Academic Grades (RQ4). *Post-hoc* analyses were conducted using Wilcoxon signed-rank tests and Cohens' *d* was used as measure of effect size.

Regarding to RQ1b and RQ2b, logistic regression analyses were run to explore the association between the application of regulatory prescriptions for SLD (independent variable, 2 groups: "students who benefited from regulatory prescriptions for SLD" vs. "students who did not benefit from regulatory prescriptions for SLD") and the stress levels of students with SLD (dependent variable, 2 categories: "low level" ranging from 0 to 5 and "medium-high level" ranging from 6 to 10). Other logistic regression analyses were used to examine the association between gender (independent variable) and the perceived stress.

For all logistic regressions, Odds Ratios (OR) and confidence intervals at 95% (CI 95%) were reported. To ensure the stability of the results, the limits of 95% of the bootstrapped distribution (R = 1,000) of beta coefficients bootstrapped percentile interval (95% BPI) were obtained.

In addition, regarding to RQ1b and RQ2b, non-parametric correlations (Spearman's Rank) were run to investigate the relation between students' age and stress measures (General Perceived Stress and Perceived Stress during DL). Where appropriate (General Perceived Stress, Perceived Stress during DL), the same analyses were conducted including students who did not have the parent survey associated (see Supplementary materials).

In parents, Friedman's ANOVA was run for the Perceived Stress during DL section (RQ5a). *Post-hoc* analyses were conducted by using Wilcoxon signed-rank tests and Cohens' *d* was used as measure of effect size.

Regarding to RQ5b, Spearman correlations were performed to explore the relation between students' age, parents' sociodemographic variables (age and educational levels) and parents' Perceived Stress during DL. Where appropriate (Academic Grades, parental Perceived Stress during DL), the same analyses were conducted including parents who did not have the student survey associated (see Supplementary materials).

Spearman correlations were also run between students' and parents' Perceived Stress during DL (RQ6).

The significance level was set at $p < 0.05$, and Bonferroni's correction for multiple comparisons was applied, when appropriate.

Analyses were run using SPSS for Windows (version 22.0; SPSS Inc., Chicago, IL).

Results

Sociodemographic information of students and parents

Of 96 students with SLD and 106 parents who completed the survey, a total of 92 student-parent dyads filled the survey.

Out of 92 adolescents (age in years: M = 14.4, SD = 1.94, range = 11–19; for more details, see Table 1), the majority (n = 87, 94.2%) were from central Italy (particularly Rome), specifically: Rome (n = 78, 84.8%), Frosinone (n = 1, 1.1%), Latina (n = 4, 4.3%), Rieti (n = 3, 3.3%), and Perugia (n = 1, 1.1%). The remaining students were from southern Italy (Catanzaro, n = 1, 1.1%; Lecce, n = 1, 1.1%; Potenza, n = 1, 1.1%) and northern Italy (Genoa, n = 1, 1.1%).

Of the 92 adolescents, 12 had a diagnosis of dyslexia (13%), 7 presented dysorthography (7.6%), and only 4 were diagnosed with dyscalculia (4.4%). Forty-four adolescents (47.8%) had a combined diagnosis of dyslexia, dysorthography, and dyscalculia, while the remaining 25 (27.2%) presented different combination of SLD, specifically: 11 with dyslexia and dysorthography (12%), another 11 with dyslexia and dyscalculia (12%), and 3 with dysorthography and dyscalculia (3.3%). More than half of them (n = 57, 62%) benefited from the regulatory prescriptions for SLD during DL as occurred during in-person learning.

Most of students with SLD presented additional comorbid psychopathological (30 out of 92, 32.6%) or neurodevelopmental disorders (39 out of 92, 42.4%). Within psychopathological comorbidities, 22 (73.3%) presented anxiety disorders, 4 (13.3%) had mood disorders and the remaining had anxiety-depressive symptoms (n = 2, 6.6%) as well as emotional dysregulation (n = 1, 3.3%). Within neurodevelopmental comorbidities, most of adolescents presented developmental coordination disorder and/or dysgraphia (n = 24, 60.7%) and the remaining had a diagnosis of ADHD (n = 15, 16.3%; Combined presentation:

TABLE 1 Sociodemographic characteristics of students with SLD.

Students		Number (%)
Gender	Male	48 (52.2)
	Female	44 (47.8)
Siblings	Yes	74 (80.4)
	1	51 (68.9)
	≥2	23 (31.1)
	No	18 (19.6)
Order of parentage	First-born	22 (29.7)
	Second-born	38 (51.4)
	Third-born	12 (16.2)
	Fourth-born	2 (2.7)
Educational level	1st grade secondary school	31 (33.7)
	2nd grade secondary school	61 (66.3)
	Technical institution	20 (32.8)
	High school	41 (67.2)

TABLE 2 Sociodemographic characteristics of parents.

Parents		Number (%)
Marital status	Single	24 (26.1)
	Married	68 (73.9)
Educational level	1st grade secondary school	8 (8.7)
	2nd grade secondary school	37 (40.3)
	Bachelor's degree	21 (22.8)
	Master's degree	20 (21.7)
	PhD	6 (6.5)
Father's occupational status	Employed	83 (90.2)
	Unemployed	2 (2.2)
	Retired	1 (1.1)
	No answer	6 (6.5)
Mother's occupational status	Employed	73 (79.3)
	Unemployed	17 (18.5)
	No answer	2 (2.2)

$n = 10$, 9.2%; Predominantly inattentive presentation: $n = 4$, 4.4%; Predominantly hyperactive/impulsive presentation: $n = 1$, 1.1%), and transient Tic Disorder ($n = 1$, 3.3%).

Of the 92 parents (age in years: M = 49.1, SD = 4.75, range = 33–58), 84 mothers (91.3%) and 8 fathers (8.7%) answered the questionnaire (for more details, see Table 2). Of these, 47 parents (51.1%) reported that their children needed support during the DL period. In particular, 31 out of 47 parents (66%) supported their children during lessons and homework, while 13 adolescents (27.6%) were helped by a private teacher. Only 3 parents (6.4%) did not answer to the question.

General perceived stress during COVID-19 lockdown in students with SLD (RQ1a and RQ1b)

When comparing the General Perceived Stress level among the family, school, and social contexts, Friedman's ANOVA revealed a significant difference [$\chi^2_{(2)} = 38.15$, $p \leq 0.0001$]. Wilcoxon signed-rank tests showed that students perceived more stress for the school context (5.82 ± 2.95) and social isolation/distancing (6.07 ± 3.28) than the family context (3.76 ± 3.13; respectively, school vs. family context: $Z = 5.09$, $p \leq 0.0001$, Cohen's $d = 1.25$; social isolation/distancing vs. family context: $Z = 4.94$, $p \leq 0.0001$, Cohen's $d = 1.20$). No significant difference emerged between school and social isolation/distancing ($Z = 0.72$, $p = 0.47$, Cohen's $d = 0.15$). After Bonferroni's correction for multiple comparisons (0.05/3), all statistical significances survived ($p \leq 0.017$) (see also Supplementary Table S1).

Logistic regressions documented that gender was not associated with the amount of stress related to the family context [$\chi^2_{(1)} = 0.03$, $\beta_1 = 0.08$, 95% BPI: −0.82–1.04, OR = 1.08, CI 95%: 0.45–2.64, $p = 0.86$], nor to school context [$\chi^2_{(1)} = 2.88$, $\beta_1 = -0.71$, 95% BPI: −1.58–0.11, OR = 0.49, CI 95%: 0.21–1.13, $p = 0.09$], and nor to social isolation/distancing [$\chi^2_{(1)} = 2.74$, $\beta_1 = -0.73$, 95% BPI: −1.72–0.13, OR = 0.48, CI 95%: 0.20–1.16, $p = 0.09$].

No significant correlations emerged between age and General Perceived Stress, including family context, school context and social isolation/distancing (all *rho* between −0.02 and −0.11, p always > 0.32).

In addition, logistic regression showed that those who no longer benefited from regulatory prescriptions for SLD as in-person learning were 3 times more likely to be more stressed than those who benefited from prescriptions as in person-learning [$\chi^2_{(1)} = 6.20$, $\beta_1 = 1.10$, 95% BPI: 0.24–2.10, OR = 3.00, CI 95%: 1.24–7.28, $p = 0.015$].

Perceived stress during distance learning in students with SLD (RQ2a and RQ2b)

Friedman's ANOVA showed a significant difference in stress perceived during DL for homework, online lessons, written tests, oral exams and use of devices [$\chi^2_{(4)} = 44.03$, $p \leq 0.0001$]. Students perceived more stress for online lessons compared to homework ($Z = 3.73$, $p \leq 0.001$, Cohen's $d = 0.84$), written tests ($Z = 4.26$, $p \leq 0.001$, Cohen's $d = 0.99$) and use of devices ($Z = 5.55$, $p \leq 0.001$, Cohen's $d = 1.42$) but not than oral exams ($Z = 1.65$, $p = 0.10$, Cohen's $d = 0.35$), as shown by Wilcoxon signed-rank tests. After

Bonferroni's correction for multiple comparisons (0.05/10), the aforementioned statistical significance survived ($p \leq 0.005$). All the remaining comparisons are shown in Table 3 (see also Supplementary Table S1).

Logistic regressions documented that boys perceived less stress related to online lessons [$\chi^2_{(1)} = 4.40$, $\beta_1 = -0.93$, 95% BPI: −1.92 to −0.07, OR = 0.40, CI 95%: 0.16–0.96, $p = 0.04$] and to the use of devices [$\chi^2_{(1)} = 6.22$, $\beta_1 = -1.10$, 95% BPI: −2.07 to −0.25, OR = 0.33, CI 95%: 0.14–0.80, $p = 0.015$] compared to girls. No significant associations emerged between gender and stress related to homework [$\chi^2_{(1)} = 2.07$, $\beta_1 = -0.61$, 95% BPI: −1.48 to 0.23, OR = 0.55, CI 95%: 0.24–1.25, $p = 0.15$], nor to written tests [$\chi^2_{(1)} = 0.16$, $\beta_1 = -0.17$, 95% BPI: −1.01 to 0.67, OR = 0.85, CI 95%: 0.37–1.92, $p = 0.69$], nor to oral exams [$\chi^2_{(1)} = 0.21$, $\beta_1 = -0.19$, 95% BPI: −1.05 to 0.63, OR = 0.83, CI 95%: 0.36–1.88, $p = 0.65$].

No significant correlations emerged between age, and Perceived Stress during DL, including homework, online lessons, written tests, oral exams, and use of devices in support to DL (all *rho* between −0.03 and −0.13, p always > 0.21).

Moreover, no significant associations emerged between students who benefited from the regulatory prescriptions for SLD such as in-person learning and the perceived stress related to homework [$\chi^2_{(1)} = 0.34$, $\beta_1 = -0.25$, 95% BPI: −1.15 to 0.61, OR = 0.78, CI 95%: 0.33–1.81, $p = 0.56$], nor to online lessons [$\chi^2_{(1)} = 2.36$, $\beta_1 = -0.69$, 95% BPI: −1.62 to 0.19, OR = 0.51, CI 95%: 0.21–1.21, $p = 0.13$], nor to written tests [$\chi^2_{(1)} = 0.29$, $\beta_1 = 0.23$, 95% BPI: −0.62 to 1.11, OR = 1.26, CI 95%: 0.54–2.93, $p = 0.59$], nor to oral exams [$\chi^2_{(1)} = 0.18$, $\beta_1 = 0.18$, 95% BPI: −0.67 to 1.08, OR = 1.20, CI 95%: 0.51–2.80, $p = 0.67$], and nor to the use of devices [$\chi^2_{(1)} = 0.17$, $\beta_1 = -0.19$, 95% BPI: −1.18 to 0.72, OR = 0.83, CI 95%: 0.35–1.99, $p = 0.68$].

Student attitudes and feelings toward distance learning in students with SLD (RQ3)

Table 4 shows the percentages of students with SLD who preferred learning during DL over in-person learning (items 2–7) and how they felt during DL vs. in-person learning (items 8–13).

Of 92, 54 (58.7%) students stated that DL was more suited to their learning rate compared to in-person learning (item 2). In contrast, most students pointed out that during in-person learning, it was easier to understand lessons ($n = 71$, 77.2%; item 3), to intervene in front of other classmates ($n = 66$, 71.7%; item 4), to ask teachers for clarifications ($n = 64$, 69.6%; item 5) and to get attention from teachers during ($n = 69$, 75%; item 6) or after lessons ($n = 64$, 69.6%; item 7) compared to DL.

In addition, most of students reported perceiving more self-efficacy ($n = 55$, 59.8%; item 8) and being less anxious ($n = 57$, 62%; item 10) during learning *via* DL compared to in-person learning.

In contrast, the majority of adolescents pointed out that during in-person learning, it was easier to pay attention and focus ($n = 73$, 79.3%; item 9) as well as they felt more motivated ($n = 68$, 73.9%; item 13) compared to DL.

Overall, out of 92, only 1 student answered the questions on DL consistently and positively and 6 students experienced DL in a totally negative way. The remaining 85 students answered both positively and negatively to the different questions about attitudes and feelings toward DL.

TABLE 3 Mean and standard deviation (SD) for distance learning perceived stress.

Questions[+] Stress related to...	M ± SD	*Post-hoc* comparisons
Homework (A)	5.26 ± 3.19	<B^ >E^ =C, D
Online classes (B)	6.28 ± 3.08	>A^, C^, E^ =D
Written tests (C)	4.87 ± 3.41	<B^, D** >E* =A
Oral exams (D)	5.65 ± 3.30	>C**, E^ =A, B
Use of devices (E)	3.99 ± 3.33	<A^, B^, C*, D^

[+]Likert-scale questions ranging from 0 (no stressful) to 10 (very stressful); *$p \leq 0.05$; **$p \leq 0.01$; ^survived after Bonferroni's correction ($p \leq 0.005$).

Academic grades (RQ4)

Friedman's ANOVA revealed a significant difference before and after DL in academic grades in the subjects Italian, Math and English [$\chi^2_{(5)} = 30.29$, $p \leq 0.0001$]. Students with SLD obtained higher Academic Grades in all subjects after DL (Wilcoxon signed-rank tests) compared to before DL (respectively, before DL vs. after DL: Italian, 6.55 ± 0.87 vs. 6.87 ± 0.98, $Z = 4.19$, $p \leq 0.0001$, Cohen's $d = 0.97$; Math, 6.48 ± 1.21 vs. 6.82 ± 1.22, $Z = 3.47$, $p \leq 0.001$, Cohen's $d = 0.78$; English, 6.49 ± 1.16 vs. 6.79 ± 1.24, $Z = 3.92$, $p \leq 0.0001$, Cohen's $d = 0.90$). After Bonferroni's correction for multiple comparisons (0.05/3), all statistical significances survived ($p \leq 0.017$) (see Supplementary Table S1).

Parental perceived stress during distance learning (RQ5a and RQ5b)

Friedman's ANOVA did not reveal a significant difference in the perceived stress related to supporting children during online lessons (4.32 ± 3.48), nor during homework (4.84 ± 3.38), nor to concomitant daily home activities and/or smart-working [4.69 ± 3.60; $\chi^2_{(2)} = 4.46$, $p = 0.11$] (see also Supplementary Table S1).

TABLE 4 The percentages of students with SLD in favor of DL compared to in-person learning in terms of attitudes (items 2–7) and feelings (items 8–13).

		Items	Number (%) in favor of DL
Attitudes toward DL	1.	The amount of homework was less than when I went to school regularly.	47 (51.1)
	2.	DL was better suited to my learning rate.	54 (58.7)
	3.	It was easier for me to understand the lessons than when I went to school regularly.	21 (22.8)
	4.	It was easier for me to intervene in front of other classmates than when I went to school regularly.	26 (28.3)
	5.	It was easier for me to ask teachers for clarifications than when I went to school regularly.	28 (30.4)
	6.	It was easier for me to get attention from teachers during lessons than when I went to school regularly.	23 (25)
	7.	Even when there were no lessons, it was easier for me to get attention from teachers than when I went to school regularly.	28 (30.4)
Feelings toward DL	8.	I think I did less well in the DL than when I went to school regularly.	55 (59.8)
	9.	It was easier for me to pay attention and focus on the lesson than when I went to school regularly.	12 (13)
	10.	Before DL, I was less anxious about homework and questions in school.	57 (62)
	11.	I felt sadder than when I went to school regularly.	44 (47.8)
	12.	I felt lonelier than when I went to school regularly.	40 (43.5)
	13.	I felt more motivated to study than when I went to school regularly.	24 (26.1)

Correlations analyses documented that age of adolescents was significantly and negatively related with parental stress in supporting children during online classes ($rho = -0.26$, $p = 0.011$), meaning that as adolescents' age decreased, parents perceived more stress. The same relation emerged between parental age and online classes support ($rho = -0.24$, $p = 0.022$), meaning that the younger the parents, the more stress they experienced. However, after applying Bonferroni's correction ($p = 0.05/9 = 0.006$), none of these significances survived.

No other significant correlations between parental perceived stress and parental educational level, adolescents' and parental age emerged (all *rho* between −0.02 and −0.19, p always > 0.07).

Relation between students' and parents' perceived stress during distance learning (RQ6)

When analyzing parental stress and stress of adolescents during DL, we found that:

- The greater the general stress perceived by adolescents during DL and the greater the parental stress related to daily home activities and/or smart-working ($rho = 0.42$, $p = 0.00003$);
- The greater the stress of adolescents during homework and the greater the parental stress in supporting them during this activity ($rho = 0.37$, $p = 0.0003$);
- The greater the stress of adolescents during online lessons and the greater the parental stress in supporting them during this activity ($rho = 0.37$, $p = 0.0003$).

After Bonferroni's correction for multiple comparisons, all statistical significances of correlations survived ($p = 0.05/9 = 0.006$).

Discussion

In the first half of 2020, one of the most drastic dispositions to contain the spread of COVID-19 contagions was the closure of all schools and universities worldwide.

The negative consequences of school closures in the daily lives of students (5–13) and families (4, 9, 31, 40) were particularly significant for those with so-called special educational needs (14–20).

The present study aimed at investigating the integrated perspective of students with SLD and their parents regarding the experience of DL during the Italian COVID-19 lockdown in terms of stress, attitudes and feelings toward DL, and academic grades.

Our results showed that students with SLD during COVID-19 lockdown perceived a higher level of stress from school and social isolation than stress in the family context. The current findings provide an opportunity to reflect on the consequences of DL for students with SLD on psychological wellbeing. Previous reports have emphasized that social distancing and the inability to freely engage with peers has represented arguably the most considerable stressor for adolescents (41, 42). The similar level of stress we found for school and social distancing can be interpreted as the effect, in both contexts, precisely of the inability to have relationships with peers both at school and on extracurricular occasions. Alternatively, we can hypothesize that for students with SLD adapting their educational needs in a new and unexplored way was as severe a burden as the impossibility of meeting peers for months.

Moreover, we found that students who no longer benefited from the regulatory prescriptions for SLD as in-person learning were 3 times more likely to be stressed than those who benefited from the prescriptions as in-person learning. Our results highlight the relevance of appropriate accommodations for students with SLD, not only to put them in the best conditions to learn and perform, but also to preserve their confidence in coping with school demands. Although different approaches to support educational support strategies for students with SLD exist worldwide, our findings are in line with other studies documenting a lack of consideration of special educational needs during DL (28, 29). We can postulate that teachers' difficulties in using new technologies and digital tools during pandemic (43), together with the effort to quickly adjust lessons in this new modality, might lead to less attention being paid to the educational needs of students with SLD.

Regarding the aspects that influenced stress during DL, students were more stressed in relation to online lessons and oral exams than the remaining elements. Our results are consistent with previous findings (26), in which both students with dyslexia and their parents described greater difficulties in attending online lessons and a worsening in oral exposition compared to controls. Similarly, students with dyslexia were found to struggle with online lessons, believing that their educational needs were not sufficiently considered by teachers (28, 29). In contrast, the use of technology contributed less to DL-related stress, as evidenced by the lowest stress score obtained in relation to the use of devices. Given the average age of our student cohort, we can assume that they had already achieved sufficient autonomy in the use of devices and videoconferencing platforms, so this aspect did not produce significant stress.

Furthermore, our results showed that boys and girls perceived stress related to various components of DL differently. Specifically, girls perceived more stress from online lessons and use of devices than boys. Extensive literature documented a higher incidence of stress, anxiety, and depressive symptoms in girls than boys during lockdown (44–46). Nevertheless, given the absence of previous studies that specifically investigated gender differences in students with SLD when coping with DL, further studies are needed to draw conclusions on this issue.

When considering attitudes and feelings toward DL, our results revealed a dual facet of DL. On the one hand, students believed that DL was disadvantageous compared to the in-person learning for some reasons. Especially, most of students indicated that during DL, it was harder to understand lessons, intervene in front of other classmates, ask teachers for clarifications, and get attention from teachers compared to in-person learning. Similarly, students pointed out that they had difficulty paying attention and concentrating during the DL and felt less motivated compared to in-person learning.

It is well-documented that students with SLD often present attention difficulties (47–50), and it is therefore possible to suppose that the demands of DL have implied considerable attentional effort for these students. Furthermore, it should be noted that DL inevitably reduces opportunities to receive appropriate attention from teachers and to interact, and this may have reduced students motivation, given previous studies demonstrating that students with SLD particularly benefit from cooperative learning activities (51, 52), which became impossible during the lockdown.

Nevertheless, more than 50% of students stated that DL fit better with their learning rate than in-person learning. In addition, when considering the emotional state related to DL, most of students reported that they perceived better performance and were less anxious while learning *via* DL than in-person learning.

These results could depend on lower performance demands, less stringent assessment standards, and more parental support during DL. In this respect, students with SLD may have experienced the DL as less demanding and more compliant with their difficulties.

To verify whether DL also affected academic achievement of students with SLD, we compared grades obtained before and after DL in three school subjects, such as Italian, Math and English. Our results indicated an overall improvement after DL in all three subjects. Several hypotheses could be postulated to interpret this improvement:

- Teachers might have a greater tolerance in assessing student performance due to the challenging and unprecedented period, and given the greater difficulty during DL to provide students with SLD with individualized support than in-person teaching. This could be supported by our findings on the less application of SLD prescriptions compared to in-person learning and on the less interaction with teachers (such as asking teachers for less clarification and receiving less attention from teachers compared to in-person learning);
- As mentioned above, parents had the opportunity to provide direct support during DL to their children's school activities, which was not possible during in-person

learning. In line with this hypothesis, in several studies involving students with and without special educational needs, parents were considered as proxy educators during the lockdown (4, 32, 40);

- DL may have somehow facilitated students with SLD, making them more confident in their abilities and more likely to succeed than in-presence learning. This latter hypothesis may be supported by the fact that most students indicated that DL was more suited to their learning rate than in-person learning. In addition, the use of technological measures may have benefited them because it prevented them from performing certain activities in the traditional way, such as writing by hand or reading from the book, that are particularly demanding for students with SLD.

To the best of our knowledge, no study that has explored the effects of DL in students with SLD has evaluated academic grades before and after DL. In particular, only reading skills before and after DL were compared, observing less than expected progress (26). Moreover, a study on university students with SLD (27) evaluated the amount of exams passed during DL in comparison with those passed by typically readers, observing a worse performance only on the former. It is therefore difficult to compare our results, which depend on teachers' judgments, with those derived from comparing more objective measures, such as the amount of exams passed or the reading level achieved before and after DL. It is therefore too premature to argue that the DL had a positive or detrimental effect on academic achievement of students with SLD.

The present study was designed to provide an integrated perspective of the DL experience, considering not only the self-perception of students with SLD, but also of their parents.

In particular, we examined the stress level of parents who had to work at home and reconcile their personal activities with their children's demands for support during DL and homework.

Parents reported that their stress levels related to supporting their children during online classes, during homework, and during concomitant daily household and/or smart-working activities were similar. Instead, we had hypothesized that the balance between work demands and child support during DL and homework was an important stressor. It could be hypothesized that parents experienced co-presence with their children at home in a positive way, as it gave them the opportunity to spend time together and to support them more than is usually the case due to work commitments. Our results show, however, that parental stress went hand in hand with children's stress, and the greater the children's perceived stress during DL, homework and online classes, the greater the parents' stress. These results support previous findings, which showed that when parents assumed the role of proxy educators during school closure and DL, the psychological wellbeing of the family was disturbed (4, 40).

Our study had some limitations.

The first limitation was the small number of participants included in the study and their homogenous geographic area (Rome)—which did not allow us to draw definitive conclusions. Despite the large number of families reached, the need to combine the two versions of the survey (for parents and students) forced us to exclude many incomplete questionnaires.

Another limitation might be that we did not compare the impact of DL between students with SLD and students who present another neurodevelopmental disorder. This could have clarified whether the observed negative and positive aspects of DL are typical of students with SLD or common to students with other special educational needs.

Moreover, elements such as personality predisposition to be more anxious, more motivated, or more self-confident may have partly influenced the answers provided in the survey. It would have been even more informative to assess the relationship between students' characteristics and perceptions of the DL.

Finally, the present study did not generally assess parents' level of psychological wellbeing during the lockdown period. In fact, our questions focused specifically on the impact the DL had on parents and students. It would have been useful to have information on the parent-child relationship before school closures, to see how the DL experience and previous family interactions would have interplayed with each other.

Moreover, taking into account the general level of stress and emotional state of parents during the lockdown period could have been helped us to better understand the relation between parents' and students' experience about DL.

Conclusion

The COVID-19 pandemic has affected everyone's life to some extent. Certainly, the heaviest cost has been paid by adolescents, who have seen their primary need, the school, challenged. The prolonged school closures and the spread of DL have brought out critical issues and strengths of alternative and technology-based teaching methods. In this context, our study offers further insights into the importance of considering the different needs of all students, including those with SLD. Given the uncertainty that still seems to characterize this pandemic phase, adopting appropriate strategies and planning teaching activities taking account of all students' needs could be a crucial challenge for 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

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

Author contributions

GL, CV, SV, and DM designed the study. AB, GL, and CV collected the data. AB, GL, and DM worked on data analyses. AB and GL drafted the manuscript, with support of DM and SV. DM and SV supervised the study. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.995484/full#supplementary-material

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Parental psychological control and adolescent social problems: The mediating effect of emotion regulation

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This study aimed to investigate relationships among parental psychological control, adolescent emotion regulation, and social problems in China. In total, 1,145 adolescents aged 12–15 years participated in the study, which used the Parental Psychological Control Scale, Adolescent Problem Behavior Scale, and Emotion Regulation Scale. The results indicated the following: (1) Compared with only-child teens, adolescents in multi-child families had significant social problems; (2) parental psychological control significantly predicted adolescents' social problems; (3) there was a partially mediating effect of adolescents' emotion regulation between parental psychological control and adolescents' social problems.

KEYWORDS

multi-child family, parental psychological control, emotion regulation, social problems, adolescent

Introduction

Many children in adolescence suffer from school weariness, depression, and social phobia (1, 2). Adolescence is a key stage of growth during which the individual undergoes a series of subtle changes in physiological, psychological, and social development, such as changes in hormone levels during puberty, continuous brain development, and the formation of individual independence. In this period, individual physical development is rapid, but psychological development is relatively slow. This imbalance in physical and mental development can easily lead to many psychological conflicts and contradictions, which often affects adolescents' emotions and increases their need for emotion regulation (3). This increased need makes them use emotion regulation more frequently, and accordingly, the level of emotion regulation also

determines the level of interpersonal interaction, problematic behavior, and mental health status of adolescents (1, 2).

The resource dilution theory (4) suggests that as the number of children in a family increases, the allocation of family resources for each child decreases, eventually resulting in a negative impact on parenting and more problem behaviors in the children. This phenomenon has been found in multi-child families (5).

Problem behavior refers to abnormal behavior that hinders individual social adaptation. In other words, it occurs when individuals violate or do not abide by social norms and codes of conduct or cannot adapt to social life well, thus causing a bad influence or even harm to society or themselves (6). Problem behaviors are classified into behaviors of social problems, thinking problems, and attention problems (7). Adolescents with social problems tend to have low self-esteem and lack necessary social skills. They often have unnecessary anxiety about social situations and interpersonal contact due to concerns about exposing their shortcomings or being negatively evaluated by others (2, 7). The formation of social problems is influenced by many factors. The problem behavior theory proposed by Jessor et al. explains the complex process of social problem formation in individuals to a certain extent (8, 9), which divides the factors into personality systems (individual's attitude, values, personality, etc.) and situational system (school, family, peers, etc.) (2, 10). The problem behavior theory shows that family factors such as multi-child families, parental psychological control, and personality factors, such as an individual's emotions, can affect adolescents' social problems.

Social problems of adolescents in multi-child families

Researchers have found that as the number of siblings in a family increases, the family resources allocated to each child decrease and the competition between siblings intensifies (4). Due to the newly revised family planning policy, the number of children in Chinese families is gradually increasing. Behavioral and emotional problems of siblings in these families are emerging, which has attracted increasing attention from social and academic researchers. Some studies have found that sibling jealousy and growing self-protection are associated with children withdrawing from their friendships or society, which in turn leads to many social problems (11). A study has found that boys in China's multi-child families are more likely to engage in aggressive behavior and have discipline violations, while girls are more likely to have social problems such as social withdrawal (12). In China, parents of multi-child families typically experience more financial pressure than parents of one-child families. As they are often busy with work, they seldom have time and energy to take their children to participate in social activities, such as going to the movies, traveling, visiting relatives and friends, and so on (13). Especially in recent years, due to the COVID-19 pandemic, children have been busy either attending school or taking online classes at home, they are even more socially isolated than before, so they may have more social problems (14, 15).

Relationship between parental psychological control and adolescent social problems

Parental psychological control belongs to parenting behavior, which refers to the behavior of parents violating adolescents' emotional and psychological autonomy through verbal or non-verbal means in the process of parenting (16–20). Despite the fact that there are researches that underscored the importance of parental psychological control in the development and autonomy of Children (17), it remains a controversial dimension because of its complexity as a construct since, even though there is consensus about the negative association between parental psychological control and adolescent behavioral problems (21–24), the specific components of parental psychological control that contribute to preventing emotional and behavioral disorders are often not clear. In Barber et al. (25) made a progress in refining understanding of some of these components: Psychological control as manipulation and coercion, psychological control as intrusion into the personal domain and psychological control as disrespect. However, their finding remains to be further examined.

Adolescence is an important period for "separation-individuation." Adolescents pursue autonomy and hope to get rid of parental authority and control (26, 27). The Self-Determination Theory states that individuals are born with a developmental tendency for self-growth and that the experience of parents meeting their children's basic psychological needs, such as autonomy and competence, is key to achieving growth in potential (28, 29). However, parents with high psychological control often impose their own demands and wishes on their children by guiding their children to feel guilty, expressing their disappointment or ignoring and humiliating their children, which has a serious negative impact on the social development of adolescents (24, 28–30). One of the important indicators of social development is social behavior, and parental psychological control tends to cause low social connectedness in children, which, in turn, generates more social problems. For example, parental psychological control is positively correlated with social anxiety in adolescents (31); Shek (32) has argued that higher levels of parental psychological control are associated with relatively lower levels of trust and willingness to communicate with parents, which in turn increases the risk of aggressive behavior with others and affects their interactions with others, resulting in social problems.

Mediating effect of emotion regulation

Emotion regulation is the process by which an individual influences the occurrence, experience, and expression of self-emotions, including cognitive reappraisal and inhibition of expression. Cognitive reappraisal refers to a process in which an individual changes their cognition and understanding of emotion-induced events and reconsiders their personal meaning. Inhibition of expression refers to the process by which an individual inhibits upcoming or ongoing emotional expression (33). Researchers generally agree that cognitive reappraisal is an adaptive emotion regulation strategy and expressive inhibition is a non-adaptive emotion regulation strategy. Cognitive reappraisal is better than expressive inhibition in regulating emotions and is beneficial to people's physical and mental health (34, 35). Investigations show that any difficulty in emotion regulation may lead to social misconduct or social problems. In studies on adolescent emotion regulation and social development, adolescents with poor emotion regulation abilities lack social skills and show more problematic behaviors (36, 37). Adolescents' choice of emotion regulation can predict individual social problems to a certain extent, and adolescents who choose positive emotion regulation have fewer social problems (38).

Morris et al. (39) have found that parenting style is associated with adolescents' emotion regulation. Li et al. (40) also found that parental psychological control has an impact on the development of adolescents through emotion regulation. Adolescents with high psychological control have imperfect emotional and cognitive development, immature use of emotion regulation strategies, and are unable to actively deal with negative emotional experiences, resulting in emotional disorders. High levels of parental psychological control also tend to increase children's negative emotions in daily interactions. When the level of parental psychological control increases, children's negative emotional experience also increases. Parental psychological control negatively predicts adolescents' emotional function (41). The more controlled adolescents are by their parents, the lower their emotion regulation ability will be (42).

Based on the above research evidence and problem behavior theory, we hypothesize that emotion regulation plays a mediating role in parental psychological control and adolescents' problem behavior in multi-child families (see **Figure 1**).

Methods

Participants

This study took a convenience sample of 1,488 adolescents in 7th and 8th grade in a school in Shaanxi Province, removed 343 people for incomplete completion of the questionnaire, and finally had a number of1,145, aged between 12 and 15, with 789 7th graders and 356 8th graders. There were 537 boys and 608 girls, 674 only children, 471 with siblings (including 41 who were the third child and above), 950 who were the oldest, 154 who were the second, and 41 who were the third and above. There were 268 people with a monthly family income of less than or equal to 5,000 yuan/month, accounting for 23.4%, 452 people with monthly family income between 5,001 and 10,000 yuan, accounting for 39.5%, and 425 people with monthly family income greater than 10,001yuan/month, accounting for 37.1%. Overall, 96.2% of the participant's main caregivers were parents.

Measures

Parental mental control scale

A revised Chinese version that incorporates different cultural contexts of the Parental Mental Control Scale developed by Wang et al. (22, 23) was used in this study. It contains authoritative assertion (e.g., "My parents tell me that what they want me to do is best for me and that I should not have questions about these things;" McDonald's $\omega = 0.872$), loving withdrawal (e.g., "If I do something my parents don't like, they will seem cold and unfriendly;" McDonald's $\omega = 0.903$), and guilt response (e.g., "When I don't do things the way my parents do, my parents tell me they are disappointed in me;" McDonald's $\omega = 0.917$), with 18 questions on a 5-point scale ranging from "never" to "daily." The higher the score, the higher the level of parental psychological control. In this study, the confirmatory factor analysis (CFA) indicators of parental mental control scale were better: $\chi^2/df = 3.460$, RMSEA = 0.048, RMR = 0.050, AGFI = 0.938, GFI = 0.963, CFI = 0.978. McDonald's ω for the scale was 0.926.

Adolescent problem behavior scale

The Youth Self-Report (YSR), developed by Achenbach and Edelbrock (43) and modified by Liu et al. (44), is a 112-item scale divided into anxiety, depression, withdrawal, somatic complaints, social problems, thinking problems, attention problems, disciplinary behavior, and aggression. In this study, the social problems subscale was used (e.g., "does not get along with other adolescents;" McDonald's $\omega = 0.858$) and was scored on a 3-point scale, with subjects completing the scale based on their performance over the past 6 months. A score of 0 was assigned for "not acting out," 1 for "sometimes acting out," and 2 for "often acting out." The higher the score, the more serious the social problem. In this study, the confirmatory factor analysis (CFA) indicators of social problems subscale were better: $\chi^2/df = 1.101$, RMSEA = 0.024, RMR = 0.028, AGFI = 0.963, GFI = 0.979, CFI = 0.989.

Emotion regulation scale

The Emotion Regulation Scale was developed by Wang et al. (22, 23) and consists of 14 questions, including expression inhibition (e.g., "When I feel happy, I try not to show it;"

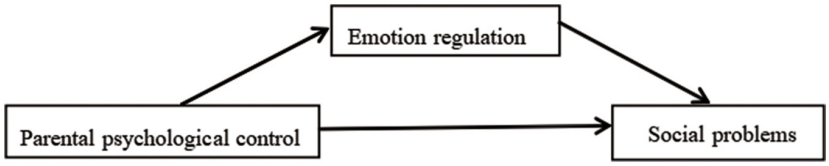

FIGURE 1
The proposed mediation model.

McDonald's ω = 0.808) and reappraisal (e.g., "I try to change my perception of my surroundings to make myself happier;" McDonald's ω = 0.894). Each dimension has 7 items, including the items that regulated the 5 basic emotions of disgust, anger, sadness, fear, and happiness, and 2 items about whether an individual used a certain strategy in general. Subjects were asked to choose the option that best represented their perceptions on a 7-point rating scale in relation to their actual situation, with 1 representing total disagreement and 7 representing total agreement. Higher scores indicated a stronger degree of that dimension. In this study, the confirmatory factor analysis (CFA) indicators of emotion regulation scale were better: χ^2/df = 3.990,RMSEA = 0.053, RMR = 0.071, AGFI = 0.957, GFI = 0.981, CFI = 0.978.

Data analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, N.Y., USA). A univariate analysis of variance, Pearson correlation analysis and the Marco PROCESS (Model 4) were used to analyze the relationships among parental psychological control, adolescent emotion regulation and social problems.

Results

A univariate analysis of variance (UNIANOVA) with number of siblings (only child, non-only child), birth order (firstborn and later born), gender (male and female), family income (≤ 5,000 yuan/month,5,001–10,000 yuan/month, ≥ 10,001 yuan/month) as factor variables, adolescents' social problems scores as the dependent variable was conducted. There was a significant main effect of number of siblings [$F(1, 1,144) = 6.180$, $p = 0.013$, $\eta_p^2 = 0.005$], and the non-only child adolescents' social problems score ($M = 0.377$, $SD = 0.015$) was significantly higher than the only child score ($M = 0.271$, $SD = 0.040$). The main effect of family income was close to significant [$F(2, 1,144) = 2.839$, $p = 0.059$, $\eta_p^2 = 0.005$], and the social problems of adolescents with a family income of ≤ 5,000 ($M = 0.375$, $SD = 0.042$) were significantly higher than those with family income ≥ 10,001 ($M = 0.251$, $SD = 0.038$). There were no significant main effects of birth order [$F(1, 1,144) = 0.595$, $p = 0.441$, $\eta_p^2 = 0.005$] or gender [$F(1, 1,144) = 1.798$, $p = 0.180$, $\eta_p^2 = 0.002$] on adolescents' social problems scores, nor was there any interaction between them ($ps > 0.05$).

Pearson correlation analysis was conducted to examine relationships among parental psychological control, emotion regulation, and social problems with sibling numbers and family income as covariates. Psychological control was positively related with expression inhibition ($r = 0.104$, $p < 0.010$), psychological control was positively related with social problems ($r = 0.230$, $p < 0.010$), and psychological control was negatively related with cognitive reappraisal ($r = -0.180$, $p < 0.010$). Expression inhibition was positively related with social problems ($r = 0.211$, $p < 0.010$), and cognitive reappraisal was negatively related with social problems ($r = -0.067$, $p < 0.05$) (see Table 1).

Based on the correlation analysis' results, Model 4 was used to test the mediating effect of cognitive reappraisal on the relation between psychological control and social problems. The results (see in Figure 2 and Table 2) showed that the direct path from psychological control to social problems (β = 0.063, $p < 0.001$) in the absence of cognitive reappraisal was significant. When psychological control and cognitive reappraisal entered the regression equation at the same time, psychological control was significantly associated with cognitive reappraisal (β = -0.267, $p < 0.001$) and social problems (β = 0.079, $p < 0.001$). Cognitive reappraisal significantly predicted social problems (β = -0.027, $p < 0.001$).

Model 4 was used to test the mediating effect of expression inhibition on the relation between psychological control and social problems. The results (see in Figure 3 and Table 3)

TABLE 1 Pearson correlation coefficients of the study variables ($N = 1145$).

	M	*SD*	1	2	3	4
1. Psychological control	2.584	0.922	–			
2. Expression inhibition	2.810	1.328	0.104**	–		
3. Cognitive reappraisal	3.434	1.369	−0.180**	0.359**	–	
4. Social problems	0.337	0.315	0.230**	0.211**	−0.067*	–

M, mean; SD, standard deviation. **$p < 0.010$, *$p < 0.050$.

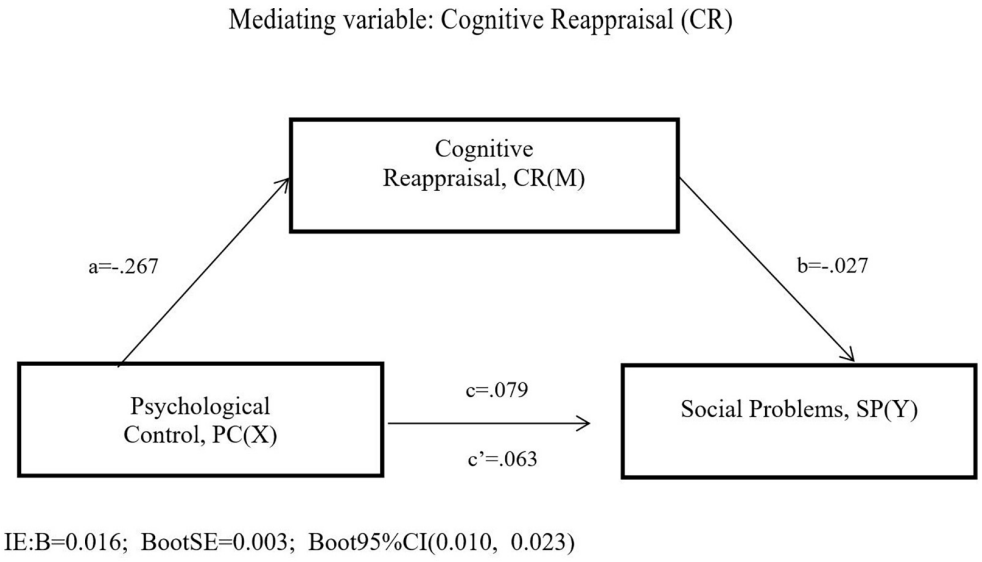

FIGURE 2
The mediation model of cognitive reappraisal.

showed that the direct path from psychological control to social problems (β = 0.063, $p < 0.001$) in the absence of cognitive reappraisal was significant. When psychological control and expression inhibition entered the regression equation at the same time, psychological control was significantly associated with expression inhibition (β = 0.149, $p < 0.001$) and social problems (β = 0.079, $p < 0.001$). Expression inhibition significantly predicted social problems (β = 0.056, $p < 0.001$).

A bootstrap procedure was applied to assess the size of the indirect effect and confidence intervals. For the indirect effect, 95% bias-corrected accelerated confidence intervals (CIs) without "zero" indicated the significant mediation effect. We generated 5,000 bootstrapping samples. The indirect effects of psychological control on social problems mediated by cognitive reappraisal (ab = 0.007, *SE* = 0.002, 95% CI [0.003, 0.012]) and expression inhibition (ab = 0.008, *SE* = 0.003, 95% CI [0.003, 0.014]) was significant. The mediation effect accounted for 8.917% and 10.191% of the total effect. The 95% confidence interval did not consist of zero, showing that psychological control exerted a significant indirect effect on social problems via cognitive reappraisal and expression inhibition.

TABLE 2 Testing the mediation effect of cognitive reappraisal on social problems.

Effects	Path	β	SE	*p*
Effect PC-CR	a	−0.267	0.043	0.000
Effect CR-SP	b	−0.027	0.007	0.000
Total effect PC-SP	c	0.079	0.010	0.000
Direct effect PC-SP	c′	0.063	0.010	0.000

PC total effect model ($F = 63.638$; $p < 0.001$; $R^2 = 0.053$)

Indirect effects	Path	β	Boot SE	Boot 95%CI	
				LL	UL
Total indirect effect		0.016	0.003	0.010	0.023

Discussion

In this study, we found that adolescent social problems were influenced by the number of siblings, and adolescents in multi-child families had significantly more social problems than those in one-child families. Consistent with previous studies, only children in adolescence had better social skills than non-only children (45, 46). In a national sample (using data from the 2010 China Household Tracking Survey), Zhang et al. (45) found that with similar personal characteristics, family status, and regional backgrounds, only children in adolescence exhibited a "psychological advantage" in socialization, leading to a subjective belief that they had stronger social competence. However, in actual social situations, there was no significant difference between only children and non-only children from similar home backgrounds (45). From a long-term developmental perspective, social problems of adolescents in multi-child families are temporary. Due to psychological changes in adolescence (self-supporting personality, rebellious psychology, etc.), they begin to alienate and even antagonize their parents and other adults. Compared with one-child families, interpersonal relationships in multi-child families

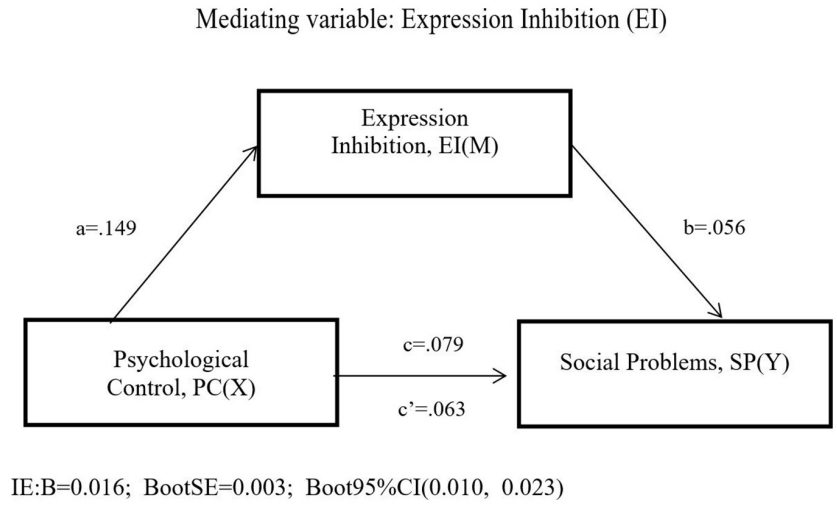

FIGURE 3
The mediation model of expression inhibition.

are more complicated, and children with siblings may face more family conflicts (differential treatment by parents, sibling conflicts, etc.) and bear greater psychological pressure, leading to more social problems. However, once they learn to cope with these psychological pressures, they may have better social skills than only children, as sibling interaction is beneficial to the development of interpersonal communication in early adulthood (14, 47).

The study also found that adolescents with a monthly family income below 5,000 yuan had more social problems. This was consistent with the resource dilution hypothesis (4, 5), which emphasizes that the more children in the family, the less the family income and the more likely the family resources are diluted, leading to more social problems among adolescents. The family stress model also posits that family socioeconomic status (SES) will affect the development of children by influencing the family process (48). For example, low family SES will lead to the negative parenting style of parents and eventually hinder the development of children (48). And in our previous studies, we found that mothers of two-child families had higher parenting stress than those of one-child families (13, 49), and in two-child families, families with an income of less than 3,000 yuan had significantly higher maternal stress than families with an income of more than 6,000 yuan (49). Adolescents with lower family SES can obtain and use relatively few kinds of resources, which will make them feel unfairly treated, and cannot adapt to the environment well, thus producing or showing more problem behaviors (50).

TABLE 3 Testing the mediation effect of expression inhibition on social problems.

Effects	Path	β	SE	*p*
Effect PC-EI	a	0.149	0.042	0.000
Effect EI-SP	b	0.056	0.007	0.000
Total effect PC-SP	c	0.079	0.010	0.000
Direct effect PC-SP	c′	0.063	0.010	0.000

PC total effect model ($F = 63.638$; $p < 0.001$; $R^2 = 0.053$)

Indirect effects	Path	β	Boot SE	Boot 95%CI	
				LL	UL
Total indirect effect		0.016	0.003	0.010	0.023

In addition, we found that emotion regulation played a partially mediating role in parental psychological control and social problems. On the one hand, parental psychological control could positively predict adolescents' social problems, indicating that the higher the level of parental psychological control, the more social problems adolescents would have, which was consistent with the research conclusion of Zhang et al. (51). Many empirical studies have also shown that a high level of parental psychological control will lead to more problem behaviors in adolescence (19–21, 24, 28, 29). On the other hand, parental psychological control might affect adolescents' social problems through emotion regulation: In one case, the more parental psychological control, the more inhibition of emotional expression of adolescents and the more serious social problems (52); in another case, the more parental psychological control, the less cognitive reappraisal of adolescents and the more serious social problems (53). Parents with high levels of psychological control often feel frustrated when their children did not live up to their expectations. Under such circumstances, they tend to blame their children, usually using methods such as making their children feel guilty, expressing disappointment

or neglecting their children, or even humiliating their children, all of which result in children's negative emotional experiences (54). Over time, their children will feel helpless and depressed, which in turn hinders their cognitive and emotional development, leading to more use of negative emotion regulation strategies such as expression inhibition, and less use of positive emotion regulation strategies such as cognitive reappraisal (55). As a result, adolescents will withdraw emotionally or physically, afraid of expressing and transmitting their inner feelings or ideas (56). Further, they may be unwilling to communicate with others, resulting in more social problems and hindering the development of independent consciousness and mental health (57). The partially mediating role of emotion regulation in parental psychological control and social problems can also be explained by problem behavior theory, which holds that family factors such as parental psychological control, individual emotions, and other personality factors jointly affect adolescents' social problems.

Implications and limitations

According to the Family System Theory (58), flexible parent-child boundaries are critical for children's healthy development, and a balance between autonomy and attachment to parents is essential for a child's healthy adaptation. If parents do not respect their children's opinions and force their children to meet their own needs, children's autonomous exploration outside the family will be hindered. Thus, children's personalized and adaptive development will be suppressed. Traditional Chinese culture emphasizes the authority of elders in the family. To help their children make progress in study, some parents will deliberately be stern and seldom praise their children directly when they achieve success. There are even parents who demean or induce guilt and anxiety in their children, intentionally or unintentionally, to increase their authority. However, parents' excessive psychological control over their children is not conducive to the healthy growth of adolescents. Therefore, we suggest that parents should adopt a positive parenting style in the process of educating their children. When living with children, parents need to maintain their own independence and leave room for their children to develop such that the children can experience a sense of autonomy. In addition, parents should pay attention to the cultivation of children's social communication skills, let children learn to use positive emotion regulation to deal with various difficulties, and learn to actively communicate with people when they encounter social problems.

This study had some limitations. Firstly, we focused on adolescent social problems, and relationships among parental psychological control, adolescent emotion regulation, and social problems in China. In the future we will explore whether other aspects of mental health could influence the reported associations with social problems. Secondly, the questionnaire on parental psychological control was answered by adolescents. It is necessary to have the psychological control questions answered by parents to reflect psychological control more comprehensively in our next research work. Thirdly, both problem behavior and emotion regulation were self-reported and lacked objective measurement. In the future, subjective evaluation and actual adolescent social problems should be further clarified. Fourthly, parents' sibling status and their potential resulting lack of experience in managing negative emotions were not investigated in the study. These should be included as measures in futures studies on the subject. Finally, results from different studies on the effects of parental psychological control on children are often contradictory. Parental psychological control might be less damaging and even beneficial to children's development in interdependent cultures (59). Therefore, more studies are needed for further validation.

Data availability statement

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

Ethics statement

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

Author contributions

GQ and YW designed the project and supervised the data collection. GQ, LL, RH, and GD collected and analyzed the data. GQ, YW, WW, CL, XH, AH, YA, and GD wrote the manuscript with input from LL, RL and RH. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Meaning in life among Chinese undergraduate students in the post-epidemic period: A qualitative interview study

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Background: COVID-19 epidemic has lasted for nearly 3 years, and revolutionized social life. In the study, in-depth interviews were conducted with Chinese undergraduate students to explore their understanding and experience of meaning in life. Meaning of life is interpreted from four aspects: life goals, life value, life enthusiasm, and life freedom. These four aspects are independent yet interrelated. Based on the free grasp of life, individuals explore and pursue the true meaning of life goals, acquire life value in evaluating the completion of life goals, and subsequently experience enthusiasm for life. Life enthusiasm and the perception of life value can help individuals to further understand and possess their meaning of life.

Materials and methods: The present study adopts the qualitative method to understand the experience of meaning in life among Chinese undergraduate students. Semi-structured interviews were conducted, and six people participated the study. The Grounded Theory was adopted to analyze the qualitative data.

Results: (1) Chinese undergraduates had clear life goals and obtained a certain sense of achievement and satisfaction when striving for these goals. (2) The life value of Chinese undergraduates was mainly to their families, but there was also a willingness to make due contributions to the country and society. (3) Chinese undergraduates' feelings about life were polarized, but they all expressed the view of "living in the moment and cherishing the present." (4) Chinese undergraduate students see life freedom as freedom of choice and generally believed that COVID-19 did not restrict their lives very much. (5) Chinese undergraduate students gained a deeper understanding of meaning in life after this major public health emergency.

KEYWORDS

post-epidemic period, Chinese undergraduate student, meaning in life, qualitative interview, COVID-19 epidemic

Introduction

The outbreak of COVID-19 in early 2020 disrupted people's lives (1). To combat the epidemic, countries around the world took actions that were effective to varying degrees. As new negative developments occurred in some countries, we stepped-up vaccination efforts to bring the epidemic under control. During this special period, Chinese undergraduate students experienced changes in their living environments and lifestyles—changes such as school closures, mask-wearing, nucleic acid testing, and health codes. These changes exposed many undergraduates to anxiety, fear, loneliness, depression, confusion, and helplessness (2–4). What is meaning in life for Chinese undergraduates facing the epidemic? What actions have they taken accordingly? Are there any special manifestations or patterns in their behavior? To answer these questions, this study combined semi-structured interviews and qualitative analyses for the real reflections of life meaning for Chinese students and the impact of the epidemic environment on life meaning.

Meaning in life was initially proposed by the famous psychologist Frankl (5). Subsequently, Crumbaugh and Maholic (6) figured that meaning in life carries a sense of existence and meaning, and that people perceive their value in the process of pursuing meaning in life. Reker (7) considered life meaning as a multi-dimensional structure consisting of a sense of continuity and satisfaction while striving for life goals. Wong and Fry (8) argued that life meaning includes cognition, motivation, and emotion. According to Steger et al. (9), life meaning consists of two dimensions, search for meaning and presence of meaning, and it represents an individual's perception of self-value and meaning of existence. In the view of Song (10), life meaning is the goal guiding individuals to a sense of existence and value. Addressing the same topic, Li (11) divided life meaning into three parts: search for life meaning, self-transcendence, and life control. In general, meaning in life refers to the goal that directs individuals to their pursuit and value (12, 13). Meaning in life cannot only give people a sense of purpose and direction in life (14), but it can also generate self-value, a positive sense of meaning, and be a driver for upward development for the individual (9).

As a result of COVID-19, people's mental health has been affected in multiple ways, especially in terms of anxiety, depression, interpersonal relationships, and life satisfaction. Emotional problems, in particular, are most prominent when people face a public health emergency (15). In the early stage of the epidemic, such problems stemmed from the degrees to which people could sense meaning in their lives (16). However, as the epidemic gradually subsided, people's negative psychological symptoms also subsided as they gained more understanding of the epidemic through the media and were able to adjust their cognitive strategies (17).

Undergraduates are in the early stage of youth, a critical period for ideological and personal development (18, 19). They have the will to search for life meaning (20), but they can be easily affected by the external environment and their confusion about growth, which often leads to a lack of meaning in life (21, 22). Thus, an undergraduate's life meaning is closely related to their mental health (19, 23, 24). Those with higher levels of life meaning enjoy greater optimism (25–27), better interpersonal communication (28–30), more positive value experience (31, 32), more happiness in life (33), more hope and satisfaction with life (34, 35), and healthier mental states (36, 37). Furthermore, search for meaning and presence of meaning can keep people away from negative mental states, such as depression (37), suicide (21), self-identity crisis (38), and loneliness (39). In contrast, those with lower levels of life meaning may suffer from a series of psychological problems, including a decline in interest and motivation (22), reduced perception of social support (33), addiction (40), emptiness, depression, and anxiety (33).

Previous research has established that only when individuals have a clear understanding of their own life experiences and a clear sense of purpose and direction in life through the interpretation of these experiences, then they can gradually acquire the ability to give meaning to their lives (9). The acquisition of meaning in life originates from the individual's active pursuit and construction (41). Cognitive appraisal is an effective adaptation mechanism when facing a stressor. Throughout the extent of COVID-19, the cognitive appraisal of undergraduate students changed. At the beginning, there was uncertainty, confusion, and a lack of understanding. So, it was difficult to cope with this new stressful event. Eventually, however, students were able to reduce adverse psychological reactions and actively pursue and construct meaning in life during the recovery period of COVID-19 (42).

According to Frankl (5), meaning in life is at the core of human happiness. One study has shown that collectivism is significantly and positively correlated with life satisfaction and emotional well-being. China is saturated with a collectivist culture (43). Thus, research related to meaning in life is paramount for people in a country like China.

To sum up, undergraduates have the will to pursue meaning in life, but their understanding and grasp of life meaning are subject to the external environment and their confusion about growth. Understanding life meaning is an essential part of undergraduates' mental growth. What characteristics and patterns have Chinese undergraduates shown, especially during a unique time like the COVID pandemic? This is an important question that deserves in-depth analysis. Ge et al. (44) used a quantitative study to evaluate meaning and well-being among Chinese undergraduates. But reducing complex mental health variables to quantitative data can be overly simplistic (45). Thus, Kelle (45) argues that it is important to supplement quantitative findings with qualitative research.

Therefore, the current study adopted a qualitative approach of deep interviews based on the Grounded Theory to explore Chinese undergraduates' understanding and experience

of life meaning in the post-epidemic period, aiming to facilitate corresponding research and provide a better reference for monitoring undergraduates' mental health and promoting life education.

Materials and methods

Participants

Sampling for qualitative research usually follows the non-probability principle, and purposive sampling is very common (46). Thus, we used purposive sampling, with all participants recruited online but interviewed offline. The following factors were considered in recruitment: (1) the ratio of male to female was set 1:1 to control for gender; (2) middle-grade (sophomore and junior) undergraduates were selected to avoid the influence of insufficient life experience or upcoming graduation; (3) ages 18–22 were selected; (4) a balance between arts and sciences was taken into account. Furthermore, the participants were required to be fluent in verbal communication and have no major mental disorders (see **Table 1**).

Method

Interview outline

To better inspire participants and guide them to reflect on their life meaning, we used semi-structured, in-depth interviews. The questionnaire outline is constructed with reference to Dong's (13) revised version of the *Meaning in Life Questionnaire* (MLQ), originally proposed by Song (10). It consists of four dimensions: life goal (degree of control over life goals), life value (identification with one's value), life enthusiasm (feeling about one's current life), and life freedom (autonomy of one's life). MLQ is derived from the *Purpose in Life Test* (PIL), developed by Crumbaugh and Maholick (47) and based on Frankl's logotherapy theory. Repeatedly revised and used, the MLQ is applicable in Chinese contexts (10, 13, 48–51). Simultaneously, it is comprehensive and conducive to a deeper exploration of individual views and understanding of various aspects of life meaning. The open-ended question outline designed against the MLQ structure is as follows (**Table 2**).

TABLE 1 Basic information of participants.

Subject No.	Gender	Age	Grade	Major
01	Female	18	Grade 2019	Cultural heritage
02	Male	21	Grade 2018	History
03	Female	22	Grade 2018	Elementary education (Teaching)
04	Male	21	Grade 2019	Electronic information
05	Male	18	Grade 2019	Electronic information
06	Female	20	Grade 2018	Preschool education (Counterpart)

Interview setting

In-depth interviews were conducted face-to-face and one-by-one in a quiet and comfortable room. Each interview was 50–60 min long. The interviewers were professional psychology researchers who remained neutral throughout the study so participants felt accepted and not judged. After participants signed informed consents, the researchers began recording and interviewing them. At the end of each interview, the researcher thanked the participant with a small gift. The study was approved by the Ethics Review Committee at the primary researchers' university.

Data acquisition and analysis

Audio recordings from the participants were transcribed into text that totaled 12,569 words and analyzed through the N-Vivo 11.0 software and based on the grounded theory. Glaser and Strauss (52) proposed the grounded theory, which was initially applied to the field of sociology and later used for a variety of topics in psychology, including environmental psychology, health psychology, clinical psychology, and psychotherapy (53).

The grounded theory approach is based on the systematic collection of information to find the core concepts that reflect social phenomena, construct connections between concepts, and eventually develop a theory (54). This approach advocates paying attention to all the details in the process of collecting materials in order to make them rich and exhaustive. The analysis of materials is achieved by categorizing them in a hierarchical coding system. According to the degree of abstraction, the coding can be divided into three different levels: primary coding is open coding, which requires the researcher to objectively code all materials in their original state; secondary coding is axial coding, which is used to establish the relationship between concepts and explore the internal connection of each part of the material; tertiary coding is selective coding, which establishes the core category and concentrates related concepts in the core category (55, 56).

In this study, meaning of life is interpreted from four aspects: life goals, life value, life enthusiasm, and life freedom. These four aspects are independent yet interrelated. Based on the free grasp of life, individuals explore and pursue the true meaning of life goals, acquire life value in evaluating the completion of life goals, and subsequently experience enthusiasm for life. Life enthusiasm and the perception of life value can help individuals to further understand and possess their meaning of life. Thus, the current research focuses on core coding through semi-structured interviews, sort-out and code the relationship between each node, and outline the interview content to each core category to elaborate new connotations (55, 56; **Table 3**).

TABLE 2 Interview outline on Chinese undergraduates' life meaning in the post-epidemic period.

Dimensions	Questions
Life goal	1. What do goals mean to you? What are your short-term and long-term goals for all aspects of life and study? 2. What efforts have you made to achieve these goals? Have you achieved your goals through these efforts? (Feelings about success/failure) 3. Did your goals change during the epidemic? (Feelings/specific changes)
Life value	1. Please make an evaluation of your own value as detailed as possible. (What kind of role are you playing with yourself and others, or in a group? What value have you acquired?) 2. What is your understanding of life value? (Value of your own life/others' lives; Did your opinions change during the epidemic?)
Life enthusiasm	1. How would you describe your current life and how do you feel about it? (Why do you have such feelings? Please give more details.) 2. Can you identify ways to improve your current life, increase your happiness, and maintain your enthusiasm for life? What attempts have you made to this end? What results have you achieved? (Feelings?) 3. Is there any difference between your feelings about life now and during the epidemic? Has your life enthusiasm changed? (Please describe in detail.)
Life freedom	1. How do you perceive the "freedom of choose"? What do you think of it? (What is your understanding of freedom?) 2. Was your life affected greatly under strict travel restrictions? (Any sense of restraint in family contact, shopping, communications with friends, classmate reunion, etc.? Or any other feelings?)

As stated, audio recordings from the participants were transcribed into text that totaled 12,569 words. The specific steps were: (1) getting immersed in the text of each case by repeated reading; (2) identifying meaningful text, generating initial open codes, and writing notes, reflections, and comments; (3) thinking about the open codes and all the notes, reflections, and comments, until these are summarized appropriately, and classified into different core concept categories; (4) turning to the next case and repeating the above steps for all cases.

Results

Life goals

According to the word cloud (Figure 1), the goals mentioned by the participants concern two aspects: life and study. They emphasized future needs and their own interest when setting goals, and focused on skill development and mental growth when striving for these goals.

After sorting the interview materials, it was found that Chinese undergraduate students have relatively clear life goals (Table 4). These students generally agreed that goals and motivation (pulling force) were important factors in making life meaningful. Things were different for each participant, but there were also similarities: After a time of consideration, most participants could figure out their short-term and long-term goals quite fluently and list their efforts to achieve these goals. In this goal-pursuing process, there was positive feedback, like increased confidence and a sense of achievement. If the goals were not accomplished, the participants would feel discouraged, but eventually re-adapt themselves. The epidemic has not had a major impact on participants' goals, but rather clarified their goals and strengthened confidence for executing their plans.

TABLE 3 The relationship and distribution of each coding node.

Core coding	Axial coding	Total number of reference points
Life goals	Goal recognition, goal practice, epidemic impact	35
Life value	Value recognition, value practice, epidemic impact	44
Life enthusiasm	Status perception, improvement approach, epidemic impact	30
Life freedom	Viewpoints and opinions, freedom recognition, epidemic impact	28

Life value

According to the word cloud, undergraduate students combine self-value and social value in their understanding of life value (Figure 2). To realize life value, they need to make plans and generate sufficient motivation under the impact of the external environment. For many participants, role models inspired them during the epidemic to view life meaning and value in a new way: their life value will not be fully achieved unless they satisfy the needs of both self-growths along with social and national development.

For the most part, participants linked their life value with the concepts of society, family, school, and group, and they evaluated their value based on their contributions to other people, the collective, and society. Most participants can feel their own value when getting along with others. It was reflective of self-value to contribute to a group, to shoulder responsibilities in the family, and also to be self-disciplined and self-guided. However, there was also a majority of participants who gave social value a relatively low score on account of limited competence to contribute direct value to society (Table 5).

FIGURE 1
Word cloud about life goal.

TABLE 4 Long-term and short-term goals.

Subject No.	Major	Short-term goals	Long-term goals
1	Cultural heritage	To pass Chinese CET 4 (College English Test 4) To get a driving license To win a scholarship To learn how to wear make-up	To pass the postgraduate exam (further study in Beijing Foreign Studies University) To obtain a teacher qualification certificate in China To learn how to manage finances To stay in Beijing for work
2	History	To learn about various regions of the world in the 7th century B.C. To eat, read, and socialize normally	To enroll in a Ph.D. program To settle in the eastern coast of China
3	Elementary education (Teaching)	To find a good job To achieve financial independence To pass the final exam	To be self-sufficient in life To become a teaching teacher To improve literary attainment To be a moral man
4	Electronic information	To increase incomes To win a scholarship	To further study in Jiangsu, China To live for myself
5	Electronic information	To improve game skills To pass exams and complete assignments To eat well, and hang out with extra money	To have a girlfriend
6	Preschool education (Teaching)	Not to fail the major exams To read the professional books I like and do mind mapping To read recommended books if there is more time To make full use of time through time management	To become an educated and cultured postgraduate To buy a house To support myself as a freelancer To be successful to a degree in my favorite field

Generally, participants believed that life value lied in creating value for society and others; it was a choice of their own that cannot be measured by others. To realize self-value, one must do what he or she should do at the moment. Thanks to the epidemic, participants refreshed their understanding of life value and improved it by valuing the moment and living a positive life. Furthermore, they became convinced that those who contributed to society during the hard times were enjoying

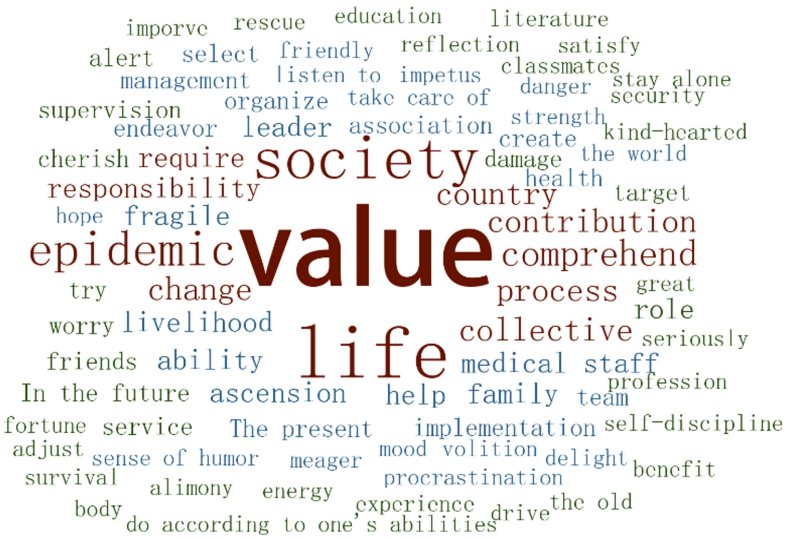

FIGURE 2
Word cloud about life value.

TABLE 5 Response examples about life value.

Categories	Subject No.	
	2	6
Value cognition	Life itself has no value. Life value is a choice and a subjective judgment, and it depends on you to decide your maximum life value. Likewise, others' value lies in their own choice.	Life value represents an individual's understanding of how to live and what life goal he or she needs to achieve. Life value cannot be measured by anyone.
Value practice	It means to be my own guider and enabler, to be humorous and sensitive to emotions when getting along with others, and to be an ice breaker in a group.	It is required to accept my shortcomings and be brave and kind; to take good care of grandparents and parents in the near future; and to study hard, benefiting society with my knowledge.
Epidemic impact	Medical workers' life value was enhanced during the epidemic when they saved more lives.	Life is fragile against nature. We must enhance vigilance, take precautions, and cherish life.

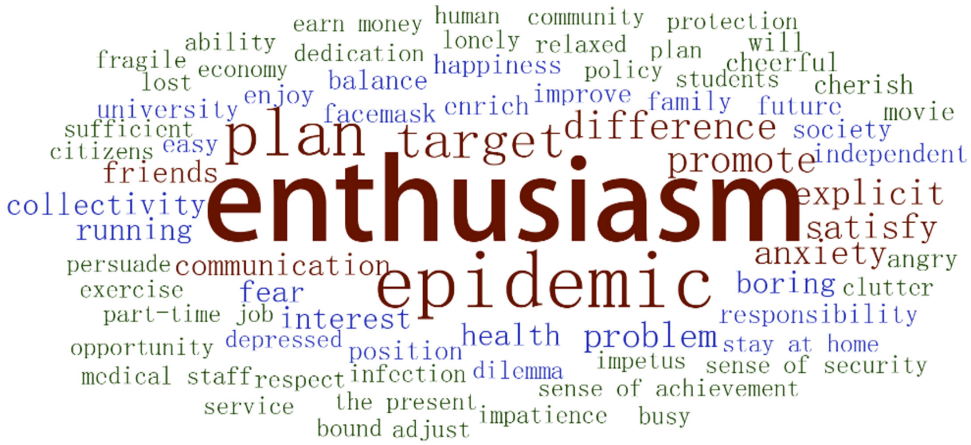

FIGURE 3
Word cloud about life enthusiasm.

TABLE 6 Response examples about life enthusiasm.

Categories	Subject No.	
	2	4
Current feelings	I'm well-clothed, well-fed, and healthy. Life is advancing as I have planned. But I will feel angry when my plan is interrupted because I don't like changes.	I feel bored, lonely, and helpless when I cannot get along well with my friends and have to lock myself in my own world. But sometimes, I enjoy such solitude.
Adaptation methods	I know how I should change myself, and I'm trying. I'm making my life less dogmatic, learning to deal with changes, and allowing myself more relaxation in a month. This feels good and comfortable.	I've identified ways to adapt myself, and I'm trying to make a difference. I do sports on the playground myself, which is a good way to relieve my stress.
Epidemic impact	I see no difference, because life plans and needs remain the same and have to be met as usual.	Differences do exist. Life during the epidemic was depressing and constraining, but it's much better now. I can do what I want to do.

higher life value. This emphasizes the importance of becoming useful to society and country for self-value enhancement (Table 5).

Life enthusiasm

In terms of life enthusiasm, the word cloud showed that undergraduate students felt bored staying at home under travel restrictions during the epidemic. But they neither changed their goals nor developed strong anxiety and uneasiness. On the whole, they were still enthusiastic about life because they were convinced that the epidemic was controllable, and that society and modern medicine were trustworthy. Feelings about current life were different from those during the home segregation as negativity decreased. There was more emphasis to cherish the hard-earned life and live in the moment (Figure 3).

Some participants complained about current boredom, unnecessary busyness, and unbalanced and unclear schedules, while the others were satisfied that life was full and on the right path as they have planned. Going through the epidemic, they identified specific ways to better appreciate the moment. Some participants reported clear plans to improve their life experience and were repaid with a greater sense of achievement, happiness, and enthusiasm (Table 6).

The epidemic has impacted Chinese undergraduates in transportation and communication. But as undergraduates gradually adapted to these changes, they enjoyed more freedom, fun, and enthusiasm under the additional rules. In other words, they were less anxious or depressed (Table 6).

Life freedom

As the word cloud shows, Chinese undergraduates believed that freedom meant the ability to make choices within certain limits and to take responsibility for their choices (Figure 4).

In the view of undergraduate students, freedom was relative within the confines of law and morality. There were some things that were beyond their subjective choices. The freedom of choice also suggested that they could make choices with a will of their own and be responsible for those choices. They could choose to avoid the influence of others, respect everyone's right of choice, and still remain true to themselves. But everything was subject to law and moral requirements: choices and decisions should not harm the interests of the country, society, or others (Table 7).

The majority of participants felt restricted in travel during the epidemic, especially when taking public vehicles, which required safeguards, and when offline communication was unavailable. But such restrictions also allowed them to enjoy more solitude and encouraged more contact with friends and family. Some participants thought they increased communication with their parents. In short, the epidemic has not posed a long-term impact on undergraduates' sense of freedom and well-being (Table 7).

Discussion

In this research, Chinese undergraduate students had relatively clear life goals, and they desired to accomplish the goals through their own efforts—a process where they obtained positive experiences. The epidemic did not have much of an impact on their life goals but rather led to an increased sense of control over the goals. This is probably because, when a major public health emergency occurs, an individual's mental state will change with the external environment (57). Since such an impact can last for a long time, it will likely act on undergraduates' life goals even in the phase of prevention and control (58).

Undergraduate students found their life value mainly from their families and friends and were disappointed that they could not contribute more to their country and society. The epidemic apparently taught them to view their social value from a new angle. They are now active in pursuing self-growth along

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FIGURE 4
Word cloud about life freedom.

TABLE 7 Response examples about life freedom.

Categories	Subject No.	
	3	5
Freedom cognition	Freedom means doing what I like under relative conditions.	There is relative freedom when you obey rules under the constraints of the law.
Opinions on the freedom of choice	I agree that people have the freedom of choice, but it depends on the specific situation and perspective. To be more accurate, people have the relative freedom of choice.	Life is like an exam; you don't know the right answers. However, you can make all the choices and be responsible for them.
Epidemic impact	I felt no restraints. As a citizen, I have the responsibility to be in line with epidemic prevention. When I volunteered and was isolated during the epidemic, I reflected on my contact with my parents and treasured my family and friends more than ever.	I couldn't gather with my classmates, but I could communicate with them online. Life went on as usual, to some extent. One thing worth celebrating was the closer bond between my parents and me.

with the development of the country and society. They expect themselves to contribute more to the country and society and truly realize self-value through hard work at college. This is consistent with previous findings that undergraduate students emphasize life responsibilities and desire to serve the country and society (59, 60).

In terms of life enthusiasm, undergraduates' feelings about life were polarized: extreme boredom compared to satisfying fullness. In general, they all emphasized one thing, and that was to live in the moment and cherish the present. According to the results of our interviews, the special experience about life and death has enabled undergraduates to have a deeper understanding of life value. This coincides with the Chinese culture's optimistic interpretation of difficulties: "How long can life be? Full admiration is that dreamy beauty worth." "Fret not over bygones and the forward journey take" (61).

Unlike the polarized view for life enthusiasm, undergraduates shared similar opinions on life freedom, although freedom was relative under the constraints of the law. They agreed that "people have the freedom of choice" and need to be responsible for their choices. Despite travel restrictions, the epidemic has deepened the relationship between undergraduate students and their parents. It has also increased time for solitude, thus minimizing the sense of restraint. Life freedom refers to the autonomy of an individual's life. As young adults, undergraduates are relatively independent and able to run their own lives (18). Therefore, when COVID-19 broke out, these autonomous individuals could deal with it fairly well and take good care of themselves.

In his work *Man's Search for Meaning*, Frankl (5) mentions three important ways to search for life meaning: to do meaningful things, to love oneself and others, and to have

the courage to overcome difficulties. In the phase of regular prevention and control, life remains an uncertainty. However, having gone through the tough pandemic, undergraduate students have refreshed their understanding of meaning in life. They are moving ahead steadily as they strive for goals, enjoy life, pursue freedom, and search for value. By and large, they are living in the moment and cherishing the present.

According to Battista and Almond (62), the development of meaning in life is divided into two stages: positive ego orientation and positive life orientation. The second stage occurs during late adolescence and early adulthood, where the main task of the individual is to develop a positive life concept and become aware of the meaning in life. This coincides with the contemporary state of undergraduate students, because they pursue goals, along with enjoyment of life, and values in life. In addition, Steger et al. (63) found that younger age groups were more motivated to pursue meaning in life through studying corresponding age trends. Undergraduates in the post-epidemic period actively seek to construct meaning in their lives by refining life goals, experiencing life values, and using cognitive strategies to improve the integration of their interactions with the environment.

Undergraduates are in a positive life orientation phase, and existential positive psychology emphasizes that such positive orientation should be accompanied by embracing the negative aspects of life (9). In a life course where good times and bad times coexist, people should construct and create meaning from negative scenarios (41) and transcend real-life dilemmas. This is very consistent with the performance of undergraduate students in the current study. Although participants experienced anxiety, panic, and limitations during the epidemic, they were committed to finding new perspectives from which to create meaning from these negative events.

In conclusion, Chinese undergraduate students have a unique understanding for meaning of life. The anxiety, depression, and fear they had during the epidemic were not insurmountable. As China enters the phase of regular epidemic prevention and control, undergraduates' negative emotions are fading as they realize they need to co-exist with viruses for a long time. They are blessed with rising adaptability and mental toughness, showing their confidence in modern medicine and technologies. In spite of its negative impacts, the epidemic has reawakened undergraduate students to reflect on life, and to be clearer about life goals and meaning. This has further inspired them to re-examine themselves, which is, in some sense, "a new stage of enlightenment" (64).

Conclusion

(1) Chinese undergraduates in this study have clear life goals and obtained a certain sense of achievement and satisfaction when striving for these goals.
(2) The life value of Chinese undergraduates in this study is mainly tied to their families, but there is also a willingness to make due contributions to their country and society.
(3) In this research, Chinese undergraduates' feelings about life are polarized, but they all express the importance of "living in the moment and cherishing the present."
(4) Chinese undergraduates in this study see life freedom as relative freedom of choice, and they generally believe that COVID-19 has not restricted their lives very much.
(5) Chinese undergraduates in this study gained a deeper understanding of life meaning after this major public health emergency.

Enlightenment and prospect

(1) The pursuit of life's purpose is an important way to gain meaning in life. The epidemic has enhanced the appreciation and reverence for life. After experiencing a major stressful event, we can guide undergraduates to sort out their correct life goals and promote their mental health by strengthening their life awareness.
(2) The pursuit of social values by the undergraduates in this study suggests that fostering their sense of altruism and responsibility can enhance their sense of meaning in life and thus promote their mental health.
(3) Lazarus believes in emotions as a response to meaning, which is determined and accomplished through cognitive evaluation (65). Therefore, in our educational activities, we can consciously foster the application of positive cognitive strategies in undergraduate students to motivate them to actively create, construct, and pursue meaning in their lives.

Limitation and future research

To the best of our knowledge, this study is the first attempt to reveal the understanding and experience of meaning in life among Chinese undergraduate students in the Post-epidemic Period. The six cases of this study are from one single university in Southwest China. Thus, due to the small sample size, the findings may be region-specific, and generalizability might be limited. Additional studies should examine and replicate our findings in other regions in China, along with other areas with different cultural contexts—exploring the understanding and pursuit of undergraduate students on the meaning in life. Moreover, in order to implement a more universal and extensive life understanding, future research with other youth groups is needed—for example, adolescents and young employees.

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 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

YG, CL, and JW contributed to the study conception and design and wrote the first draft of the manuscript. CL, MS, and HW performed the interview and data collection. CL, MS, and CP were responsible for data collation, mining, and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Risk perception of COVID-19 among college students in China: Latent profile analysis

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Background: The outbreak of the new coronavirus-2019 (COVID-19) has had a significant impact on people's mental and physical health. Meanwhile, people's perceptions of risk may influence their emotional states and preventative behavior during an epidemic. Previous research have revealed the diversity and uniqueness of risk perception, and college students may have a different perspective on risk perception. The objective of this study was to describe the subtypes of risk perception for COVID-19 among college students in China, identify the subtypes' traits, and investigate their affecting variables.

Methods: College students from 10 Chinese provinces participated in a cross-sectional study (n = 2,000) that from January 16 to 30, 2022. The latent profiles and influencing factors for risk perception were investigated using latent profile analysis, one-way analysis of variance, and multinomial logistical regression.

Results: The sample group of this survey was 1,946 students, and the response rate was 97.3%. The best model was suggested to consist of three profiles: "neutral risk perception" (20.3%), "perception seriously without susceptible" (52.8%), and "low risk perception" (26.9%). Risk perception of COVID-19 was positively associated with attention to negation information ($r = 0.372$, $p < 0.01$), anxiety ($r = 0.232$, $p < 0.01$), and depression ($r = 0.241$, $p < 0.01$), and negatively associated with perceived social support ($r = -0.151$, $p < 0.01$). Logistic-regressions analyses mainly revealed that the risk perception of three profiles related to having chronic diseases ($OR = 2.704$, $p < 0.01$), medical major ($OR = 0.595$, $p < 0.01$; $OR = 0.614$, $p < 0.05$), without having COVID-19 confirmed cases around ($OR = 0.539$, $p < 0.01$), attention to negative information ($OR = 1.073$, $p < 0.001$; $OR = 1.092$, $p < 0.001$), and perceived social support ($OR = 0.0.975$, $p < 0.01$).

Conclusions: The level of risk perception for COVID-19 among Chinese college students was unsatisfactory, and the risk perception of COVID-19 had significant group characteristics and heterogeneity. Colleges and public health practitioners could have a theoretical and empirical basis to implement risk perception intervention efforts by identifying latent subgroups during the COVID-19 epidemic.

KEYWORDS

college students, COVID-19, risk perception, latent profile analysis, anxiety, depression

Introduction

The World Health Organization (WHO) declared the COVID-19 pneumonia epidemic a global public health emergency in 2019 after it was first detected in Wuhan Nationality City, Hubei Province, China. And on March 11, 2020, COVID-19 reached pandemic status throughout the world. Since the outbreak of COVID-19, many colleges have adopted closed management to prevent the spread of the infection among teachers and students (1). However, the COVID-19 epidemic has caused serious threats and heavy losses to health and lives around the world, including Chinese college students (2), and with that comes lots of stress, anxiety, depression, and panic. These negative emotions may trigger serious mental health problems and different perceptions of the epidemic (3). So, these college students' mental health and attitude toward COVID-19 should be taken seriously.

In China, college students are one of the most dynamic groups with strong mobility and socialization. They live a concentrated life, which can easily spread from them to others and lead to serious public health events once infected (4). And, as the special group within COVID-19, they are more vulnerable and suffer greater impact and serious mental health problems. Besides, they are alert and sensitive to health information. Their knowledge, protective behavior, and risk awareness have a significant impact on those around them's risk perception (5, 6). Therefore, college students are the key population for epidemic prevention and control, and it is necessary to focus on their risk perception and mental health.

Risk perception refers to an individual's subjective perception and judgment of various objective external risks (7, 8). Many studies suggested that risk perception was associated with individual preventive behavior, decision-making, and mental health (9–11). Individuals with similar levels of risk perception may adopt different forms of preventive behavior, which is the basis of people's response behavior to public health emergencies (12, 13). In addition, one's risk perception is positively correlated with self-protective behavior during the COVID-19, with self-consciously highly susceptible individuals tending to reduce social contact and increase washing frequency (14, 15). People with higher levels of risk perception are more likely to receive risk warning information more readily and earlier (16, 17). Conversely, people with low risk perceptions are less inclined to adopt protective behaviors and believe they are less likely to be infected, underestimating the severity of diseases (12, 18, 19). From this, it's clear that risk perception is a key factor in individual health behavior and social infectious disease prevention and control and of great significance also.

However, risk perceptions of college students in different countries, including China, are moderate or low in existing studies (3, 10, 20, 21). For example, Soltan et al. (22) defined the score at 75% as high, 50–75% as moderate, and 50% as low level. However, this study found that due to the different number of questions and scoring range of risk perception measurement tools, there are differences in judging the level of risk perception, which leads to the inability to distinguish group differences and analyze the internal characteristics of college students. In addition, a socio-mathematical model of risk perception demonstrates that the heterogeneity of risk perception is manifested by differences in perception by age, gender, expression of feelings, and media consulted in the university community (23). Therefore, the characteristics of risk perception among college students are heterogeneous. When defining the level of risk perception in terms of susceptibility and severity, it will be considered as a whole. However, when in the same group with high levels of risk perception, we do not consider whether individuals are sensitive to severity or susceptibility; some individuals are more dominant in their perception of the severity of the outbreak; and some individuals may be at a disadvantage in perceived severity and more prominent in perceived susceptibility, but we habitually define both as high levels of risk perception, without taking into account possible intra-individual differences. Furthermore, during the COVID-19 epidemic, risk perception was influenced by anxiety, depression, information about the epidemic, gender, age, and the presence of confirmed cases, but it is unclear whether these factors influenced risk perception category characteristics among college students, and further exploration is required (10, 24–26).

Latent profile analysis (LPA) is an individual-centered analysis technique that can improve group category distinction by grouping individuals with similar response patterns into the same subgroup and clarifying response characteristics (27, 28). Therefore, this study aims to investigate the potential categories of the risk perception of COVID-19 among medical students in universities and the differences in their characteristics by using latent profile analysis, which enables us to make reasonable risk assessments, risk regulations, and accurate management decisions according to group characteristics.

This study proposed the following hypotheses: Firstly, according to the socio-mathematical model (23), the heterogeneity of risk perception is manifested by differences in perception by age, gender, expression of feelings, and so on in a university community. Meanwhile, college students were observed to have different levels of knowledge and attitudes toward COVID-19 (29). A survey from China also revealed that income, education, major, and COVID-19 knowledge were the important factors affecting the COVID-19 risk perception of medical college students (4). Therefore, this study hypothesized that college students may perceive varying risks of contracting COVID-19 and that risk perception of COVID-19 may be modified by demographics. Secondly, some studies have discovered that the high COVID-19 risk

perception in college students increases their depression and anxiety (30), and risk perception may be affected by perceived social support, and in the high-risk condition, individuals' behavioral intention may be increased by issue salience and deliberate information processing (31, 32). This COVID-19 epidemic has affected college students' mental health and caused post-traumatic stress symptoms, and attention to negative information was a key mediating post-traumatic cognitive factors (33). Besides, the attention bias toward negative information (e.g., news or rumors about COVID-19) increases individuals' tendency to readily percept threatening stimuli or negative information (34). Therefore, this study hypothesized that depression, anxiety, perceived social support, and attention to information are the predictors of risk perception of COVID-19.

Methods

Participants

In this survey, participations were voluntary, 16 years old, full-time and internet accessible students, and those who had been diagnosed with anxiety and depression by a psychiatrist previously were excluded from this study.

Procedure

A cross-sectional survey was conducted from January 16 to 30, 2022, in 10 provinces of China. The anonymous questionnaire was established using an online survey platform (Wen Juan Xing, wjx.cn). We recruited participants by phone, email, and posters, then the questionnaire was forwarded through the Wechat app. Some information, including the purpose of the survey and information confidentiality, was stated at the beginning of the questionnaire to obtain participants' informed consent. Besides, participants were encouraged to share this questionnaire with their friends or classmates, and they were asked to have only one opportunity to fill in this questionnaire. Therefore, snowball sampling was used.

Measurements

Sociodemographic and COVID-19 related data

The demographic information questionnaire included items about age, gender, nationality, place of student source, having chronic diseases, major, and the frequency of COVID-19 related topics discussed with family in the last month, having COVID-19 confirmed cases around, and participating in volunteer activities during COVID-19.

COVID-19 risk perception scale

The risk perception of COVID-19 was defined as the subjective perception of COVID-19 susceptibility, severity, and controllability (COVID-19 Risk Perception Scale, CRPS). It was measured by nine items on a five-point Likert Scale, assigned 1–5 (1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, and 5 = strongly agree), and total score from 9 to 45 ($\alpha = 0.824$, split-half reliability = 0.731) (35).

Attention to positive and negative information scale

In this study, the sub-scale attention to negative information was selected from the Attention to Positive and Negative Information Scale (APNI). It contains 11 items on a five-point likert scale, assigned 1 (very much not in line) to 5 (very much in line), with a total score of 55, and higher scores indicate higher levels of attention to negative information ($\alpha = 0.820$) (36).

Perceived social support scale

Perceived social support refers to the extent to which individuals perceive support from various sources of social support and is measured by the Perceived Social Support Scale (PSSS). This comprised various supports, including family support, friend support, and other support, and was measured by 12 items on a seven-point response scale, from 1 to 7, representing "strongly disagree" to "strongly agree." The scores are summed, and the higher the total score, the higher the level of social support of the individual, and 61–84 are designated as high, 37–60 as moderate, and 12–36 as low level ($\alpha = 0.898$) (37).

Generalized anxiety disorder-7

The individual's mental psychological activity in the past 2 weeks measured taken by Generalized Anxiety Disorder-7 (GAD-7). It contains seven items on a four-point Likert Scale, assigned 0 (not at all) to 3 (almost every day), with a total score of 0–21, and 0–5 defined as no symptoms, 6–9 as mild anxiety, 10–14 as moderate anxiety, and 15–21 as severe anxiety, the total score of $\geq$7 was used as a threshold to screen for anxiety symptoms ($\alpha = 0.920$) (38–40).

Patient health questionnaire-9

The individual's mental and psychological activity in the past 2 weeks was measured by Generalized Anxiety Disorder-7

(GAD-7). It contains seven items on a four-point Likert Scale, assigned 0 (not at all) to 3 (almost every day), with a total score of 0–21, and 0–5 defined as no symptoms, 6–9 as mild anxiety, 10–14 as moderate anxiety, and 15–21 as severe anxiety. The total score of ≥7 was used as a threshold to screen for anxiety symptoms ($\alpha = 0.857$) (39, 41).

Statistical analysis

All collected data was entered into Excel V.2019 and transferred to SPSS 26.0 statistical software for analysis. Variables were coded and processed for accuracy and consistency. Using tables and graphs, descriptive statistics were expressed as mean, SD, percentage, and frequency.

The data was then analyzed based on the type of exogenous variable, with nine items from the COVID-19 Scale as observed variables and Mplus 7.4. (i) Log-likelihood (LL), Akaike information criterion (AIC), Bayesian information criterion (BIC), and adjusted Bayesian information criterion (aBIC) were the model fit test indicators. The smaller the above four values are, the better the model fit is. (ii) Entropy, the value range of 01, the closer to 1, the higher the classification accuracy. (iii) when $p < 0.05$, the Lo-Mendell-Rubin and Bootstrapped likelihood ratio test (BLRT) show that the model with K categories outperforms the model with K-1 categories. None of the above indicators had critical values, and the optimal model needed to meet the following criteria: AIC, BIC, and aBIC values were the smallest in the model; Entropy > 0.7 and $p < 0.05$ for LMR and BLRT (42–44).

Furthermore, multinomial logistic regression analysis to identify different category participants' risk perception of COVID-19 and its influencing factors. Pearson correlation analysis was used to explore the association between COVID-19 risk perception and anxiety, depression, perceived social support, and attention to negative information. Moreover, the magnitude of the association between different independent variables with regard to dependent variables was measured using *OR* with a 95% *CI*. All tests were two-sided and $\alpha < 0.05$ was considered statistically significant.

Ethical standards

The study was approved by the Biomedical Ethics Committee of the Department of Medicine, Xi'an Jiaotong University (No. 2022-0006), and all procedures performed on Chinese college students were in accordance with the guidelines of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

TABLE 1 College students' sociodemographic and COVID-19 related data characteristics ($N = 1,946$).

Variable	Frequency (%)
Sex	
Male	649 (33.4)
Female	1,297 (66.6)
Ethnicity	
Han ethnicity	1,745 (89.7)
Others	201 (10.3)
Place of student source	
Cities and towns	857 (44.0)
Rural	1,089 (56.0)
Having chronic diseases	
Yes	93 (4.80)
No	1,853 (95.2)
Major	
Medical	1,707 (87.7)
Non-medical	239 (12.3)
Frequency of COVID19-related topics discussed with family in the last month	
Never	218 (11.2)
At least once a month	550 (28.3)
At least once a week	889 (45.7)
At least once a day	289 (14.9)
Having COVID-19 confirmed cases around	
Yes	17 (0.9)
No	1,793 (92.1)
Unclear	136 (7.0)
Participated in volunteer activities during COVID-19	
Yes	882 (45.3)
No	1,064 (54.7)

Results

Descriptive results

A sample of 1,946 college students participated in this study with a response rate of 97.3%. In Table 1, the mean age of the students was 19.6 (SD 1.7, range 16–30) years. Six hundred fifty-seven (44%) of those who took part were from cities and towns (Table 1).

Correlation between risk perception and other variables

As shown in Table 2, the anxiety score of college students was 6.09 ± 5.41 and the depression score was 4.00 ± 4.45. There were 43.73% (851) college students in the state of anxiety symptoms and 30.37% (591) in the state of depression. Besides, Pearson correlation analysis showed that: the risk perception

of COVID-19 for college students was positively correlated with attention to negation information ($r = 0.372$, $p < 0.01$), anxiety ($r = 0.232$, $p < 0.01$), and depression ($r = 0.241$, $p < 0.01$). Attention to negation information was positively correlated with anxiety ($r = 0.556$, $p < 0.01$) and depression ($r = 0.507$, $p < 0.01$), and perceived social support was negatively correlated with the risk perception of COVID-19 ($r = -0.151$, $p < 0.01$), attention to negation information ($r = -0.285$, $p < 0.01$), anxiety ($r = -0.303$, $p < 0.01$), and depression ($r = -0.268$, $p < 0.01$), anxiety was highly positively correlated with depression ($r = 0.802$, $p < 0.01$).

LPA results

Model fit indices for the LPA analysis are shown in Table 3. Both AIC and BIC values decreased continuously from model one to four as the categories increased, and LMR and BLRT reached significant levels when divided into three categories (both $p < 0.05$) and Entropy > 0.8, but LMR did not reach significant levels when retained to four categories ($p > 0.05$), indicating that model three was superior to model four, which inferred that model three was the best model. Therefore, a three-latent-class model (AIC = 45,485.126, BIC = 45,696.920, and entropy = 0.881) was selected based on its minimal AIC, BIC, and aBIC values with entropy >0.80. Among the three-class solutions, profile 1 described 26.9% and comprised 532 college students; profile 2 described 52.8% and comprised 1,028 college students, and profile 3 described 20.3% and comprised 395 college students (Table 4).

As shown in Figure 1, the first latent profile named "low risk perception" (26.9%) has the lowest scores in perceived risk of COVID-19. The second-and largest latent profile named "perception seriously without susceptible" (52.8%) consisted of those who had high scores in "Once infected, it can have a very serious impact on one's health" and "The COVID-19 is far from over and there is always a risk of infection." And the third latent profile named "neutral risk perception" (20.3%) consisted of six items tending to choose "not sure."

Associations between demographic data and risk perception profiles

The first profile showed that college students who had chronic diseases accounted for the smallest proportion. Overall, there were significant differences in the places of student source, having chronic diseases, major, and having COVID-19 confirmed cases among three latent profiles (both $p < 0.05$). In addition, there were significant differences in the other four variable scores among the three latent profiles (both $p < 0.05$). However, there were no significant differences among the three groups in age, sex, ethnicity, and so on (both $p > 0.05$) (Table 5).

A multinomial logistic regression analysis was conducted to identify the relevant factors of risk perception among the three profiles. When the other covariates remained constant, those with chronic diseases ($OR = 2.704$, 95% CI: 1.365–5.357) tend to be classified as Profile 3. What's more, medical student ($OR = 0.614$, 95% CI: 0.391–0.964), no confirmed cases of COVID-19 around ($OR = 0.539$, 95% CI: 0.338–0.859), and perceived social support ($OR = 0.975$, 95% CI: 0.965–0.985) was the protective factor for Profile 3, medical student ($OR = 0.595$, 95% CI: 0.407–0.869) was also a protective factor for Profile 2, and the lower the attention to negative information ($OR = 1.073$, 95% CI: 1.058–1.088; $OR = 1.092$, 95% CI: 1.073–1.112) was more likely to belong to Profile 1. Student source location, anxiety, or depression were not related to latent profile memberships (Table 6).

Discussion

The study was designed to explore the latent profiles of risk perception, and three latent profiles were found ultimately: "low risk perception, perception seriously without susceptible, and neutral risk perception." The first group, dubbed the "low risk perception group," included 26.9% of the participants. It indicates that nearly one-third of college students have a low level of risk perception, consistent with the results of previous studies (10). Risk perception refers to people's subjective evaluation and judgment of the severity, characteristics, and management of possible risk exposure. It is influenced by personal, social, cultural, and environmental factors and is based on experience, beliefs, attitudes, and judgments (45). College students have fewer comorbidities and fewer overall health problems and have a different understanding of disease risk than other populations. The lower risk perception of this group may be the result of an interaction of several factors. However, prevention behavior was affected by risk perception (46). People with a low level of risk perception have less possibilities to implement compliance and preventive behavior (18). Perhaps interviews could be conducted with this group to explore the factors that influence risk perception, leading to relevant activities.

Among the participants in profile 2, the "perception seriously without susceptible group" consisted of 52.8% of the participants. The characteristics of this group were high perceived severity, but they were not susceptible to infection under subjective judgment. It is clear that more than half of the students perceived the severity of COVID-19, but their subjective judgment of susceptibility risk may be lower than Han nationality objective levels. Some studies have shown that during the COVID-19 epidemic, social media widely publicizes relevant developments and the internet is also flooded

TABLE 2 Descriptive statistics and correlations between study variables.

Variable	1	2	3	4	5
The risk perception of COVID-19	1				
Attention to negation information	0.372**	1			
Perceived social support	−0.151**	−0.285**	1		
Anxiety	0.232**	0.556**	−0.303**	1	
Depression	0.241**	0.507**	−0.268**	0.802**	1
Mean	20.74	30.04	63.36	6.09	4.00
SD	7.08	10.01	14.15	5.41	4.45

N = 1,946; **p < 0.01.

TABLE 3 Fit indices of latent class analysis on risk perception sub-types.

Model	AIC	BIC	aBIC	Entropy	LMR	BLRT	Class probability
Class 1	52512.291	52612.615	52555.429	–	–	–	1
Class 2	47424.338	47580.397	47491.440	0.870	<0.001	<0.001	0.387/0.613
Class 3	45485.126	45696.920	45576.193	0.881	<0.001	<0.001	0.269/ 0.528/0.203
Class 4	43788.895	44056.424	43903.927	0.970	0.2063	<0.001	0.278/0.194/0.253/0.275

AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, adjusted Bayesian Information Criterion; LMR, Lo-Mendell-Rubin likelihood ratio test; BLRT, bootstrapped likelihood ratio test.

TABLE 4 Average latent profile class probabilities for the most likely class membership (row) by latent class (column).

Latent class[a]	Class membership			
	1 ($n = 532$)	2 ($n = 1,028$)	3 ($n = 395$)	Total score for risk perception (M ± SD)
1	0.964	0.036	<0.001	11.48 ± 0.12
2	0.045	0.928	0.026	22.47 ± 0.11
3	<0.001	0.036	0.964	28.53 ± 0.23

[a]The columns refer to the latent class, and the rows refer to the most likely profit membership. Profile 1 = low risk perception; Profile 2 = perception serious without susceptible; Profile 3 = risk perception neutrals.

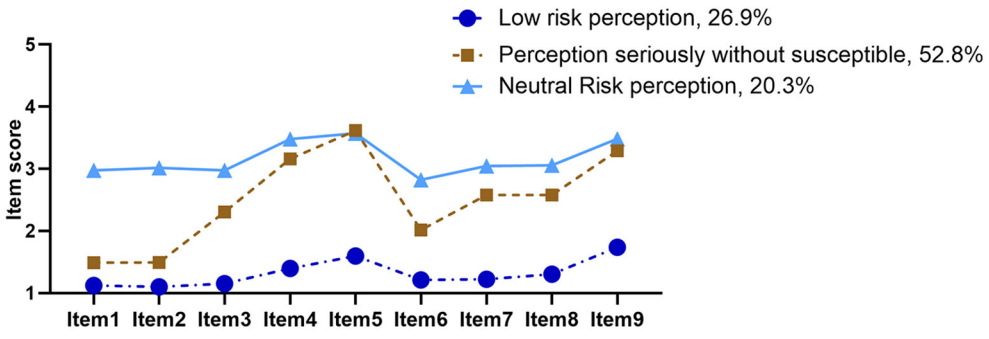

FIGURE 1
The three profiles of risk perception of COVID-19 by latent profile analysis.

with information about the epidemic (47, 48). Thus, college students, as a highly information-sensitive group (9), have deeply recognized the seriousness of the epidemic and the adverse effects of COVID-19 infection. Besides, on-campus students may consider the campus environment relatively safer compared to off-campus (49). Moreover, Chinese universities

TABLE 5 Demographic information for three profile latent profiles among different college students (*n*, %).

Variable	Low risk perception	Perception serious without susceptibile	Risk perception neutrals	χ^2/F	*p*-value
Sex				4.510[b]	0.105
Male	193 (36.9)	324 (31.5)	132 (33.4)		
Female	330 (63.1)	704 (68.5)	263 (66.6)		
Ethnicity				0.487[b]	0.786
Han ethnicity	472 (90.2)	922 (89.7)	351 (88.9)		
Others	51 (9.8)	106 (10.3)	44 (11.1)		
Place of student source				8.118[b]	0.017
Cities and towns	254 (48.6)	448 (43.6)	155 (39.2)		
Rural	269 (51.4)	580 (56.4)	240 (60.8)		
Having chronic diseases				14.006[b]	0.001
Yes	14 (2.7)	47 (4.6)	32 (8.1)		
No	509 (97.3)	981 (95.4)	363 (91.9)		
Major				12.964[b]	0.002
Medical	481 (92.0)	888 (86.4)	338 (85.6)		
Non-medical	42 (8.0)	140 (13.6)	57 (14.4)		
Frequency of COVID19-related topics discussed with family in the last month				10.419[b]	0.109
Never	71 (13.6)	98 (9.5)	49 (12.4)		
At least once a month	143 (27.3)	292 (28.4)	115 (29.1)		
At least once a week	223 (42.6)	483 (47.0)	183 (46.3)		
At least once a day	86 (16.4)	155 (15.1)	48 (12.2)		
Having COVID-19 confirmed cases around				15.107[b]	0.006
Yes	484 (92.5)	964 (93.8)	345 (87.3)		
No	5 (1.0)	7 (0.7)	5 (1.3)		
Unclear	34 (6.5)	57 (5.5)	45 (11.4)		
Participated in volunteer activities during COVID-19				1.220[b]	0.547
Yes	238 (45.5)	456 (44.4)	188 (47.6)		
No	285 (54.5)	572 (55.6)	207 (52.4)		
Anxiety	2.86 ± 4.19	4.05 ± 4.29	5.38 ± 4.78	37.465[c]	<0.001
Depression	4.63 ± 5.45	6.22 ± 5.06	7.66 ± 5.75	37.108[c]	<0.001
Attention to negative information	24.82 ± 11.38	31.25 ± 8.81	33.80 ± 8.13	119.521[c]	<0.001
Perceived social support	66.77 ± 15.67	63.46 ± 13.03	58.57 ± 13.51	39.306[c]	<0.001

χ2 = b; F = c.

mostly adopt closed management and strict prevention and control measures, so college students' daily lives and social mobility are restricted in many ways. The possibility of exposure to infection was reduced, so college students felt that they were less likely to be infected on campus. However, it should be noted that accurate risk assessment and risk perception are crucial; excessive perceived severity can cause unnecessary fear; and self-judgment of not being susceptible can affect effective protective behavior. Hence, universities should adopt a variety of strategies to promote risk communication and two-way interaction among college students.

The third profile, named the "neutral risk perception," consisted of 20.3% of the participants. They also perceived the seriousness of COVID-19, but were "not sure" on many items. They were unsure whether they would be infected, what effect the COVID-19 infection would have on their bodies, and whether the infection could be cured and controlled. So, it is necessary to know the scientific information about COVID-19 through official media such as Wechat, Facebook, and newspapers (24).

In this study, risk perception was associated with attention to negative information, perceived social support, anxiety, and depression, which was consistent with previous studies (32, 50, 51). The threat stimulus perceived by an individual may lead to attention bias. Attention bias toward negative information increases an individual's tendency to pay attention to threatening stimuli (34). Therefore, the more focused on COVID-19 negative information, the higher perceived threat

TABLE 6 Multinomial logistic regressions for predicting in three profile latent classes among college students.

Variable[a]	Class 2		Class 3	
	OR	95% *CI*	*OR*	95% *CI*
Place of student source (rural)	0.890	0.710–1.116	0.801	0.602–1.067
Having chronic diseases (yes)	1.526	0.812–2.867	2.704**	1.365–5.357
Major (medical)	0.595**	0.407–0.869	0.614*	0.391–0.964
Having COVID-19 confirmed cases around (no)	1.188	0.766–1.842	0.539**	0.338–0.859
Anxiety	1.003	0.958–1.050	1.046	0.991–1.104
Depression	0.983	0.945–1.022	0.967	0.923–1.014
Attention to negative information	1.073***	1.058–1.088	1.092***	1.073–1.112
Perceived social support	0.996	0.987–1.004	0.975***	0.965–0.985

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.
[a]Reference group: Profile 1. OR, Odds ratio; 95% CI, 95% Confidence Interval.

and risk. People tend to overestimate the risk of negative outcomes due to excessive emotional stress, so ministries of health and education can increase positive messages or news releases, but in moderation; overwhelming messages can also trigger feelings of fear and stress. Besides, the occurrence of risk events can create a stressful environment, generating negative emotions such as anxiety and tension, leading to mental health problems (52). Social support from family and friends may be protective against depressive symptoms because it mediates regulation of risk perception, positive coping (53) and mental health (54). This suggests that during the COVID-19 epidemic, mental health strategies and programs from a risk perception perspective can be designed and integrated into them.

Furthermore, it's found that participants with chronic diseases tend to perceive the severity of the outbreak more easily, which was similar to previous studies (10). Patients with chronic diseases have a higher risk perception and are more likely to be infected after admission, according to data from Portugal (55). This may be related to their poor body resistance and immunity, which could lead to serious complications once infected, making it easier to perceive the risk of infection. On the other hand, risk perception was inevitably influenced by the risk environment in which the participants were exposed (50), chronic diseases may cause psychological stress and stigma for these students, so we should make use of available resources to help them cope with the dual stress of COVID-19 and chronic disease. Additionally, "no confirmed cases of COVID-19 around" and perceived social support were protective factors for Class 3. According to previous literature, predictors of higher risk perception for COVID-19 include the presence of new positive cases in socially exposed populations (25). During the epidemic, campuses are usually in a closed state. Therefore, a serious public health event may occur once someone is infected, which undoubtedly causes great fear and anxiety. However, if there are no suspected or confirmed cases on campus, students will feel relatively safe in the campus environment and be more objective and rational in risk assessments and decision-making.

Medical college students have more rational and reasonable risk perception. According to previous literature (56), medical students have higher levels of knowledge of COVID-19 and preventive behaviors. They are also considering healthier lifestyles in response to the outbreak. However, the level of risk perception of medical students varies at different stages of study and clinical practice (21), and medical students will be the main force in the fight against epidemics in the future, so differentiated education and training are required for students at different grades and practice stages.

In this study, the results show the higher the perceived social support, the lower the risk perception. With the support coming from family, friends, and school, college students have a comprehensive knowledge of COVID-19. Furthermore, social support moderated the relationship between perceived uncontrolled and mental health symptoms (54) and helped buffer the negative emotions associated with high risk perceptions (53). Thus, when students suffer from severe emotional distress that is triggered by excessive risk perception, they should seek psychological or social support, either from a major, family, or friend. In addition, this study also found that the more focused was paid to attention to negative information, the more improbable it belonged to the low risk perception group. Cognitive theories of anxiety propose that selective attention to negative information plays a central role in the development and maintenance of anxiety (57), and young adults attend more to negative emotional information and report more negative emotional reactions to the same information than older adults do (58). Various news reports and negative information were followed during the COVID-19 outbreak, and attention bias to negative information motivated individuals to quickly identify and react to the threat. It may also increase the risk of infection, which can trigger anxiety and depression. Thus, college students should not overly focus on or

completely ignore negative information, which can lead to over- or under-assessment of risk. Instead, they should divert their attention appropriately, pay attention to positive information, and enhance their discernment skills.

The results from this study have clinical implications for targeting prevention and intervention for the risk perception of college students. High or low risk perception can lead to risk assessment bias and imbalanced risk decisions, so underestimating or overestimating risk will not be conducive to preventive behavior (6). Risk communication can be seen as the basis for accurate and scientific risk perception that can contribute to the effectiveness of risk management during the COVID-19 outbreak (59). Therefore, after determining which risk perception profile one is in, we can implement these interventions based on the individual's perceived risk characteristics, such as expanding health education on outbreak-related knowledge and focusing on individual preventive behaviors; strengthening social support networks; accurately communicating outbreak risk information through social media; improving the healthcare system during the epidemic to provide precision services to individuals; and involving professionals (such as psychological counselors) in the implementation of scientific and effective risk communication.

This study added to the literature by exploring the potential relationship between personal attention to negative information, perceived social support, anxiety, and depression of college students and their risk perception of COVID-19. And the latent profile analysis conducted found obvious heterogeneity in the risk perception of COVID-19 for college students, which may contribute to developing the appropriate interventions in a targeted manner. We also found obvious heterogeneity in the risk perception of COVID-19 for college students in 10 provinces of China, which could be divided into three latent profile classes. These chronically ill students were studying medicine, and the greater the emphasis on negative information, the greater the perceived severity.

However, this study also has some limitations. The sample size is small and cannot represent the risk perception characteristics of Chinese college students in all provinces. And, during this survey, the outbreak was occurring in some areas (especially in Shanxi and Henan), so some students could not go home, which may have led to perceptual biases in risk perceptions and somewhat affected the credibility of the results. Besides, all questionnaires were self-reported, which may lead to bias in results without longitudinal tracking of time-varying patterns of risk perception. A number of researchers have studied risk perception in Chinese college students during the COVID-19 outbreak. In addition, the current study is the first effort to identify subtypes of risk perception among the college population using latent profile analysis to designate categories. The results of this study have implications for the development of targeted risk communication interventions for subtypes.

Conclusion

In general, risk perception is influenced by emotion, attention, society, environment, and other factors, and an individual's risk perception of COVID-19 has significant group characteristics and heterogeneity. This study has identified three profiles of risk perceptions toward COVID-19 for a sample of Chinese college students, which indicates that an accurate perception of this pandemic risk is beneficial to psychological health and preventive behavior during the outbreak of COVID-19. These results may provide a theoretical and empirical basis for colleges and public health practitioners to implement risk perception intervention efforts during the COVID-19 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.

Author contributions

Material preparation, data collection, and analysis were performed by JR, ZZ, YM, WW, QS, MW, and ZH. The first draft of the manuscript was written by JR, YM, and WW. All authors contributed to the study conception and design, commented on previous versions of the manuscript, read, and approved the final manuscript.

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Conflict of interest

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

Publisher's note

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COVID-19-related future anxiety is associated with the health-related quality of life in school-aged children and adolescents—A cross-sectional study

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Background: Over the course of the COVID-19 pandemic, previous studies have shown that the physical as well as the mental health of children and adolescents significantly deteriorated. Future anxiety caused by the COVID-19 pandemic and its associations with quality of life has not previously been examined in school children.

Methods: As part of a cross-sectional web-based survey at schools in Mecklenburg-Western Pomerania, Germany, two years after the outbreak of the pandemic, school children were asked about COVID-19-related future anxiety using the German epidemic-related Dark Future Scale for children (eDFS-K). Health-related quality of life (HRQoL) was assessed using the self-reported KIDSCREEN-10. The eDFS-K was psychometrically analyzed (internal consistency and confirmatory factor analysis) and thereafter examined as a predictor of HRQoL in a general linear regression model.

Results: A total of $N = 840$ 8–18-year-old children and adolescents were included in the analysis. The eDFS-K demonstrated adequate internal consistency reliability (Cronbach's $\alpha = 0.77$), and the confirmatory factor analysis further supported the one-factor structure of the four-item scale with an acceptable model fit. Over 43% of students were found to have low HRQoL. In addition, 47% of the students sometimes to often reported COVID-19-related fears about the future. Children with COVID-19-related future anxiety had significantly lower HRQoL ($B = -0.94$, $p < 0.001$). Other predictors of lower HRQoL were older age ($B = -0.63$, $p < 0.001$), and female ($B = -3.12$, $p < 0.001$) and diverse ($B = -6.82$, $p < 0.001$) gender.

Conclusion: Two years after the outbreak of the pandemic, school-aged children continue to exhibit low HRQoL, which is further exacerbated in the presence of COVID-19-related future anxiety. Intervention programs with an increased focus on mental health also addressing future anxiety should be provided.

KEYWORDS

school children, health-related quality of life (HRQL), mental health, COVID-19-related future anxiety, KIDSCREEN-10, Dark Future Scale for children

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Introduction

Long after the COVID-19 outbreak, the pandemic continues to impact our everyday lives with new emerging SARS-CoV-2 variants, frequently changing hygiene requirements, and contact restrictions. However, it is not only the impact of COVID-19 as a disease, but also the psychosocial consequences of lockdowns and contact restrictions in particular that had an impact on society. As previous studies have shown, children and adolescents worldwide suffered massive physical and psychological burdens as a result of the restrictions imposed by the pandemic (1–4). In addition to school closures and lack of exercise, it was above all the restrictions on social life that impaired children's and adolescents' everyday lives (5). Several risk factors for increased psychosocial distress were identified, such as low socioeconomic status, small living space, chronic physical conditions and mental stress on parents due to a job loss, or preexisting mental problems, whereas social and family support, along with a positive coping style, were associated with better mental health outcomes (2, 6–11).

One systematic review by Viner et al. investigating studies conducted during the first COVID-19 wave from February to July 2020 concluded that studies of short-term school closures reported adverse mental health symptoms and health behaviors among children and adolescents (3). In Germany, nationwide cross-sectional and longitudinal studies performed during the COVID-19 pandemic in children and adolescents found a significantly reduced health-related quality of life (HRQoL), more mental health problems, and higher anxiety levels during the pandemic (12–15).

The pandemic affected all areas of life and led in many ways to increased uncertainty about the future, e.g., regarding travel plans, leisure activities, participation in social and cultural events (such as theater, concerts, weddings), the pursuit of hobbies, but also regarding the employment perspective: Many sectors (e.g., tourism, event industry) have been restructured in the context of the pandemic, employment perspectives have worsened for a variety of professions, and many workers were laid off or put on short-time work. If the perspective on a positive future is overshadowed by worries, this can cause future anxiety. According to Zaleski, future anxiety is a state of apprehension, uncertainty, fear, worry, and concerns about unfavorable changes in the future, whereby the future refers to a greater temporal distance (16). In this context, future anxiety does not only refer to fears of specific future events, but also to the general perception of the personal future with crises, difficulties, the non-achievement of important goals and social aspects (16, 17). Here, cognitive and emotional processes, such as thoughts, associations, and fantasies regarding the future are stimuli for future anxiety of which people are fully aware (conscious anxiety) (16).

Previous studies have examined future anxiety and the impact of health literacy, particularly among college students (18, 19). It was found that higher health literacy was associated with lower future anxiety among Polish adults (18). Furthermore, one survey in Germany comprising over 14,000 university students showed that high levels of future anxiety were associated with low/very low wellbeing (20). Another study from Norway found no effect of COVID-19-related worries (worries about infecting others with COVID-19 and worries about family / friends becoming sick) in adolescents (16–18 years olds) on HRQoL (21). However, to our knowledge until to date, no study has examined future anxiety in children and adolescents and its influence on HRQoL.

The primary aim of this study was therefore to examine the association of COVID-19-related future anxiety and HRQoL in children and adolescents.

Methods

Study design and sample

As part of the project schugi-MV (scientific support of school opening in Mecklenburg-Western Pomerania), a cross-sectional online survey of students in Mecklenburg-Western Pomerania, Germany was conducted from 11th of February until 07th of March 2022. The primary aim of the study was to examine the HRQoL of school-aged children and adolescents in relation to future anxiety associated with the COVID-19 pandemic. The study was approved by the ethics committee of the University Medicine Greifswald (BB 163/21).

Study region

The study was conducted in the northern German state Mecklenburg-Western Pomerania. At the time of the survey, two years after the first COVID-19 pandemic outbreak, the 7-day incidence in the region averaged at 3,262 PCR confirmed infections among 6–11-year olds and at 2,597 among 12–17-year olds [Supplementary Figure 1, (22)]. During the study period, school attendance was compulsory. On 07th of March 2022, the mask requirement during classes was lifted for all grade levels, but was still in effect in the school building outside of the classrooms until 25th of April. Mandatory rapid antigen tests in schools were conducted three times per week until 29th of April 2022.

Implementation of the survey

The web-based survey was conducted using SoSci Survey (23). In addition to demographic variables such as age, gender,

grade level, and type of school, the self-reported KIDSCREEN-10 was applied to assess the HRQoL and the epidemic-related Dark Future Scale for children (eDFS-K) was used to assess COVID-19-related future anxiety. With regard to the assessment of the type of school, there are different secondary school types in the study region with varying length of education: regional school (5th−10th grade), grammar school (5th−12th grade) and comprehensive school (5th−10th grade and 5th−12th grade). The general university entrance qualification can be achieved at grammar schools and comprehensive schools upon completion of the 12th grade. Gender could be specified as female, male or diverse. The KIDSCREEN-10 was applied under a cooperative agreement with the KIDSCREEN group (24–26). The eDFS-K is available for non-commercial research purposes by ZIS (license CC-BY-NC-SA-4.0), an open access repository for social and behavioral science measurement instruments operated by GESIS—Leibniz Institute for Social Sciences (27).

The links to the online survey were sent to all general schools in Mecklenburg-Western Pomerania (total of N=134,505 students at general schools in 2020/2021) by the responsible Ministry of Education, Science and Culture Mecklenburg-Western Pomerania and were forwarded to parents and students by the school principals and teachers. There was no direct contact between the study team and the participants. The introductory text of the survey indicated that parents should consent to the child's participation, however, the children were encouraged to complete the questionnaire themselves. A reminder was sent out once during the study period. The online survey was conducted anonymously. No personal identifying data was collected and no IP addresses were stored. It was not possible to trace the data back to individuals or schools.

Self-reported KIDSCREEN-10

A standardized, validated, and internationally recognized instrument was used to measure the HRQoL (28). The self-reported KIDSCREEN-10 Index consists of 10 items and measures the general HRQoL in 8- to 18-year-olds (25). It includes questions such as "*Did you feel fit and well?*", "*Did you feel sad?*", or "*Did you do well at school?*". All items are rated on a 5-point Likert scale with the options "never", "rarely", "sometimes", "often", and "always". Based on these items, a T-score was calculated according to the developers' specifications with a mean of 50 and a standard deviation of 10. Here, higher values indicate a higher HRQoL. As recommended by the Word Health Organization (WHO) the well-established general health item (GHI) was additionally assessed ("In general, how would you rate your health?") with a five-point Likert scale (from 1 = "excellent" to 5 = "poor") (29). The KIDSCREEN-10 index yields a global HRQoL score and is recommended for use in large epidemiological surveys (25).

The KIDSCREEN-10 index previously demonstrated good internal consistency (Cronbach's alpha = 0.82) and good test-retest reliability/stability (r = 0.73; ICC = 0.72) (25). Additional statistical analyses showed that the KIDSCREEN-10 index is able to differentiate between groups, whereby children and adolescents with behavioral problems (SDQ, effect size Cohen's d = 1.30) and with a high number of psychosomatic complaints (d = 1.69) had significantly lower HRQoL compared to the respective control group (25).

The optimal cutoff values of Hirschfeld et al. were used to classify HRQoL, with values below this cutoff indicating poor HRQoL and values above this cutoff indicating good HRQoL. The threshold for good HRQoL was above 42.52 for children and younger adolescents (<14 years) and above 40.29 for older adolescents (≥14 years) (30).

Epidemic-related Dark Future Scale for children (eDFS-K)

The German Likert-scaled epidemic-related Dark Future Scale for children ("**e**pidemiebezogene **D**ark **F**uture **S**cale für **K**inder", eDFS-K) exemplified by COVID-19 was developed by Voltmer and von Salisch in 2021 and is based on the five-item Dark Future Scale by Zaleski et al., which represents a short version of the Future Anxiety Scale (16, 17, 31).

The eDFS-K measures children's future anxiety in specific relation to an epidemic (17). In the present study, direct reference was made to COVID-19, as in the validation study, but as pointed out by the authors, the scale can be adapted to any epidemic (17). The scale consists of the following four items:

1) Are you afraid that [the Corona virus] will stay for a long time?
2) Are you afraid that your life will get worse due to [the Corona virus]?
3) Are you afraid that your family will soon be able to afford less due to [the Corona virus]?
4) Are you afraid that due to [the Corona virus] you won't be able to pursue your hobbies, graduate from school or get your dream job in the future?

The 4-point Likert scale consists of the response options "Never" (0 points), "Rarely" (1 point), "Sometimes" (2 points), and "Often" (3 points). The scores of the individual items were summed up as specified by the developers, resulting in summed scores of 0–12, whereby higher scores indicate more pandemic related future anxiety. Sum scores of 0–6 were grouped as never to rarely anxious and sum scores of 7–12 were grouped as sometimes to often anxious. The developers first validated the scale on N = 140 third and fourth grade school children aged between 7 and 11 years in Germany (17). Since the present

study applied the scale to 8–18-year-old students, the scale was validated for the respective age group.

Psychometric analysis of the eDFS-K

The psychometric analysis was based on methods from classical test theory (CTT) and included besides item and scale characteristics the investigation of inter-item correlations and corrected item-total correlations (discriminatory power). Correlation coefficients between the items >0.30 were considered adequate, and, thus, assumed to measure the same construct (32). Reliability (internal consistency) was tested with Cronbach's α, whereby values ≥0.7 were considered acceptable (33). Furthermore, Cronbach's α was reported if one item of the eDFS-K was not included.

To verify the assumed one-factor structure (construct validity), a confirmatory factor analysis (CFA) was conducted for the total sample and additionally for subgroups divided by age (8–11 years-olds and 12–18 years-olds). Overall model fit testing was performed using χ^2 test. The CFA was performed by robust maximum likelihood estimators (MLR) considering the root mean square error of approximation (RMSEA) with values ≤0.06, the standardized root mean square residual (SRMR) with values ≤0.08, the Tucker-Lewis index (TLI) with ≥0.95 and the comparative fit index (CFI) with ≥0.95 as acceptable model fit (32, 34). Path diagrams were used to display the standardized factor loadings and variances. Confirmatory factor analysis (CFA) was performed on R version 4.0.4 using the lavaan package version 0.6–11.

Statistical analysis

Questionnaires were excluded from the analysis if both the eDFS-K and KIDSCREEN-10 were not completed or if students were not 8–18 years old, as the KIDSCREEN-10 is recommended and has been validated for 8–18 years-olds by the developer. The standardized questionnaires were evaluated according to the developers' specifications. The results of the KIDSCREEN-10 [the T-score calculated according to the developer's specifications (25) and the proportion of children and adolescents with low HRQoL according to cut-off values by Hirschfeld et al. (30)] were presented for the total group and subdivided by gender and in relation to the frequency of future anxiety (rarely to never vs. sometimes to often).

Nominal variables were presented with absolute and relative frequencies, whereas continuous or ordinal variables were reported with the mean and standard deviation (SD) or with the median and interquartile range (IQR) depending on presence or absence of a normal distribution. The Chi-Square (χ^2) test was applied to compare two categorical variables. The Spearman rank correlation was performed for the comparison of at least two ordinal scaled variables. The Spearman rank correlation coefficient (Spearman Rho) is reported together with its 95% confidence interval (CI).

A general linear regression model was fitted to examine factors associated with the HRQoL (T-scores) measured by the KIDSCREEN-10 (dependent variable). The following independent variables were included in the model: Age in years, gender, school type, grade level (categorized into 1st−6th grade and 7th−13th grade), and sum of the eDFS-K. After univariable analysis all variables were considered in a multivariable model. Furthermore, interactions between variables were examined. Due to multicollinearity between the variables age in years and grade level, grade level was not considered in the two multivariable regression models. With respect to heteroscedasticity, we reported robust standard errors (HC3 estimators) (35). Marginal effect plots with the estimated values and the 95% confidence interval (CI) were generated for each of the independent variables in the multivariable regression model to illustrate the effects on HRQoL using the R package 'ggeffects' (36, 37).

Regression coefficients (B) are reported with 95% CI. The goodness of fit of the model was assessed using R^2 and the corrected R^2. Cohen's f^2 was calculated with the formula f^2 = [corrected R^2/(1-corrected R^2)], whereby f^2 ≥0.02, f^2 ≥0.15, and f^2 ≥0.35 represent small, medium, and large effect sizes, respectively (38). A p-value <0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS Statistics version 27 and R (version 4.0.4).

Results

A total of N = 1,043 students participated in the web-based survey. Of these, n = 162 (15.5%) students did not complete the eDFS-K and KIDSCREEN-10, and another n = 41 (3.9%) students were outside the age range of 8–18 years.

Sociodemographic characteristics

Overall, N = 840 participants were included in the analysis. The sociodemographic characteristics of the students are shown in Table 1. On average, participants were 14.8 years old, nearly 60% were female, and the majority of participants attended grammar schools (68%).

Psychometric analysis of the eDFS-K

The results of the psychometric analysis can be found in the supplementary data file (see Supplementary Tables 1–4 and Supplementary Figure 2). On average, the total sum score of the eDFS-K was 5.98 points, with items 1, 2 and 4

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TABLE 1 Descriptive statistics for participating school children included in the study.

Sociodemographic characteristics	School children ($N = 840$)
Age in years (mean, SD)	14.8 (±2.3)
Gender, *n* (%)	
Male	320 (38.9%)
Female	491 (59.7%)
Diverse	12 (1.5%)
School type, *n* (%)	
Elementary school	41 (4.9%)
Regional school	123 (14.7%)
Grammar school	566 (67.8%)
Comprehensive school	103 (12.3%)
Special school	2 (0.2%)
Grade, *n* (%)	
1st–6th grade	107 (12.8%)
7th–13th grade	731 (87.2%)

averaging between 1 and 2 points and item 3 averaging at 1 point, indicating that COVID-19 related future anxiety was rarely to sometimes present on average. Cronbach's alpha was calculated to estimate the internal consistency of the eDFS-K. The developer specified an acceptable alpha of 0.76, which we confirmed in our study ($\alpha = 0.77$), indicating that the answers to the questions of the instrument are rather consistent (17). When one item was removed, there was no increase in internal consistency ($\alpha = 0.66$–0.76). There was a good inter-item correlation (between $r = 0.34$ and $r = 0.64$), as well as a good corrected item-total correlation (between $r = 0.47$ and $r = 0.66$).

The construct validity of the eDFS-K was demonstrated using a confirmatory factor analysis, which indicated an acceptable model fit ($\chi^2 = 56.4$, df = 2, $p < 0.001$, RMSEA = 0.18, CFI = 0.94, TLI = 0.82, SRMR = 0.05), especially for 8–11 years-old students supporting that the four items of the eDFS-K measure one single construct (Supplementary Table 4). However, the RMSEA score indicated poor model fit, which might be due to the few degrees of freedom (df = 2) in this study (39). The significant *p*-value indicated a poor overall model fit, however, this is most likely due to the high sample size (40). Factor loadings for the overall model ranged from 0.49 to 0.85, with the model for 8–11 years-olds showing higher factor loadings at 0.72 to 0.81 (Supplementary Figure 2). In the model for 12–18 years-olds, item 3 indicated a lower factor loading of 0.46 compared to the other three items (0.60–0.85), which indicates that the question about fears of the future regarding the family's financial situation is less reflective of the construct of pandemic-related future anxiety among adolescents.

Content and criterion validity as well as test-retest reliability could not be determined because the eDFS-K was due to the cross-sectional study design queried only once, no additional instrument was used, and no experts were consulted.

COVID-19-related future anxiety (eDFS-K)

The results of the four-item eDFS-K are shown in Table 2. The distribution of responses for items 1, 2, and 4 were comparable. 20–21% of respondents never feared that the Corona virus will stay for a long time, that life will deteriorate as a result of the Corona virus, or that they will not be able to pursue their hobbies, graduate from school, or gain their dream job, whereas 24–28% often feared such things. The fear that the family will be able to afford less due to Corona virus was often feared by 13% of participants, while 39% never had this fear.

Overall, 46.5% of the students reported sometimes to often COVID-19-related fears about the future, with a significantly higher proportion of females reporting frequent fears about the future compared to males and participants with diverse gender (females: $n = 272$, 56.7%; males: $n = 97$, 30.6%; diverse: $n = 4$, 33.3%; $p < 0.001$). There were no age differences between respondents who indicated more or less frequent fears about the future (never to rarely: 14.8 ± 2.2 years; sometimes to often: 14.9 ± 2.5 years; $p = 0.169$). However, elementary school students were found to have significantly higher eDFS-K sum scores ($n = 41$, median = 8.0, IQR = 6.5) than students from grammar schools ($n = 554$, median = 6.0, IQR: 4.0; $p = 0.010$) regional schools ($n = 121$, median = 6.0, IQR = 6.0; $p = 0.035$), and comprehensive schools ($n = 103$, median = 6.0, IQR = 5.0; $p = 0.003$). There were no significant differences in eDFS-K sum scores between students from grammar schools, regional schools, and comprehensive schools (grammar vs. regional school, $p = 0.928$; grammar vs. comprehensive school, $p = 0.231$, regional vs. comprehensive school, $p = 0.307$).

Health-related quality of life (KIDSCREEN-10)

Overall, 43.5% of students had low HRQoL, whereby the proportion of girls with low HRQoL was significantly higher than the proportion of boys (52.6 vs. 28.9%, $p < 0.001$, Table 3). When considering HRQoL subdivided by age group, 34.3% of children under 12 years of age and 44.7% of children 12 years of age and older showed low HRQoL ($p = 0.094$). Furthermore, it was found that the HRQoL was significantly lower in children with more frequent future anxiety (sometimes to often) than in children with infrequent future anxiety (never to rarely) (59.1%

TABLE 2 Results of the epidemic-related Dark Future Scale for children (eDFS-K).

Item no.	Epidemic-related Dark Future Scale for children ($N = 826$)	Never	Rarely	Sometimes	Often
1	Are you afraid that the Corona virus will stay for a long time?	174 (21.1%)	163 (19.7%)	288 (34.9%)	201 (24.3%)
2	Are you afraid that your life will get worse due to the Corona virus?	171 (20.7%)	176 (21.3%)	277 (33.5%)	202 (24.5%)
3	Are you afraid that your family will soon be able to afford less due to the Corona virus?	325 (39.3%)	218 (26.4%)	177 (21.4%)	106 (12.8%)
4	Are you afraid that due to the Corona virus you won't be able to pursue your hobbies, graduate from school or get your dream job in the future?	163 (19.7%)	182 (22.0%)	250 (30.3%)	231 (28.0%)

vs. 30.8%, $p < 0.001$). Boys with no to rare future anxiety reported the highest HRQoL (normal/high HRQoL = 78.7%) and girls with more frequent future anxiety had the lowest HRQoL (normal/high HRQoL = 36.6%).

Association of HRQoL and COVID-19-related future anxiety

All items of the KIDSCREEN-10 were negatively correlated with the eDFS-K (from $r = -0.18$ to $r = -0.29$; $p < 0.001$) except for the two items that have to be reversed for the calculation of the overall HRQoL score (item 3, $r = 0.35$; item 4, $r = 0.36$; $p < 0.001$), as for these items higher scores indicate lower HRQoL (see Supplementary Table 5). Furthermore, the negative association between the sum score of the eDFS-K and the HRQoL overall score was robust across age groups subdivided by 2-year intervals (3-year interval for 8–10 years-olds due to small sample sizes), respectively ($r = -0.36$ to $r = -0.49$, $p \leq 0.004$; see Supplementary Table 6).

To further investigate factors that influence HRQoL, a general linear regression model was fitted (Table 4). Participants attending special schools were not included in the regression models due to the small sample size. In the univariable models, older age ($B = -0.8$, $p < 0.001$), female ($B = -4.8$, $p < 0.001$) and diverse ($B = -7.9$, $p < 0.001$) gender, 7th−13th grade attendance ($B = -3.9$, $p < 0.001$), and more frequent future anxiety ($B = -1.1$, $p < 0.001$) were associated with decreasing HRQoL. Elementary ($B = 4.6$, $p = 0.010$), regional ($B = 2.8$, $p = 0.003$), and comprehensive school students ($B = 2.8$, $p = 0.001$) had higher HRQoL compared to grammar school students.

Thereafter we examined interactions between variables. The negative association between HRQoL and age in years was stronger in females than in males ($B = -0.6$, $p = 0.035$). We did not find any interactions between eDFS-K sum and sociodemographic variables, such as age, gender, and school type.

The multivariable model 1 without considering any interactions showed a decrease in HRQoL with increasing age ($B = -0.6$, $p < 0.001$), female ($B = -3.1$, $p < 0.001$) and diverse ($B = -6.8$, $p < 0.001$) gender, and more frequent COVID-19-related future anxiety ($B = -0.9$, $p < 0.001$). The school type was no longer associated with HRQoL. Grade level was not included in the multivariable model due to multicollinearity with age. Overall, the model accounted for 24% of the variance with a medium effect size ($R^2 = 0.248$, corrected $R^2 = 0.242$, Cohens $f^2 = 0.32$). Estimated values with the respective 95% confidence interval of HRQoL are illustrated in Figures 1A–D for all predictors in the multivariable model 1.

After adding the interaction term between age and gender to the model (Table 4, Multivariable Model 2), age as well as female and diverse gender alone were no longer associated with HRQoL, and the interaction between age and female gender trended toward significance ($B = -0.5$, $p = 0.060$). An interaction plot illustrates the interaction of gender and age in years on HRQoL (Figure 2). The regression coefficient of the sum score of the eDFS-K was comparable to the multivariable model 1. Model 2 also accounted for 24% of the variance with a medium effect size (Model 2: $R^2 = 0.253$, corrected $R^2 = 0.244$, Cohens $f^2 = 0.32$). Overall, the interaction term did not contribute significantly to the predictive power of the model.

Discussion

In the context of the COVID-19 pandemic, previous studies have found significant burdens on children and adolescents, with adverse effects on the mental and physical health (1–3, 15). To the best of our knowledge the present study is the first to examine COVID-19-related future anxiety two years after the onset of the pandemic in over 800 8–18 years-old children and adolescents using the eDFS-K in terms of its association with HRQoL. It was shown that more than 40% of the children and adolescents still have a low HRQoL 2 years after the onset of the COVID-19 pandemic and more than 45% sometimes to often fear that life will deteriorate due to the Corona virus and that hobbies, school graduation or the dream job can no longer be pursued or achieved. More frequent COVID-19-related future anxiety was associated with lower HRQoL.

As part of the study, a psychometric analysis of the eDFS-K was conducted, based on the application of the instrument among children and adolescents aged 8–18 years. So far, the instrument has only been evaluated for children aged 7–11 years (17). On the one hand, we were able to confirm the developer's results for 8- to 11-year-olds (17), and on the other hand to

TABLE 3 Results of the self-reported KIDSCREEN-10.

	All 8–18 years old's			Never to rarely afraid children (eDFS-K)			Sometimes to often afraid children (eDFS-K)			*p*-value[#]
	N	TS	Low HRQoL* (%)	*N*	TS	Low HRQoL* (%)	*N*	TS	Low HRQoL* (%)	
Male	311	46.2	28.9	216	48.0	21.3	93	42.3	45.2	<0.001
Female	481	41.5	52.6	205	43.7	40.5	265	39.4	63.4	<0.001
Diverse	12	38.3	58.3	8	40.6	37.5	4	33.8	100	–
Total	804	43.3	43.5	429	45.8	30.8	362	40.1	59.1	<0.001

TS, mean values of T-score of KIDSCREEN-10.
*Low HRQoL according to cutoff values by Hirschfeld et al. (30).
[#]*p*-values resulting from χ^2 test comparing low vs. normal/high HRQoL between eDFS-K groups (never to rarely afraid children vs. sometimes to often afraid children).

TABLE 4 General linear regression models with health-related quality of life (self-reported KIDSCREEN-10) as dependent variable, *N* = 787.

Variable	Univariable model		Multivariable model 1		Multivariable model 2	
	B (95% CI)	*p*-value	*B* (95% CI)	*p*-value	*B* (95% CI)	*p*-value
Intercept			59.62 (54.89, 64.34)	**<0.001**	55.03 (47.80, 62.27)	**<0.001**
Age						
in years	– 0.766 (– 1.034, – 0.498)	**<0.001**	– 0.627 (– 0.917,−0.336)	**<0.001**	– 0.324 (– 0.787, 0.140)	0.171
Gender						
Male	ref.		ref.		ref.	
Female	– 4.809 (– 6.031, −3.587)	**<0.001**	– 3.116 (– 4.281,−1.950)	**<0.001**	4.248 (– 3.729, 12.226)	0.296
Diverse	– 7.888 (– 11.490, – 4.285)	**<0.001**	– 6.819 (– 10.283, – 3.356)	**<0.001**	– 13.224 (– 35.502, 9.053)	0.244
Age*Gender						
Age*Female	– 0.597 (– 1.152, – 0.042)	**0.035**	–	–	– 0.497 (−1.015, 0.021)	0.060
Age*Diverse	0.598 (– 2.265, 3.460)	0.682	–	–	0.430 (– 1.048, 1.908)	0.568
School type						
Grammar school	ref.		ref.		ref.	
Elementary school	4.599 (1.113, 8.085)	**0.010**	1.366 (– 2.551, 5.284)	0.494	1.890 (– 2.077, 5.857)	0.350
Regional school	2.802 (0.982, 4.622)	**0.003**	1.561 (– 0.217, 3.340)	0.085	1.589 (– 0.187, 3.365)	0.079
Comprehensive school	2.792 (1.076, 4.509)	**0.001**	1.122 (– 0.493, 2.738)	0.173	1.146 (– 0.470, 2.762)	0.164
Grade						
1st−6th grade	ref.					
7th−13th grade	– 3.871 (– 5.794, – 1.948)	**<0.001**	–	–	–	–
Dark future scale						
Sum (0–12 points)	– 1.124 (– 1.314, – 0.934)	**<0.001**	– 0.944 (– 1.144, – 0.743)	**<0.001**	– 0.934 (– 1.133, – 0.735)	**<0.001**

Ref., reference group. *p*-values < 0.05 are printed in bold.

demonstrate comparable validity and reliability for 12–18 years-olds. Only item 3 of the eDFS-K, asking about future anxiety in relation to the family's financial situation, reflected the one-factor construct of pandemic-related future anxiety to a lesser extent for 12–18 years old school students than for 8–11 years old school children. One reason for this might be a more differentiated view of the financial situation with increasing age. Two years after the onset of the pandemic, fewer occupational and thus financial changes in the family were to be expected, and our results indicate that this situation could be better assessed by older children. Despite a somewhat poorer model fit for the 12–18 years-olds compared to the 8–11 years old school students, our results largely confirm the findings with respect to internal consistency reliability and construct validity of the eDFS-K from the previous validation study (17), indicating that the instrument can be used to assess COVID-19-related fears about the future among children and adolescents.

In Germany, a recent representative nationwide study in 7–17 years-old children and adolescents has been conducted by Ravens-Sieberer et al. as part of the COPSY study (COVID-19

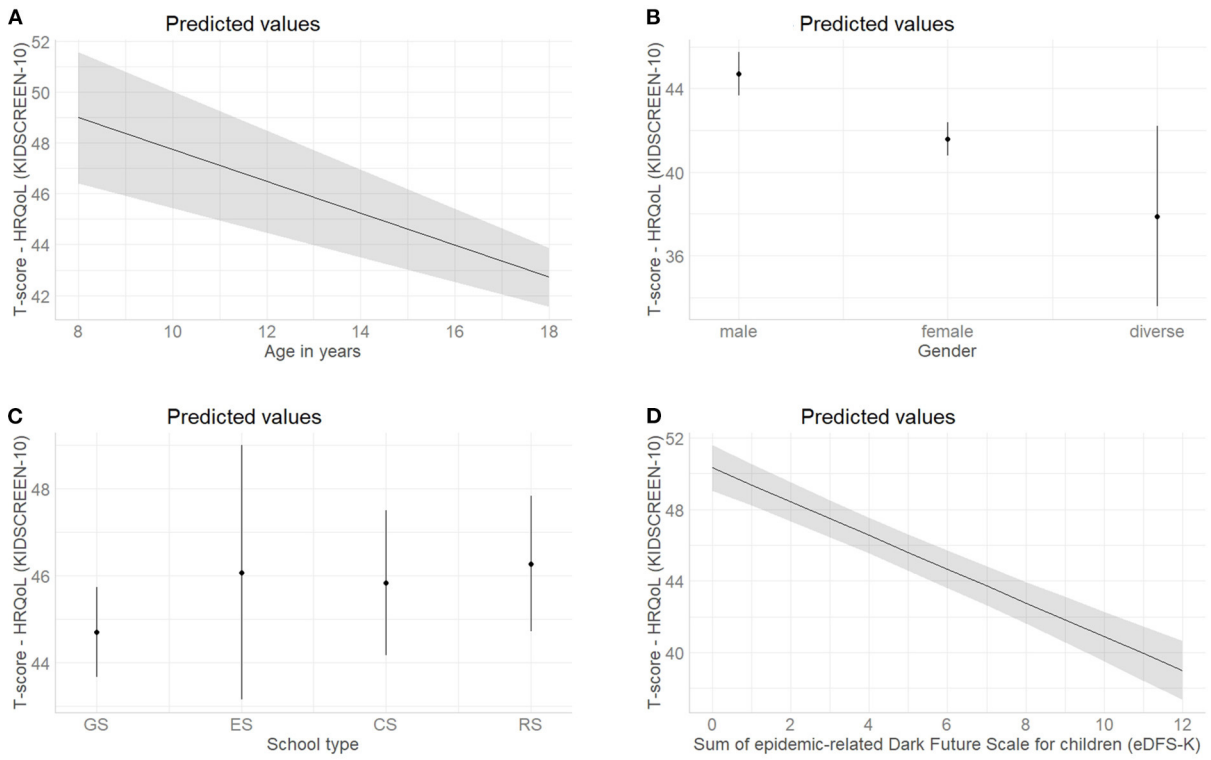

FIGURE 1
Marginal effect plots with the predicted values and the 95% confidence interval of health-related quality of life (self-reported KIDSCREEN-10) for all predictors included in the multivariable model 1 (see Table 4, $N = 787$); **(A)** Estimated effect of age in years; **(B)** Estimated effect of gender; **(C)** Estimated effect of the school type, Abbr.: GS, grammar school; ES, elementary school; CS, comprehensive school; RS, regional school; **(D)** Estimated effect of sum of epidemic-related Dark Future Scale for children (eDFS-K). For continuous predictors, the gray lines and gray areas represent the estimated effect and 95% confidence interval, while for nominal variables this is represented by dots and dashes.

and Psychological Health). In their first analysis, cross-sectional data collected between May and June 2020 were compared to pre-pandemic data from the nationally representative BELLA study (Behavior and Well-being of Children and Adolescents in Germany) (13). In both studies HRQoL was also assessed using the KIDSCREEN-10. In the COPSY study the proportion of children with low HRQoL was 40.2% overall, 44.7% in girls, and 35.7% in boys (13). A significant increase in the proportion of children with a low HRQoL compared to before the pandemic was observed. Subsequently, the Corona cohort was surveyed again between December 2020 and January 2021 (12). At this time the proportion of children and adolescents with a low HRQoL had further increased to 47.7%. This difference compared to the first Corona cohort, however, was not statistically significant (12).

Overall, the proportion of children and adolescents with a low HRQoL after 2 years of the pandemic remains high at almost 44% compared to data from the COPSY study from South Tyrol (Italy) and Germany from May–June 2021 and September–October 2021, respectively, where the overall self-reported low HRQoL rate of children and adolescents was 33–35% (15, 41). One possible cause for the increase of the

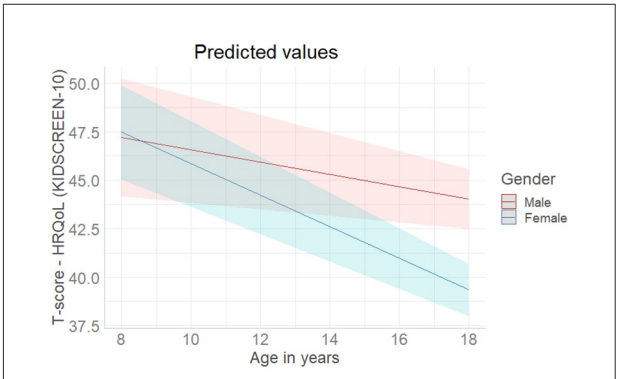

FIGURE 2
Interaction plot of age in years and female gender in relation to health-related quality of life (self-reported KIDSCREEN-10. Adjusted for school type and sum of epidemic-related Dark Future Scale for children (eDFS-K) (see Table 4, Multivariable Model 2). The colored lines and the colored areas represent the estimated effects and the 95% confidence intervals.

population with a low HRQoL in our study could be the intensification of restriction measures in schools in the study region over the winter of 2021 and spring of 2022 due to

high SARS-CoV-2 incidence rates, which was accompanied by mandatory masking, and mandatory testing in schools (3x per week). In Swiss primary school children, it was also found that HRQoL deteriorated at the heights of the COVID-19 waves, however, it could not be determined whether fear of the disease or the restrictions caused this decrease in HRQoL (42).

Furthermore, our study showed a decrease in HRQoL with increasing age and for female and diverse gender. We found that in terms of HRQoL, age and gender interact: For females, HRQoL tended to decrease more strongly with age compared to males. Barbieri et al. observed that the proportion of children in South Tyrol with low HRQoL was higher in girls compared to boys (38 vs. 28%) (41). Another recent study from Germany also reported such age and gender differences (43). However, these findings are not surprising. In previous studies conducted before the onset of the COVID-19 pandemic, gender and age differences in HRQoL were found, whereby a higher HRQoL was found in younger than in older and in male compared to female participants; the age-specific difference was more pronounced in girls (44–46). The reasons for these gender- and age-related differences have not yet been conclusively clarified (47). Increasing pressure on girls and boys with the onset of puberty is thought to play a crucial role in the age-related differences (48). Furthermore, it has been found that girls face more stressful events during the transition to adolescence than boys and show a stronger maladaptive coping pattern—in particular with regard to social stressors (49). Hormonal changes are also discussed as causative factor for the gender-related differences (49, 50). Gender- and age-related differences are also evident in the prevalence of a range of mental health problems and subjective wellbeing, with girls being more frequently affected than boys (49, 51).

In addition to HRQoL, mental health problems, as well as anxiety and depression, were also examined during the COVID-19 pandemic by Ravens-Sieberer et al. (12). The proportion of children and adolescents with mental health problems (17.6% pre-Corona vs. 30.4% in the first Corona cohort and 30.9% in the second Corona cohort), anxiety symptoms (14.9% pre-Corona vs. 24.1% and 30.1%), and depressive symptoms (10.0% pre-Corona vs. 11.3% and 15.1%) also increased after the onset of the pandemic (12). Girls reported depressive symptoms (females 20.2%, males 10.3%) and generalized anxiety symptoms (females 34.6%, males 19.2%) more frequently than boys (41). In the validation study of the eDFS-K, girls showed more pronounced COVID-19-related future anxiety than boys, which is also consistent with the findings of the present study (17). With respect to age-related differences, a different trend was observed in the present study than for HRQoL: COVID-19-related fears about the future peaked among 8–10-year old's, then decreased until 13–14 years of age, and then increased again until late adolescence. These results however should be interpreted with caution, as future anxiety was not longitudinally assessed, the participation rate of 8- to 10-year-olds was low and no reference values are available.

Interestingly, a study by Van Oort et al. who longitudinally assessed general anxiety symptoms of 2200 boys and girls showed a similar pattern: They found that anxiety symptoms first decrease during early adolescence, and subsequently increase from middle to late adolescence (52). Similar findings were also reported in another longitudinal study by Cohen et al. with anxiety symptoms decreasing until age 12 (the "developmental knot") and then increasing into early adolescence (53). They hypothesized that the often stressful transition from childhood to early adolescence, along with changing life circumstances, such as most children transfer from elementary to secondary school, may be reflected in initially higher anxiety scores in late childhood (52, 53). In later adolescence, as the children mature into autonomous, independent individuals, adult expectations increase, and feelings of insecurity and worry during this time may explain the increase in anxiety (52, 53). With regard to COVID-19-related future anxiety, one might hypothesize that such processes may also contribute to increased anxiety about the future. However, in the validation study by Voltmer et al. a trend toward an increase in COVID-19 related future anxiety was reported in 7–11 years-old elementary school students [$r = 0.15$, $p = 0.074$, (17)]. Ultimately, further longitudinal studies with sufficient power are needed to determine age-related differences with regard to future anxiety in children and adolescents.

Our results indicate that two years after the onset of the pandemic the mental burdens of the COVID-19 pandemic remain persistently high and that the pandemic management in Germany does not seem to be effective in addressing them. A need for psychosocial support for children in Germany was registered by scientists and the government and recommendations for action were postulated; concepts for mental health care promotion in children and adolescents with specific aims, however, have not yet been defined (54, 55).

Our results add to the growing body of evidence showing that psychosocial support during an outbreak is not less important than infection control (56). In particular, multidisciplinary support by professionals such as psychiatrists, psychologists, social workers, and pediatricians is needed during a pandemic, which requires a structured and organized program, especially with regard to future pandemics, as described, e.g., by Hyun et al. (56). Thus, psychological counseling and guidance services should be expanded to help children and adolescents to better cope and regain a healthy psychological structure. Parents should also pay more attention to children's mental health, working together with teachers and experts to identify and specifically address mental problems and future anxiety. Therefore, short-term objectives for mental health care promotion should be to provide specific information about

research findings on the impact of the COVID-19 pandemic on child and adolescent psychosocial health and guidance for parents and stakeholders of schools (teachers and school principals), e.g., the importance of talking with a trusted person about fears and anxieties related to the COVID-19 pandemic and associated negative feelings. This should be supported by policy-makers to ensure that it has a widespread outreach to parents and schools. Health care providers also play an essential role in educating families about how to talk to children about COVID-19 at home (57).

Furthermore, the results obtained indicate the importance of implementing intervention measures, e.g., low-threshold measures in family and school settings such as relaxation programs to reduce stress and prevention programs to strengthen resilience. Besides the increased incidence of symptoms of depressiveness and anxiety, fears about the future are also an important target for intervention programs. Therefore, long-term objectives for mental health care promotion should contain the implementation of school-based mental health promotion programs into standard educational practice to enhance resilience and coping skills that have been shown to positively impact the student's ability to manage daily stressors (58–60). However, implementing such programs into everyday life requires considerable time and could, e.g., first be examined for feasibility and acceptance as part of pilot projects in model regions. Since the burden on schools has increased during the pandemic, e.g., due to illness-related staff absences and canceled classes, time and personnel resources must also be available for such important intervention programs, which should be supported by the respective state governments. In addition, previous studies have indicated that psychosocial distress is negatively associated with academic achievement (61, 62). Our study also showed a negative association between perceived academic achievement and the frequency of anxiety about the future, further highlighting the need for action.

It is noteworthy that we were able to show for the first time that frequent COVID-19-related future anxiety is associated with lower HRQoL. However, a differentiation between future anxiety as assessed and anxiety disorders was not possible in the context of this study and needs to be further evaluated in further studies. It would also be of interest to assess stress perception, self-efficacy, and coping skills, and to examine the impact on future anxiety.

A limitation of this survey is the cross-sectional design, whereby the results only represent one point in time. Further, no pre-pandemic results were available for our setting, which would have allowed a direct comparison. Another important limitation is the use of an instrument that has so far been rarely used in studies to measure COVID-19-related future anxiety in children and adolescents. We were able to show that construct validity and internal consistency reliability were also high in children 12 years and older. However, content and criterion validity as well as test-retest reliability could not be determined, thus further studies are needed for a comprehensive psychometric analysis of the eDFS-K in children and adolescents. Also, the survey may not be representative because the response rate of the students was comparatively low (<1% of all students in the study region participated), adolescents from grammar schools were overrepresented and the study region was limited to one Federal State in Germany. We do not see, however, clear indication for any structural difference between Mecklenburg-Western Pomerania and other Federal States with respect of the perception of the COVID-19 pandemic and its possible impact on the future among school children. Moreover, comparable results regarding the HRQoL have also been published in other countries (21, 63). In addition, it should be mentioned that 15% of the participants did not complete the questionnaire. Based on the available data, we cannot make any assumptions about the reasons for dropping out of the survey. One could assume that the content of the questionnaire, which was primarily related to psychosocial health, was perceived as too personal by some participants, or some people only wanted to take a look out of interest and did not intend to participate in the survey. Another limitation was that self-reported questionnaires were used, so the participation of children under 12 years of age was low. In addition, it cannot be conclusively determined whether the students completed the questionnaire independently or with the help of another person. The survey was conducted exclusively online and not paper-based, so that children and families without technical equipment might not have been able to participate.

In conclusion, our results further support the findings from the previous validation study suggesting that the eDFS-K can be used as an assessment tool measuring COVID-19-related future anxiety in children and adolescents aged 8 to 18 years. Future anxiety in children and adolescents with regard to HRQoL has to our knowledge not been studied so far. It was shown that frequent COVID-19-related future anxiety was associated with a lower HRQoL. Addressing future anxiety in children and adolescents should become a prime target in future intervention programs to alleviate the impact of the pandemic on the young generation. Further studies are needed to investigate future anxiety in children and adolescents in a more differentiated manner.

Data availability statement

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

Ethics statement

The study was reviewed and approved by the Ethics Committee of the University Medicine Greifswald (BB 163/21).

By participating in the survey, respondents confirmed that the legal guardian/next of kin consented to participate in this study.

Author contributions

Conceptualization and methodology: AK, PL, and WH. Data analysis: AK, PL, AH, LS, and JL. Writing—original draft preparation: AK. Writing—review and editing: PL, AH, LS, JL, and WH. Funding acquisition: WH. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1003876/full#supplementary-material

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Rumination and "hot" executive function of middle school students during the COVID-19 pandemic: A moderated mediation model of depression and mindfulness

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Background: The outbreak of COVID-19 had a widely negative effect on adolescents' academics, stress, and mental health. At a critical period of cortical development, adolescents' cognition levels are highly developed, while the ability of emotion control is not developed at the same pace. Faced with negative emotions such as stress and social loneliness caused by COVID-19, adolescents' "hot" executive function encounters severer emotional regulation challenges than ever before.

Objective: The present study established a moderated mediation model to investigate the impact of rumination on "hot" execution function among Chinese middle school students during the COVID-19 pandemic, and the specific role of depression and mindfulness in the association.

Materials and methods: This cross-sectional study was conducted on 650 students recruited from a province in central China. The participants completed questionnaires and experiment between July 2021 and August 2021. Rumination Responses Scales, Self-rating Depression Scale, and Mindful Attention Awareness Scale were used to measure the level of rumination, depression, and mindfulness. The reaction time and accuracy of the emotional conflict experiment were recorded to reflect the "hot" executive function.

Results: The results of the moderated mediation model indicated that rumination of middle school students significantly and positively predicted depression in adolescents ($\beta = 0.26$, $p < 0.001$). Meanwhile, the indirect effect of depression on the relationship between rumination and "hot" executive function was significant; depression partially mediated this relationship (word-face congruent condition: $\beta = -0.09$, $p < 0.01$; word-face incongruent condition: $\beta = -0.07$, $p < 0.05$). Furthermore, mindfulness buffered the association between rumination and depression, according to moderated mediation analysis ($\beta = -0.11$, $p < 0.001$). For adolescents with low levels of mindfulness, the relationship was substantially stronger.

Conclusion: In the context of the COVID-19 pandemic, middle school students' rumination would lead to depression, which can negatively impact their "hot" executive function. Besides, mindfulness could resist the adverse effect of rumination on depression. The educators should pay more attention to students' mental health, provide targeted strategies that boost mindfulness to promote their cognitive flexibility, and thus protect the normal development of their executive function during crisis events.

KEYWORDS

COVID-19, rumination, depression, mindfulness, executive function

Introduction

For nearly 3 years, COVID-19 has been sweeping the globe, dramatically changing everyone's life. Due to the community quarantine and the "Online Learning at Home" education policies, middle school students are one of the social groups most affected by the epidemic. Relative to adults, adolescents exhibit stronger "bottom-up" affective reactivity in response to socially relevant stimuli (1). Meanwhile, it is a sensitive and window period of maturation of brain functions, especially the development of the executive function. As a general control system, the executive function (EF) regulates and controls adolescents' cognitive processes, and further determines their cognitive and social function. Although EF is booming during this time, it is still affected by adolescents' external environment and themselves. Therefore, it is urgent and necessary to profoundly investigate the influencing factors and underlying mechanism of adolescents' EF under the worldwide spread of the pandemic.

Rumination and "hot" executive function

Executive function is an umbrella term that refers to higher-order cognitive processes and behavioral competencies, including planning, cognitive flexibility, social cognition [e.g., empathy and theory of mind (ToM)], and emotion regulation (2). According to the neurodevelopmental model of EF, it can be divided into "cold" and "hot" functions. The former is an unemotional cognitive process related to the activation of the dorsolateral prefrontal cortex, while the latter contains an affective or reward system involving the recruitment of the orbitofrontal cortex (OFC) (3). Previous studies have shown that when compared to cold EF which focuses on purely non-contextualized and non-emotional cognitive activities, hot EF is mainly based on emotional involvement, which requires individuals to assess the emotional meaning of stimuli flexibly and is used to deal with problems related to motivation and emotion regulation, including both emotional decision-making and emotional conflict (4–6). Specifically, hot EF is a goal-directed, future-oriented cognitive process elicited in contexts that engender emotion, motivation, and tension between immediate gratification and long-term rewards (7).

Rumination is engaged in a passive focus on one's symptoms of distress and on the possible causes and consequences of these symptoms (8). Recent studies have revealed that adolescents will perform worse on cognitive tasks with repetitive and recurrent negative thinking about their personal concerns and upsetting experiences (9), indicating the negative effect of rumination on EF (10). According to the Resource allocation theory, negative thoughts of rumination deplete limited cognitive abilities, which would otherwise be directed toward task-relevant processes (11–13). This view is confirmed in the studies that when negative information is maintained in working memory, it is difficult for participants to exert executive control over it. This is due to the limitations of cognitive resources; on one hand, suppressing negative stimuli takes up resources that had been used to process the stimuli. On the other hand, the entrance of the stimulus into working memory lets the adolescent pay greater attention to it. This may account for the continual perpetuation of the rumination cycle (14, 15). In addition, the attentional scope model of rumination holds that rumination can lead to difficulty in working memory updating. To be specific, adolescents with a high level of rumination may have difficulty in processing and disengaging from negative information (16–18).

Although a large number of studies demonstrated the link between rumination and EF, previous studies mainly focused on the "cool" EF, yet the effect of rumination on hot EF has not received much attention (19, 20). Several recent studies have shown that people engaging in higher levels of rumination may lead to impulsive behaviors such as binge eating or drinking (21), and non-suicidal self-injury (22), indicating the impairment of executive control abilities by rumination. It was also found that adolescents with high rumination exhibited deficits in the inhibition of negative emotional stimuli when completing the Affective Go/No-go task (23). The task examines the planning and inhibitory control components of individuals' EF with the necessary requirement of highly

emotional involvement. As mentioned above, the difference between cold and hot EF is that hot EF prefers to address emotion-related information rather than abstract cognitive information. These findings further indicate the inner link between rumination and hot EF. Specifically, adolescents' ability to accurately process emotional information will be inhibited when they repeatedly and passively think about their negative emotional condition, the causes, and the consequences of their negative emotions. Based on the theoretical and literature review, we proposed Hypothesis 1: rumination can negatively predict the hot EF of adolescents.

Depression as a mediator

If rumination can negatively affect the hot EF in adolescents, then the question we urgently need to address is: what is the underlying psychological mechanism for this effect? Previous research has focused on how rumination interferes with the rational allocation of limited attentional resources and prevents individuals from selectively attending to the information in the current task. However, the hot EF emphasizes the processing of motivational and emotional information. Thus, rumination not only affects emotional processing by interfering with attention, but more likely prevents the processing of emotional tasks by directly bringing about disruptive emotions. In fact, a large number of studies have shown a close relationship between rumination and depressed mood. Individuals who fall into rumination tend to focus their attention on depressive symptoms and on behaviors or thoughts related to depressed mood. According to Beck's influential cognitive theory (24), individuals with depressive symptoms also have similar negative schema, manifested as the mental representations of past negative events and negative evaluations of the self for a long time (25, 26). Moreover, the response style theory of depression proposes that rumination, as a trait-like response style to distress, will amplify and prolongs individuals' existing negative emotional state and associated negative thinking, ultimately leading to depression (27).

Empirical studies have also proved the relationship between rumination and depression in different dimensions. For example, a longitudinal study revealed that high rumination positively predicted the development, maintenance, and recurrence of depression (28, 29). Neuroimaging studies further provide physiological evidence for a correlation between rumination and depression, showing that the activation of the subgenual cingulate area, which has been proved to be associated with rumination in depression patients, was significantly stronger than that in healthy controls (30). A cross-sectional study with adolescents also showed that increased levels of stress and rumination in early adolescence predicted depression (31). Adolescents with high levels of rumination always get caught up in their current distress and engage in repetitive thoughts about negative events, causing them unable to find positive strategies to fix the problem, which leads to a more intensely depressed mood (32, 33). During COVID-19, when the epidemic kept people from fulfilling purposes, adolescents who constantly thought about why they failed would slip into rumination and increase the risk of depression. That is to say, the negative events associated with the epidemic may lead to negative beliefs in adolescents, which would significantly increase the risk of adolescent depression.

Besides the relationship between rumination and depression, some studies have also focused on the impact of depression on the EF, which obtains ambiguous results. For example, researchers found that when assessing the ability to sustain attention in children and adolescents with depressive disorders using the continuous performance test (CPT), the patients made more errors and responded more slowly than participants under healthy control (34). Indeed, it has been found that error rates of positive stimuli were higher for depression groups than healthy controls, while the performance of the negative stimulus showed no difference between the two. Besides, depressed participants appeared to respond to negative stimuli more quickly than healthy ones (35, 36). Moreover, depressed patients had significantly longer reaction times to negative mood backgrounds than to neutral backgrounds in the Emotional n-back task (37). Neuroimaging evidence also confirms the negative impact of depression on EF: there are functional abnormalities in key brain regions responsible for EF in depressed adolescents (38). However, the results of other studies have shown little impairments in some sub-dimensions of the EF for depressive patients such as response inhibition, selective attention, and verbal WM (working memory) (39–41). The reason for the inconsistent results may be that different research did not distinguish between the hot and cold components of the EF. Since depression has been associated with an attention bias toward negative stimuli (42), it may be more associated with a greater sensitivity to the processing of emotional information than to non-emotional cognitive activities. Therefore, we argue that depression may play a particular role in the connection between rumination and adolescents' hot EF, specifically, whether rumination affects hot EF through the mediating role of depression (Hypothesis 2).

Mindfulness as a moderator

To fully explore the underlying mechanisms that promote adolescents' mental health and cognitive development, it is not enough to only analyze the risk factors but is equally important to look for protective factors from external communities and adolescents themselves. Changes in the surrounding environment caused by the epidemic bring floods of negative emotions to adolescents, which may lead them to rumination. More importantly, there is an unprecedented challenge to

adolescents' emotion management as well as EF development. However, not all adolescents facing these conditions will go to the depths of depression, causing irreversible damage to cognitive development. More and more evidence from clinical and empirical studies has proved the inherent positive relationship between mindfulness and adolescent mental health. Mindfulness, acting as a positive factor, entails directing attention to the present moment in a non-judgmental and accepting way, which is contrary to rumination solely focused on and guided by past negative experiences. Hence, mindfulness may mitigate the negative effects of rumination on adolescent emotion and cognitive control ability. First, substantial empirical research has supported that enhancing mindfulness can decrease rumination and reduce depressive symptoms in individuals. For instance, completers of the MBSR (mindfulness-based stress reduction) class showed increases in mindfulness and overall wellbeing as well as decreases in rumination and symptoms of depression (43). By shifting their attention to the present moment from rumination, mindfulness-based interventions can reduce the possibility of depression relapse by producing a significant or moderate reduction of rumination (44). Second, mindfulness also creates cognitive diffusion (45), which helps individuals to realize that they are in a dysfunctional thinking pattern, such as rumination.

According to the information-processing model, mindfulness can also enhance the capacity to regulate emotion, which is a core element of hot EF (46). In addition, the reawakening model indicates that mindfulness can help individuals improve their cognitive flexibility by expanding attentional space and changing their maladaptive thinking patterns, which ultimately reduces the incidence of depression (47). Besides, mindfulness is conceptualized in terms of self-regulation of attention (48), which can be fully applied to adjust individuals ' negative emotions and thus shape positive perceptual experiences. Researchers using rs-fMRI and local synchronization measurements found that major dispositional mindfulness correlated to left OFC, while local synchronization levels of the OFC are widely assumed to predict activation of positive emotions in the brain (49). Therefore, we predict that mindfulness would moderate the association among rumination, depression, and hot EF (Hypothesis 3).

The present study

Based on previous studies and the theoretical framework, we argue that the association of rumination with adolescents' hot EF can be mediated by depression. Firstly, the impact of COVID-19 has significantly changed the learning and living environment of Chinese adolescents. Specifically, when they are at home without face-to-face contact with teachers and friends, their feelings of isolation increase (50). However, when they return to school, the strict epidemic prevention policy leads to the reduction of their leisure time and the increase of their study time, which increases their academic stress. In conclusion, based on previous studies, it was found that the rumination and depression of Chinese adolescents increased significantly during the epidemic (51, 52). Therefore, in this study, we explore these two variables hoping to find their underlying cognitive mechanisms and promptly intervene on them.

Secondly, adolescence is a critical window for adolescents' cognitive development, and EF, as a general control system, has a fundamental role in the development of adolescents' cognitive and social function (2). As a two-dimensional concept, on the one hand, EFs include non-emotional cognitive functions such as inhibition control, memory refreshment, and cognitive flexibility; on the other hand, adolescents also rely on EFs to make their judgments on emotional stimuli and make emotional decisions. The latter has been insufficiently explored in previous studies, so this study hopes to add and expand on this area (4, 6, 7).

Finally, the mechanisms by which rumination affects hot EF are unclear, thus the present study includes depression as a mediating variable. At the same time, the level of mindfulness in adolescents was considered a protective factor to mitigate the effects of both types of negative emotions on hot EF. The reason for this is that the mechanisms of rumination and depression have something in common. Moreover, neurophysiology has found supporting evidence that the brain regions involved in both overlaps. Moreover, mindfulness, as a positive psychological variable, has also been suggested to help shift adolescents' attention away from negative events, which means that it increases the flexibility of emotional cognition. Therefore, we suggest that adolescents' rumination and depression would have a significant negative impact on their hot EF, while their level of mindfulness could mitigate this negative effect.

Thus, in this study, we aimed to investigate both the association and the underlying mechanisms between rumination and adolescents' hot EF, with a focus on the potential mediating effect of depression. We expected to find direct and negative relations between rumination and depression in the hot EF of adolescents. Finally, we also expected the negative relationship to be mediated by mindfulness (**Figure 1**). Based on the literature review, we propose a moderated mediation model.

Materials and methods

Participants

In this study, we recruited students from one randomly selected junior high school in a developed city in Henan province located in central of China. The Chinese education system is a 9-year compulsory education system in which children graduate from primary school and move on to middle

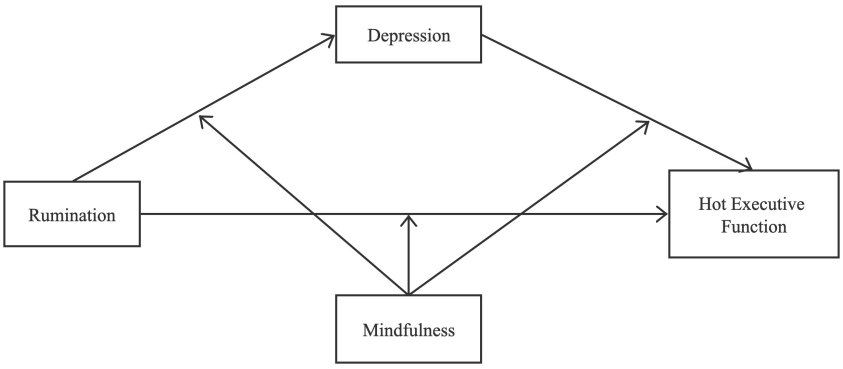

FIGURE 1
The proposed theoretical model.

school to complete the remaining 3 years of compulsory education. At the stage of middle school, the average age of adolescents is about 12–15 years old, and they are allowed to go home every 2 weeks due to the impact of the epidemic. A total of 650 questionnaires were collected through our survey, and 583 were valid, yielding a valid response rate of 89.69%. In addition, we also removed the extreme data with response times below 300 ms or over 1500 ms and invalid data with a total correct rate of less than 65% in the Word-Face Stroop experiment. In the end, 516 valid data were retained. These respondents consisted of 268 boys (51.9%) and 248 girls (48.1%), 261 (50.6%) were from grade seven, 138 (26.7%) were from grade eight, and 117 (22.7%) were from grade nine, only children accounted for 20.50%, and non-only children accounted for 79.50% (Table 1).

TABLE 1 Demographic characteristics of respondents.

		N	%
Gender	Male	268	51.90%
	Female	248	48.10%
Grade	Seventh-grade	261	50.60%
	Eighth-grade	138	26.70%
	Ninth-grade	117	22.70%
Family	Only-children	106	20.50%
	Non-only children	410	79.50%

All students took our survey voluntarily and they were told they could withdraw from the survey at any time. In addition, written informed consent was obtained from all participants prior to the start of the questionnaire and experiment. The study procedures were approved by the Zhengzhou University Ethics Committee. The study complied with the principles of the 1964

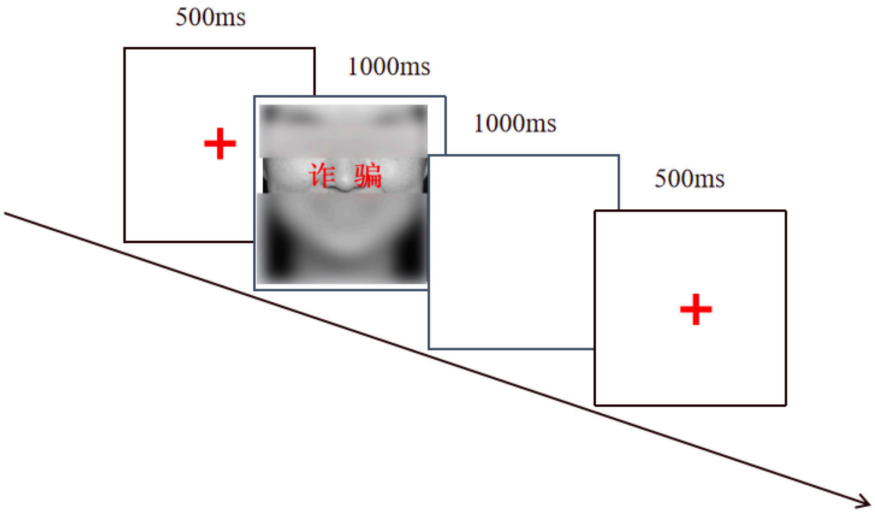

FIGURE 2
The experimental trial of the Word-Face Stroop task.

TABLE 2 Means, standard deviations, and correlations of the main variables.

	M	SD	1	2	3	4	5	6
(1) Rumination	41.72	12.22	–					
(2) Depression	48.52	9.28	0.54**	–				
(3) Mindfulness	64.59	14.33	−0.60**	−0.57**	–			
(4) ICA	0.85	0.12	−0.19**	−0.18**	0.14**	–		
(5) CCA	0.92	0.07	−0.22**	−0.22**	0.15**	0.53**	–	
(6) ICRT	748.11	148.9	−0.04	−0.02	−0.01	−0.17**	0.07	–
(7) CCRT	710.23	140.85	−0.04	−0.01	0.00	−0.17**	0.04	0.95**

$N = 516$; *$p < 0.05$; **$p < 0.01$.
CCA, congruent condition accuracy; ICA, incongruent condition accuracy; CCRT, congruent condition reaction time; ICRT, incongruent condition reaction time.

TABLE 3 The mediation effect and moderated mediation effect of rumination on hot executive function (EF).

Predictors	Model 1 (Depression)		Model 2 (CCA)		Model 3 (ICA)	
	β (95%CI)	t	β (95%CI)	t	β (95%CI)	t
Rumination	0.26 (0.17, 0.34)	6.00***	−0.08 (−0.14, −0.02)	−2.66**	−0.09 (−0.16, −0.02)	−2.67**
Depression			−0.09 (−0.15, −0.03)	−2.92**	−0.07 (−0.14, −0.01)	−2.11*
Mindfulness	−0.38 (−0.47, −0.30)	−8.95***				
Rumination Mindfulness	−0.11 (−0.17, −0.05)	−3.62***				
R^2	0.400		0.06		0.05	
F	113.96***		16.87***		12.38***	

$N = 516$; *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
CCA, congruent condition accuracy; ICA, incongruent condition accuracy.

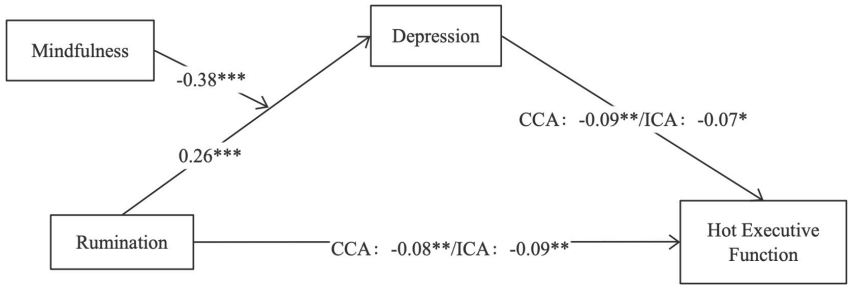

FIGURE 3
The final moderated mediation model. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Declaration of Helsinki (including its subsequent amendments or similar ethical standards).

Rumination responses scales

The Rumination Responses Scale (RRS) was used to assess levels of rumination. Han and Yang (53) interpreted a Chinese language version of the RRS, which has been widely employed in Chinese culture with satisfactory reliability and validity (53). This scale consists of 22 items with three dimensions, including symptom rumination, brooding, and reflective pondering. Participants were required to respond to each item on a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always). This scale exhibited good reliability in the present study (Cronbach's α = 0.93).

Self-rating Depression Scale

Depression was measured by the Chinese version of Zung's Self-Rating Depression Scale (SDS) (54). The SDS has 20 items that assess emotional, physiological, psychomotor, and psychological imbalances. Each item was measured by a 4-point Likert scale. The total scores ranged from 25 to 100 ($20 \times 1 \times 1.25$ to $20 \times 4 \times 1.25$), the higher the score, the more severe the depressive symptoms. The Cronbach's α coefficient of the SDS was 0.75 in this study.

Mindful attention awareness scale

The Chinese version of the Mindfulness Attention Awareness Scale was revised by Chen et al. to measure mindfulness based on "current attention and awareness" (55). There are 15 items, each of which is scored from 1 to 6, with high scores indicating higher levels of awareness and attention. The Cronbach's α coefficient for the MAAS in this study was 0.90, which was considered reasonable.

The Word-Face Stroop paradigm

Stimuli

Compound stimuli consisted of pictures with facial expressions and affective words were used in this experiment. Picture stimuli were selected from CFAPS [the Chinese Face Affective Picture System; (56)] and were widely used in previous studies to investigate executive function of emotional conflict (57, 58). The valence and arousal of these expressions were evaluated on a 9-point scale by 24 middle school students who did not participate in the formal experiment. Twenty-four positive and twenty-four negative expressions were selected according to the rating result, with photos of each valence comprising 12 male and female faces, respectively. There were significant differences in the valence and arousal between positive and negative expressions (Valence: $M_{positive}$ = 7.24, $M_{negative}$ = 2.67, F = 1.45, $p < 0.001$; arousal: $M_{positive}$ = 5.46, $M_{negative}$ = 4.39, F = 4.56, $p < 0.001$). Affective words were selected from the word database of Yao's study. After evaluating valence and arousal, 48 affective words (24 positive and 24 negative words) were selected as the final experimental materials from 60 original materials. There were significant differences in valence and arousal between positive and negative words (Valence: $M_{positive}$ = 7.54, $M_{negative}$ = 2.23, F = 9.40, $p < 0.001$; arousal: $M_{positive}$ = 6.66, $M_{negative}$ = 6.23, F = 2.76, $p < 0.001$).

Ninety-six compounded stimuli were prepared with negatively or positively valenced words in prominent red color superimposed on pictures. The word and facial expression of a compound stimulus were either congruent [e.g., "彩虹" (rainbow) was superimposed onto a positive expression] or incongruent [e.g., "诈骗" (swindle) was superimposed onto a positive expression]. The main experimental stimuli conclude consisted of 40 incongruent trials and 40 congruent trials (in each of the two blocks). Before the formal experiment, there were another 16 trials containing both experimental conditions as a practicing part.

Procedure

The experiment was programmed and presented using E-Prime 2.0 and was conducted within a multimedia classroom. The stimuli were shown on the gray background at the center of a laptop monitor, from which participants were seated 60 cm away. Each trial begins with a fixation "+" for 500 ms. Then, the face-word stimuli appeared in the center of the screen. Participants were asked to judge the valence of the words as quickly as possible, which necessitated inhibition of the emotion induced by the facial expression. Half of the participants were told to press the F key for the positive valence and to press the J key for the negative valence, while the other half were given a reversed response. Then a blank screen was presented for 1000 ms and followed by the next trial. If the participant does not respond after 2000 ms, the program will record it as an incorrect response (see **Figure 2**).

The administration process of this study was conducted by two graduate students in psychology as the main examiners. The test was conducted in a computer classroom and we received permission from students, teachers, and school officials before the administration. Students were asked to answer the questions independently according to their real feelings, and the test was collected on the spot after completion. After the questionnaires and the word-faces Stroop test were collected, descriptive statistics, independent samples t-test, one-way ANOVA, repeated measures ANOVA, and product-difference correlation analysis were conducted using SPSS 22.0, as well as mediating effects tests and moderated mediating effects tests using Model 59 and Model 7 of Hayes' PROCESS macro program.

Results

Preliminary analyses

Table 2 shows means, SDs, and Pearson correlations for the study variables. As the results demonstrated, rumination was positively correlated with depression and negatively correlated with mindfulness and congruent/incongruent condition accuracy. In addition, depression negatively correlated with congruent/incongruent conditions accuracy. Notably, the reaction time of congruent/incongruent conditions was only negatively correlated with incongruent condition accuracy and has no significant correlations with rumination, depression, and mindfulness. Therefore, the following analysis used congruent/incongruent condition accuracy as the indicator for evaluating the hot EF of adolescents.

Testing for mediation effect

The result showed that rumination was negatively correlated with CCA and ICA supporting Hypothesis 1 (CCA: $\beta = -0.13$, $t = -5.00$, $p < 0.01$, 95%CI = [−0.19, −0.07]; ICA: $\beta = -0.13$, $t = -4.49$, $p < 0.001$, 95%CI = [−0.19, −0.07]). In Hypothesis 2, we assumed that depression mediates the relationship between rumination and hot EF. The hypothesis was tested with Model

4 of the PROCESS macro. As Table 3 showed, rumination was positively associated with depression (β = 0.52, t = 14.43, $p < 0.001$, 95%CI = [0.45, 0.59]), which in turn was negatively related to hot EF (CCA: β = 0.08, t = −2.66, $p < 0.01$, 95%CI = [−0.14, −0.02]; ICA: β = −0.09, t = −2.92, $p < 0.01$, 95%CI = [−0.15, −0.03]). In the meantime, the negative direct association between rumination and hot EF remained significant. The result of the mediation effect analysis supported Hypothesis 2, verifying that depression partially mediated the relationship between rumination and hot EF.

Moderated mediation effect analysis

Model 59 of the SPSS Macro Program PROCESS (version 2.13) was used to test whether there was a moderating effect of mindfulness in the mediated model. Statistical results showed that only the interaction term between rumination and mindfulness had a significant negative predictive effect on depression in adolescents. The interaction term between rumination and mindfulness and the interaction term between depression and mindfulness did not have a significant effect on the hot EF.

Further, Model 7 of the SPSS Macro Program PROCESS (version 2.13) was used to test the moderating effect of mindfulness. According to the method proposed, the relationship between rumination and hot EF, the mediating role of depression, and the moderating role of mindfulness are discussed (59). With depression as the dependent variable, rumination significantly predicted depression positively (β = 0.26, t = 6.00, $p < 0.001$), mindfulness significantly negatively predicted depression (β = −0.38, t = −8.95, $p < 0.001$), and the interaction between rumination and mindfulness significantly negatively predicted depression of middle school students (β = −0.11, t = −3.62, $p < 0.001$). This shows that mindfulness moderates half of the mediating role between rumination and depression. In the second equation, with the accuracy of congruent/incongruent condition as the dependent variable, depression significantly negatively predicted the accuracy of congruent/incongruent condition (β = −0.09, t = −2.92, $p < 0.01$; β = −0.07, t = −2.11, $p < 0.05$), rumination significantly negatively predicted the accuracy of congruent/incongruent condition (β = −0.08, t = −2.66, $p < 0.01$; β = −0.09, t = −2.67, $p < 0.01$). According to the results of moderated mediated effects, mindfulness regulates the first half path of the mediation process. Therefore, mindfulness plays a moderating role in the first half of the mediating effect, and Hypothesis 3 is verified. The specific model is shown in Figure 3.

The product (interaction term) of rumination and mindfulness had a significant predictive effect on depression (β = −0.11, t = −8.95, $p < 0.001$). The result supported Hypothesis 3. To further portray the interaction, we conducted simple slope plots and calculated beta coefficients at −1SD and +1SD from the mean of mindfulness (Figure 4). The result of simple slope tests showed that for middle school students with a lower level of mindfulness, the influence of rumination on depression had a steeper slope, meaning it was statistically significant (β_{simple} = 0.36, t = 2.68, $p < 0.01$). For middle school students with a higher level of mindfulness, the influence of rumination on depression was positively and statistically significant (β_{simple} = 0.15, t = 2.68, $p < 0.01$).

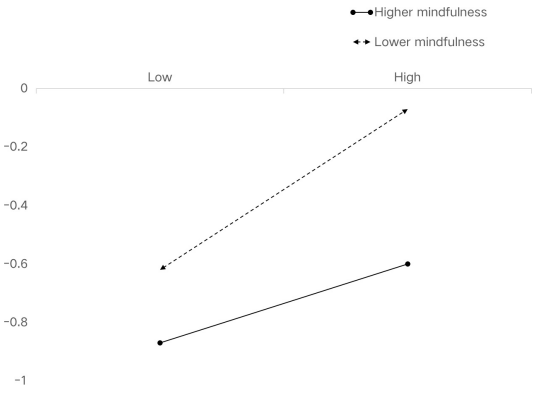

FIGURE 4
Association between rumination and depression at higher and lower levels of mindfulness.

Discussion

The present study investigated the relationship and the underlying mechanism between rumination and hot EF in Chinese middle school students during the spread of COVID-19. Our findings show that rumination can negatively predict adolescents' hot EF with the mediating role of depression. Furthermore, mindfulness played a moderating role in the effect of rumination on depression.

The mediating role of depression

Prior research has shown that both rumination and depression are crucial risk factors for adolescents' EF (16, 60, 61). Nevertheless, on the one hand, these studies have developed independently of each other, neglecting the possible linkage between rumination and depression. Researchers followed 200 adolescents for 15 months and found that adolescents with higher levels of rumination showed reduced selective attention and attentional shifts at follow-up compared to baseline, without finding a predictive effect of depression levels (62). On the other hand, they explored almost solely the cold part of EF, lacking evidence from the hot EF. The present study highlights depression as a critical

carrier of the impact of rumination on hot EF. Therefore, depression is not only an outcome of rumination but also causes damage to the hot EF of adolescents. These findings uncover why rumination may negatively predict the hot EF of adolescents.

Firstly, rumination directly affects adolescents' hot EF, which manages emotions and repairs negative emotions. It has been suggested that cognitive inhibition is a key mechanism for repairing emotions, and to accomplish this process requires individuals to exert effective attentional control over negative emotions in working memory. Caught in repetitive negative thoughts, rumination impairs this function due to depleting cognitive resources and affecting the individual's ability to solve emotional problems (63). According to the cognitive construct of the emotion regulation strategy, the effectiveness of emotion regulation depends on the working memory capacity to reevaluate current negative events, meaning to modify or update these negative thoughts with new neutral or positive information (20). When adolescents fall into rumination, their working memory is occupied with negative information (64), which hinders effective emotional regulation and then causes impairment to the hot EF. Moreover, the researchers measured the level of rumination in 52 adolescents before asking them to complete the Affective Go/No-go task and found that it was difficult that inhibit negative information when switching from negative to positive blocks on an Affective Go/No–go task (23).

Secondly, consistent with the negative cognitive model, the mediating pathway suggests that rumination positively predicts the level of depression in adolescents. According to the response style theory (64), when faced with stress or adverse life events, individuals exhibiting high levels of rumination usually regard the problems more negatively and are divorced from adaptive problem-solving behaviors that serve to address the source of the issue (65). Besides, adolescents with high levels of rumination always get caught up in their current distress and engage in repetitive thoughts about negative events, especially in the social epidemic environment. This cognitive style causes them to be unable to find positive strategies to fix the problem, which eventually increases the risk of depression occurrence (66). In addition, the study revealed that depression plays a special role between rumination and the hot EF of adolescents. For adolescents who are at a critical stage of mental development, depression will destroy their ability to regulate their emotions and cause them to make a series of decisions that are detrimental to their future development (67). According to emotion regulation theory, effective emotion regulation requires an additional cost in cognitive resources (68). When rumination keeps adolescents focusing on their depressive symptoms (21), it may imply an increase not only in self-understanding but also in negative cognition. Therefore, this will occupy adolescents' cognitive resources for effective problem solving and will correspondingly impair their hot EF (69).

The moderating role of mindfulness

Although rumination of adolescents may be significantly associated with hot EF through the mediating role of depression, this relationship is not stable and unchanging. Therefore, the present study meanwhile explored potential moderating variables that may influence the relationship among rumination, depression, and hot EF. By exploring the positive factors, we can implement effective interventions for negative thinking in adolescents to improve their ability to cope with frustrating events and maintain their mental health. Consistent with our hypothesis, mindfulness moderated the relationship between rumination and depression. Specifically, the higher the level of mindfulness in adolescents, the weaker the prediction from rumination to depression. Previous research has also found that high personality mindfulness can break down the maintenance of rumination and can reduce the risk of depression relapse (70). As we proved above, focusing on negative information may lead to continuous negative emotions like depression and even impair the cognitive ability to deal with emotion-related tasks. However, a high level of mindfulness helps adolescents to consciously bring their attention back to the internal and external experiences occurring in the present moment and thus move away from the cognitive control of negative emotions, thereby lowering the adverse effects of negative emotions on hot EF. This finding is consistent with previous research which also verified that mindfulness training could not only improve its own level but, more importantly, reduce the level of rumination (43).

The result that mindfulness as a protective factor weakens the adverse effects of rumination on depression in adolescents can be explained from several aspects. Firstly, COVID-19 causes mass negative emotions in adolescents because they are at a unique stage of physical and mental development. Therefore, the contradiction and conflict between the internal and external environment make them fall into rumination, which triggers depression (29, 71). However, according to cognitive flexibility theory, mindfulness advocates the conscious awareness of the present moment and non-judgmental acceptance, which is different from the rumination cognitive style that focuses on negative information and bad situations (16, 61). Adolescents with higher levels of mindfulness can more quickly be aware of changes in their surroundings and take flexible responses to get themselves out of negative emotions as soon as possible. Secondly, positive psychological approaches treat mindfulness as one of the positive variables that enable individuals to increase their attentional flexibility, cognitive abilities, and a variety of positive psychological resources such as mental toughness and self-esteem (72). Using a wealth of psychological resources, adolescents can counteract the effects of the external environment on their emotions. This means that mindfulness can motivate adolescents to become aware of their surroundings in an objective, non-judgmental, and accepting manner, thus

breaking the rumination and alleviating their depression (73). When uncontrollable events occur, mindfulness can be used to adjust teens' cognition to buffer the adverse consequences caused by the crisis event.

Strength and limitations

Firstly, adolescent rumination and EF are two areas of research with rich empirical findings, while studies focusing on the effects of rumination on hot EF in adolescents are scarce, especially in the uncertain situation of a worldwide pandemic. This study explored this using a combination of measurement and experimental research methods. As hot EF is a complex high-level cognitive process under consciousness, it is difficult to measure through self-report scales and is more accurately reflected through performance on real-time cognitive processing tasks. The present study explored it using the Word-Face Stroop paradigm, which improved the accuracy of the study. More importantly, the findings of this study show that adolescents' rumination can directly affect individuals' hot EF, as well as indirectly by impacting depression levels. Adolescent individuals are maturing physiologically at a rapid pace and going to become true adults, which often endures various internal and external conflicts and contradictions psychologically. This is the objective reason why they are prone to rumination. They tend to escape whenever they encounter insurmountable obstacles, and the feeling of powerlessness also induces the possibility of depression.

More critically, adolescence is a window of opportunity for intervention and improvement of the hot EF, and the findings of this study confirm that at this stage, the development of hot EF must be given attention by all educational authorities. First of all, educators need to grasp the psychological developmental characteristics of junior high school students. In regular school mental health education, their attention should be paid to preventing students from developing negative cognitive patterns of rumination. For example, they can increase their positive emotional experiences through some recreational activities, and they can also provide interview exchanges and psychological counseling to help them learn ways to reasonably dissipate negative emotions. In addition, when young people experience unpleasant events, educators should guide them to resolve the issue through adaptive means, such as transference or seeking solutions, rather than repeatedly dwelling on what caused the event to occur. By preventing the occurrence of rumination, the adolescent's hot EF are protected from developing properly.

In addition to school educators, we expect the families of teenagers to give the necessary attention to their mental health. Parents should pay attention to the psychological needs behind their behavioral problems, and timely relieve and diffuse the confusion that cannot be resolved due to the physical and mental limitations of their teens. At the same time, parents of adolescents should provide them with a peaceful and love-filled growing family, respect their ideas and foster effective methods of communication, thus enhancing the positive psychological resources of these minors.

In addition to the two perspectives above, we should also note another important finding of this study, which is that mindfulness plays a moderating role among rumination, depression, and hot EF. For individuals with high levels of mindfulness, the predictive effect of rumination on depression was diminished. This is an important insight into the need for targeted measures to improve the level of mindfulness in junior high school students. In detail, a mindfulness program is necessary in order to guide students to internalize and apply mindfulness in their daily lives, thereby extending the cognitive flexibility of individuals, guiding them to remain aware and alert to the present moment and to be able to allocate more of their limited cognitive resources to positive aspects. This will motivate young people to adopt positive coping strategies to detach themselves from undesirable cognitive patterns or negative emotions as soon as possible, contributing to their physical and mental health and hot EF.

Despite revealing meaningful insights, the present study still has some limitations that need to be noted. Firstly, this study is a cross-sectional study, and given the current broader epidemiological context, a cross-sectional survey is far from adequate to capture the psychological state of adolescents. COVID-19 has in fact affected our participants for up to 3 years, and this long-term change in their life circumstances will have a lifelong impact on the development of their mindset and EF. Therefore, a longitudinal study or a cross-lagged approach to confirm the impact of rumination on their EF would be a very important complement to the results of the cross-sectional study. Secondly, due to the impact of the prevention and control policy, only a small administrative region in central China was chosen as the source of participants, and the homogeneity of the source of participants hinders the extension of the findings to a more general group of adolescents. Therefore, in future studies, we hope that researchers will be able to compare the psychological states of adolescents across regions and cultures to increase the generalizability of the findings. Finally, we only measured adolescents' levels of mindfulness, but lacked interventions to treat their levels of mindfulness. Therefore, this study is a *post-hoc* test and can only anticipate that increasing adolescents' levels of mindfulness will improve their development of hot EF. Future studies can further validate the positive effects of mindfulness by comparing the mental states of the participants before and after the mindfulness intervention.

Conclusion

In conclusion, this study presented the role of rumination and mindfulness in hot EF of middle school students.

Rumination negatively affects adolescents' hot EF by aggravating their depression, and mindfulness can moderate the effects of rumination on depression. Our results highlight that rumination of adolescents was dangerous during the COVID-19 pandemic, as it had a strong relationship with depression. Although rumination, as negative cognition, could increase depression, mindfulness could decrease depression.

Data availability statement

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

Ethics statement

The study procedures were approved by the Zhengzhou University Ethics Committee. Written informed consent was obtained from all participants prior to the start of the questionnaire and experiment.

Author contributions

YL and YW contributed to conception and design of the study. HK organized the database. XM performed the statistical analysis. GQ and YL wrote the first draft of the manuscript. XM and GQ wrote sections of the manuscript. LC and TL read and contributed to manuscript revision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Relationship between negative coping style and fear of COVID-19 among Wuhan college students during the post-pandemic period: A moderated chain mediation model

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Objectives: After a long-term lockdown, particularly one in which human life is at risk, negative psychological consequences are expected. In this study, we aimed to explore the cause of stress and fear of coronavirus-19 (COVID-19) among Chinese college students in Wuhan during the latest strictest lockdown.

Methods: During the COVID-19 outbreak, 1,070 college students from Wuhan, aged 18–29 years, took part in an online survey. We used correlations, bootstrap tests, and other statistical analysis methods to analyze the data.

Results: Negative coping style significantly positively predicted fear of COVID-19, and stress had a significant mediating effect on the relationship between negative coping style and fear of COVID-19. In addition, rumination and stress had a chain-mediating effect on the relationship between negative coping style and fear of COVID-19. Perceived social support moderated the three paths of this serial mediation model.

Conclusion: Negative emotions, such as stress and fear of COVID-19, in college students are caused by both behavior (e.g., negative coping style) and cognition (e.g., rumination). Importantly, negative cognitive thinking (i.e., rumination) is often a malign consequence of a negative coping style. Thus, to improve students' mental health, students should be encouraged to engage in more positive behaviors and seek social support during periods of adherence to regular prevention and control measures.

KEYWORDS

COVID-19, negative coping style, rumination, stress, fear of COVID-19

Introduction

The World Health Organization (WHO) declared on March 11, 2020, that the spread of the novel corona virus known as COVID-19 (in which pneumonia is a serious complication) had become a global pandemic (1). In the recommendations made by the WHO, quarantine and social distancing measures were emphasized (2). The quarantining that occurred across most countries to minimize the spread of COVID-19 significantly altered the ways in which people lived their lives. At the same time, strict compliance with quarantine regulations during the lockdown (which led to the suspension of almost all social activities) posed the risk of contributing to the onset of psychological problems, and the fear of COVID-19 posed a potential threat to public mental health (3). The Chinese government put in place unprecedented measures to combat the virus and these measures have proven to be effective. As a result, control of the pandemic has become normal in China, and people's lives and work have gradually adjusted to the new normal with regular prevention and control (e.g., intermittent closure of some public places). The Chinese media refers to this phase as the "post-pandemic period". This period is now being explored in several Chinese studies, including mental health issues that have become apparent (4, 5).

A retrospective review of some COVID-19-related studies points to several limitations in existing research. First, some qualitative open-ended studies that only summarized the contents of coping styles of residents during the pandemic (6). Some studies explored the relationship between negative coping styles and mental health in response to societal changes, but they only performed a preliminary analysis and did not explore the underlying mechanisms (7, 8). Second, previous studies have primarily focused on the mental health of individuals during the pandemic and few studies have explored psychological changes during the post-pandemic period with widely varied lockdown. This may be because many countries have not yet entered the stage of pandemic prevention and control, therefore, exploring mental health issues during this period is prospective. Third, most current research has focused on the benefits of positive coping styles (9–11), few studies have separately explored the effects and mechanisms of negative coping styles. According to the two-dimensional theory of emotion, the effects of positive and negative emotions can work independently in some sense (12, 13). This means exploring the adverse psychological consequences of negative coping styles in isolation has its own unique significance, especially in terms of practical significance. Researches has shown that when faced with public health emergencies, Chinese college students often resort to mental avoidance or malign coping methods rather than solving problems positively (14–16), something school administrators should be aware of. Based on the above reasoning, this study focuses on exploring the relationship and mechanism between negative coping strategies and fear of COVID-19 in a post-pandemic context. Findings should be informative for other countries about to enter this phase, as well as provide theoretical inspiration for related practical interventions.

Negative coping style and fear of COVID-19

Since it was first proposed, the conservation of resources (COR) theory has become a broad theoretical system (17–19) with distinct clinical, psychological, and theoretical features. It describes the explanatory mechanisms for behavioral expression and psychological problems. The theory assumes that the sense of stress originates from real-life situations rather than a purely subjective construction process, and emphasizes the objectivity and contextual nature of the stressor (20, 21). The COVID-19 pandemic fits with the definition of being a sudden and objectively stressful event, and the subsequent quarantine policies that limited people's behavioral motivations were contextual.

Hobfoll (21) suggested that coping with mental health problems in humans is more complex than a simple stimulus–response process, so the COR theory describes the generation of, and coping with, stress according to individual resources. The key point of the COR theory is that the accelerated loss of resources following a stressful event leads to a spiral of loss if the individual is unable to effectively resolve the stressful event and has no opportunity to organize timely compensation (21, 22). In a nutshell, COR theory views stressful events as an objective existence and people need to consume resources in order to deal with problems. Lack of resources increases the risk of coping failure, which in turn increases the psychological burden on the individual. When faced with the COVID-19 pandemic, people have used a variety of coping resources, accompanied by psychological changes. Therefore, based on COR theory, this study sought to determine the psychological mechanism underlying the relationship between college students' coping styles and fear of COVID-19.

According to the transactional model of Lazarus and Folkman (23), coping is described as an individual's cognitive or behavioral efforts to address internal or external demands in stressful situations. Coping style can be divided into two types: positive coping style is directed at changing the situation or removing the threat by using problem-solving strategies, such as redefining the problem and considering various solutions. In contrast, negative coping style is directed at changing or modifying reactions to events and involves the use of behavioral or cognitive adjustment strategies to reduce emotional stress, including problem avoidance, self-blame, and some unhealthy behaviors (e.g., smoking and drinking) (24). Studies have

shown that these negative coping styles are associated with psychological distress (25, 26).

For students, limiting the scope of activities in schools was one of the lockdown measures to prevent infiltration and spread of the virus. However, quarantine can also induce numerous negative emotions, such as fear (3). It is well known that during a lockdown, individuals do not receive timely and effective resource support and adopt a passive coping approach, which will exacerbate their negative feelings about COVID-19. Previous studies have reported that negative coping predicted poor psychological consequences (27), that is, the more negative coping styles are used, the more severe the psychological problems. Furthermore, negative coping styles were found to be positively correlated with fear during the COVID-19 pandemic (28). Therefore, it was reasonable to propose H1: negative coping style will positively predict fear of COVID-19.

Rumination

Rumination is a maladaptive form of cognitive self-reflection, the repetitive and passive recollection of negative thoughts associated with destructive events is a characteristic of rumination (29). From a COR theory perspective, individuals who are unable to stop the depletion of resources will be caught in a "stress spiral" (21, 22). In other words, individuals who adopt poor coping styles will not only fail to solve problems but this approach may even deepen their psychological distress. During the lockdown, students pass negative news to each other and this can reinforce the adverse cognitive responses. Research has shown that passive stress coping styles are associated with rumination (30) and a study with a sample of Chinese college students also indicated that negative coping style was positively correlated with each dimension of rumination (31).

Rumination threatens many components of mental health. For example, it enhances negative thinking, impairs problem-solving abilities, and interferes with support acquisition (29). A recent study in South Korea revealed that unhealthy ruminative thinking is positively associated with psychological distress (32). Furthermore, a study showed that rumination is positively associated with fear of COVID-19 (33). Given these findings, the present study hypothesized that H2: the relationship between negative coping style and fear of COVID-19 will be mediated by rumination.

Stress

According to COR theory, individuals use certain strategies to stop the loss of resources when coping with stressful situations (22). Negative coping, as an avoidance strategy, has been found to be associated with emotional maladjustment in previous studies (34, 35). The finding that negative coping styles are positively associated with stress in the context of the COVID-19 pandemic has been widely demonstrated (36, 37). Lardier et al. (38) found 56% of students showed a high level of perceived stress during the COVID-19 pandemic in Poland, as well as negative coping styles were significantly and positively associated with stress during this time.

Previous studies have shown that a range of negative psychological problems, including stress, is associated specifically with different types of negative life events (39). There is a strong relationship between stress and fear, and stressful situations can sometimes be a source of fear (40). Based on this, it is not difficult to speculate that there is an association between stress and fear of COVID-19. Indeed, the relationship between stress and fear of COVID-19 has been demonstrated consistently (41, 42). A study among Spanish university students found that a significant positive relationship between the stress and fear of COVID-19 (43). Based on the above theory and empirical research, the present study hypothesized that H3: the relationship between negative coping style and fear of COVID-19 will be mediated by stress.

Rumination and stress

According to the theory about rumination, rumination is not only a consequence of sudden stressors but also an antecedent of stress consequences (29). A diathesis-stress model was tested in a 6-month longitudinal study, demonstrating that rumination and stress interact to predict psychological distress (44). Another study revealed that rumination is significantly positively associated with stress (45). Set in the social ecology of COVID-19, a follow-up study on Chinese college students showed that rumination is a partial catalyst for stress consequences (46). In light of this, the present study hypothesized that H4: the relationship between negative coping style and fear of COVID-19 will be serially mediated by rumination and stress.

Perceived social support

Perceived social support is the emotional support that individuals subjectively experience and is obtained *via* social interactions. It includes positive experiences, such as being respected and understood (47). As an effective personal resource for coping with stressful life events, social support is considered an important protective factor for mental health when individuals encounter negative life events.

A meta-analysis showed that low perceived social support is associated with post-traumatic stress disorder, and a lack of social support during or after trauma has a stronger effect than pre-trauma factors (48). The buffering model of social support

states that effective social support can ameliorate the adverse psychological consequences of stress (49). A study conducted during the COVID-19 pandemic demonstrated that although individuals undergoing self-isolation had significantly higher rates of depression, those who reported high levels of social support had a 63% lower risk of depression symptoms than those with low levels of social support (50). In addition, a study of Chinese residents during the COVID-19 pandemic revealed that perceived social support effectively reduced the impact of quarantine measures; moreover, social support from family was related to lifestyle changes aimed at promoting mental health (51). Studies have also found that perceived social support is negatively associated with rumination (52). Therefore, the present study hypothesized that H5: perceived social support will moderate the serial mediation model (see Figure 1).

Methods

Participants

In May 2022, participants were recruited from three universities in Wuhan, China. Because COVID-19 infections had emerged in other regions, these universities were under strict management at this time. Students were restricted from leaving campus and were required to maintain social distancing. First, three of the 52 public universities in Wuhan (a comprehensive university, a polytechnic university, and a normal university) were selected during a lockdown. These three types cover a very large proportion of colleges and universities in China, so the randomly selected samples from these three universities in Wuhan are considered representative.

Then, 1,184 students were randomly selected from the students enrolled in these three universities to be survey respondents using a convenient sampling method. After removing 107 unqualified responses (e.g., failing a polygraph question and completion time <100 s), 1,070 Chinese college students (52.2% men; 47.8% women) volunteered to participate with an effective rate of 90.37%. These included 53 senior students, 53 sophomores, 440 juniors, and 524 freshmen. Participants ranged in age from 18 to 29 years, with a mean age of 19.60 years (standard deviation [SD] = 1.35), and 40.7% were from urban areas whereas 59.3% were from rural areas. The study was approved by the Wuhan University ethical committee. Participants completed online questionnaires using the Wenjuanxing System (Enterprise Premium Version, https://www.wjx.cn/wjxenjoy.aspx), which is an established platform providing functions equivalent to Amazon Mechanical Turk. All participants completed an informed consent form voluntarily and anonymously prior to completing the survey.

Measures

The questionnaire included sociodemographic variables, such as sex, college year, and subjective family socioeconomic status (SES), and several other variables (as described below).

Negative coping style

The negative coping subscale was used to measure the frequency of negative coping style use. This subscale was derived from the Simplified Coping Style Questionnaire (SCSQ) (24). The negative coping subscale is a one-dimensional, self-report instrument in which participants score eight items on a four-point Likert rating scale ranging from 0 (never) to 3 (always). A higher score indicates that individuals are more inclined to use negative coping styles or ways to minimize distress when faced with setbacks or difficulties. Example items include "when facing problems, I escape troubles by drinking, taking drugs, and smoking." or "imagining a miracle will come, and change in the status quo." The subscale has been shown to have high internal consistency for passive coping styles in a Chinese sample (53). The Cronbach's α in the present study was 0.80.

Rumination

The Ruminative Responses Scale—Short Version (RRS-10) was used to measure the level of rumination. RRS-10 is a multi-dimensional scale, and includes brooding and reflection. The two-factor structure was proposed by Treynor et al. (54). The scale is a 10-item, self-report measure scored on a four-point Likert rating scale ranging from 1 (almost never) to 4 (almost always). Higher scores indicate higher rumination levels. Example items include "Why do I have problems other people don't have?" The RRS-10 has been previously used in research related to COVID-19 in the Chinese population (55). The Cronbach's α in the present study was 0.91.

Stress

The stress subscale of the Depression, Anxiety, and Stress Scale (DASS-21) was used to measure the level of stress (56). The stress subscale is a one-dimensional instrument containing seven items (questions 1, 6, 8, 11, 12, 14, and 18). Participants rate items according to their experience on a four-point Likert rating scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much). Example items include "I tended to over-react to situations." The stress subscale has been previously used in research related to COVID-19 in the Chinese population (57). The Cronbach's α in the present study was 0.90.

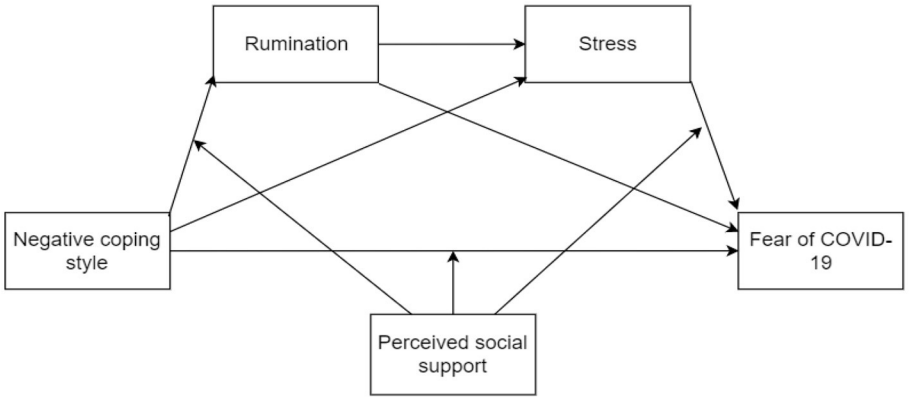

FIGURE 1
Hypothetical indirect pathways between negative coping style and fear of COVID-19, and moderating pathways of perceived social support.

Fear of COVID-19

Participants' fear of COVID-19 was assessed using the Fear of COVID-19 Scale (FCV-19S) (58). It is a one-dimensional scale in which participants score seven items on a five-point Likert rating scale ranging from 1 (strongly disagree) to 5 (strongly agree). A higher score indicates a greater fear of COVID-19. Example items include "It makes me uncomfortable to think about coronavirus-19." We used the Chinese version of the FCV-19S, which has been shown to have high internal consistency, reliability, and convergent and discriminant validity (59). The Cronbach's α in the present study was 0.90.

Perceived social support

The perceived social support scale (PSSS) was used to assess the perceived support received from family, friends, and other people (60). PSSS is a multi-dimensional scale, including the dimensions of family, friends, and significant others. The scale is a validated 12-item, self-report scale, and each item is scored on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). A higher score indicates a higher level of perceived social support. We used the Chinese version of the PSSS, which has high internal consistency and reliability (53). The Cronbach's α in the present study was 0.97.

Data analysis

Model 4 of the PROCESS macro for IBM SPSS Statistics Version 25.0 (61) was used to test the mediation effects described in H1 to H3, and Model 6 of the PROCESS macro was used to test the serial mediation effects described in H4 (61). To test H5, we used Model 92 (61). Sex, age, and subjective SES were controlled for as covariates, and the data were centralized for all analyses. The bootstrap method with 10,000 replicate samples was used to determine statistical significance, and 95% confidence intervals (CIs) of the indirect effects were calculated. Mediating and moderating effects were considered significant if the 95% CI did not include zero (61). All data analyses were conducted using IBM SPSS Statistics 25. The sample size was determined *via* G*Power 3.1 which showed that a sample of 210 participants achieved power at 0.95 to detect a medium effect for condition ($d = 0.5$, $\alpha = 0.05$, two-tailed). In addition, the sample size of this study was more than 10 times the number of independent variable question items. Therefore, the sample size of this study fully met the statistical requirements.

Common method bias tests

Harman's single-factor test was used to test for common method bias (62). All items were included in the exploratory factor analysis. Results showed that the Kaiser-Meyer Olkin (KMO) value was 0.93 and the Bartlett value was 34,184.70 ($p < 0.001$). Results of the factor analysis without rotation showed that six factors with characteristic roots >1 were generated, which explained 64.76% of the variation. The first factor explained 21.85% of the variance variation, which was below the 30% threshold. Therefore, there was no common method bias issue in our measurements.

Results

Preliminary analyses

Correlations, reliability, and descriptive statistics for the study variables are provided in Table 1. As expected, fear of COVID-19 was positively associated with negative coping style

TABLE 1 Descriptive statistics and correlations among study variables.

Variable	1	2	3	4	α	*M*	*SD*
Negative copy style	–				0.80	18.36	4.64
Rumination	0.30***	–			0.91	11.09	3.18
Stress	0.24***	0.38***	–		0.90	11.96	4.35
Fear of COVID-19	0.18***	0.16***	0.39***	–	0.90	16.93	5.84
Perceived social support	0.10**	−0.01	−0.20***	−0.01	0.97	59.40	15.27

$N = 1070$. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

TABLE 2 Regression analysis among study variables.

Result variable	Predictive variables	R^2	β	*t*	95% CI
Rumination	Negative coping style	0.099	0.304	10.395***	[0.247, 0.361]
Stress	Negative coping style	0.173	0.138	4.692***	[0.080, 0.195]
	Rumination		0.334	11.397***	[0.277, 0.392]
Fear of COVID-19	Negative coping style	0.172	0.093	3.130**	[0.035, 0.151]
	Rumination		−0.019	−0.623	[−0.080, 0.042]
	Stress		0.374	12.219***	[0.314, 0.434]

$N = 1{,}070$. The beta values are standardized coefficients.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

($r = 0.18$, $p < 0.001$), rumination ($r = 0.16$, $p < 0.001$), and stress (r = 0.39, $p < 0.001$). Stress was positively associated with negative coping style ($r = 0.24$, $p < 0.001$) and rumination ($r = 0.38$, $p < 0.001$) and negatively associated with perceived social support ($r = -0.20$, $p < 0.001$). Rumination was positively associated with negative coping style ($r = 0.30$, $p < 0.001$). Negative coping style was positively associated with perceived social support ($r = 0.10$, $p < 0.01$).

Mediation analyses

Results of the regression analyses are presented in Table 2. Confirming H1, we found a positive direct effect of negative coping style on fear of COVID-19 ($\beta = 0.093$, $p < 0.01$). The result suggested that students who use negative coping style more frequently reported a higher level of fear of COVID-19. In addition, negative coping style was found to be a positive predictor of rumination ($\beta = 0.304$, $p < 0.001$) and stress ($\beta = 0.138$, $p < 0.001$).

Results of mediation analyses showed that H2 to H4 were supported. Specifically, the indirect effect of negative coping style on fear of COVID-19 via rumination was significant ($\beta = 0.032$, $SE = 0.012$, 95% CI = [0.009, 0.056]), confirming H2. The result suggested that the relationship between negative coping style and fear of COVID-19 was mediated by rumination. As well as, the indirect effect of negative coping style on fear of COVID-19 *via* stress was significant ($\beta = 0.088$, $SE = 0.016$, 95% CI = [0.059, 0.121]), confirming H3. The result suggested that the relationship between negative coping style and fear of COVID-19 was mediated by stress. Moreover, when we included two mediators in the analysis, the coefficient increased (total effect, $\beta = 0.176$, $p < 0.001$), the indirect effect of negative coping style on fear of COVID-19 *via* both rumination and stress was significant with a point estimate of 0.038 ($SE = 0.007$, 95% CI = [0.025, 0.054]). The result suggested that negative coping style could have an effect on the fear of COVID-19 via rumination and stress. Therefore, H4 was also confirmed (see Table 3).

Moderation analyses

Consistent with H5, perceived social support moderated three paths in the chain mediation model. Specifically, perceived social support moderated the relationship between negative coping style and rumination. A follow-up simple slope analysis revealed that negative coping style predicted rumination for participants with high (+1 SD) perceived social support ($\beta = 0.232$, $t = 6.422$, $p < 0.001$), and negative coping style significantly predicted rumination with low (−1 SD) perceived social support ($\beta = 0.408$, $t = 10.234$, $p < 0.001$; Figure 2).

Additionally, perceived social support moderated the relationship between negative coping style and fear of COVID-19. A follow-up simple slope analysis revealed that negative coping style did not predict fear of COVID-19 for participants with high (+ 1 SD) perceived social support ($\beta = 0.032$, $t =$

TABLE 3 Indirect effect of intolerance of uncertainty on mental wellbeing *via* rumination and fear of COVID-19.

Path	Coefficient	95% CI	
		LL	UL
Negative coping style → Rumination → Fear of COVID-19	−0.006	−0.028	0.014
Negative coping style → Stress→ Fear of COVID-19	0.052	0.024	0.082
Negative coping style → Rumination → Stress→Fear of COVID-19	0.038	0.025	0.054
Total effect	0.176	0.118	0.235
Direct effect	0.093	0.035	0.151
Total indirect effect	0.084	0.050	0.120

$N = 1{,}070$. The beta values are standardized coefficients.
CI confidence interval, *LL* lower limit, *UL* upper limit.

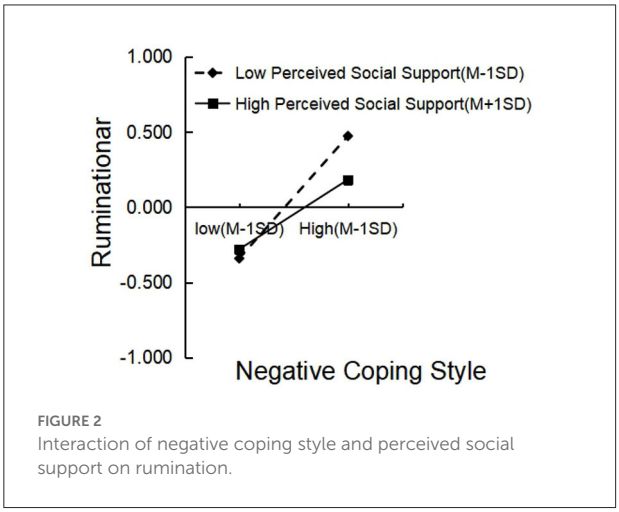

FIGURE 2
Interaction of negative coping style and perceived social support on rumination.

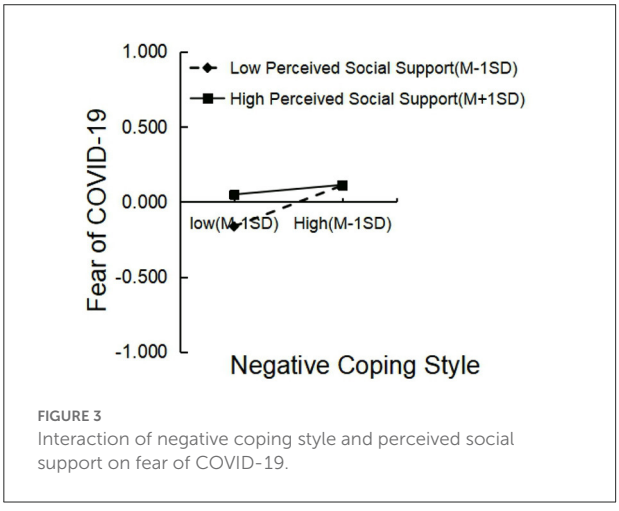

FIGURE 3
Interaction of negative coping style and perceived social support on fear of COVID-19.

0.871, $p = 0.384$), whereas negative coping style predicted fear of COVID-19 for those with low (– 1 SD) perceived social support ($\beta = 0.137$, $t = 3.230$, $p < 0.01$; Figure 3).

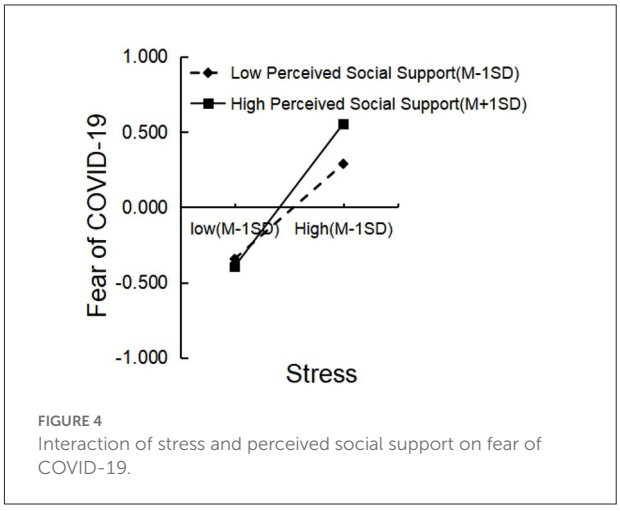

FIGURE 4
Interaction of stress and perceived social support on fear of COVID-19.

Finally, Perceived social support moderated the relationship between stress and fear of COVID-19. A follow-up simple slope analysis revealed that stress predicted fear of COVID-19 for participants with low (−1 SD) perceived social support ($\beta = 0.316$, $t = 7.990$, $p < 0.001$), and stress significantly predicted fear of COVID-19 for those with high (+ 1 SD) perceived social support ($\beta = 0.475$, $t = 11.582$, $p < 0.001$; Figure 4).

To summarize, the results of this study indicated that negative coping style positively predicted fear of COVID-19, and there was a significant indirect effect of negative coping style on fear of COVID-19 *via* stress. The association between coping style and fear of COVID-19 was partially mediated by high levels of both rumination and stress, and perceived social support played a moderating role in the serial mediation model (see Figure 5).

Discussion

When this study was conducted, the COVID-19 pandemic had entered the normalization management stage in China. The

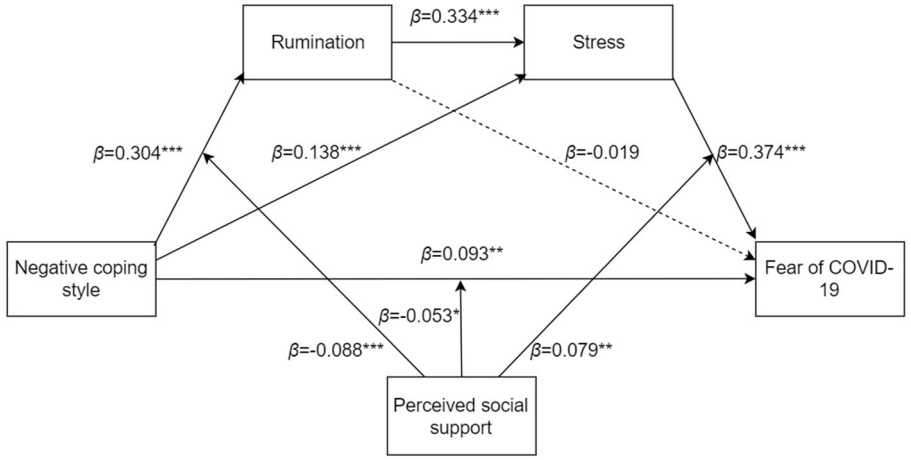

FIGURE 5
The moderated mediation model of negative coping style, rumination, stress, fear of COVID-19, and perceived social support.

COVID-19 pandemic was an obvious stressor and had induced changes in the physical and mental behavior of many people. This coupled with the impact of quarantine policies that limited individuals' access to resources, and the sense of uncertainty and loss of control, impacted psychological health (63). Therefore, closely examining the negative psychological ramifications of the pandemic is crucial, and prompted us to explore the relationships among negative coping style, rumination, stress, and fear of COVID-19. The results of the study confirmed our hypotheses, which we discuss next.

Negative coping style is relevant to fear of COVID-19

The results of this study indicated that negative coping style positively predicted fear of COVID-19, which was consistent with the results of previous studies, and H1 was verified. According to the COR theory, the generation of stress is not a purely internal psychological process but rather, a process of continuous interaction between the individual and the situation (22). In response to the threatening event that was the COVID-19 pandemic, people took various means to protect themselves. For instance, in the United Kingdom, various positive and adverse coping strategies were used simultaneously by individuals (6). The crux of the matter lies in that coping styles play a pivotal role in mental health, particularly during adaptation to stress caused by COVID-19 (64). For example, research conducted in Australia showed that behavioral disengagement led to higher levels of depression (7). The results of this study also provided supporting evidence. This study revealed that Chinese college students who applied a more negative coping style increased their mental health problems, such as fear of COVID-19. Specifically, students who applied more negative coping strategies had higher levels of rumination and stress, and this in turn increased their fear of COVID-19.

The mediating effect of rumination and stress

In line with H2 and H3, the results indicated that negative coping styles influenced fear of COVID-19, fueled by rumination. Meanwhile, stress was found to mediate the relationship between negative coping style and fear of COVID-19. Importantly, the main hypothesis (H4) was confirmed. The results of this study support the serial mediation model, which indicated that rumination and stress play mediating roles in the relationship between negative coping style and fear of COVID-19.

During the quarantine period of the COVID-19 pandemic, individuals were forced to turn to negative coping styles because of limiting objective factors, such as the restriction of movement to school or home, which increased the risk of developing psychological problems (65). In general, a positive coping style involves proactively taking constructive action. In contrast, those who adopt negative coping styles try to avoid stress as a way to minimize distress and focus on negative thoughts (66). Because students were only able to visit a few fixed locations during the normalization stage of the COVID-19 pandemic, their external activities were disrupted, and contact with the outside world decreased substantially, which exhausted their coping strategies, which possibly turned to being progressively more negative. Examples include avoidance strategy and the

use of unhealthy means to solve problems (such as drinking or smoking).

However, in reality, these coping measures do not solve the problem but excessively deplete the individual's psychological resources. In such situations, individuals likely ruminated about and analyzed COVID-19-related events. Studies did confirm that young people spent considerable time thinking about the COVID-19 pandemic (67). However, previous studies have provided evidence that dysphoric rumination leads students to recall more bad situations or memories than good ones (68, 69). Moreover, repeated thinking about a catastrophic event results in the enhancement of negative self-evaluations that are observed clinically (70). According to COR theory, stress increases when individuals run out of psychological resources but fail to solve problems successfully (21, 22). Therefore, students with higher levels of rumination may believe that they are less capable of problem solving, and then perceive more stress.

Further, along with unresolved problems, students' feelings of helplessness can lead to fear under COVID-19 lockdown. As previous studies have shown, stress leads to the development of fears (40). Consequently, through reinforcement by rumination and stress, students who adopt a negative coping style can become more fearful of the COVID-19 pandemic.

The moderating effect of perceived social support

Numerous studies conducted during the COVID-19 pandemic have shown that social support has a significant impact on mental health outcomes (50, 71, 72). We found that perceived social support moderated three pathways of the model, namely, the relationships between negative coping style and rumination, negative coping style and fear of COVID-19, and stress and fear of COVID-19. In the two pathways related to negative coping style, the moderating role of social support is not difficult to understand. Perceived social support contributes to health-promoting behaviors and was shown to have a particularly significant impact on compliance with stay-at-home orders during the COVID-19 outbreak (73). Thus, in the pathway involving a negative coping style, the deleterious effects may be enhanced under low perceived social support conditions. Specifically, individuals who received sufficient coping resources initially were likely to appropriately manage the stress according to the COR theory (22). Conversely, in the absence of social support, it is difficult for individuals to adopt active problem-centered coping strategies, which can lead to the production of more passive coping measures, such as drinking, avoidance, and fantasy in lockdown. However, when these approaches prove ineffective, individuals become trapped in painful reflections and become more fearful of COVID-19.

Surprisingly, for the relationship between stress and fear, the harmful effect was amplified in high perceived social support conditions. We speculate that this may reflect a special psychological state that arose during the post-pandemic period. The echo chamber effect describes how information in a group gradually becomes homogenized, and discussions can lead to the increase of irrational emotions among group members (74, 75). During the long-term lockdown, a cocoon of information was formed within schools, so students moving within the school boundaries were readily exposed to negative information from those around them when seeking social support, for example, when confiding in roommates. In such cases, students who applied a strategy to seek out surrounding social support resources in high-stress situation often received negative feedback about COVID-19, creating a vicious cycle and echo chamber effect. This eventually would lead to even less hope and increased fear of COVID-19. Of course, this is only a preliminary inference combining the current study results and our assessment of the post-pandemic situation, and more studies are needed to verify and explore the mechanisms involved.

Practical applications

Given these findings, this research contributes to the development of practical applications. First, administrative departments of universities could develop programs to reduce fear of COVID-19 that can be implemented online or offline, such as photography-based interventions (76), and administrative departments also can host various on-campus events, such as yoga/meditation group counseling, campus concerts, movies, and other interesting collective events. These activities can help students break out of information cocoons to prevent or reduce their psychological fear. Second, when giving advice, college counselors should encourage students to confide in them from the perspective of seeking social support (e.g., talking to more experienced teachers or family members) rather than talking to classmates who also harbor negative emotions, as this may instead deepen the negative rumination of the person seeking help.

The present study mainly explored and demonstrated the psychological crisis brought about by negative coping style during the post-pandemic period. This serves as a caution significance to school administrators. So schools could encourage students to engage in positive coping on their own, such as listening to music, reading books, and taking daily exercise. In addition, because college students have access to various types of information during quarantine *via* social media, social media channels, such as Wechat, Douyin, and Weibo, may be used to spread negative messages. For this reason, along with academic instruction, educators need to remind students to carefully

screen information and obtain useful information from online sources.

Limitations and prospects

This study has several limitations. First, although the sample size was sufficient, the cross-sectional design did not enable us to determine causal relationships among variables. Thus, associations should be explored using a longitudinal design to verify the circular model, whereby during public health emergencies, maladaptive coping styles can lead to negative psychological consequences, which in turn can strengthen maladaptive coping styles and cognitions. Second, the present study used self-report measures. Future studies could explore variables related to COVID-19 and other mental health outcomes using alternative methods, such as the empirical sampling method and/or behavior observation to overcome the subjective biases of self-report measures. Additionally, the study was conducted on a sample of college students. During isolation, the movement of the general population may be more restricted than that of students; thus, our findings may not generalize to the general population. Moreover, the present study presented some interesting results, such as the positive correlation between negative coping style and perceived social support, which needs to be verified further, although the same conclusion has been reached by previous studies (77, 78). We also found a discrepancy in the moderation of perceived social support across different pathways, which may predict complex changes in the psychology of individuals in the particular context of the COVID-19 post-pandemic, and therefore, more explanations are expected from future related studies.

Conclusions

We showed in a Wuhan college student sample using serial multiple mediational analyses that rumination and stress play a chain-mediated role in the relationship between negative coping style and fear of COVID-19. Therefore, we suggest that negative coping styles promote negative cognition, such as rumination, and these negative behaviors and emotions give rise to negative psychological outcomes (such as stress and fear of COVID-19) in those in isolation during the COVID-19 post-pandemic. The observed chain pathway provides a theoretical reference for mental health interventions during the normalization stage of COVID-19 prevention and control. In addition, perceived social support served as a moderating variable that could help protect the individuals from the negative effects of negative coping style and rumination, and also serve as a signal of psychological crisis in the particular case of quarantine.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Department of Psychology, School of Philosophy, Wuhan University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

LY generated the idea, designed study, and wrote the manuscript. ZY and YX participated in the data collection and supervised the study. All authors have contributed to and have approved the final manuscript.

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Conflict of interest

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

Publisher's note

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Chinese college students COVID-19 phobia and negative moods: Moderating effects of physical exercise behavior

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Objective: We investigated the effects of COVID-19 fear on negative moods among college students, and assessed the efficacy of physical exercise behavior as a moderator variable.

Methods: This was a cross-sectional study. Students from three colleges and universities in Shangqiu City, Henan Province and Yangzhou City, Jiangsu Province were enrolled in this study, which was performed during the COVID-19 pandemic using an online questionnaire. A total of 3,133 college students completed the questionnaire. Measurement tools included the COVID-19 Phobia Scale (C19P-S), Depression-Anxiety-Stress Self-Rating Scale (DASS), and the Physical Activity Behavior Scale (PARS-3).

Results: During the COVID-19 pandemic, the rates of depression, anxiety, and stressful negative moods among college students were 35.5, 65.5, and 10.95%, respectively; there was a positive correlation between COVID-19 fear and negative moods among college students ($r = 0.479$, $p < 0.001$), which was negatively correlated with physical exercise behavior ($r = -0.4$, $p < 0.001$); the regulating effects of physical exercise behavior were significant ($\Delta R2 = 0.04$, $p < 0.001$).

Conclusion: The rate of negative moods among college students is high, and the fear for COVID-19 is one of the key factors that lead to negative moods. Physical exercise can modulate the impact of COVID-19 fear among college students on negative moods. Studies should elucidate on mental health issues among different populations during the COVID-19 pandemic.

KEYWORDS

specific phobias, negative moods, moderating effects, COVID-19, mental health, college students

Introduction

Coronavirus disease 2019 (COVID-19) is a global pandemic (1) whose rapid spread has led to an increase in negative news. Knowledge on health among people in China is low, which hampers efforts that are aimed at establishing the onset of epidemics to design appropriate control strategies (2). Therefore, COVID-19 is a major infectious disease that is associated with various stressful psychological disorders, such as worry, anxiety, depression, helplessness, panic, and anger among others. Its pathological symptoms include tachycardia, body tremors, anorexia, and difficulty falling asleep. Studies were aimed at developing suitable approaches to reduce psychological stress levels during global pandemics, such as COVID-19, and to improve immunity (3).

College students are in the transition stage from adolescence to adulthood. Due to various external factors (such as interpersonal relationships, study pressures, campus life, etc.) and their own bad cognition, these students have frequently experienced psychological problems with extreme cases such as suicide and self-harm (4, 5). Among them, incidences of emotional behavior problems due to negative moods are higher and are more harmful (6, 7). Negative moods are correlated with perception of various kinds of pain and unpleasantness, and they often lead to intense behaviors (such as suicidal behaviors) and physiological reactions (such as crying) (8, 9). Among the connotative indicators of negative moods, depression, anxiety and stress are the most common among college students (10). Depression, anxiety, and stress are interconnected and often co-occur, leading to extreme behavioral problems such as suicide among college students (11, 12). Therefore, studies on related factors that induce negative moods are important to improve the mental health of college students.

Epidemics such as the H1N1 virus and the SARS-coronavirus had severe negative psychological effects, and caused phobia in people (13–15). Phobias are defined by persistent and excess fear of objects, situations, and phenomena. According to the American Psychiatric Association (APA) Diagnostic and Statistical Manual of Mental Disorders (DSM-V) criteria, phobias include social phobia, agora phobia and specific phobia (16). The phobia caused by COVID-19 is a specific phobia (17–19). Individual temperament, genetic and physiological factors, as well as environmental conditions are predisposing factors for specific phobias (16). Major infectious disease outbreaks, such as the COVID-19 pandemic, are among environmental triggers of phobias. Globally, specific phobias are the most common psychiatric disorders (20, 21). Persistent specific phobias can trigger suicidal tendencies, major depressive disorders and anxiety disorders among others (22, 23). Therefore, it is necessary to pay attention to phobias during major public health emergencies.

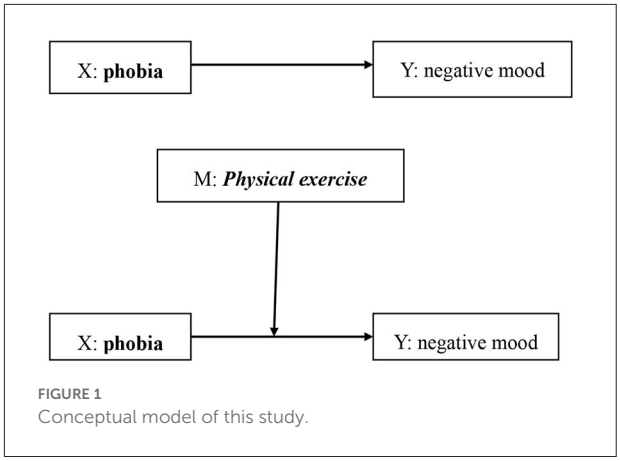

FIGURE 1
Conceptual model of this study.

Physical exercise is effective for coping with psychological stress. Different exercise programs, exercise durations and exercise intensity have different effects on the body's response to psychological stress. Moderate-intensity physical exercise enhances immune functions, which enhances adaptability to chronic and acute psychological stress (24–27). Studies on empirical interventions of mental health challenges among college students through sports programs verified the above conclusions (28, 29). Therefore, this study introduced physical exercise behavior as a moderator variable.

Based on literature review, college students were used as study participants, "COVID-19 fear and negative moods" was the breakthrough point, and physical exercise behavior was introduced as a moderator variable. The hypotheses in this study were: H1: There is a significant positive correlation between COVID-19 fear and negative moods among college students; H2: Physical exercise behavior can moderate the impact of COVID-19 fear on negative moods among college students (Figure 1). The purpose of this study is to verify the above two null hypotheses. To test whether physical exercise behavior of college students can alleviate negative emotional problems caused by COVID-19 fear. This study is of great significance as it elucidates on inducing factors of negative moods such as anxiety, depression and stress to promote the mental health of college students.

Materials and methods

Participants

We used an online questionnaire, which is published online through the "Questionnaire Star" software. Eight questionnaire

investigators were trained in this study, and the identity of every investigator was a "student counselor". Students from three universities; Yangzhou University in Yangzhou City, Jiangsu Province, Shangqiu College in Shangqiu City, Henan Province, and Shangqiu Normal University were enrolled in the questionnaire survey [Yangzhou City, Jiangsu Province (investigation time: October 2021) and Shangqiu City, Henan Province (investigation time: May 2021)]. The universities under investigation have epidemic prevention and control plans to restrict students' out-of-school activities. Questionnaires were distributed and collected through the online platform (Questionnaire Star).

The main questionnaire distribution procedures were: (i) Unified release of standardized filling instructions, questionnaires and reward mechanism descriptions; (ii) Subjects filled in anonymously, of which 151 people filled in their real names, and those who anonymously completed their questionnaire get paid after completing the questionnaire. The IP address was set to allow filling only once. This part of the sample was set as sample 1, and the questionnaire filling time was 5 working days. (iii) After an interval of 10 working days, real names were filled in to complete the second filling. This sample was set as sample 2, and the questionnaire filling time was 5 working days. Sample 2 was only used for test-retest reliability assessment of the scale.

Measurements

COVID-19 phobia scale

The COVID-19 phobia scale (C19P-S) is a specific phobia scale specifically developed to assess the fear of COVID-19. Arpaci et al. (17), at the recommendation of the APA, developed a test item based on the current C19P-S that corresponds to the DSM-V's specific phobia diagnostic criteria. The C19P-S has a total of 20 items, including 4 factors of psychology, physiology, economy and society, each of which can be individually applied. Since the scale has no precedent for its application in the Chinese population, we conducted translation and adaptation tests on the scale.

Chinese translation of C19P-S was performed *via* the "round-trip translation method". First, a graduate student majoring in English and a graduate student majoring in psychology independently translated the questionnaire, after which the two graduate students discussed and obtained the first draft of the translation. Then, the first draft was handed over to a Ph.D. in psychology (associate professor, doctoral supervisor) for English back-translation. Finally, a Chinese scholar who is familiar with Chinese and English and who lives in an English-speaking country was invited to review the content of the back-translation, conduct Chinese translation, and finally determine the Chinese final draft of C19P-S. The C19P-S uses a Likert 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The higher the score, the higher the fear of COVID-19.

Based on classical measurement theory, we conducted a reliability and validity test for C19P-S. Reliability and validity tests showed that the means for all items in C19P-S were between 1.79 and 2.53, while their standard deviations were between 0.97 and 1.39. Correlations r between each item score and total score were above 0.78 (Table 1), indicating that all items have a good discrimination degree. Exploratory factor analysis showed that: KMO = 0.97, Bartlett sphericity test was significant ($\chi 2 = 64{,}554.62$, df = 190, $p < 0.001$), indicating that factor analysis was suitable. Exploratory factor analysis was performed by principal component analysis. Based on characteristic root >1, 4 factors were extracted. Combined with the gravel diagram, the fifth eigenvalue was established to be an inflection point, after which the trend became flat, and was considered appropriate for extraction of the 4 factors. Therefore, exploratory factor analysis was performed after setting the number of factors to 4. Factor loading for each item was between 0.42 and 0.89 (Table 2), which indicated that the scale had good construct validity. The test-retest reliability coefficient was between 0.69 and 0.95, indicating that the scale had good test-retest reliability. Cronbach's alpha coefficients for the four sub-test scales were 0.79, 0.81, 0.85, and 0.78, respectively, while the overall Cronbach's alpha coefficient for the scale was 0.69, which indicated that the scale had good internal consistency. Overall, based on the classical measurement theory, it was determined that the C19P-S could be used in the Chinese college student population.

Depression, anxiety, and stress scale

The depression, anxiety and stress scale (DASS) is based on the three-dimensional model proposed by Clark and Watson, which argues that depression and anxiety have both unique and common symptoms (30). In this study, the 21-Item Depression Anxiety and Stress Scale (DASS-C21) was adapted by Wen, specifically for Chinese college students (31). The scale uses the Likert 4-point scoring standard, with corresponding scores ranging from 0 to 3, and higher scores indicating higher levels of negative moods.

The reliability and validity of DASS-C21 among Chinese college students is high (31). The norm for DASS-C21 college students is: depression score ≤9 is normal, 10–13 is mild, 14–20 is moderate, 21–27 is severe, ≥28 is very severe. Anxiety score ≤7 is considered normal, 8–9 is mild, 10–14 is moderate, 15–19 is severe, and ≥20 is very severe. A stress score of ≤14 is considered normal, 15–18 is considered mild, 19–25 is considered moderate, 26–33 is considered severe, and ≥34 is considered very severe (31). DASS-C21 is often used to assess negative mood symptoms in clinical practice.

The reliability and validity of DASS-C21 among Chinese college students are relatively high (31). The overall Cronbach's alpha coefficient and test-retest reliability of the scale are 0.912 and 0.751, respectively, while the average correlation coefficient

TABLE 1 Summary of C19P-S descriptive analysis, correlation analysis, and exploratory factor analysis results.

Dimension	Item	Descriptive analysis		Related analysis	Exploratory factor analysis				
		M	SD	*r*	Factor 1	Factor 2	Factor 3	Factor 4	Commonality
Psychology									
	PS_1	2.181	1.178	0.831**		0.741			0.760
	PS_2	2.532	1.394	0.804**		0.811			0.781
	PS_3	2.338	1.269	0.849**		0.842			0.884
	PS_4	2.325	1.258	0.859**		0.823			0.862
	PS_5	2.413	1.276	0.852**		0.820			0.856
	PS_6	2.375	1.274	0.823**		0.738			0.755
Physiological									
	PH_1	1.845	1.008	0.804**	0.861				0.889
	PH_2	1.806	0.981	0.788**	0.883				0.924
	PH_3	1.795	0.968	0.789**	0.889				0.933
	PH_4	1.830	0.995	0.811**	0.868				0.938
	PH_5	1.857	1.030	0.822**	0.842				0.916
Economy									
	EC_1	1.938	1.065	0.854**				0.451	0.874
	EC_2	1.989	1.071	0.873**				0.611	0.893
	EC_3	2.018	1.077	0.874**				0.623	0.876
	EC_4	1.991	1.052	0.870**				0.588	0.878
Society									
	SO_1	2.172	1.181	0.881**			0.420		0.859
	SO_2	2.442	1.293	0.809**			0.812		0.896
	SO_3	2.517	1.303	0.776**			0.813		0.882
	SO_4	2.203	1.172	0.867**			0.564		0.800
	SO_5	2.194	1.153	0.881**			0.538		0.820

**$P < 0.001$.

TABLE 2 Distribution of research objects (sample 1).

Index	Number	Percentage (%)
Sex		
Male	1,311	41.8
Female	1,822	58.2
Area		
Shang Qiu	1,979	63.2
Yang Zhou	1,154	36.8
Grade		
First	1,492	47.6
Second	1,086	34.7
Third	555	17.7
Overall	3,133	100.0

between items is 0.338. The Pearson correlation coefficient of the total score of the scale is between 0.895 and 0.910, while the correlation coefficient between the scores for each subscale is 0.708–0.741 ($p < 0.01$). CFI = 0.914, IFI = 0.909, TLI = 0.894, RMSEA = 0.059 (31). In general, DASS-C21 is suitable for Chinese college students.

Physical activity rating scale

The physical activity rating scale (PARS-3) was compiled by the Japanese scholar, Takao Hashimoto, and was subsequently completed by Liang in China. Physical exercise volume was assessed with respect to exercise intensity, frequency, and time of one exercise activity to measure physical exercise participation (32).

Physical exercise volume score = intensity × (time – 1) × frequency (2)

Each parameter was evaluated using five score levels. Level standards were: small exercise volume ≤19 points, moderate exercise volume = 20–42 points, and large exercise volume ≥43 points (32). Re-test reliability of this scale was 0.820. Follow-up related research showed that internal consistency reliability of PARS-3 was Cronbach's $\alpha = 0.85$. The value of the scale was used to reflect physical exercise behaviors of college students.

Statistical analysis

We used SPSS 25 for analysis. The main calculation steps for C19P-S reliability and validity were: (i) Determination of the mean and standard deviations for each item, and using the Spearman rank correlation to assess correlations between the score for each item and total score, so as to perform item analysis; (ii) Using exploratory factor analysis to test the construct validity of the scale; (iii) Performing the Spearman rank correlation analysis to assess the test-retest reliability; (iv) Using the Cronbach α coefficient to test the internal consistency reliability of the scale.

In this study, descriptive data were used to analyze the current situation of college students' COVID-19 fear, negative moods and physical exercise behaviors, with one-way ANOVA performed to analyze differences in COVID-19 fear among students of different gender and grades. The effect size was η^2; the chi-square test was performed to assess differences in negative moods and physical exercise behaviors of students of different genders and grades (effect size is based on Cramer's V coefficient). The Pearson simple correlation analysis was used to assess correlations among COVID-19 fear (including four sub-tests of physiology, psychology, economy and society), negative moods (including three sub-tests of depression, anxiety and stress) and physical exercise. Linear regression analysis was performed to verify the moderating effects of physical exercise behaviors. The three variables were standardized (Z-score) before the assessments of moderating effects.

The procedure for testing the moderating effect is as follows. (i) Negative emotion is the dependent variable, and all control variables are added to form M0. (ii) On the basis of M0, the independent variable COVID-19 phobia and the moderating variable physical exercise behavior were added to form M1. (iii) On the basis of M1, the interaction term (independent variable * moderating variable) is added to form M2. In the interpretation of the results, we mainly refer to the following indicators. The F-value is used to determine whether the model is meaningful, and when $p < 0.05$, it indicates that the model is meaningful. R^2 represents how well the model fits, and the closer to 1, the better. ΔR^2 stands for model change and is used to explain the explanatory force of the model. In the step-by-step interpretation of the above statistical indicators, when all the tests are passed, ΔR^2 can be used to verify the adjustment effect of the interaction between the independent variable and the adjustment variable, and the larger the value of ΔR^2, the more significant the adjustment effect (33).

Results

Descriptive analysis

Table 3 shows that there were significant gender differences with regards to psychological, physiological, economic, social and total scores of COVID-19 fear among college students. Specifically, the score for women was significantly higher than that of men ($p < 0.05$), implying that women are more afraid of COVID-19. Differences in psychological scores of college students in different grades were insignificant ($p = 0.192$), with the highest score in the first grade and the lowest score in the second grade. There were significant differences in scores among different grades of physiology, economy, society and total scores ($p < 0.05$). The highest score was in the second grade while the lowest score was in the first grade, in contrast to the psychological score and trend.

In Table 4, the normal evaluation of depression in the negative moods of college students included in the analysis was 64.48% of the total sample, about 35.5% of college students had depressive symptoms, and about 13.25% of the total sample was moderate or above. College students in the anxiety test accounted for 34.50% of the total sample. About 65.50% of college students had symptoms of anxiety. Incidences of severe and very severe anxiety were 5.68 and 1.79%, respectively. The stress test showed that 89.05% of college students were normal, only 10.95% had severe stress, 3% had moderate or above stress, and there were no college students with very severe stress. Physical exercise assessment revealed that 66.14% of college students performed small amounts of exercise, 16.01% performed moderate amounts of exercise, while 17.81% of total sample were engaged in large amounts of exercise.

The rates of depression and anxiety were significantly higher among women than in men (Cramer's $V = 0.085$, $p < 0.001$). The rate of anxiety was significantly higher in males than in females (Cramer's $V = 0.11$, $p < 0.001$). Men and women had comparable stress rates. Overall, the negative moods among college students included in the analysis were serious, and were more severe among women than in men. There were significant differences in physical exercise behaviors among college students of different sex (Cramer's $V = 0.369$, $p < 0.001$). Proportions of moderate and heavy exercises among male students were higher than in female students. Differences in rates of negative moods and physical exercise behaviors among college students of different grades were also significant ($p < 0.001$ for both). The proportion of students in the second grade who exercised moderately and heavily was greater than that of students in the first and third grades.

Correlation analysis

Table 5 shows that the correlation coefficient between total score of C19P-S scale and physical exercise behaviors for college students was -0.1400 ($p < 0.001$). The four subscales of C19P-S were negatively correlated with physical exercise behaviors of college students. Specifically, the correlation coefficient between college students' physiological phobia and physical exercise behavior was -0.577 ($p < 0.001$), that between college students' economic phobia and physical exercise behavior was -0.393

TABLE 3 COVID-19 fear among students of different gender and grade.

	Overall		Sex				Grade					
			Male (n = 1,311)		Female (n = 1,822)		First (n = 1,492)		Second (n = 1,086)		Third (n = 555)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Psychology												
Original score	14.030	6.456	12.676	6.382	15.004	6.335	13.796	6.278	14.269	6.651	14.248	6.550
Standard score	2.339	1.076	2.113	1.064	2.501	1.056	2.299	1.046	2.378	1.108	2.375	1.092
F					98.782					1.649		
p					<0.001					0.192		
η^2					0.031					0.001		
Physiological												
Original score	8.700	4.214	8.507	4.449	8.843	4.034	8.338	3.886	9.127	4.501	8.891	4.434
Standard score	1.741	0.843	1.701	0.890	1.769	0.807	1.668	0.777	1.825	0.900	1.778	0.887
F					3.993					12.184		
p					0.045					<0.001		
η^2					0.001					0.008		
Economy												
Original score	7.610	3.701	7.132	3.690	7.958	3.672	7.336	3.498	7.925	3.840	7.783	3.928
Standard score	1.904	0.925	1.783	0.923	1.990	0.918	1.834	0.874	1.981	0.960	1.946	0.982
F					36.154					8.05		
p					<0.001					<0.001		
η^2					0.011					0.005		
Society												
Original score	11.030	5.014	10.092	4.999	11.699	4.918	10.706	4.795	11.337	5.142	11.343	5.318
Standard score	2.206	1.003	2.018	1.000	2.340	0.984	2.141	0.959	2.267	1.028	2.269	1.064
F					77.203					5.453		
p					<0.001					0.004		
η^2				0.024				0.003				
Overall												
Original score	41.381	17.356	38.490	17.832	43.461	16.704	40.209	16.306	42.658	18.260	42.031	18.087
F					68.803					5.729		
p					<0.001					<0.001		
η^2					0.020					0.004		

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TABLE 4 Status quo and gender and grade differences in NM and physical exercise behaviors among college students.

Index	Overall		Sex				Grade					
			Male ($n = 1,311$)		Female ($n = 1,822$)		First ($n = 1,492$)		Second ($n = 1,086$)		Third ($n = 555$)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Depression												
Normal	2,020	64.475	871	66.438	1,149	63.063	1,010	67.694	644	59.300	366	65.946
Mild	698	22.279	249	18.993	449	24.643	336	22.520	245	22.560	117	21.081
Moderate	361	11.523	159	12.128	202	11.087	135	9.048	161	14.825	65	11.712
Severe	43	1.372	23	1.754	20	1.098	11	0.737	28	2.578	4	0.721
Very serious	11	0.351	9	0.686	2	0.110	0	0.000	8	0.737	3	0.541
$\chi 2$					22.608					53.776		
p					<0.001					<0.001		
Cramer's V					0.085					0.093		
Anxiety												
Normal	1,081	34.504	522	39.817	559	30.681	506	33.914	369	33.978	206	37.117
Mild	858	27.386	330	25.172	528	28.979	441	29.558	267	24.586	150	27.027
Moderate	960	30.642	353	26.926	607	33.315	446	29.893	350	32.228	164	29.550
Severe	178	5.681	74	5.645	104	5.708	87	5.831	62	5.709	29	5.225
Very serious	56	1.787	32	2.441	24	1.317	12	0.804	38	3.499	6	1.081
$\chi 2$					38.028					36.104		
p					<0.001					<0.001		
Cramer's V					0.110					0.076		
Stress												
Normal	2,790	89.052	1,162	88.635	1,628	89.352	1,363	91.354	931	85.727	496	89.369
Mild	249	7.948	95	7.246	154	8.452	104	6.971	105	9.669	40	7.207
Moderate	83	2.649	44	3.356	39	2.141	25	1.676	42	3.867	16	2.883
Severe	11	0.351	10	0.763	1	0.055	0	0.000	8	0.737	3	0.541
Very serious	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
$\chi 2$					16.574					30.404		
p					0.001					<0.001		
Cramer's V					0.073					0.070		
Physical exercise												
Small	2,072	66.135	608	46.377	1,464	80.351	1,119	75.000	626	57.643	327	58.919
Moderate	503	16.055	286	21.815	217	11.910	210	14.075	194	17.864	99	17.838
Large	558	17.810	417	31.808	141	7.739	163	10.925	266	24.494	129	23.243
$\chi 2$					427.650					117.044		
p					<0.001					<0.001		
Cramer's V					0.369					0.137		

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TABLE 5 Correlations between COVID-19 fear, NM, and physical exercise behaviors among college students.

		Physiological	Economy	Society	C19P_S	Depression	Anxiety	Stress	DASS
Psychology	*r*	0.624**	0.709**	0.759**	0.894**	0.374**	0.413**	0.421**	0.420**
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Physiological	*r*	1	0.854**	0.689**	0.856**	0.429**	0.443**	0.412**	0.446**
	p		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Economy	*r*	0.854**	1	0.813**	0.919**	0.427**	0.440**	0.434**	0.452**
	p	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Society	*r*	0.689**	0.813**	1	0.912**	0.372**	0.396**	0.403**	0.407**
	p	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
C19P_S	*r*	0.856**	0.919**	0.912**	1	0.442**	0.470**	0.465**	0.479**
	p	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001
Depression	*r*	0.429**	0.427**	0.372**	0.442**	1	0.868**	0.875**	0.953**
	p	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001
Anxiety	*r*	0.443**	0.440**	0.396**	0.470**	0.868**	1	0.894**	0.959**
	p	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001
Stress	*r*	0.412**	0.434**	0.403**	0.465**	0.875**	0.894**	1	0.965**
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
DASS	*r*	0.446**	0.452**	0.407**	0.479**	0.953**	0.959**	0.965**	1
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
PARS-3	*r*	−0.377**	−0.393**	−0.485**	−0.400**	−0.482**	−0.577**	−0.480**	−0.483**
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

**$P < 0.001$.

($p < 0.001$), while the correlation coefficient between college students' social phobia and physical exercise behavior was −0.393 ($p < 0.001$). The correlation coefficient for behavior was −0.485 ($p < 0.001$). From the perspective of negative moods, the correlation coefficient between DASS total score and physical exercise behavior was −0.483 ($p < 0.001$), that between depression and physical exercise behavior in the subscale was −0.482 ($p < 0.001$), anxiety and physical exercise correlation coefficient of behavior was −0.577 (p <.001). The correlation coefficient between stress and physical exercise behavior was −0.480 ($p < 0.001$). The correlation coefficient between C19P-S and DASS total scores was 0.479 ($p < 0.001$). Moreover, there were significant correlations between the four dimensions of C19P-S and the three dimensions of negative mood ($r = 0.372$–0.443, $p < 0.001$). The above results suggest that further moderating effect analysis can be conducted on COVID-19 phobia, negative moods and physical exercise behaviors among college students.

Moderating effects test

Table 6 shows the moderating effects of physical exercise behavior. Table 6 shows that in model 1, the explanation rate of independent variables and moderator variables for the dependent variable is 23%, and in model 2, the predictive power increases by 4%. These findings imply that under the condition that independent and moderator variables remain unchanged, an increase of 4% is the predictive ability of the interaction term for the dependent variable, that is, the contribution rate of the moderating effect. The significant F change was <0.001 in model 1 and 0.034 (<0.05) in model 2, indicating that the independent and moderator variables were significant in predicting the dependent variable. Further, p values in ANOVA were all < 0.001, indicating that the moderating effect of the moderator variable on the independent variable was significant.

Discussion

In this study, we established that college students mainly indulge in small amounts of exercise (about 66.14% of the students in this study), and exercise level among males was significantly higher than among females. These findings are in tandem with those of previous studies. After the COVID-19 pandemic, the proportion of college students engaging in small exercises increased significantly, which had a significant negative impact on college students' physical exercise. A previous study reviewed the impact of the outbreak of the new crown epidemic on physical activities among college students. Walking, intensities and total physical activity levels among college students in different countries were found to be significantly decreased (34). The COVID-19 pandemic has exacerbated the

TABLE 6 Analysis of the moderating effects of physical exercise behaviors.

Model	Model summary					ANOVA	
	R^2	ΔR^2	df 1	df 2	Sig. change	*F*	*p*
1	0.230	0.230	2	3,130	<0.001	468.422	<0.001
2	0.230	0.040	1	3,129	0.034	312.232	<0.001

decline in physical activities of various groups of people, and the relevant epidemic prevention policies in China restricted students' outdoor physical exercises to a certain extent.

Regarding negative moods among college students, we established that the rates of depression, anxiety and stress were 35.5, 65.5, and 10.95%, respectively. Xiao et al. reported that the rate of depressive symptoms in Chinese college students during the COVID-19 pandemic was 59.35%, while that of anxiety symptoms was 54.34% (35). In their study, Xiang et al. found that during the COVID-19 pandemic, incidences of depressive and anxiety symptoms in China were 41.8 and 31.0%, respectively (36). These results differ from ours, but they all show that the rates of depression and anxiety among Chinese college students during the COVID-19 pandemic was higher.

In this study, gender had a significant impact on college students' COVID-19 phobia, physical exercise behaviors and occurrence of negative moods. In accordance with our results, gender has been significantly associated with the mental health of college students during the COVID-19 epidemic (37). Social isolation as well as the qualities of social relationships and information received were significantly associated with mental health among college students during the COVID-19 epidemic (37).

The optimal intensity of exercise is to choose the content and intensity of exercise independently based on individual differences to better stimulate exercise motivation and emotional responses, and fixed intensity exercise leads to poor emotional responses and efforts (38, 39). Regarding the form and content of exercise, Wang et al. reported that high-frequency, high-dose moderate-to-high-intensity aerobic exercise combined with strength training and various coordination training has better intervention effects on negative moods (40). Home or school isolation during the COVID-19 pandemic negatively impacted college students' mental health (41–43). Moreover, due to the closed and depressing environment, lack of venues, equipment, and training partners, the duration and intensity of most students' exercise decreased (44), which may have reduced the effectiveness of physical exercise in preventing and improving negative moods. In addition, a longer period of epidemic isolation exacerbated the worsening of negative moods among college students. The results of this study validate the positive effects of physical exercise on mental health.

College students' COVID-19 phobia was positively correlated with negative moods. Hypothetically, COVID-19 phobia affects students' cognitive thinking and emotional cognition, thereby increasing the detection rate of negative moods among college students. This study confirmed the negative correlation between COVID-19 phobia and physical exercise behaviors among college students, that is, the higher the degree of fear, the lower the level of physical exercise. All four dimensions of the C19P-S scale were negatively correlated with physical exercise behaviors. The negative correlation with physical exercise behavior is that fear contains factors that can make students feel afraid, so that students' physical exercise behavior is weakened. In addition, isolation or blockade in movement during the pandemic may have resulted in psychological, physical, social and economic fears among students, which may be the main reason for the reduction in physical exercise.

Our findings validated the null hypothesis H1; the rates of COVID-19 phobia and negative moods among college students were significantly and positively correlated. The more the rates of negative moods among college students, the less the physical exercise. College students independently face academic, employment, social, emotional and other issues, thus, they were more likely to have negative moods during the pandemic. Physical exercise is important for reducing negative moods among college students and is positively correlated with enhancement of college students' self-esteem and self-confidence (45). The negative relationship between college students' negative moods and physical exercise has been widely verified, and the time, intensity and frequency of sports are the main indicators that affect college students' negative moods (46, 47). This result provides a new perspective for combination of school sports and education to jointly improve the mental health and physical activity levels of college students. This study has certain practical significance for guiding students' psychological interventions and strengthening physical exercises in future.

The results of this study validate the null hypothesis H2; physical exercise behaviors can moderate the effects of college students' COVID-19 phobia on negative moods. The mental health of college students can be improved through physical exercise (48–50). Some studies used different sports programs to enhance the mental health of college students. Jiao et al. used Wuqinxi to enhance the mental health of female college students, they found that after a semester of interventions, depressive symptoms among students were significantly reduced (51). By changing the exercise behaviors of

the subjects to increase the amounts of physical activities, such as increasing the intensity, frequency, and increasing the duration of behaviors. Negative moods decrease with increasing physical exercise levels.

Results from the moderating effects can be explained using the distraction hypothesis, which states that sustained physical activity can divert individuals from unpleasant stimuli or painful physical discomfort, thereby improving overall moods (52). The monoamine hypothesis at the physiological level states that appropriate intensities of physical activities can increase the release rate of monoamine transmitters in the human body, promote the transmission of monoamine transmitters between neurons, and accelerate the absorption of monoamine transmitters by neurons, thereby improving the moods of subjects (53). Based on these theories, studies should aim at establishing suitable approaches for promotion or improvement of mental health of college students by exercise.

The limitation of this study is that we adopted a cross-sectional study design, thus, the dose-response relationship between COVID-19 phobia and negative moods was not explored. The methodological system for assessment of causality in health research is relatively mature. For the five types of challenges in exploration of causality, such as measurement bias, omitted variables, mutual causality, common cause and selection bias, the causal relationship has been established. Inference methods include randomized controlled experiments, propensity score matching, instrumental variables, difference-in-differences, breakpoint regression designs, and individual fixed-effects models (cross-lag models, latent growth linear models, etc.) (54). Scholars can choose the methodology according to their own research expertise, and at the same time, combined with the current development of big data technology, make full use of machine learning to enhance the scientific nature of their own research, improve research efficiency, and improve the generalization and popularization of research conclusions so as to enhance academic strength for the realization of a higher level of national health.

Conclusion

We found a high rate of negative moods among college students during the COVID-19 pandemic period, which was higher among female students compared to male students. College students' COVID-19 phobia may be one of the key factors inducing negative moods. Physical exercise can moderate the impact of COVID-19 phobia on negative moods among college students. More studies should elucidate on mental health issues in different populations during the COVID-19 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 Nantong University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization: S-sH. Data curation: S-sH, BL, Y-hH, Y-zK, G-xW, S-qM, Y-xL, Z-lC, and W-xT. Formal analysis: S-sH and W-xT. Funding acquisition: S-sH, Y-zK, S-qM, Y-xL, and W-xT. Investigation: S-sH, Y-xL, and W-xT. Methodology: S-sH, G-xW, Y-xL, and W-xT. Project administration: S-sH, BL, Y-zK, G-xW, S-qM, Z-lC, and W-xT. Resources: W-xT. Software: S-sH and G-xW. Supervision: W-xT. Validation: S-qM and Z-lC. Visualization: Y-xL and W-xT. Writing—original draft: S-sH, BL, Y-hH, and Y-zK. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

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

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How has the COVID-19 pandemic affected young people?—Mapping knowledge structure and research framework by scientometric analysis

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Since the outbreak of COVID-19, there has been a large body of literature focusing on the relationship between the COVID-19 pandemic and young people. The purpose of this study is to explore the current research status and the specific mechanism of COVID-19's effects on young people based on related literature. This paper mainly used VOS viewer and CiteSpace software to conduct a scientometric analysis of 5,077 publications retrieved from the Web of Science database. The results show that the main contributors to the field were mainly from North America and Europe, and the trend of research focus was from shallow to deep. The five main research areas in the field were summarized by keyword clustering analysis as follows: lifestyle changes due to lockdown; changes in stress and emotions; psychological illness and trauma; risk perception and practice toward the epidemic; interventions and social support. Finally, they were linked by four pathways to form a framework that integrates the relationships between the five domains and between elements within each of them, revealing the mechanism of COVID-19's effect on young people. In addition, less studied but promising elements are also presented in the framework, such as research on special groups (disadvantaged socioeconomic groups and sexual minority youth) and extreme suicidal tendencies that deserve our further attention.

KEYWORDS

COVID-19, teenager, adolescent, children, mental health, lifestyle, VOS viewer, CiteSpace

Introduction

Since the emergence of the Corona Virus Disease 2019 (COVID-19), the virus has rapidly swept the world due to its high infectiousness. As of September 2022, there were more than 600 million cumulative confirmed cases and more than 6 million deaths worldwide (1). Countries around the world have responded with various measures to

control the spread of the virus. And in many cases, people have to reduce their social activities and keep a social distance. For this group of young people, social isolation (such as the closure of schools and social venues) has kept them in a state of long-term online learning and weakened their connections with teachers, classmates, and other social networks. At the same time, emerging adults who are about to enter society and seek employment also feel confused and uneasy about their futures (2). With COVID-19 now in its third year, the prolongation of such a public crisis event generates fear, sleep disorders, anxiety, depression, and other risk factors that affect the mental health of young people (3–5) and can even lead to unhealthy lifestyles, reduced physical fitness, and other physical problems in the future as a result (6).

So far, a large amount of literature has been published in this field to investigate and analyze the effects of COVID-19 on young people, and it can be said that the relationship between the COVID-19 pandemic and young people deserves our attention. However, the scope of research involves different countries and regions, the content of research is abundant, and the focus of research is different. In the face of the vast literature, some meta-analyses or reviews have existed, but most of them are relatively one-sided, and there is a lack of more comprehensive and systematic studies. Scientometrics, as a quantitative research method, enables a systematic and objective analysis of a large number of publications to identify the current development status and research focus in a particular field (7, 8). In this paper, we will collect and organize the literature in this field in the Web of Science database through the corresponding search strategy and visualize the retrieved literature by using VOS viewer and CiteSpace. The goal of this paper is to provide this field with a new way to understand knowledge distribution through visual analysis and to summarize the research status, hotspots, and main research framework in this field.

Compared with previous review articles on this topic, there are three main contributions as follows: (1) The current state of research (number of publications and leading countries, institutions, subject categories, journals, and references), research focus, and research trends are visualized to provide a new approach to understanding the field from a scientometric perspective. (2) Through keyword clustering analysis, five main research domains within the field are identified, and based on this, they are linked by four pathways to form a framework showing the influence relationships between them and their respective internal elements, thus revealing how the COVID-19 pandemic has affected young people. (3) Studies that are difficult to be noticed due to less research but still have the prospect of development (e.g., suicidal extremism, special groups such as disadvantaged socioeconomic groups and sexual minority youth) are also captured and presented in the framework.

Materials and methods

Data sources and search strategies

The Web of Science Core Collection (WoSCC) was selected as the data source for this study, with a large number of publications covering the most comprehensive range of literature possible. The search date for this study was November 4, 2022, and the search date range was 2020-01-01 to 2022-09-30, with the search term "TS = (COVID-19 OR SARS-CoV-2 OR Coronavirus disease 2019 OR severe acute respiratory syndrome coronavirus 2) AND TS = (teenager OR adolescent OR juvenile OR young OR child OR children OR offspring OR descendant OR junior OR son OR daughter)." After the search, the document types were restricted to "review" and "article," and the language was restricted to English. In order to ensure that the results are more accurate and effective, after discussion with experts from related disciplines, it was determined that the Web of Science Categories should be limited to Public Environmental Occupational Health, Health Care Sciences Services, Psychology Multidisciplinary, Psychology Developmental, Psychology Clinical, Education Educational Research, Health Policy Services, Social Sciences Interdisciplinary, Social Work, Psychology Social, Sport Sciences, and Psychology Social. Then, the two authors continued to conduct manual screening to eliminate publications that were not related to the research theme. Finally, after deleting duplicate records, a total of 5,077 records were obtained, including 4,851 original research articles and 226 reviews. In summary, authoritative database sources, comprehensive search terms, rigorous category screening, and ultimately manual screening can effectively ensure the accuracy of the study sample.

Scientometric tools and functions

Visualization software

VOS viewer is a free JAVA-based software that focuses on the visualization of scientific knowledge through the use of literature data (9), and the version used in this article is VOS viewer1.6.17. We used the citation, co-citation, and co-occurrence functional modules of the software to visualize and analyze institutions, journals, references, and keywords. Each node in the visualization map represents a different parameter, such as institution, journal, keyword, etc. The larger the node, the greater its weight. Nodes are connected by links. Total Link Strength (TLS) is an important metric for identifying this type of visual graph, and the TLS value of a node refers to the number of times that node appears together with all other nodes (10). CiteSpace is a JAVA application for presenting the structure, patterns, and distribution of scientific knowledge (11). The version used in this article is CiteSpace V6.1.R2. The

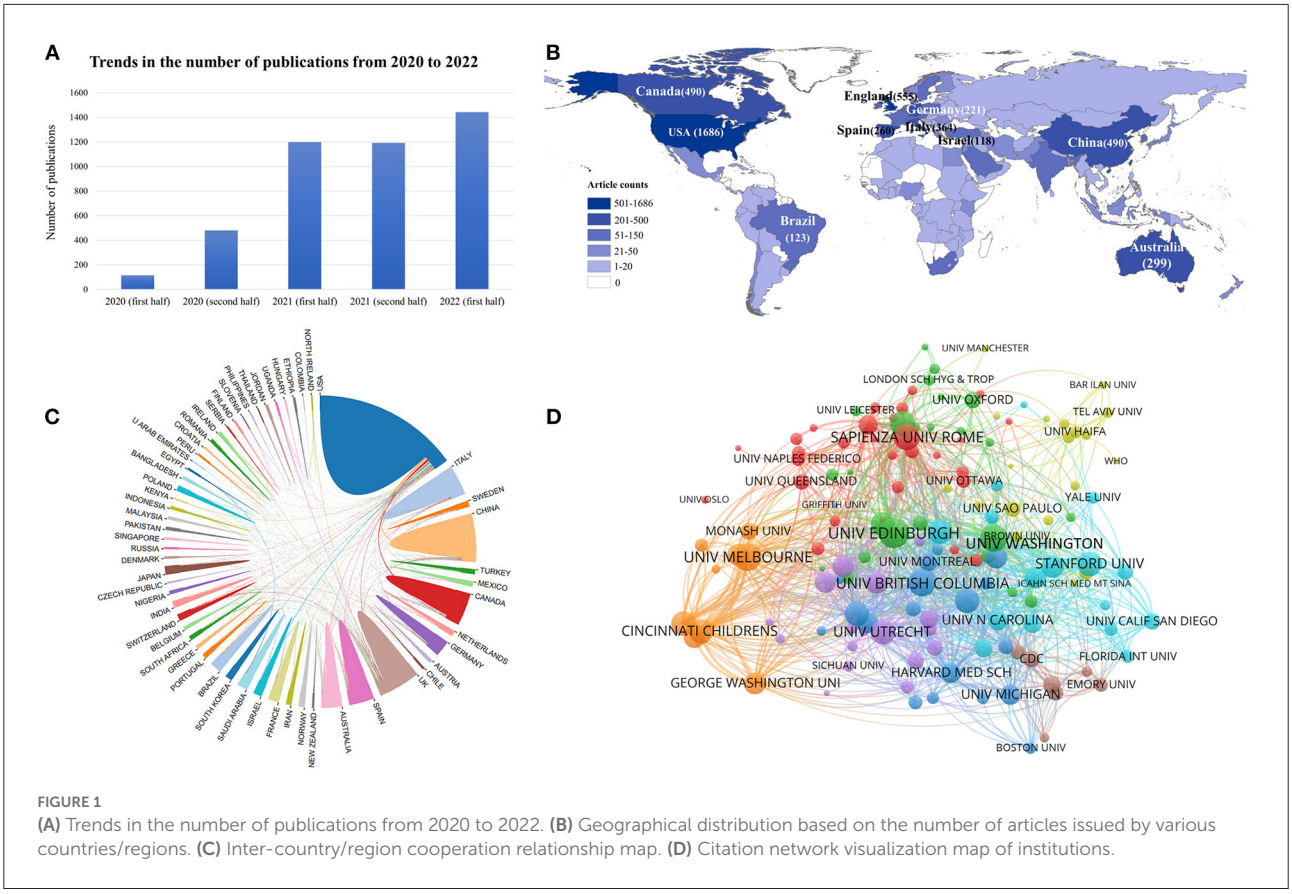

FIGURE 1
(A) Trends in the number of publications from 2020 to 2022. **(B)** Geographical distribution based on the number of articles issued by various countries/regions. **(C)** Inter-country/region cooperation relationship map. **(D)** Citation network visualization map of institutions.

program focuses on analyzing the research progress in a field by using information such as literature authors, titles, keywords, abstracts, citations, etc. In this study, we used CiteSpace to mine the data and produce the dual-map overlay of the journals and the network visualization map of subject categories.

Visualization process

In the process of visual analysis by VOS viewer software, the basic parameters were set as follows: The visualization scale was set at 1.0, and the weight of the node size was total link strength; the layout used the default value; the algorithm for the clustering process using this software was the association strength of the normalization method, as well as a clustering resolution of 1.00 and a minimum cluster size of 1. Based on the above parameter settings, we performed citation analysis of institutions, co-citation analysis of journals and references, and co-occurrence analysis of keywords. The number of clusters in each visualization map will be automatically generated by the software's association strength algorithm.

This article used CiteSpace software to make the dual-map overlay of the journals, set the source circle size to 120, set the target circle size to 15, and checked Z scores. In the process of creating the visualization map of subject categories, the following parameters were set: Time Slicing was 2020 to 2022; Node Type was chosen as categories; Pruning was checked as pathfinder and pruning sliced networks; the rest were the default settings.

Results and discussion

Knowledge structure of research status

Publications and geographic distribution

Figure 1A presents the trends in the number of publications from 2020 to 2022 on a half-yearly basis. Overall, there is a growing body of research exploring the relationship between COVID-19 and young people: from 2020 onwards, the number of publications starts to increase significantly; from the second half of 2021 to the present, the upward trend plateaus. A small increase in the number of publications in this area is expected in the second half of 2022. From the search results, a total of 156 countries/regions have published articles in this research area. The country/region with the highest number of publications and citations was the USA, and its number far exceeded that of other countries, followed by England and China.

Figure 1B shows a geographical distribution based on the number of articles issued by various countries or regions in the

TABLE 1 The top 10 most active institutions.

Rank	Institutions	Continents	Article counts	Total citations	Average citations per article
1	University of London	Europe	191	3,408	17.84
2	University of California System	North America	182	1,406	7.73
3	Harvard University	North America	112	1,327	11.85
4	University College London	Europe	104	2,701	25.97
5	University of Toronto	North America	93	701	7.54
6	Pennsylvania Commonwealth System of Higher Education (PCSHE)	North America	75	593	7.91
7	State University System of Florida	North America	71	1,276	17.97
8	University of North Carolina	North America	67	580	8.66
9	University of Melbourne	Oceania	65	447	6.88
10	University of Texas System	North America	63	402	6.38

field of research on the relationship between COVID-19 and young people. This map allows us to visualize that the majority of articles came from North America, Western Europe, and East Asia. The inter-country/region cooperation relationship map (Figure 1C) shows the international partnerships between countries/regions with at least 20 publications by connecting the lines of different colors. We can clearly see that the USA and the UK were the countries that cooperated the most with other countries.

A total of 6,226 institutions have published articles related to this topic. Table 1 shows the top 10 most active institutions. Overall, these prolific institutions were mainly from Europe and North America. Figure 1D shows the citation network visualization map of institutions. By limiting the documents of the institutions to at least 15, this figure presents a total of 140 nodes representing institutions and 3,290 links. The institution with the highest TSL value was the University of Edinburgh from England (TLS = 324), which had a strong influence among the institutions. Followed by the University of Melbourne (TLS = 288) from Australia and the University of Washington (TLS = 270) from the USA.

Analysis of subject categories and interdisciplinary

In this paper, we analyzed the subject categories obtained from the search results using CiteSpace software and created a network visualization map consisting of several nodes representing the subject categories shown in Figure 2A. Nodes with a centrality value >0.1 are key nodes and carry a purple outer ring. The higher the centrality value of a node, the greater its influence. The top three disciplinary categories with the highest centrality values were PUBLIC, ENVIRONMENTAL and OCCUPATIONAL HEALTH (0.7), PSYCHOLOGY, MULTIDISCIPLINARY (0.29), and PSYCHIATRY (0.28).

The dual-map overlay of the journals (Figure 2B) reflects the topic distribution of journals, which are clustered and named by the LLR algorithm. In the final result presentation, the citing graph of journals is on the left, the cited graph of journals is on the right, and the curves are the citation links (12, 13). On the left side, the focus was on the topics "6. PSYCHOLOGY, EDUCATION, HEALTH" and "2. MEDICINE, MEDICAL, CLINICAL," which were connected to "5. HEALTH, NURSING, MEDICINE," "7. PSYCHOLOGY, EDUCATION, SOCIAL," and "8. MOLECULAR, BIOLOGY, GENETICS" on the right side by four connecting lines. These four lines were the most dominant citation paths among journals in this field. And on the right side of the graph, it can be seen that the topic distribution of cited journals was more dispersed.

Authoritative journals and highly cited references

The journals with the most contributions are listed in Table 2. Figure 3A shows a visualization of the co-citation network of journals, which presents the journals with at least 180 citations in the field, forming a total of 170 nodes with 14,188 links in the graph. The top three journals with the largest TSL values were *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH* (TSL = 96,741), *PLOS ONE* (TSL = 68,082), and *PSYCHIATRY RESEARCH* (TSL = 61,294). These three journals had the strongest correlation with other journals in the field.

Figure 3B shows the co-citation network visualization map of references. One hundred fifty-eight references with at least 40 citations were filtered out to form this visualization map. Among them, the reference with the largest TLS value was *The psychological impact of quarantine and how to reduce it: rapid review of the evidence* (14) published in 2020 by Brooks SK et al. in the *Lancet*, which shows that this article had the most associations with other articles.

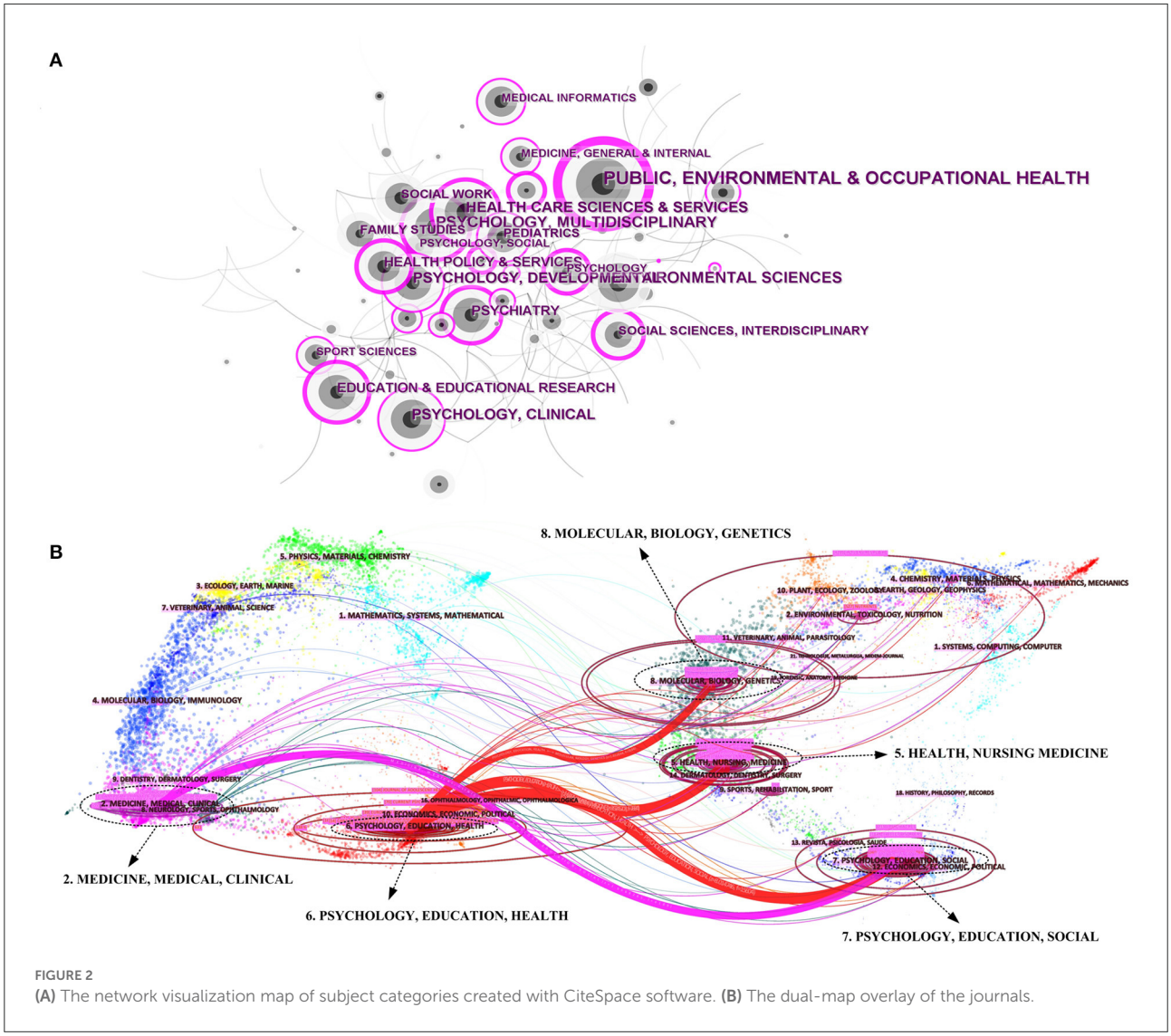

FIGURE 2
(A) The network visualization map of subject categories created with CiteSpace software. **(B)** The dual-map overlay of the journals.

Research focus and trends

Changes in co-occurrence keywords

The analysis of high frequency co-occurrence keywords not only identifies the research focus but also reveals the changing themes and trends. We filtered keywords that occurred 30 or more times as high-frequency keywords and excluded keywords that were duplicated with the search terms to finally generate the co-occurrence overlay visualization map (Figure 4A).

In Figure 4A, the keywords with the largest nodes, i.e., the most co-occurrences, are "depression," "anxiety," "mental health," "stress," "impact," "prevalence," etc., indicating that most of the research in this area has focused on mental health. The color of each node in the figure is determined by the average appearing year (AAY), and the color of the nodes with earlier appearing years is purple, while the color of the nodes with later appearing years is yellow. The number of keywords obtained for 2020, 2021, and the first half of 2022 were 2,140, 6,580, and 4,481, respectively, indicating that the scope study is expanding rapidly and showing a further growth trend.

At the beginning of the epidemic in 2020, research was focused on: "outbreak," "social isolation," "quarantine," "outcomes," "fear," "worry," "mortality," etc., which reflects the harm caused by the spread of the epidemic itself and the intuitive feelings it brought to young people. In 2021, the co-occurrence keywords were mainly focused on words like "mental health," "anxiety," "depression," "disorders," "prevalence," and "symptoms," etc. This indicates that medium term concerns were more serious psychological affects. Since entering 2022, keywords such as "therapy," "vaccine," "sex," "ADHD," "suicide," "predictors," and "adjustment" have emerged. People's attention has shifted from the initial outbreak itself to the treatment of the harm caused by the outbreak and more in-depth and detailed research, such as the investigation of the hesitancy of young

TABLE 2 The journals with the most contributions.

Rank	Journal title	Publications	IF (2021)	JCR (2021)	Total citations
1	International Journal of Environmental Research and Public Health	685	4.614	Q1/Q2	6,868
2	Frontiers in Psychology	292	4.232	Q1	3,233
3	Frontiers in Public Health	208	6.461	Q1	1,224
4	BMC Public Health	130	4.135	Q2	1,328
5	Journal of Adolescent Health	104	7.83	Q1	2,870
6	Healthcare	77	3.16	Q2	250
7	Current Psychology	70	2.387	Q3	309
8	Journal of Medical Internet Research	54	7.076	Q1	1,162
9	European Child Adolescent Psychiatry	40	5.349	Q1/Q2	1,415
10	Social Science Medicine	33	5.887	Q1/Q2	590

people regarding vaccines (15, 16), the study of the sexuality of adolescents and young adults (17, 18), and the study of the impact of the epidemic on children and adolescents with ADHD (19).

Cumulatively, studies of the impact of COVID-19 on young people show a trend from superficial to deeper, evolving from focusing on the initial stage of the outbreak to exploring more subtle changes.

Evolution of research topics

After sorting the keywords by frequency and focusing on the top 100 most frequently occurring keywords, a bubble chart of this study area by quarterly changes between January 2020 and September 2022 is shown in Figure 4B with 11 topics and 4 main categories, which can visually display the change in the heat of the main research hotspots in the field through the evolution of time.

The content of Category 1 "mental health" ("emotional changes" and "psychological disorders") is the most researched, indicating that the mental health of young people has been receiving great academic attention from 2020 to 2022, and its content mainly focuses on issues such as depression, anxiety, stress, and loneliness in young people. Although interest declined at the end of 2021, it rebounded rapidly afterward.

Category 2 focuses on "support from various groups." Except for the topic "teacher perceptions," the popularity of other topics in this category has decreased in 2022.

Category 3 mainly discusses "impact on lifestyle." The main components of the topics "physical activity" and "network & digitization" are the investigation and confirmation of the decrease in physical activity and the increase in internet use among young people during the epidemic (20). The year 2021 is the culmination phase of these topics, followed by a decline, suggesting that academic interest in these topics is declining. However, the topics "substance use" and "quality of life" in category 3 have not fluctuated much in the past 2 years and will continue to receive attention in the future.

Category 4, "epidemic control," includes topics such as "lockdown and isolation" and "COVID-19 vaccination." "Lockdown and isolation," which focuses on the outbreak itself and the immediate impact of lockdown and isolation on young people, has received considerable attention but is now less and less studied. Meanwhile, the popularity of the COVID-19 vaccination has increased in 2022. This is because, since the emergence of the COVID-19 vaccine as one of the major measures for people to deal with COVID-19, its safety and efficacy, as well as young people's attitudes toward the vaccine, have been the subject of research.

Main research domain and framework

Cluster analysis of keywords

Cluster analysis of frequently occurring keywords facilitates a precise grasp of the main knowledge distribution in the field, which is essential for understanding hotspots and anticipating trends. In this study, the keywords were visualized and clustered by VOS viewer. The number of keyword occurrences was limited to 30 or more, and duplicate or unreasonable keywords were manually removed, thus forming the keyword network visualization map (Figure 5). Based on the association strength algorithm, the software divided the high-frequency keywords into five clusters. However, over-reliance on the content of high-frequency keywords for the analysis may result in the five clusters obtained from the results being difficult to achieve comprehensive coverage of all information or having partial overlap between the clusters. Therefore, after understanding and analyzing the five clusters, we imported the data into CiteSpace for keyword clustering analysis. Then, after verifying the Silhouette score several times, we confirmed that the five clusters here are all reasonable. Finally, by inviting three experts

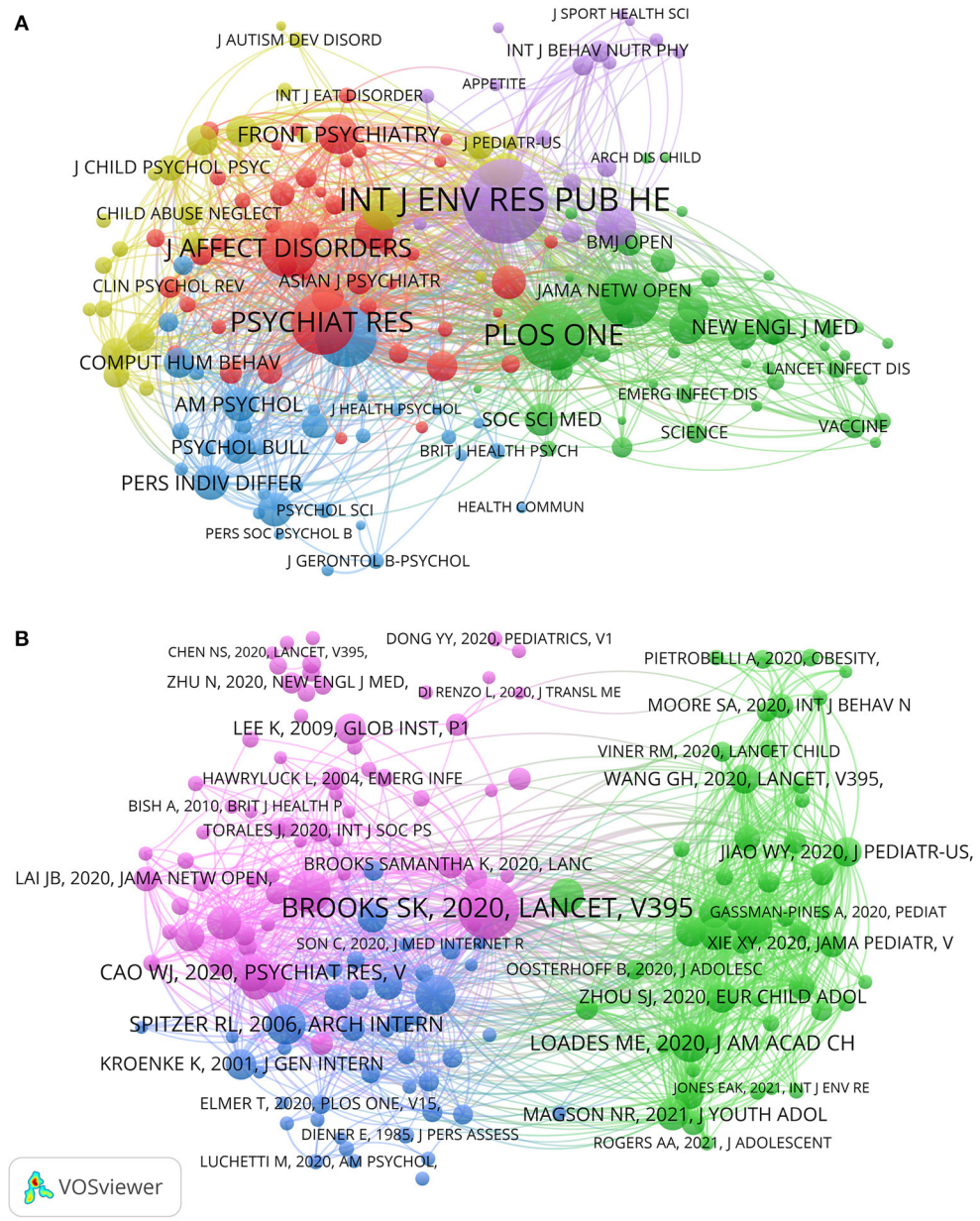

FIGURE 3
(A) Co-citation network visualization map of journals by VOS viewer. **(B)** Co-citation network visualization map of references by VOS viewer.

in adolescent mental health and two experts in youth sports to study and discuss the keywords in each cluster, we named each of these five clusters, which are shown below:

Cluster 1 (lifestyle changes due to lockdown, purple nodes): The main keywords included in this cluster are: "lockdown," "physical activity," "screen time," "substance use," "wellbeing," etc. Lockdown is one of the essential preventive and control measures during the COVID-19 pandemic to prevent the transmission and spread of the epidemic. However, because of the social isolation and school closures, the living conditions of young people are very different compared to those of the past. From several of the most significant nodes in the cluster, it can be summarized that the research in this cluster focused on the changes in physical activity, internet use, and substance use among young people as a result of the lockdown under COVID-19.

Cluster 2 (changes in stress and emotions, yellow nodes): The prominent keywords in this cluster are: "stress," "loneliness," "emotion," "fear," etc. Children and adolescents are still immature in their physical and psychological development and

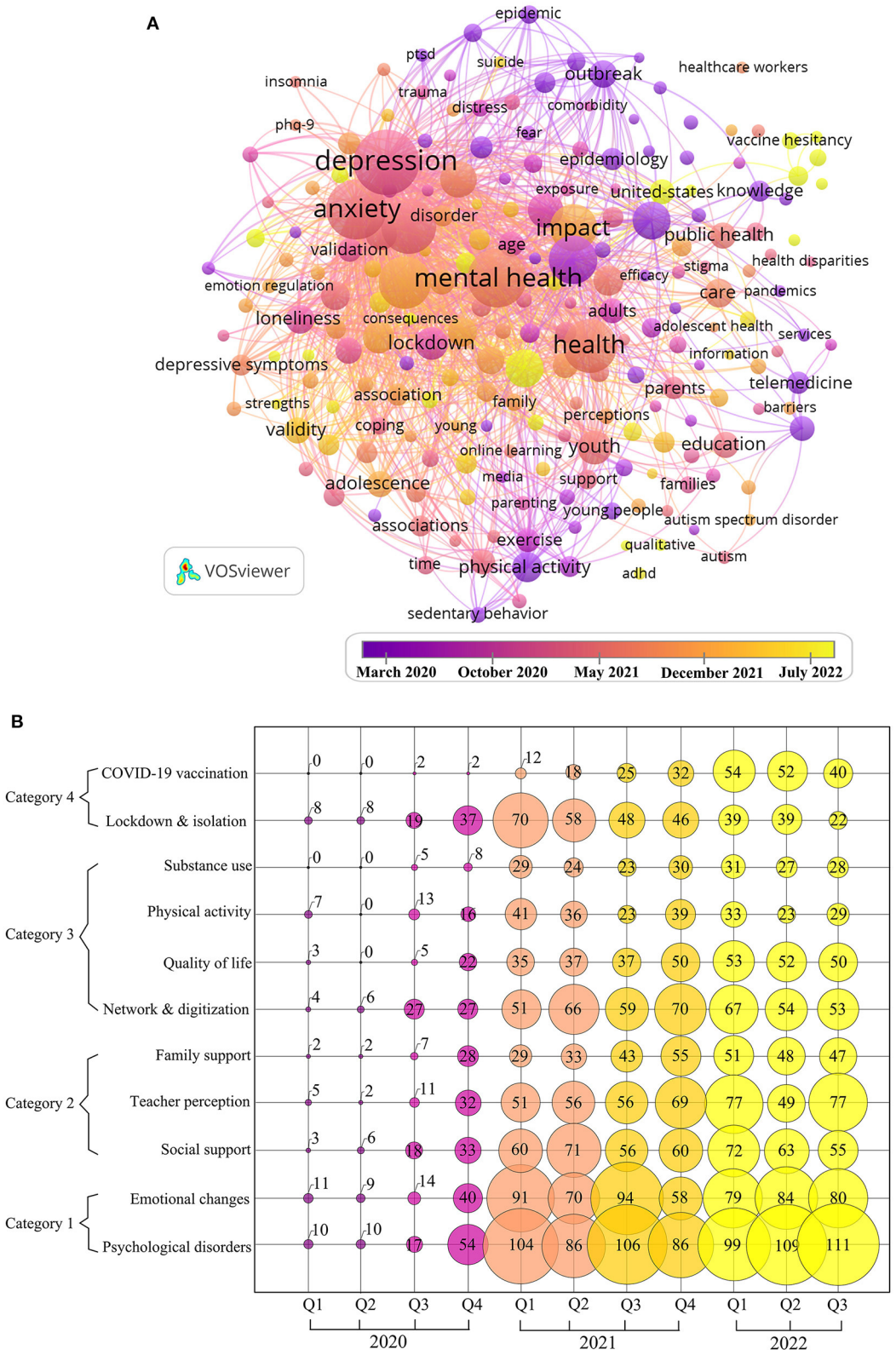

FIGURE 4
(A) Co-occurrence overlay visualization map of high-frequency keywords. **(B)** Bubble charts of research topics.

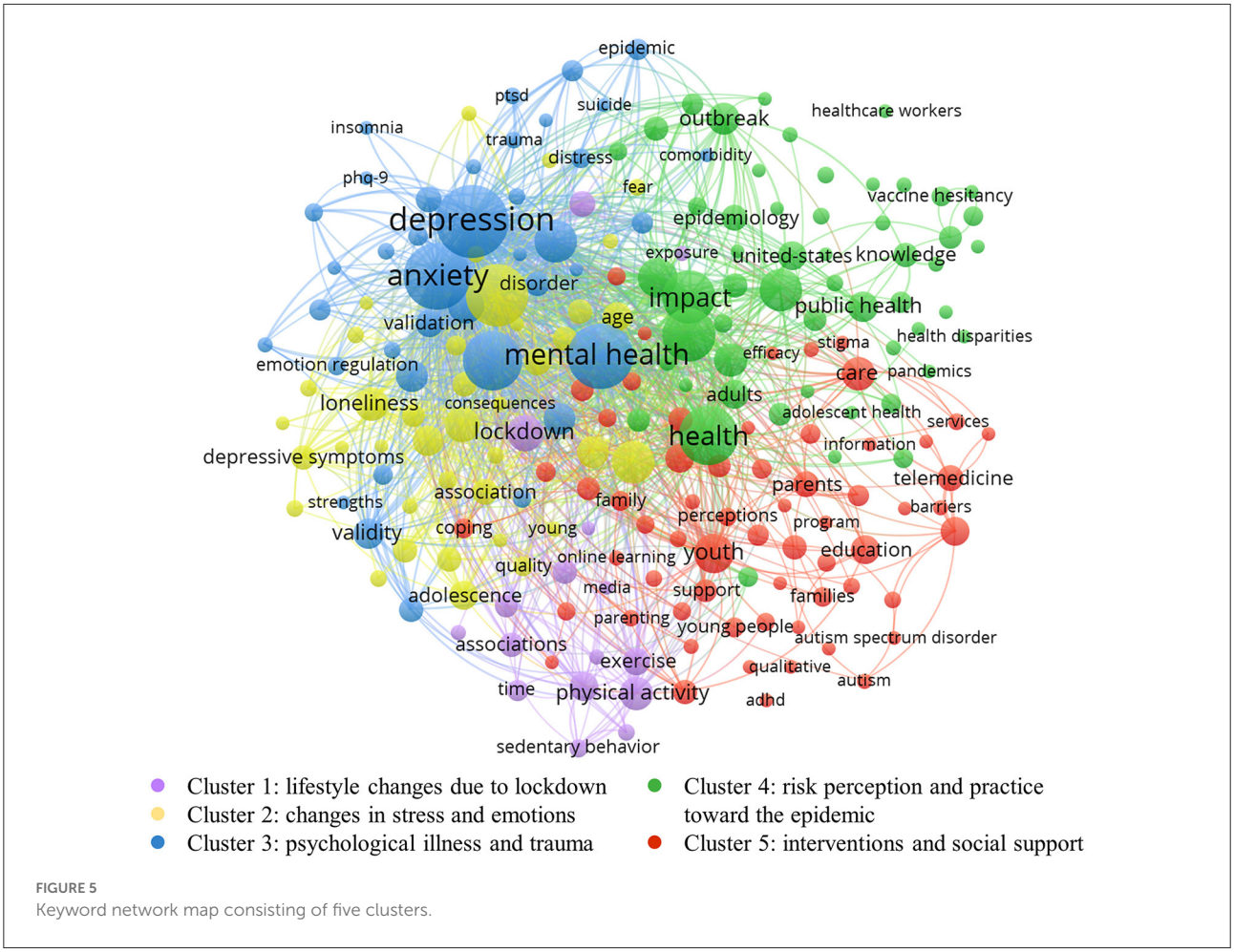

FIGURE 5
Keyword network map consisting of five clusters.

have a limited ability to cope with external stress and stabilize their emotions, while young people entering society are also facing a volatile situation pattern. Therefore, the changes in stress and emotions among young people during the epidemic have received much attention and have led to a series of related studies, which is another major research area in this field.

Cluster 3 (psychological illness and trauma, blue nodes): This cluster reflects the increased stress and emotional distress associated with the COVID-19 pandemic, leading to the onset of some psychological illness and trauma in young people. The majority of the literature in this area highlights the impact of COVID-19 as a health crisis on the development of psychological illness in young people, which is one of the most important and typical topics in these clusters. The main keywords included in this cluster are: "mental health," "depression," "anxiety," "disorders," "PTSD," etc.

Cluster 4 (risk perception and practice toward the epidemic, green nodes): the main keywords included in this cluster are: "risk," "health," "attitude," "knowledge," "vaccination," etc. The high risk of COVID-19 puts people at constant risk of infection, but subjective risk perceptions of the epidemic often vary from person to person. Young people's risk perceptions of outbreaks influence their outbreak prevention behaviors and mental health status, and this area has received attention in academic circles.

Cluster 5 (interventions and social support, red nodes): COVID-19 and its attendant controls have a significant impact on young people, so another major area of research on how to provide appropriate early interventions and strong social support for young people is presented in this cluster. The main keywords included in this cluster are: "intervention," "support," "service," "education," "parents," etc.

The mechanism of COVID-19's effect on young people

By reading and sorting out the representative literature involved in each cluster, we identified the relationships among the clusters and produced the framework of the effect of COVID-19 on young people (Figure 6). The colored boxes in

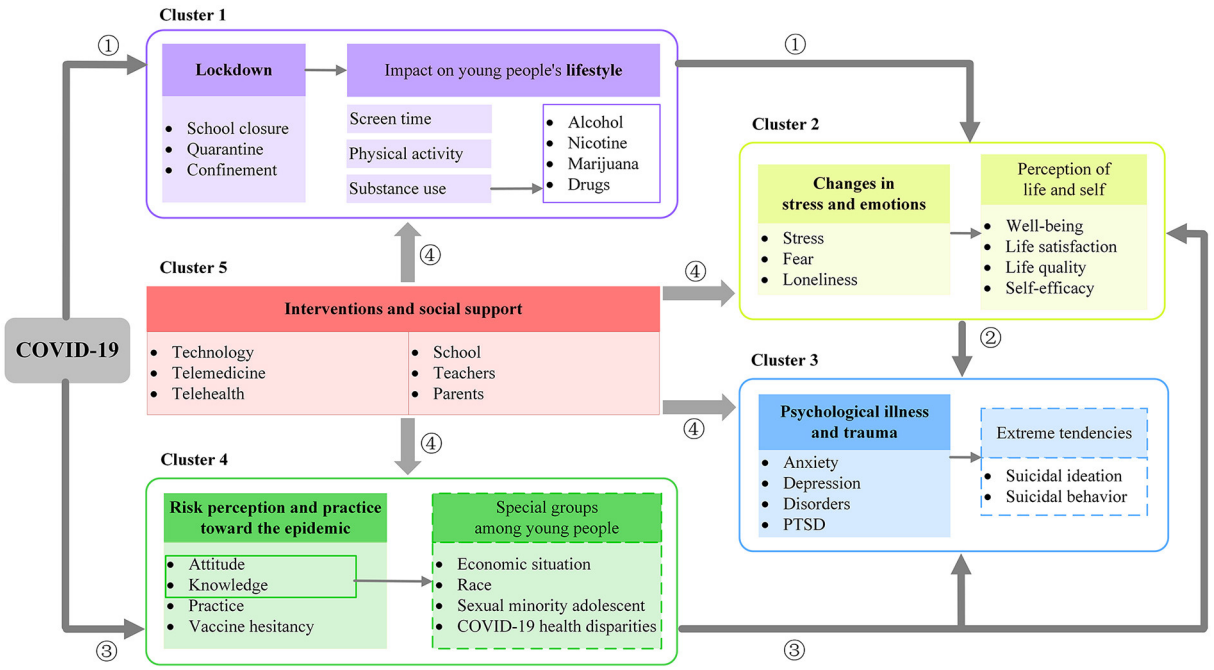

FIGURE 6
The framework of the effect of COVID-19 on young people, based on high-frequency keywords and cluster analysis.

the figure coincide with the colors to which the clusters belong in Figure 5. The text in the dashed box indicates that it is not represented in the co-occurring keyword clusters due to the small number of existing studies, but it still deserves our further attention.

Mechanism between the five clusters

In Figure 6, there are four pathways expressing the relationship between these five clusters in the effect mechanism. Firstly, pathway 1 shows that the global outbreak of COVID-19 has caused countries and regions to adopt lockdown measures to deal with this highly infectious virus, which has changed the lifestyles of young people (**Cluster 1**). The disruption of the formerly standard and healthy lifestyle of young people has had a consequent impact on their mental health status. Secondly, pathway 2 is a shift from **Cluster 2** to **Cluster 3**. That is, increased stress and fluctuating emotions (e.g., the emergence of adverse feelings such as fear, loneliness, etc.) in young people during COVID-19 further intensify into serious psychological disorders and severe trauma (e.g., anxiety, depression, PTSD, etc.). Pathway 2 reflects this exacerbation process. In addition, from pathway 3, the perceived risk profile and action performance of young people in the context of the COVID-19 pandemic are also a major research component (**Cluster 4**). The level of risk perceived by young people facing such a major public health hazard and the uncertainty and uncontrollability of that risk will increase the psychological stress and negative emotions of individuals and have an impact on their mental health. Finally, pathway 4 flows to the other four clusters centered on intervention and social support for young people (**Cluster 5**). Given that the aforementioned COVID-19 has led to lifestyle changes, severe risk perceptions of the epidemic, increased stress, mood swings, and psychological disorders among young people, interventions and strong social support are needed to address the current unpromising situation of young people.

We focus on the specific mechanisms of effect within each cluster as follows.

Effect mechanisms within each cluster

Effect mechanism in cluster 1: Lifestyle changes due to lockdown

The impact of the lockdown measures on young people's lifestyles is reflected in the purple box in Figure 6. First, there has been a general increase in screen time use by young people who are confined to their homes due to the need for online learning and contact with family and friends *via* the Internet (20, 21). However, with the increase in screen time, game addiction and compulsive internet use have been exacerbated, especially among adolescents and young adults (22, 23). This may be a risk factor for worsening sleep quality, increased stress, and the development of depression and anxiety symptoms (24–26). Second, it is reflected in the reduction of physical activity among young people as a result of the lockdown, which has now been

confirmed by numerous studies (27–29). More exercise can be effective in protecting one's mental health, such as preventing the emergence and development of anxiety and depression (30, 31), but the current situation of young people today is deviating from this. Third, in the context of COVID-19, substance use among young people has changed (32, 33). Since the beginning of social distance, studies have found increased alcohol and marijuana use among adolescents (34, 35), and there are also studies linking the emergence of the COVID-19 pandemic to increased nicotine use and prescription drug abuse (36). For young people in the early exploratory stages of substance use, uncontrolled substance use during COVID-19 has the potential to lead to the emergence of substance use disorders, increased dependence, and poorer mental health (37, 38).

Effect mechanism in cluster 2: Changes in stress and emotions

Children and adolescents are one of the most vulnerable groups in this pandemic in terms of the development of psychological abnormalities (39, 40). It was found that their stress during this epidemic mainly stemmed from the inability to participate in social activities/normal daily activities and important plans/events being canceled or postponed (41). Children and adolescents who did not originally have mental health disorders experienced a significant deterioration in mood during the pandemic (42), and feelings of anxiety and sadness were prevalent among them (43). It can be argued that the increased stress and unstable emotions caused by COVID-19 may reduce young people's quality of life and life satisfaction, affecting their daily wellbeing. Also, young adults exhibit strong concerns and feelings of loneliness during the COVID-19 pandemic (44, 45), which would predict the emergence of certain mental health symptoms. Compared with older adults, young adults are more susceptible to stress-induced mood swings and respond to stressful situations with fewer resources and experience. Their greatest stress stemmed mainly from uncertainty, such as not knowing when the COVID-19 pandemic will end (41). Young adults who have just reached adulthood are likely to be confused and worried about their future in the face of a difficult college life and a worsening economic environment, which could have a serious impact on their self-efficacy and undoubtedly reduce their sense of wellbeing.

Effect mechanism in cluster 3: Psychological illness and trauma

Overall, the prevalence of anxiety and depression was much higher than before the COVID-19 pandemic (41, 46, 47), and more pronounced in females (41). The COVID-19 pandemic is sufficient as a life-threatening infection to cause post-traumatic stress disorder (PTSD), which may have more severe consequences for children and adolescents (48, 49). Young people's unattended and unimproved psychological problems may lead to extreme tendencies if they continue to grow. A portion of the research has addressed the impact of the COVID-19 pandemic on suicidal ideation and behavior among young people, but because it has not been adequately studied, this portion is shown in the blue dashed box. According to related studies, pediatric mental health-related ED visits among adolescents aged 12–17 years increased by 31% in the USA beginning in April 2020, compared with 2019 data (50). In May 2020, there was also an increase in the number of ED visits for suspected suicide attempts among young people aged 12–25 years (51). In Australia, an increase in the number of contacts regarding suicide/self-harm was also found through helplines used by children and adolescents (52). Of particular interest to us is the fact that an increase in suicide rates among young people was not found in some areas early in the outbreak (53, 54), suggesting that suicidal ideation and behavior among young people may also increase cumulatively over time during the epidemic (55, 56). Further research is still necessary to determine whether COVID-19 caused the rise in the suicide rate among young people.

Effect mechanism in cluster 4: Risk perception and practice toward the epidemic

It was found that young adults perceived a higher risk than older adults during the epidemic (57) and exhibited higher anxiety values (58). This higher risk perception may be related to the high exposure to COVID-19 information on social media and the emotions of anger and fear (59). Adolescents, on the other hand, showed a lower perception of risk, which could lead to their worse practice performance (60). Adolescence is a stage of life that experiences excitement and adventure, and as such, some adolescents may feel invulnerable and fail to comply with preventive measures. Also, there is a strong correlation between COVID-19 risk perception and vaccination status: individuals with a higher COVID-19 risk perception are more likely to be vaccinated. In addition, there are specific groups that differ in their risk perception. Some studies have shown that young people from disadvantaged socioeconomic groups still have a lower level of awareness and acceptance of COVID-19 (61, 62). Unfortunately, this gap is also reflected in studies of health disparities among young people facing COVID-19. Young people may differ in their vulnerability and susceptibility to COVID-19 depending on family conditions, race, etc. For example, children from low-income families (63) and black or Spanish children (64, 65) have significantly higher rates of COVID-19 infection and mortality. Research has found that youth who identify as sexual minorities experienced higher levels of disruption and adversity during the pandemic (66). And sexual minority youth are more vulnerable and affected than other cisgender and heterosexual peers (67, 68). There is a lack of research on such groups, which is shown in the green dashed box.

Effect mechanism in cluster 5: Interventions and social support

Social support could help young people face challenges. Positive teacher-student relationships can help young people in the student phase to effectively improve their mental health (69, 70). A survey found that more than two-thirds of teens said communication with teachers decreased during the pandemic (71). Enhancing students' school connectedness has been shown to have substantial protective effects on health and wellbeing during adolescence and adulthood (66). Therefore, those working in education should pay attention to this issue and increase student-teacher interaction to meet the social and emotional needs of students during COVID-19. Next, family relationships act as a double-edged sword that has a dual impact on young people who are closed to home. On the one hand, it is seen that many adolescents have experienced significant negative changes in their relationships with their parents, such as having more anger, arguments, and resentment, compared to the pre-pandemic period (72). And these poor parent-child relationships are risk factors for the development of anxiety and depressive symptoms (73). On the other hand, positive and stable family relationships help to alleviate mental health problems in young people (74). It was found that families with high levels of education were effective in alleviating adolescents' stress and emotional fluctuations during the COVID-19 pandemic, while adolescents from low/moderately educated families experienced more dramatic and negative changes in their emotional health (75). In addition, the emergence of telemedicine in a lockdown setting offers a new intervention to help young people respond to the COVID-19 pandemic and has proven to be effective (76, 77). Telemedicine and specific practices for dealing with various conditions deserve to be further explored in the future to support and help young people with adverse mental health conditions.

Limitations

First, although this study tried to collect data as accurately and comprehensively as possible, the database selected for this paper was the Web of Science. There are also databases such as PubMed, Google Scholar, and Scopus that were not covered, which may lead to the omission of a small number of relevant articles. Second, this paper obtained the main research domains in this field by clustering keywords, which is not comprehensive. This is because it relies too much on keyword content analysis, but does not provide enough in-depth knowledge of specific reviews, which is the result of the shortcomings of bibliometrics. Therefore, future studies need to be combined to further elucidate how the COVID-19 pandemic has affected young people from multiple perspectives (including country, discipline, study design, etc.).

Conclusion

Since the beginning of 2020, the number of publications exploring the relationship between COVID-19 and young people has increased, the scope of studies has expanded, and the content of studies has been refined. The current research in this area is mainly from North America and Europe, and systematic and comprehensive studies across regions still need to be explored. The effect of the COVID-19 pandemic on young people has been focused on mental health, as evidenced by a large body of literature. The research hotspots have gradually evolved from focusing on the superficial description in the early stages of the outbreak and the intuitive impact on young people to exploring more in-depth and detailed psychological problems and countermeasures.

In this study, the literature in this field was classified into five main research domains through keyword clustering analysis. Linking these five domains by four pathways helps us to reveal the mechanism of COVID-19's effect on young people and to identify research content that has not yet received much attention but has some promise for the future. The development of specific groups (young people from disadvantaged socioeconomic groups, sexual minority adolescents) and extreme tendencies (suicide) among young people during the COVID-19 period deserve further attention.

Data availability statement

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

Author contributions

XL proposed the topic and designed the overall article. JY analyzed the data and wrote the article. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1052727/full#supplementary-material

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The association between physical activity and mental health in medical postgraduates in China during COVID-19 pandemic

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Background: Chinese medical postgraduates (CMPs) are a special subpopulation that has a great risk of mental health due to high workload, and heavy academic and clinical pressure during the COVID-19 pandemic. Physical activity has been demonstrated to be positive for the mental health of human being. However, little is known about the risks to mental health among CMPs as well as the potential effects of physical activity on mental health in CMPs during the COVID-19 pandemic.

Aims: In the present study, the aims are to (1) investigate the levels of PA and mental health that CMPs had; (2) to identify the potential factors that contribute to mental health among CMPs; (3) to explore the potential effects of PA on the mental health in CMPs.

Methods: The survey was conducted online across 25 provinces of mainland China in 28 medical colleges or universities with structured questionnaires. Physical Activity Rating Scale-3 (PARS-3), Depression, Anxiety, Stress Scales (DASS-21), and General Self-Efficacy Scale (GSES) were employed to assess the levels of PA, Negative emotional states, and self-efficacy of the participants, respectively. Resilience was evaluated using Connor-Davidson Resilience Scale (CD-RISC). The chi-square and Wilcoxon rank-sum tests were used to compare inter-group differences in demographic data and mental health conditions. Spearman's rank correlation test and partial correlation analysis were used to assess associations between exercise scores and mental health.

Results: We found some socio-demographic variables such as the location, education levels of parents and the levels of degrees they are training had potential effects on outcomes of mental health among 2,217 CMPs ($P < 0.05$); furthermore, we also found that PA was negatively correlated with the negative emotion ($r = -0.045$, $P < 0.05$) such as depression ($r = -0.052$, $P < 0.05$), anxiety and stress, ($r = -0.051$, $P < 0.05$) but positively correlated with the self-efficacy ($r = 0.143$, $P < 0.001$) and resilience ($r = 0.192$, $P < 0.001$) among Chinese postgraduate medical students.

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Conclusion: We concluded that for Chinese postgraduate medical students, taking part in physical activity would depress negative emotions such as depression, anxiety, and stress, but improve their self-efficacy and resilience, which will benefit them in completing their studies and training.

KEYWORDS

Chinese medical postgraduates, physical activity, negative emotion, self-efficacy, resilience

Introduction

Medical postgraduate education is a critical stage of training high-qualified clinicians and will make a profound influence on the global healthcare system. Globally, the demands of healthcare service are gradually increasing due to the rapid population growth, an expanding aging population, and the COVID-19 pandemic, which requires more high-qualified clinicians (1, 2). The situation highlights the significance of Medical postgraduate education. Actually, the last 30 years have witnessed a dramatic increase number of Chinese medical postgraduate students (CMPs). According to the China Health Yearbook from National Healthcare Commission, there are more than 33 000 medical postgraduate students in China in the year 2020, compared with ∼1 300 in the 1900s (3). These students are undergoing postgraduate specialty training and will become the main force of health care in the country in the coming decades. Despite this, there are still great demands in the labor force of health care, for example, there are only 1.8 physicians in every 1,000 people in China while 3.6 and 4.6 physicians serve 1,000 people in Austria and Norway, respectively (4). Furthermore, the heavy workload of medical postgraduate is also due to the higher requirements of theory and practical skills, compared to the students from other disciplines (5, 6).

China has a unique educational system for training clinicians after the students graduated from medical school for 5 years of learning (7). Different from other countries, the education of medical postgraduate in China is divided into two different levels: master's and doctorate, which is parallel with the training mode of the Ph.D. degree in the UK. Due to different purposes, there are two different types of medical postgraduate: one is postgraduate with an academic degree (PAD) and the other is postgraduate with a professional degree (PPD) (8, 9). PAD is aimed to improve theoretical knowledge and academic performance, which means that it will take plenty of time to participate in biomedicine research in addition to clinical practice (10). In the contrast, PPD lays particular stress on the abilities of clinical practice, the goal of which is to train high-qualified clinicians with strong innovation capability (7).

Recently, Chinese government has reformed postgraduate medical education and standardized residency training (SRT), which requires PPD students to have SRT for at least 33 months while finishing postgraduate medical education (7, 11). For PAD students, also have high pressure to publish high-quality papers as one of the requirements for obtaining degrees in many institutions (9). Therefore, CMPs, regardless of PAD or PPD, as the backbone working in the Chinese healthcare frontline, is currently experiencing a high workload and heavy academic or clinical pressure. Because heavy clinical and academic workloads can cause tension, which may bring great risks of mental health problems (such as depression, anxiety, and stress) and poor self-efficacy. There was more than 30% of medical postgraduate students have mild to severe depression symptoms according to a national cross-sectional study in China (12). In another cross-sectional study with a small, specific population (∼500 participants of dental postgraduates), more than 30% of Chinese dental postgraduates suffered from job burnout, career choice regret, and depressive symptoms in a cross-sectional study (13). In a comparative study, Peng et al. (14) found that both medical and non-medical postgraduates have mental distress but medical postgraduates have higher perceived stress due to an unsatisfied healthcare environment.

Furthermore, the pandemic of COVID-19 may aggravate this situation (12). For example, a study showed that more than 2/3 of medical students had deteriorated mental health such as depression and anxiety during COVID-19 pandemic, which was higher than the general population (15). In China, there was also a study also showed more than half of medical postgraduates had mild anxiety symptoms during the COVID-19 pandemic (16). Because CMPs represent a large group in the system of medical care, the mental health of these students is an extensive concern in universities and hospitals. This problem can persist if not treated resulting in numerous undesirable personal and professional consequences (17).

Many studies have demonstrated that physical activities (PA) can have a positive effect on the mental and physical health of human beings. Moderate-to-vigorous PA can effectively

maintain body weight, reduce the risk of diseases, benefit brain health, and improve negative emotional states and mental symptoms, although the mechanisms may be different (18). Furthermore, lack of PA is one of the three leading causes of chronic disease and premature death (19). Although there are several data about PA on the mental health of undergraduate medical students in China, few data about the association between PA and the mental health of CMP are available. Given this background, the aims of the present study were to (1) investigate the levels of PA and mental health that CMPs had; (2) identify the potential factors that contribute to mental health among CMPs; (3) explore the potential effects of PA on the mental health in CMPs. In the present study, we investigated the association between PA and mental health in this population. Our finding in the present study will provide the fundamental information and suggestion for to improve mental health of CMPs which will benefit the reform of postgraduate education.

Materials and methods

Ethics approval and consent to participate

The main procedures of the present study were reviewed and approved by the Ethical Committee of the Xuzhou Medical Univeristy (XZMU-2020-ZK043).

Participants and study design

The survey was carried out online across 25 provinces of mainland China in 28 medical colleges or universities from 20 October 2020 to 5 April 2021 with structured questionnaires (Supplementary Table 1). The online questionnaire was undergone *via* an online survey platform (www.wjx.cn) which was distributed to postgraduates by the administration of postgraduates in medical colleges or universities. Before beginning the questions about their demographic data, participants were informed about the objectives of the study and provided with an e-signature to indicate their informed consent. Their majors that were engaged were inquired about. A total of 2,595 Chinese postgraduate students volunteered to attend this study and 2,424 participants (93.41%) had valid responses to this survey. Of these participants, 2,217 students were in the major of medicine. In the following, these post-graduate students majoring in medicine were subjected to questionnaire demographic characteristics, including age, gender, major, location, degree applied for, and so on (Table 1), and further questions in the following.

TABLE 1 Descriptive statistics of the participants in the present study.

Variable		Frequency	Percentage (%)
Genders			
	Male	702	31.66
	Female	1,515	68.34
Ages			
	20–23	562	25.35
	24–27	1,388	62.61
	28–31	193	8.71
	32–35	57	2.57
	>36	17	0.77
Location			
	City	1,090	49.17
	Villages	1,127	50.83
Income of family			
	Low	294	13.26
	General	1,818	82.00
	High	105	4.74
Education of parents			
	High and above high school	869	39.20
	Senior	989	44.61
	Junior	335	15.11
	Unschooled	24	1.08
Degrees			
	Master	2,151	97.02
	Doctor	66	2.98
Types of degree			
	Academic	782	35.27
	Professional (clinical medicine, stomatology)	1,166	52.59
	Professional (others)	269	12.13
Grade			
	Level 1	1,201	54.17
	Level 2	671	30.27
	Level 3	345	15.56
Total		2,217	100

Measurements

Physical Activity Rating Scale-3 (PARS-3) was employed to assess student PA level, which was revised by Liang (20). The scale mainly includes three items of physical exercise intensity (what is the intensity of PA that you usually engaged in?), duration (*How long do you spend in each PA session in 1 week?*), and frequency (*how often do you spend in each PA session in 1 week*). The Likert 5-scale scoring standard is adopted, and

the corresponding scores are 1–5 points respectively. Physical exercise score = intensity score × (time score−1) × frequency score. The PA score interval ranged from 0 to 100 points. A higher score means more physical activity. The test-retest reliability of PARS-3 in this study was 0.82.

Negative emotional states were evaluated using Depression, Anxiety, Stress Scales (DASS-21) (21). DASS-21 includes three dimensions of stress, anxiety, and depression with 21 items and each dimension has seven items. For each item, the Likert 4-scale scoring standard (0–3) was employed to evaluate each item. DASS-21 score ranges from 0 to 63. The higher score suggests a higher level of depressive and anxiety symptoms and higher pressure on participants. As confirmed by Sahebi et al. (22) this scale has validity and reliability between 0.77 and 0.79. The internal consistency of this questionnaire was approved (Cronbach's alpha: 0.870–0.893) in this study.

General Self-Efficacy Scale (GSES) was used to assess the level of self-efficacy of each participant (23). The GSES includes 10 items and each item was measured on a 4-point Likert (1–4 scores). The total score of GSES ranges from 10 to 40. A higher score indicates a higher capacity for self-efficacy. The internal consistency of this questionnaire was determined (Cronbach's alpha: 0.892) in this study.

Resilience was assessed using Connor-Davidson Resilience Scale (CD-RISC) developed by Connor-Davidson and adopted by Yu over the past month (24, 25). The scale consists of 25 items within three dimensions including hardiness, strength, and optimism. The response to each item is based on a 5-point Likert scale (1–5): 1 (not true at all) to 5 (true nearly all of the time). Thus, the total score of resilience ranges from 1 to 125, with higher scores suggesting greater resilience. Cronbach's alpha of the ADRS in the present study was 0.71–0.786.

Statistical analysis

The normality of variables was tested using the Shapiro-Wilk normality test and the KS normality test. Continuous variables were presented as means ± SD for normally distributed data and medians and interquartile ranges (1st quartile, 3rd quartile) for non-normally distributed data. The chi-square and Wilcoxon rank-sum tests were used to compare inter-group differences in demographic data and mental health conditions as appropriate. Spearman's rank correlation test and partial correlation analysis were used to assess associations between exercise scores and mental health. P values less than 0.05 were considered statistically significant. SPSS 19.0 software (IBM, Armonk, NY, USA) was used for data analysis.

TABLE 2 Descriptive analysis of PA and mental health index.

Variable	Mean	95% CI−	95% CI+	SD
Physical activity (PA)	14.37	13.67	15.07	16.80
Negative emotion	8.15	7.76	8.54	9.42
Depression	2.86	2.72	2.99	3.18
Anxiety	3.49	3.32	3.65	3.94
Stress	1.81	1.68	1.93	3.06
Self-efficacy	26.30	26.11	26.49	4.53
Resilience	85.35	84.70	85.99	15.49

Results

Socio-demographic characteristics, PA, and mental health condition

Tables 1, 2 showed the key statistical data on the variables. there were a total of 2,217 CMPs attending the survey. Table 1 showed that male students constituted 31.7% of the sample and the percentage of female students in the total population was 68.3% in this survey. The participants aged 24–27 years old were the most subpopulation (62.6%). More detailed information including the location, income of the family, education of parents, degrees, and so on were shown in Table 1. In Table 2, the average score of PA in CMPs that took part was 14.37 (95% CI: 13.670–15.069, SD: 16.7953) assessed by PARS-3. The mean score of negative emotional states (the sum of Depression, Anxiety, and Stress assessed by DASS-21) was 8.147 (95% CI: 7.755–8.539, SD: 9.4225). Each variable that indicates mental health were also shown in Table 2.

The potential factors on the mental health of CMPs

Next, we investigated the possible risk factors that can make effects the mental health of CMPs. As shown in Table 3, among these socio-demographic variables, we found that genders, ages, income, and types of degrees (academic or professional) have no significant effects on the mental health of CMPs. However, we found that the locations (villages or cities, $\chi^2 = 10.369$, $P < 0.05$)) and education levels of parents (above high school, senior, junior or illiteracy, $\chi^2 = 7.250$, $P < 0.05$) had effects on self-efficacy of CMPs. Furthermore, we also found that the levels of degrees (master's or doctorate) that they are pursuing had significant influences on the negative emotion including depression ($\chi^2 = 8.172$, $P < 0.05$), anxiety ($\chi^2 = 6.708$, $P < 0.05$), and stress ($\chi^2 = 6.4$, $P < 0.05$).

TABLE 3 The variables that possibly affect mental health among Chinese postgraduate students.

Variable	Negative emotion		Depression		Anxiety		Stress		Self-efficacy		Resilience	
	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value	χ^2	*P*-value
Gender	2.93	0.57	5.06	0.28	1.04	0.90	4.57	0.33	1.18	0.88	4.23	0.38
Ages	0.45	0.50	0.12	0.73	0.65	0.42	0.84	0.36	3.08	0.08	2.33	0.13
Location	2.86	0.41	2.89	0.41	2.41	0.49	2.32	0.51	10.37	0.02	5.77	0.12
Education of parents	1.80	0.41	2.35	0.31	1.67	0.43	0.24	0.89	7.25	0.03	0.93	0.63
Income	0.56	0.45	0.08	0.90	1.22	0.27	1.93	0.17	0.521	0.47	0.19	0.66
Levels of degrees	8.17	0.02	6.71	0.04	8.41	0.02	6.40	0.04	3.55	0.17	5.57	0.06
Types of degree	1.69	0.43	1.42	0.49	3.11	0.21	2.48	0.29	2.14	0.34	3.17	0.21

TABLE 4 The relationship between physical activity on negative emotion, depression, anxiety, stress, self-efficacy, and resilience in medical postgraduate students in China.

Variable	Negative emotion		Depression		Anxiety		Stress		Self-efficacy		Resilience	
	r	*P*-value	*r*	*P*-value	*r*	*P*-value	*r*	*P*-value	*r*	*P*-value	*r*	*P*-value
Physical activity frequency	−0.05*	0.04	−0.03	0.12	−0.03	0.11	−0.05*	0.03	0.06**	0.003	0.1**	0.00
Physical activity intensity	0.004	0.87	−0.007	0.73	0.011	0.62	−0.01	0.80	0.11**	0.000	0.14**	0.00
Physical activity duration	−0.06**	0.004	−0.061**	0.004	−0.06**	0.005	−0.05*	0.01	0.14**	0.000	0.18**	0.00
Physical activity	−0.05*	0.02	−0.052*	0.01	−0.04	0.074	−0.05*	0.02	0.14**	0.000	0.19**	0.00

*$P < 0.05$.
**$P < 0.01$.

The association between PA and mental health condition of CMPs

We further used Spearman's rank correlation test and partial correlation analysis to explore the association between PA and the mental health conditions of CMPs (Table 4). For PA, the data showed that there was a negative correlation between PA and negative emotions of students ($r = -0.045$, $P < 0.05$), between PA and Depression ($r = -0.052$, $P < 0.05$), between PA and stress ($r = -0.051$, $P < 0.05$). Furthermore, we also found that there was also a positive correlation between PA and self-efficacy ($r = 0.143$, $P < 0.001$), and between PA and Resilience ($r = 0.192$, $P < 0.001$). Specifically, we found that physical activity frequency was also negatively correlated with negative emotion ($r = -0.045$, $P < 0.05$), but was a positive correlation with self-efficacy ($r = 0.063$, $P < 0.01$) or Resilience ($r = 0.096$, $P < 0.001$); Physical activity intensity was also found to be positively correlated with Self-efficacy ($r = 0.11$, $P < 0.001$) or Resilience ($r = 0.136$, $P < 0.001$. For Physical activity duration, it was found that there was a negative correlation with scores of Negative emotion ($r = -0.61$, $P < 0.01$), but positively correlated with self-efficacy ($r = 0.138$, $P < 0.001$) or Resilience ($r = 0.184$, $P < 0.001$). Taken together, these data suggest PA has negative effects on negative emotions (such as Depression, Anxiety, and Stress), but positively improves self-efficacy and resilience in the group of CMPs.

Discussion

In the present study, we reported a comprehensive, national study of PA and mental health among postgraduate medical students in China. To our best knowledge, this study is the first report that investigated PA and mental health, as well as exploring their potential associations among postgraduate medical students in China. We found some socio-demographic variables such as the location, education levels of parents and the levels of degrees they are training had potential effects on outcomes of mental health among those Chinese postgraduate medical students; furthermore, we also found that PA was negatively correlated with the negative emotion such as depression, anxiety, and stress, but positively correlated with the self-efficacy and resilience among Chinese postgraduate medical students. Therefore, we concluded that for Chinese postgraduate

medical students, taking part in physical activity would depress negative emotions such as depression, anxiety, and stress, but improve their self-efficacy and resilience, which will benefit them in completing their studies and training. Although CMPs have multiple pressures during accomplishing their studies and training, previous studies showed that there were no significant differences in the prevalence between medical students and non-medical students that have mental health problems, especially after the outbreak of COVID-19 (14, 26). Similarly, our study showed a moderated score of negative emotion in CMPs (Mean score: 8.17, 95% Cl: 7.755–8.539). The reasons that account for the phenomenon might be like this: as postgraduate medical students, they are equipped with the basic knowledge and skills to adjust their mental and physical conditions for adapting to the high pressures they have (23, 27), which were in line with our studies showing a relatively high resilience (mean score: 85.349) and self-efficacy (mean score: 28, full score is 40) among CMPs.

In our present study, we also found that levels of degrees (doctors or masters) had potential effects on mental distress, but the education levels of parents and the locations of CMPs exerted some influences on the self-efficacy of these students, which finally bring the effects on the academic achievements of GMPs. There is a study also showed that poor education of parents significantly affected an individual's schooling pursuits, which is in line with our present study (28). Because the requirements of obtaining degrees for master's and doctorate are quite different, for example, the doctor trainee is much higher heavier academic and clinical work to finish than those master trainee (11), the doctor candidates may be subjected to a higher pressure than that of the master trainee. Furthermore, there is a dual structure of urban and rural areas in China, which makes the urban-rural split very clear in economics, education, medical care, and so on (29). These differences may reflect that students have different tolerance to mental distress, self-efficacy, and resilience.

The relationship between PA and mental health has been well-documented in different populations of different ages and disease conditions (30, 31). There were many mechanisms by which PA improves mental health: at the molecular level, regular PA can increase the produce brain-derived neurotrophic factors (BNDF), which leads to the activation of ERK signaling pathway and inhibition of depressive-like behavior (32, 33). In addition, PA can change the structures and functions of the brain *via* the hypothalamic-pituitary-adrenal (HPA) axis, which is critical to meliorate the symptoms of depression and anxiety (34); at the psycho-social level, it is also suggested that psycho-social factors such as resilience were also involved in the PA-induced anti-mental disorders. In our present study, we found that PA especially the duration of PA had a negative relationship with negative emotions such as depression, anxiety, and stress, but self-efficacy or resilience among CMPs, which agreed with other studies although they surveyed different populations (20, 35, 36). These findings suggested that self-efficacy or resilience may probably be important mediators between PA and negative emotion (37). However, in our present study, we didn't any relationship between physical activity intensity and negative emotion, but it can be positively correlated with self-efficacy or resilience, suggesting that PA harmed negative emotion independent of the intensity of PA (38, 39).

In the present study, we investigated the potential effects of PA on the mental health of CMPs, a special population in China. Although we conducted a large investigation across 25 provinces in China, obtaining massive data, our study had some limitations: we didn't analyze the status of mental health that CMPs in detail. We will further analyze these data to find the potential risk factors that influence the mental health of CMPs. Additionally, since these mental disorders may have a potential effect on the academic performance of CMPs, which should be further investigated.

In summary, our study suggests physical activity would depress negative emotions such as depression, anxiety, and stress, but improve the self-efficacy and resilience of CMPs. Given the strong link between PA and mental health in medical postgraduate students in China, there are strong demands to urge CMPs to take part in physical exercise, which will not only benefit the postgraduate medical students themselves but also the whole medical care system.

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

C-LY and CY designed the experiments. C-LY collected the data. BZ and XG contributed to the data analysis. CY and SK wrote the paper. CY reviewed the final version of the manuscript and supervised the project. All authors read and approved the final version of the manuscript.

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Conflict of interest

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

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Supplementary material

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Prevalence and predictors of pornography exposure during the third wave of the COVID-19 pandemic: A web-based cross-sectional study on students in Bangladesh

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Background: Pornography exposure, particularly among students, in Bangladesh, has increased in the twenty-first century. However, pornography exposure during the COVID-19 pandemic, when people were compelled to "stay at home" and relied extensively on the internet for all forms of activities, including academia, socializing, and communication, has remained unexplored. The present study aimed to assess the prevalence of pornography exposure among students during the third wave of the COVID-19 pandemic and to determine the associated predictors.

Methods: A web-based cross-sectional study was carried out among students with certain specifications, i.e., current students at high school/college/university with access to the internet and valid social media accounts. By administering a semi-structured e-questionnaire using Google Forms, a total of 646 valid responses were retained for this study. The data were analyzed in two phases by Pearson's Chi-square and multiple logistic regression model, using IBM SPSS Statistics, version 25. The results were expressed as an adjusted odds ratio (AOR) with a 95% confidence interval (95% CI).

Results: The findings suggest that 75.9% of students were exposed to pornography during the third wave of the COVID-19 pandemic and preferred to watch the amateur/professional genre of pornography. Pornography

exposure was significantly associated with age and relationship status, as students aged 22–24 years (95% CI: 1.01–2.41; $p = 0.045$) and over 25 years (95% CI: 1.61–10.03; $p = 0.003$) were more likely to watch pornography, while married students and those in relationships (95% CI: 1.24–3.49; $p = 0.006$) also watched pornography during the pandemic. In contrast, students who were living alone (95% CI: 0.38–0.92; $p = 0.021$), were living in the Khulna division (95% CI: 0.16–0.52; $p < 0.001$) or had a negative attitude toward pornography (95% CI: 0.94–0.99; $p = 0.002$) were less likely to be exposed to pornography.

Conclusion: Pornography exposure was higher among students in Bangladesh during the COVID-19 pandemic, and religiosity and disapproving attitudes toward pornography negatively influenced the pornography exposure. For a better understanding of the complex dynamics of socio-demographic issues with pornography exposure among students, extensive research is required for policymakers to devise appropriate strategies and interventions to ensure healthy and safe sex life for the younger population.

KEYWORDS

prevalence, pornography exposure, risk factors, COVID-19, students, Bangladesh

Introduction

The outbreak of coronavirus disease (COVID-19) in late 2019 in Wuhan, China (1) and the declaration of a pandemic in mid-March 2020 by the World Health Organization (2) necessitated drastic non-therapeutic protective and preventive measures, i.e., "lockdown," "social distancing," and "face mask," for the general population and "home confinement," "isolation," and "quarantine" for infected and suspected people. This was done in order to contain the virus and to minimize the risk of "human-to-human" infection (3, 4). Despite the collective efforts of governments and international organizations, the world has witnessed over 60 million confirmed cases and 6.5 million deaths as of 7 September 2022 (5).

The prolonged "lockdown" adversely affected people's mental wellbeing, and a spike in mental health disorders was observed worldwide (6, 7); people in Bangladesh were no exception. Studies have suggested that people, irrespective of age, sex, caste, and creed, have experienced an unprecedented increase in mental health disorders and associated self-harm behaviors, including depression, anxiety, stress, and fear (8–13). This may have led to sleep disturbance (14) and in the worst cases suicide (15, 16), particularly among students. In addition to degraded mental health during the "lockdown," students were also frustrated due to uncertainty over their academic future and professional career (17), although the government did begin online/remote education in order to continue educational activities (18) while maintaining "social distancing." However, during the "lockdown," online activities increased substantially among students. For example, Hossain et al. (19) reported that during the first wave of COVID-19 in Bangladesh, 64.1% of 493 students were almost always active in their "virtual life." A similar study in China also noticed that 87.1% of the 1,189 students frequently updated their online statuses (20).

To maintain social and relational communication and to be involved in different events, including academia, socializing, leisure, and shopping, young people did almost everything in their "virtual life" (21); they, thus, became obsessed with a wide range of online-based activities during "lockdown", one of which was watching pornography (21–25). Zamboni et al. (21), for example, reported that 21.6% of Italian adults were using pornographic materials during the "lockdown." A similar study on adults in the United Kingdom and the United States suggests that, on average, pornography viewing increased during the lockdown, from 5.54 to 8.55 h per week (23). In a study on health service providers in New Zealand, Rodda et al. (24) noted that pornography viewing among health service recipients increased significantly during the period of social distancing.

Regarding pornography exposure, there have been a few studies undertaken in Bangladesh. Mamun et al. (26), for example, found that 72% of 313 undergraduate students had consumed pornography at least once in their lifetime, and half of them consumed it frequently. They further noted that pornography exposure was positively determined largely by male sex, urban residence, involvement in romantic relationship, and frequent use of social media, while negative attitudes toward pornography did not impact on pornography exposure (26). Golder et al. (27), in their study, found that 81% of students had been exposed to pornography before 16 years of age and that pornography exposure was significantly associated with

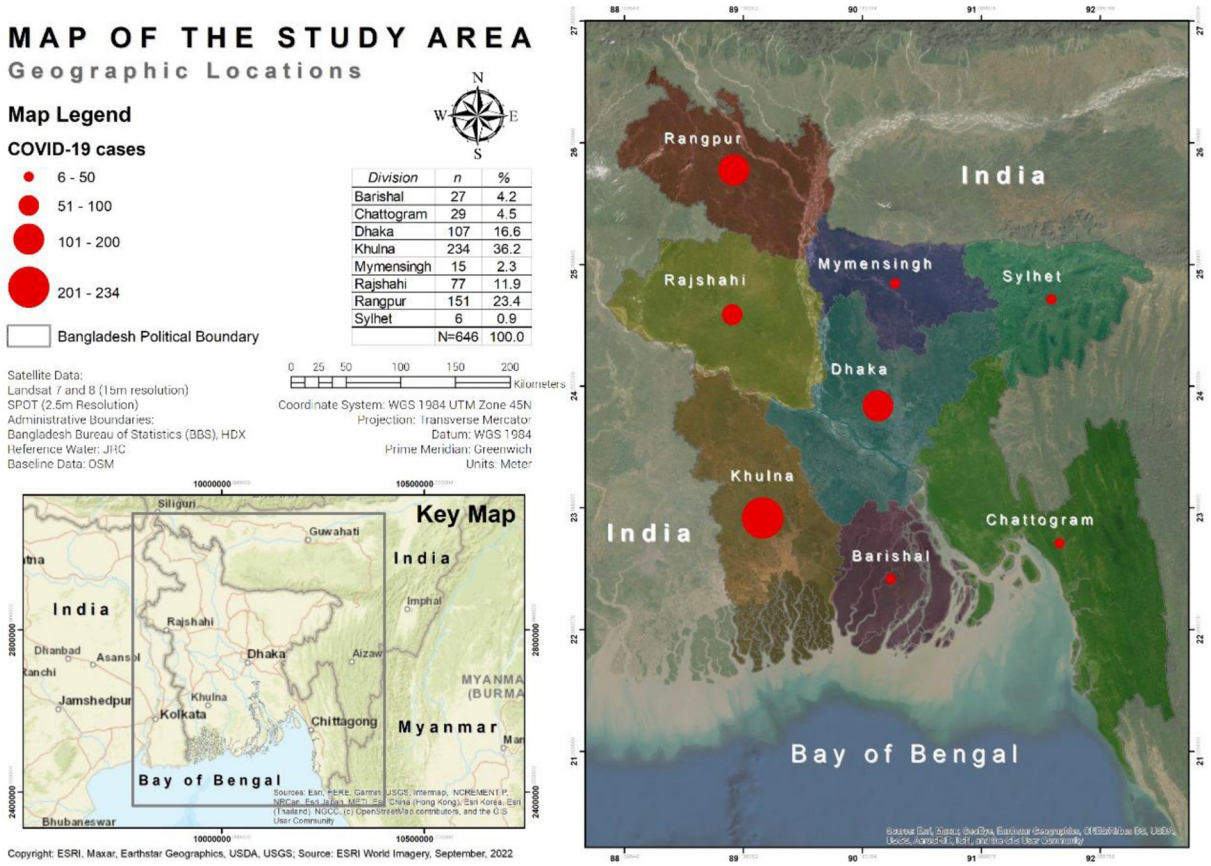

FIGURE 1
Map of the study area.

residence, religiosity, and internet access. A similar study on private university students observed that 41.8% of students watched porn, and that the prevalence was significantly higher among male students (28). From the existing literature, it is evident that there is a lack of empirical research on pornography exposure among students during the COVID-19 pandemic in Bangladesh. The current study aims to assess the prevalence and predictors of pornography exposure during the pandemic and to fill the literature gap by exploring the phenomenon nationwide.

Materials and methods

Study settings and participants

This web-based cross-sectional explanatory study was administered through a semi-structured e-questionnaire using Google Forms among students during the COVID-19 pandemic in all eight divisions of Bangladesh (see Figure 1). The participants were approached based on certain inclusion criteria: (i) must be students; (ii) must be enrolled in either school (school students must be in either Class IX or Class X), college or university; (iii) must have access to the internet through desktop, laptop, tablet, or smartphone; (iv) must have an active account on social media (Facebook, Messenger, or WhatsApp). Accounting for the above criteria, around 1,200 potential participants were purposively approached through social media by their respective school, college or university teachers, and the link to the e-questionnaire was shared alongside the online written informed consent form. The semi-structured e-questionnaire was divided into five mutually exclusive modules, focusing mainly on socio-demographic information, pornography exposure during the COVID-19 pandemic, and attitudes toward pornography, respectively. The e-questionnaire was in English and Bangla in order to allow the participants to comprehend the questions. The data were collected from June to July 2022, and out of a total of 662 anonymous responses, the information from 646 participants was retained for this study after careful scrutiny; the rest

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TABLE 1 Basic characteristics of participants and their association with pornography exposure.

Variables	*f* (%)	Pornography exposure		Test statistics	*p*-value
		No	Yes		
Overall		**156 (24.1)**	**490 (75.9)**		
Age					
≤21	173 (26.8)	65 (37.6)	108 (62.4)		
22–24	359 (55.6)	83 (23.1)	276 (76.9)	35.491	**<0.001**
25≥	114 (17.6)	8 (7.0)	106 (93.0)		
Sex					
Others[a]	181 (28.0)	56 (30.9)	125 (69.1)	6.330	**0.012**
Male	465 (72.0)	100 (21.5)	365 (78.5)		
Education					
Others[b]	99 (15.3)	11 (11.1)	88 (88.9)	10.850	**0.001**
Honors	547 (84.7)	145 (26.5)	402 (73.5)		
Religious preference					
Atheist/agnostic	31 (4.8)	1 (3.2)	30 (96.8)		
Others[c]	96 (14.9)	21 (21.9)	75 (78.1)	8.470	**0.014**
Muslim	519 (80.3)	134 (25.8)	385 (74.2)		
Self-rated religiousness					
Below average	82 (12.7)	8 (9.8)	74 (90.2)		
Average	219 (33.9)	51 (23.3)	168 (76.7)	12.326	**0.002**
Above average	345 (53.4)	97 (28.1)	248 (71.9)		
Residence					
Rural/sub-urban	275 (42.6)	58 (21.1)	217 (78.9)	2.444	0.118
Urban	371 (57.4)	98 (26.4)	273 (73.6)		
Relationship status					
Unmarried/single	478 (74.0)	132 (27.6)	346 (72.4)	12.058	**0.001**
Married/in a relationship	168 (26.0)	24 (14.3)	144 (85.7)		
Socioeconomic status					
Marginal/lower class	125 (19.3)	19 (15.2)	106 (84.8)	6.776	**0.009**
Middle/upper class	521 (80.7)	137 (26.3)	384 (73.7)		
Living arrangement					
With roommates/romantic partner	344 (53.3)	69 (21.1)	275 (79.9)		
With parents/spouse	212 (32.8)	69 (32.5)	143 (67.5)	12.152	**0.002**
Alone	90 (13.9)	18 (20.0)	72 (80.0)		
Division					
Others[d]	154 (23.8)	20 (13.0)	134 (87.0)		
Dhaka	107 (16.6)	23 (21.5)	84 (78.5)	32.416	**<0.001**
Khulna	234 (36.2)	85 (36.3)	149 (63.7)		
Rangpur	151 (23.4)	28 (18.5)	123 (81.5)		
Sexual orientation					
Homosexual/bisexual	28 (4.3)	1 (3.6)	27 (96.4)	6.766	**0.009**
Heterosexual	618 (95.7)	155 (25.1)	463 (74.9)		

(Continued)

TABLE 1 (Continued)

Variables	*f* (%)	Pornography exposure		Test statistics	*p*-value
		No	Yes		
Overall		**156 (24.1)**	**490 (75.9)**		
Educational institution					
Others[e]	52 (8.0)	8 (15.4)	44 (84.6)	2.371	0.124
Public university	594 (92.0)	148 (24.9)	446 (75.1)		

f, Frequency.
[a]Others include female and third sex.
[b]Others include secondary, higher secondary and master.
[c]Others include Hindu, Christian, and Buddhist.
[d]Others include Barishal, Chattogram, Mymensingh, and Sylhet.
[e]Others include college, national university, and private university.
Bold values are significant at 5% level of significance.

(16 responses) were discarded because of repetitive responses and missing information.

Ethical issues

This study was approved by the institutional ethical clearance committee (Reference No. KUECC – 2022/06/15). The participants responded to this web-based cross-sectional study by filling out a written informed consent form in the first section of the e-questionnaire. All participants responding voluntarily to the e-questionnaire were provided with information in the consent form which explained the research purpose, anonymity, confidentiality of information, and right to revoke participation without prior justification.

Measures

Socio-demographic information

The socio-demographic information consisted of age (in year), sex (male, others—female and third sex), education (honors, others—higher secondary and master), religious preference (atheist/agnostic, Muslim, others—Hindu, Christian, and Buddhist), self-rated religiousness (below average, average, above average) (29) residence (rural/suburban, urban), relationship status (unmarried/single, married/in a relationship), socioeconomic status (marginal/lower class, middle/upper class) (9, 30), living arrangement (with roommates/romantic partner, with parents/spouse, alone), division (Dhaka, Khulna, Rangpur, others—Barishal, Chattogram, Mymensingh, and Sylhet), sexual orientation (homosexual/bisexual, heterosexual) and educational institutions (public university, others—college, national university, and private university).

Pornography exposure

Pornography exposure in Bangladesh was assessed as per previous studies (26–28). The questions regarding pornography exposure during COVID-19 were—"Did you watch pornography in the past two months during COVID-19?", and "What type of pornography did you most prefer to watch?" In this study, pornography is defined as "any sexually explicit content, whether videos or pictures on the internet, which showed intimate relations 'between men and women' or between women' or 'between men' and led to sexual arousal among the viewers".

Attitude toward pornography

The attitude toward pornography (AtP) is a scale developed by Evans-DeCicco et al. (31) to measure general positive and negative attitudes toward pornography. The AtP consists of 13 items and is scored on a 7-point Likert scale, ranging from "strongly disagree" to "strongly agree," with a higher score indicating an anti-pornography attitude (31). The overall internal consistency of the original AtP was 0.85. In this study, the AtP was measured on a five-point Likert scale, and the internal consistency was Cronbach's $\alpha = 0.78$.

Analysis

The data were analyzed in two consecutive stages using IBM SPSS Statistics, version 25. First, the Pearson's Chi-square (χ^2) test of independence was executed to measure the association

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TABLE 2 Multiple logistic regression analysis of variables associated with exposure to pornography.

Variables	B	SE	Sig.	AOR Exp (B)	95% CI of AOR	
					Lower	Upper
Age						
≤21[RC]				1.00		
22–24	0.445	0.222	**0.045**	1.56	1.01	2.41
25≥	1.392	0.466	**0.003**	4.02	1.61	10.03
Sex						
Others[aRC]				1.00		
Male	0.309	0.222	0.164	1.36	0.88	2.11
Education						
Others[bRC]				1.00		
Honors	−0.329	0.401	0.413	0.72	0.33	1.58
Religious preference						
Atheist/agnostic[RC]				1.00		
Others[c]	−1.381	1.115	0.216	0.25	0.03	2.24
Muslim	−1.509	1.090	0.166	0.22	0.03	1.87
Self-rated religiousness						
Below average[RC]				1.00		
Average	−0.762	0.448	0.089	0.47	0.19	1.12
Above average	−0.955	0.436	**0.029**	0.39	0.16	0.91
Relationship status						
Unmarried/single[RC]				1.00		
Married/in a relationship	0.732	0.264	**0.006**	2.08	1.24	3.49
Socioeconomic status						
Marginal/lower class[RC]				1.00		
Middle/upper class	−0.422	0.295	0.152	0.66	0.37	1.17
Living arrangement						
With roommates/romantic partner				1.00		
With parents/spouse	−0.186	0.323	0.564	0.83	0.44	1.56
Alone	−0.518	0.224	**0.021**	0.60	0.38	0.92
Division						
Others[dRC]				1.00		
Dhaka	−0.515	0.362	0.155	0.60	0.29	1.22
Khulna	−1.239	0.297	**<0.001**	0.29	0.16	0.52
Rangpur	−0.489	0.336	0.146	0.61	0.32	1.19
Sexual orientation						
Homosexual/bisexual[RC]				1.00		
Heterosexual	−1.508	1.050	0.151	0.22	0.03	1.73
Attitude toward pornography	−0.038	0.012	**0.002**	0.96	0.94	0.99

B, unstandardized regression weight; SE, standard error; Sig., significance; AOR, adjusted odds ratio; Exp (B), predicted change in odds for an increase in the predictor; CI, confidence interval. Bold values are significant at 5% level of significance.

[a]Others include female and third sex.

[b]Others include secondary and master.

[c]Others include Hindu, Christian, and Buddhist.

[d]Others include Barishal, Chattogram, Mymensingh, and Sylhet.

[e]Others include college, national university and private university.

[RC]Reference category.

of the explanatory variables with pornography exposure at 5% level of significance; at the second and final stage, the multiple logistic regression model was performed accounting for the pornography exposure-related variables found to be statistically significant in the Pearson's Chi-square ($\chi 2$) test. The findings are shown using the adjusted odds ratio (AOR) with a 95% confidence interval (95% CI).

Results

Table 1 presents the prevalence of pornography exposure and the basic characteristics of the participants. The overall prevalence of pornography exposure was 75.9%. Regarding the socio-demographic characteristics among the participants, the majority (55.6%) were aged 22–24 years, and 72.0% were male students. Most of the participants (84.7%) were undergraduate students and 80.3% were Muslim. More than half (57.4%) of the participants lived in urban areas, and 74.0% were unmarried/single; 80.7% came from middle/upper class families and 92% studied in public universities.

According to Table 2, pornography exposure increased with the increase in age [ranging from 62.4% (<21 years) to 93.0% (25 ≥ years)]; male participants (78.5%) were more exposed to pornography than other sexes. It was also found that honors students (73.5%) were less exposed to pornography than other students (88.9%), while atheists and agnostics had a higher (96.8%) exposure to pornography than Muslims (74.2%) and other religious groups (78.1%). Regarding residence, pornography exposure was relatively higher among rural and sub-urban students (78.9%) than among those from urban areas (73.6%). About 86% of students who were married or in a relationship watched pornography; pornography exposure was also relatively high among students from marginal/lower class families (84.8%). Students living alone (80.0%) or with roommates and romantic partners (79.9%) had more exposure to pornography than those living with parents or families (67.5%). The percentage of pornography exposure was higher among college, national university, and private university students (84.6%).

In bivariate analysis, factors such as age ($p < 0.001$), sex ($p = 0.012$), education ($p = 0.001$), religious preference ($p = 0.014$), self-rated religiousness ($p = 0.002$), relationship status ($p = 0.001$), socioeconomic status ($p = 0.009$), living arrangement ($p = 0.002$), division ($p < 0.001$), and sexual orientation ($p = 0.009$) were significantly associated with pornography exposure.

Figure 2 suggests the types of pornography preferred by the sexes. Findings showed that three out of five students watched amateur or professional pornography (65.7%), of these, three quarters were male (76.4%) and the rest were female (23.6%). However, only 3.9% of participants viewed homosexual/bisexual pornography; female participants constituted a quarter of these viewers (26.3%).

From the bivariate analysis (Table 1), this study only considered significant factors for an adjusted binary logistic regression model, measured by the odds ratio with a 95% confidence interval. The findings suggested that students aged 22–24 years and over 25 years were 1.56 (95% CI: 1.01–2.41; $p = 0.045$) and 4.02 (95% CI: 1.61–10.03; $p = 0.003$) times more likely, respectively, to report watching pornography in the past 2 months compared to students aged 21 and under. Students with above-average religiousness were 0.39 (95% CI: 0.16–0.91; $p = 0.029$) times less likely to report watching pornography than those with below-average religiousness. It is also apparent that married students and those in relationships were 2.08 (95% CI: 1.24–3.49; $p = 0.006$) times more likely to report watching pornography in the past 2 months compared to students who were unmarried or single. In contrast, students who were living alone, students living in Khulna division and students with an anti-pornography attitude were 0.60 (95% CI: 0.38–0.92; $p = 0.021$), 0.29 (95% CI: 0.16–0.52; $p < 0.001$), and 0.96 (95% CI: 0.94–0.99; $p = 0.002$) times less likely, respectively, to report watching pornography.

Discussion

The study aimed to explore the prevalence of pornography exposure among students and to identify its predictors during the third wave of the COVID-19 pandemic in Bangladesh. The results showed that three out of four students admitted to watching pornography in the last 2 months during the COVID-19 pandemic. The overall pornography exposure reported in this study during the COVID-19 pandemic was higher than that of Italy (21.6%) (21), the USA (21%) (32), the UK (43%) (23), and New Zealand (30%) (24), and significantly higher than reported by pre-COVID-19 studies in Bangladesh [42% (28), and 72% (26)]. The heightened prevalence of pornography among students can be attributed to the growing number of internet users during COVID-19 (33), particularly among the younger population, who had more access to and better familiarity with the internet (22, 26).

This study observed that students above 21 years of age watched pornography higher than their younger counterparts during the COVID-19 pandemic. A possible reason for higher pornography exposure could be their inclination to learn about and prepare for sexual activities during marriage, as the average age at marriage for men in Bangladesh is 25.2 years, for women it is 19.4 years (34). Besides, watching pornography for sex education was not an exception (35). In contrast, students under 21 may have been spending more time with their peers in offline activities, minimizing online engagement and reducing exposure to pornography (36). The findings of the current study complement the work of Golder et al. (27) who noted a

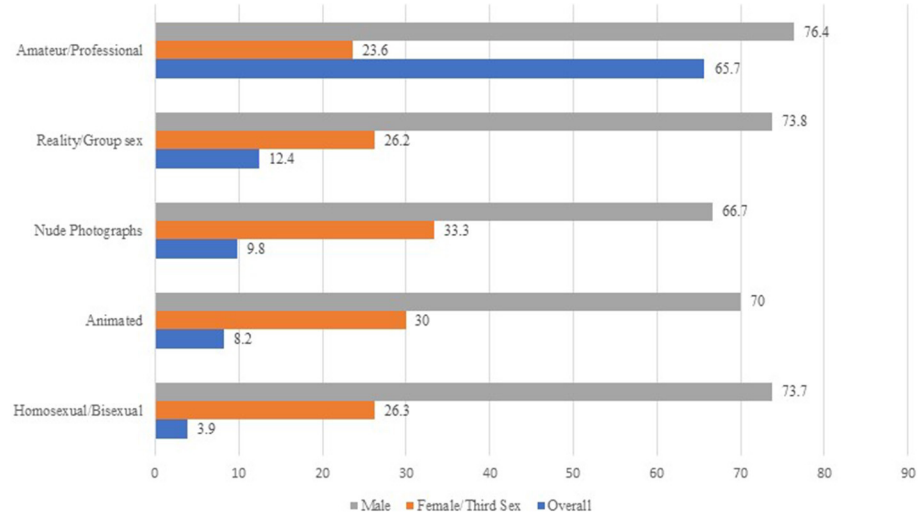

FIGURE 2
Type of pornography preferred by sexes ($N = 490$).

higher exposure to pornography among older students, while Chowdhury et al. (28) found greater exposure among younger students than among their older counterparts.

The current study found that students with above-average religiosity were less exposed to pornography during the pandemic. A sense of moral stigma around pornography (37), together with a fear of shame on the part of religious persons, may have deterred them from watching pornography (38). Eljawad et al. (39), in explaining the lower prevalence of pornography searches on the internet among Arabs, pointed to the high degree of religiosity and conservatism in the Muslim-dominated Middle Eastern countries, which do not approve of sexual activities outside marriage. Likewise, Bangladesh—a Muslim majority country—does not promote sexual content online or offline; additionally, it endorsed an act to reduce people's exposure to pornography across the country (40), because exposure to pornography may lead to offensive sexual behavior toward women. Vera Cruz (41), for example, found that men with frequent exposure to pornography, especially young men, were more likely to engage in sadistic sexual behavior toward their female partners, largely due to their sexual fantasies. However, the findings of this study supports that of Golder et al. (27), who noted that higher religiosity reduces the possibility of pornography exposure; Mamun et al. (26), in contrast, found no influence of religious and moral values on pornography consumption, because strong religiosity may not always translate into specific activities prohibited by religion, such as pornography use (42).

Married students or those in a relationship watched pornography higher than those of unmarried and single students during the pandemic; this finding complements the work of Cascalheira et al. (43) as they observed an increase in sexual fantasies among people living with romantic partners during the "lockdown." The finding is also aligned with pre-COVID studies in Bangladesh (26) and elsewhere (38). Intensified exposure to pornography among people in relationships can be attributed to the fact that watching pornography with a spouse or romantic partner may increase willingness to explore newer sexual practices in order to meet each other's sexual wants and fantasies. Some studies, however, suggest otherwise. Perry (44), for example, in a longitudinal study, found that frequent exposure to pornography may not only reduce sexual satisfaction but also degrade the quality of marital life, largely because of unmet sexual fantasies and increasingly sadistic sexual behavior (41).

In addition, it is apparent that students living alone watched pornography less than those living with roommates or romantic partners. This lower exposure to pornography can be attributed to these students' more frequent involvement in peer groups engaged in offline activities (36), as well as the growing pressure of the online education system during COVID-19 (17, 18), which may have occupied their free time. Cascalheira et al. (43) and Sallie et al. (23), in contrast, found an increase in sexual practice and pornography consumption among people living alone; this behavior was attributed to boredom and increased free time. Rothman et al. (35) also observed that loneliness or boredom were the key factors motivating young Americans, both men and women, to watch pornography and thus satisfy their sexual desires through masturbation.

Regarding residence, it appeared that students from the Khulna division had lower exposure to pornography; their limited access to computers and the internet may have reduced their exposure. The latest nationwide survey on ICT use and access by individuals and households has shown that only 2.3%

of households in the Khulna division have a computer, with another 4.2% having access to the internet (45). Although there was a sharp rise in internet users during COVID-19 (33), the unstable internet connectivity, frequent load shedding, and inadequate low-cost devices (18, 46) may have limited access and exposure to pornography among students in the Khulna division. Furthermore, financial struggle cannot be denied, particularly among middle and lower-income people in the southwestern region of Bangladesh (9, 47–49); this may also have had some impact on access to the internet and exposure to pornography during the COVID-19 pandemic.

Attitudes toward pornography also predict the pornography exposure, as students with anti-pornography attitudes were less exposed to pornography; this result supports a pre-COVID-19 study in Bangladesh. Mamun et al. (26) observed that a positive attitude toward pornography may have increased unhealthy practices and sentiments among university students, while a negative attitude could prevent them from engaging in sadistic behavior, particularly against the opposite sex. Likewise, Evans-DeCicco and Cowan (31) found that anti-pornography attitudes are significantly associated with negative views about pornography and its actors.

Strengths and limitations

The current study has certain strong points. First, to the best of the authors' knowledge, this is the only empirical study that has investigated the prevalence and predictors of pornography exposure among students during the COVID-19 pandemic in Bangladesh. Second, this study was carried out using an online platform, avoiding the risk of "human-to-human" infection with COVID-19 by maintaining "social distancing." Third, the data regarding pornography exposure among students were collected through a globally approved and reliable standardized questionnaire. Nevertheless, no study is without limitations. This was a cross-sectional study; therefore, causality could not be established. Data were only collected from students with access to the internet, which may limit the generalizability of the findings to other groups. The sample selection, using non-probability sampling, may also have limited the generalizability due to sampling biases. The self-evaluation of pornography exposure by students may have played a role in over- or under-reporting pornography exposure. Moreover, the adjusted models identified some crucial predictors of students' pornography exposure; nevertheless, there may be a possibility of residual confounding. As such, more extensive research on a nationally representative population is required.

Conclusions and policy implications

The current study aimed to assess the prevalence and identify the predictors of pornography exposure among students during the COVID-19 pandemic. The findings showed that pornography exposure was higher among students than in previous studies conducted before COVID-19; various factors, including age, religiosity, relationship status, living arrangement, residence, and attitude, significantly predicted pornography exposure. For a better understanding of the complex dynamics of socio-demographic issues with pornography exposure among students, extensive research (longitudinal as well as in-depth studies) is required for policymakers to devise appropriate strategies, e.g., introducing sex education at secondary and higher secondary levels, to ensure healthy and safe sex life for the younger population through age-specific interventions.

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 Khulna University Ethical Clearance Committee Khulna University. Written informed consent to participate in this study was provided by the participants.

Author contributions

MTH: conceptualization, investigation, data curation, formal analysis, methodology, resources, software, and writing—original draft. BA, NJ, MAI, and MR: data curation, formal analysis, software, and writing—original draft. BA, MAI, MR, BK, MS, MN, MHasa, MHasi, and MNI: investigation and resources. BK, MS, MN, and RR: resources and writing—original draft. All authors: writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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Effects of college students' mindfulness on depression symptoms during the epidemic prevention and control period: The mediating effect of psychological resilience

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Depression symptoms significantly impact college students' mental health, particularly during the "closed management" period during the spread of COVID-19. Exploring the mechanism that affects college students' depression symptoms can help alleviate the impact of closed management policies on individual mental health and improve their mental health level. The onset of the COVID-19 pandemic resulted in the normalization of epidemic prevention and control in China and the implementation of the dynamic zero-COVID policy. This study used the Five-Factor Mindfulness Questionnaire—Short Form, Psychological Resilience Scale, and Beck Depression Scale to investigate the mindfulness, psychological resilience, and depression symptoms of 1,062 students under closed management conditions at Northwest Normal University. The mindfulness, psychological resilience, and depression status of students in closed management were investigated using an online questionnaire survey. Eight hundred and ten college students (M_{age} = 20.43, SD = 1.67, range = 17-30) were selected to test the model using the structural equation model and bootstrap method. The results showed that the gender differences in mindfulness and psychological resilience were not significant. Gender differences in depression symptoms were significant, and depression symptoms in men were significantly higher than in women. Grade differences in resilience, mindfulness, and depression levels were not significant. Thus, psychological resilience is negatively associated with depressive symptoms. Psychological resilience plays a mediating role between mindfulness and depressive symptoms. This study provides reference and inspiration for improving college students' mental health under epidemic prevention and control circumstances.

KEYWORDS

depression symptoms, mindfulness, psychological resilience, COVID-19, mental health

1 Introduction

Since December 2019, the novel coronavirus disease 2019 (COVID-19) has become endemic worldwide. Due to the severity of its clinical symptoms and the widespread infections, COVID-19 has significantly damaged the global economy and human health (1). As China enters the normalization of epidemic prevention and control stage,[1] China's dynamic zero-COVID policy[2] has become the general policy. While travel restrictions and closed public spaces policies have achieved considerable results (4), they have also significantly impacted the mental health of residents with limited living space. These residents' mental health level is generally poor, exhibiting symptoms of psychological stress (5). Many colleges and universities have adopted closed management measures to curb the virus's spread. This means that teachers and students are prohibited from moving across campuses; teachers are restricted to their homes, while students are restricted to their dormitories. Under closed management, teaching is conducted online; libraries, study rooms, stadiums, and other public places are temporarily closed; hall meals are canceled; meals are taken at staggered times in the campus canteen; and express delivery and takeaways are suspended. The epidemic has led to changes in lifestyle, isolation at home or in schools, and concerns about unmet basic living needs (6, 7). These pose several challenges to college students (8), inducing high levels of depression (9). Meta-analysis showed that during the outbreak of COVID-19, the depression score of college students was significantly higher than that of other groups; the rate of severe depression particularly, was approximately 20% higher than before the epidemic (10). This finding suggests that more attention should be paid to the mental health needs of college students. The change in college students' lifestyles under closed management epitomizes the change experienced in all Chinese residents' lifestyles under the epidemic prevention policy. Exploring college students' depression status and influence mechanisms during the epidemic prevention and control period is also relevant to understanding citizens' mental health levels under the same situation. This information can help in formulating targeted intervention measures for various populations.

Mindfulness is a protective factor helping individuals recover from adversity and pressure (11). It is of particular significance to college students facing the external pressures of epidemic prevention and control. Mindfulness is a conscious and non-judgmental awareness focusing on the present moment (12). It is an individual's ability to maintain attention and awareness of the present moment and is often regarded as a trait-like psychological state (13). The mindfulness reperceiving model can explain the mindfulness mechanism promoting mental health. People who consciously adopt an objective and non-judgmental attitude can better manage their present circumstances and may even recognize the positive meaning underlying adverse events, leading to successful self-regulation (14). Additionally, mindfulness encourages individuals to search for meaning and more actively manage negative events (15). Xu et al. (16) demonstrated that mindfulness is an internal resource that helps injured individuals adjust and improve their psychological resilience. In the epidemic environment, college students' mindfulness is the most protective factor related to depression and stress perception. High-level mindfulness can reduce pain and depression symptoms caused by the epidemic and significantly improve individual tolerance of pressure (17).

Mindfulness is directly and negatively associated with an individual's depression symptoms (18, 19). Individuals with higher levels of mindfulness usually exhibit better mental health and lower negative emotions. Such individuals are also effective at focusing on the present; they can better distinguish emotions and adopt a more objective perspective to recognize themselves and various life events through self-regulation (20, 21). Individuals with lower mindfulness levels are more likely to experience depression when facing stressful events (22). Empirical studies have shown that mindfulness interventions significantly ameliorate clinical groups' anxiety and depression levels (13, 23). Furthermore, for non-clinical individuals, mindfulness can increase positive emotions, and mitigate negative ones (24).

Psychological resilience, which is also an important protective factor for mental health (25), refers to an individual's ability to overcome adversity and restore normality; it is a relatively stable and universal personality trait (26, 27). Some scholars also believe that psychological resilience is a dynamic process for individuals to adapt well to dangerous environments (28). The framework of resilience in action posits that psychological resilience, as a type of innate potential, promotes the development of varied positive personal characteristics. These might include self-efficacy and cooperation, which constitute the internal resources necessary for individuals to manage stress in the future (29). Kumpfer's resilience framework explains the mechanism of psychological resilience. When

1 "Normalization" refers to the gradual transformation of affairs or states that originally had sudden, uncertain, and accidental characteristics into daily, regular, and lasting ones. Normalization of epidemic prevention and control means that due to the rapid spread of COVID-19 around the world, China may coexist with the epidemic indefinitely. In view of the epidemic development worldwide, the Chinese government has transformed emergency measures taken under certain situations into sustainable and long-term prevention and control measures (2).

2 "Clearing" is the process of clearing the epidemic. "Dynamic" means that the occurrence and elimination of the epidemic are constantly changing. Dynamic zeroing means that the Chinese government does not seek to eliminate all domestic epidemics. Instead, it quickly identifies and handles the COVID-19 epidemic, cuts off the transmission chain of the virus, and controls it in a relatively short period of time. This prevents the spread of novel coronavirus virus in the place where the epidemic originates, as well as other regions. As a result, Chinese society as a whole is gradually moving toward the elimination of COVID-19 (3).

individuals face risk, psychological resilience facilitates active emotional and cognitive regulation, which can better integrate individuals' internal and external resources to cope with stress (30). Rutter's (31) psychoelastic development model emphasizes that psychological resilience is not targeted at reducing the individual's contact with risk factors. Rather, it aims to develop the individual's internal strength, dampening the impact of crisis events, and blocking the negative reactions precipitated by risk factors to enhance the individual's ability to cope with stress and frustration. When individuals experience setbacks, those with high psychological resilience exhibit less psychological distress, fewer psychopathological symptoms, and better mental health than those with low psychological resilience (32, 33). In the epidemic context, psychological resilience is crucial to effectively cope with difficulties, uncertainties, and changes that affect the individual's perception of pressure and prevent maladaptive behaviors (34, 35).

Mindfulness and psychological resilience are closely related as protective factors of mental health. Research has shown a significant positive correlation between individuals' mindfulness traits and psychological resilience. Mindfulness traits are the internal psychological resources that improve psychological resilience. Mindfulness training also significantly improves practitioners' cognitive function and psychological resilience (36, 37). Mindfulness training emphasizes the unconditional acceptance of emotion and cognition, which is conducive to improving the individual's sense of cohesion and psychological resilience. Additionally, psychological resilience is significantly negatively correlated with negative psychological experiences such as depression (38). Individuals with low psychological resilience exhibit more severe depressive symptoms (39, 40), while individuals with high psychological resilience are more effective at utilizing positive emotions to resist the impact of depression symptoms. These individuals are also more likely to recover from negative emotions when facing pressure, learn from them, and exhibit an improved level of mental health after stressful events (41, 42). The present study hypothesizes that psychological resilience is the explanatory mechanism of mindfulness on depression symptoms. Specifically, mindfulness, through the acceptance of emotion and cognition, uses emotion regulation strategies (such as changing the way of perceiving stress), enhancing psychological resilience, reducing depression levels, and promoting better mental health.

The research on mindfulness, psychological resilience, and depression symptoms is still controversial. Some studies point out that psychological resilience bridges mindfulness and mental health (43, 44). However, other studies have shown inconsistent results, such as no linear relationship between psychological resilience and depression symptoms (45). These differences may be because most existing studies are conducted in particular groups, such as chronic gastritis patients, patients in the recovery period of depression, and women undergoing pregnancy termination for fetal abnormality. Moreover, the demographic characteristics of the research group also impact the results. Early studies on the COVID-19 epidemic indicated that women had high levels of mindfulness and depression symptoms and low levels of psychological resilience (46–48). In addition, the mental health level of older adults was higher than that of young individuals (49). However, with the continuation of the epidemic and an increase in citizens' understanding of it, the impact of demographic variables on mental health gradually decreased (7). Therefore, whether the mindfulness, psychological resilience, and depression symptoms models can be extended to more representative groups (such as college students) and tested in the current epidemic environment remains to be seen. Given the context and the influence of the COVID-19 pandemic, the characteristics of depression symptoms, mindfulness, and psychological resilience have undergone some changes. Specifically, mindfulness and psychological resilience have had a positive impact on the individual's ability to cope with the COVID-19 epidemic, becoming a topic of interest to researchers and other persons. Concurrently, false information, negative emotions, and lifestyle changes have a continuous negative impact on protective factors such as psychological resilience. The epidemic has aggravated individuals' depressive symptoms. The depression diagnosis rate during the epidemic has increased significantly compared to before the epidemic (10, 17, 34). In summary, we selected ordinary college students under closed management conditions as the research object to establish a mediation model. In the context of the large-scale public health event of COVID-19, we explored the impact of mindfulness and psychological resilience on depression symptoms in a more representative sample group. This is of theoretical and practical significance as it can help us to engage with the challenges of the COVID-19 epidemic in a more targeted manner.

This study proposes the following hypotheses: Hypothesis 1: There are significant differences in depressive symptoms, psychological resilience, and mindfulness between genders and grades. Hypothesis 2: A significant negative correlation exists between college students' mindfulness and depression symptoms during the epidemic prevention and control period; a significant positive correlation exists between mindfulness and psychological resilience; a significant negative correlation exists between psychological resilience and depression symptoms. Hypothesis 3: In the context of epidemic prevention and control, psychological resilience mediates the effect of mindfulness on depression symptoms.

2 Materials and methods

2.1 Participants

In this study, Questionnaire Star (a widely used data collection platform in China) was used to investigate college

students' mindfulness, psychological resilience, and depression symptom levels during the epidemic prevention and control period. The data were collected in April 2022 (1 month after the initiation of closed management). All survey participants were from Northwest Normal University and provided informed consent online. We distributed recruitment information in student exchange groups and campus forums. The target participants are all students under closed management.[3] They will be informed of the purpose and results of the study as far as possible. One thousand sixty-two Northwest Normal University students anonymously completed the test. The collected questionnaires were screened according to the response time, and 810 valid questionnaires were included after excluding random and regular questionnaires. The effective rate was 76.27%. A total of 810 participants (M_{age} = 20.43, SD = 1.67, range = 17-30 years, 89.6% female, 31.4% freshman, 25.2% sophomore, 28.0% junior, 9.4% senior, 6.0% graduate student) were included in the final statistical analysis.

2.2 Measures

2.2.1 Mindfulness

Mindfulness was measured by the Five-Factor Mindfulness Questionnaire—Short Form (FFMQ- SF) designed by Bare et al. (50) and revised and verified by Deng et al. (51). The revised scale has 20 items divided into five dimensions: observation, description, conscious action, non-judgment, and non-reaction. Each item was scored on a Likert scale ranging from 1 (not at all) to 7 (completely); the higher the score, the higher the mindfulness trait level. This scale is widely used by scholars in China and abroad (52, 53). In this study, the questionnaire's Cronbach's α coefficient was 0.71 and each dimension's Cronbach's α coefficient was 0.82, 0.83, 0.86, 0.68, and 0.73, respectively. The results of the confirmatory factor analysis show that the structural validity of the questionnaire is acceptable ($\chi 2/df$ = 5.34, CFI = 0.91, TLI = 0.89, RMSEA = 0.07, SRMR = 0.07).

2.2.2 Psychological resilience

Psychological resilience was measured using the Psychological Resilience Scale designed by Connor and Davidson (54) and revised and verified by Yu and Zhang (55). The scale has 25 items covering three dimensions: tenacity, strength, and optimism. Each item was scored on a Likert scale ranging from 1 (never) to 5 (always). The scores for the items are summed to obtain the psychological resilience score: The higher the score, the stronger the psychological resilience. In this study, this scale's Cronbach's α coefficient was 0.96, and each dimension's Cronbach's α coefficient was 0.95, 0.89, and 0.72, respectively. The results of the confirmatory factor analysis show that the structural validity of the questionnaire is acceptable (χ^2/df = 5.81, CFI = 0.91, TLI = 0.90, RMSEA = 0.08, SRMR = 0.04).

2.2.3 Depression symptoms

Depression symptoms were measured using the Chinese version of the Beck Depression Scale, revised and verified by Wang et al. (56). The scale has 21 items, each with a score between 0 and 3. The total score is the sum of the scores of all items: The higher the score, the more severe the individual's depression symptoms. The total score on the scale ranged from 0 to 63 points. A score of 0–13 points indicates no depression symptoms, 14–19 points indicates mild depression symptoms, 20–28 points indicates moderate depression symptoms and 29–63 points indicates severe depression symptoms. This scale's Cronbach's α coefficient was 0.931 in this study. The results of the confirmatory factor analysis show that the structural validity of the questionnaire is acceptable (χ^2/df = 4.84, CFI = 0.91, TLI = 0.90, RMSEA = 0.07, SRMR = 0.05).

2.3 Data analysis

The lavaan R package software and SPSS 24.0 were used to store and manage data. Data on mindfulness, psychological resilience, and depression symptoms are all collected using self-report scales, which may lead to common method bias (57). This

TABLE 1 Descriptive statistics of grades and gender.

Grades	Gender	PS ($M \pm SD$)	MD ($M \pm SD$)	DP ($M \pm SD$)
First year	Male	91.47 ± 2.87	88.07 ± 1.90	8.63 ± 1.36
	Female	90.79 ± 1.05	88.47 ± 0.70	5.24 ± 0.50
Second year	Male	98.90 ± 3.60	92.00 ± 2.39	2.95 ± 1.70
	Female	90.49 ± 1.16	90.40 ± 0.77	5.20 ± 0.55
Third year	Male	84.75 ± 3.51	85.20 ± 2.33	7.30 ± 1.66
	Female	92.05 ± 1.09	90.63 ± 1.28	5.16 ± 0.52
Last year	Male	90.30 ± 4.97	85.70 ± 3.30	10.70 ± 2.35
	Female	91.20 ± 1.93	90.64 ± 1.28	3.86 ± 0.91
Postgraduate	Male	97.80 ± 7.02	94.00 ± 4.66	4.40 ± 3.32
	Female	85.16 ± 2.37	85.11 ± 1.57	6.82 ± 1.12

N = 810, Grade was dummy coded such that 1, first year; 2, second year; 3, third year; 4, fourth year; 5, postgraduate; PS, Psychological resilience; MD, Mindfulness; DP, Depression symptoms.

3 Closed management is a common management measure adopted by Chinese Universities during the outbreak of COVID-19. It mainly refers to the temporary and strict closed management system adopted to prevent the spread of the virus. Specifically, teachers and students are prohibited from moving across campuses. Teachers must isolate at home and students in their dormitories. Only online teaching takes place. Students are not allowed to enter or leave the school, and most of the time remain isolated in the dormitory. They can only move within the limited space on campus within specified time frames. Libraries, study rooms, stadiums and other public places are temporarily closed. Students go to the canteen to order food at a specified time and take it back to the dormitory to eat. Express delivery and takeaways are not permitted on campus.

study adopted anonymous measurement and reverse scoring methods to control for the common method bias. After data collection, the Harman univariate test was used to measure the size of the common method deviation. Unrotated exploratory factor analysis results extracted a total of 10 factors with eigenvalue roots greater than 1. The maximum factor variance explanation rate was 19.70%, lower than the critical standard of 40%. This indicates there is no evident common method bias in the present study. Descriptive statistics and correlation analyses were performed. The structural equation model and bootstrap test were used to examine the bootstrap method. The 95% upper and lower limits of confidence intervals (CIs) were used to investigate the mediating effect of psychological resilience between mindfulness and depression symptoms.

3 Results

3.1 Preliminary analysis

A 2 (gender: male, female) × 3 (variables: mindfulness, psychological resilience, depressive symptoms) multivariate ANOVA was conducted. The results showed that the interaction between gender and the variables was significant ($F = 3.11$, $p < 0.05$, $\eta_p^2 = 0.008$). Simple effect analysis showed that there was no significant gender difference in mindfulness ($F = 0.10$, $p > 0.05$, $\eta_p^2 = 0.001$) and psychological resilience ($F = 1.96$, $p > 0.05$, $\eta_p^2 = 0.000$). Furthermore, the gender difference in depressive symptoms was significant ($F = 5.87$, $p < 0.05$, $\eta_p^2 = 0.006$). The depressive symptom score for men was significantly higher compared to women ($F = 4.64$, $p < 0.05$, $\eta_p^2 = 0.006$).

A 5 (grade: freshman, sophomore, junior, senior, graduate) × 3 (variables: mindfulness, psychological resilience, depressive symptoms) multivariate ANOVA was conducted to test grade differences among mindfulness, psychological resilience, and depression symptoms. The results revealed no significant differences among them ($F = 1.35$, $p > 0.05$, $\eta_p^2 = 0.007$). Thus, Hypothesis 1 of this study was partially confirmed. Table 1 shows college students' scores for mindfulness, psychological resilience, and depressive symptoms according to grade and gender.

In this study, the total score obtained on the Beck Depression Scale for college students ranged from 0 to 55; the average score was 5.37 ± 7.47. According to the demarcation line, 706 college students exhibited no depressive symptoms, accounting for 87.2% of the total; 104 college students showed depressive symptoms, accounting for 12.8%. Among them, 59, 32, and 13 college students had mild, moderate, and severe depression symptoms, accounting for 7.3, 4, and 1.6% of the total, respectively. The level of college students' depression symptoms in this study was significantly lower than that of the college students in the study by Jiang (t = -8.28, $p < 0.001$, 7.54 ± 6.31) (58).

3.2 Correlation between mindfulness, psychological resilience, and depression symptoms

Table 2 shows the means, standard deviations, and Spearman correlation coefficients for all variables in the current study. Due to depression symptoms having a non-normal distribution, the Spearman correlation test was used to test the correlation coefficient in our study. Correlation analysis showed that during the epidemic prevention and control period, college students' mindfulness exhibited a significant negative correlation with depression symptoms, a significant positive correlation with psychological resilience, and a significant negative correlation between psychological resilience and depression symptoms. This confirms Hypothesis 2.

3.3 Mediating effect of psychological resilience

During the epidemic prevention and control period, the correlation analysis results showed a significant negative correlation between college students' mindfulness and depression symptoms and between psychological resilience and depression symptoms. There was also a significant positive correlation with psychological resilience, thus fulfilling the mediation effect analysis conditions. A structural equation model was used to investigate the mediating effect of psychological resilience on mindfulness and depressive symptoms. Mindfulness was an exogenous latent variable, psychological resilience was an endogenous latent variable, and the depression scale was an observational variable as it had only one dimension. Mindfulness includes observation (a1), description (a2), conscious action (a3), non-judgment (a4), and non-reaction (a5) as potential variables. Psychological resilience includes tenacity (b1), strength (b2), and optimism (b3) as potential variables. The measurement model was created using the item parceling method, adjusting the model according to

TABLE 2 Descriptive statistics and Spearman correlations for all measures.

Measure	*M*	*SD*	1	2	3
1 Mindfulness	89.45	10.51	1		
2 Psychological resilience	90.87	15.77	0.65**	1	
3 Depression symptoms	5.37	7.47	−0.36**	−0.39**	1

N = 810, Depression scale was dummy coded such that 0, no depression symptoms; 1, mild depression symptoms; 2, moderate depression symptoms; and 3, severe depression symptoms. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

the MI index. The fitting index of the intermediary model was $\chi 2/df$ = 9. 12 ($\chi 2$ = 136. 84, df = 15), CFI = 0. 97, TLI = 0. 94, RMSEA = 0. 10, SRMR = 0.04. The maximum likelihood ratio method in SEM causes the chi-square to expand significantly when the number of samples is greater than 500; hence the goodness of fit of the model is acceptable overall.

The path coefficients and relationships between the three variables are shown in **Figure 1**. Mindfulness was significantly positively correlated with psychological resilience (path coefficient is estimated at 0.54). In contrast, psychological resilience was significantly negatively correlated with depression symptoms (path coefficient is estimated at -0.48). Psychological resilience played a complete mediating role between mindfulness and depressive symptoms (the mediating effect is -0.26).

The bootstrap method was used to test the intermediary effect of the data collected in this study. According to Preacher and Hayes (59), the sample size was 5,000. At the 95% confidence interval, the results of the direct effect of mindfulness on depressive symptoms included 0 (LLCI = −0.06, ULCI = 0.06), indicating that the direct effect of mindfulness on depressive symptoms was not significant. The direct effect of mindfulness on psychological resilience did not include zero (LLCI = 0.46, ULCI = 0.72), indicating that the direct effect of mindfulness on psychological resilience was significant. The results of psychological resilience on depression symptoms did not include 0 (LLCI = −0.25, ULCI = −0.17), indicating a significant direct effect on depression symptoms. The result of the mediation effect did not include 0 (LLCI = −0.16, ULCI = −0.09), indicating that the mediation effect of psychological resilience was significant. Therefore, mindfulness is negatively correlated with depression symptoms, and psychological resilience plays a completely intermediary role, confirming Hypothesis 3.

3.4 Path analysis of the mediation model

We analyze the factor load of each potential variable. The factor load of mindfulness in the model was more than 0.50, and the factor load of non-reaction was approximately 0.90. This indicates that observation, description, non-judgment, and non-reaction are typical dimensions of mindfulness, and individuals can refrain from reacting to perceived cognition and emotion. This plays an important role in the relationship between mindfulness and depressive symptoms. The factor loads of psychological resilience were all above 0.80. Moreover, tenacity and strength factor loads were above 0.90, indicating that tenacity, strength, and optimism are typical dimensions of psychological resilience. Mindfulness is involved in improving the strength and tenacity of college students in the epidemic environment. In addition, the dimension of conscious action (path coefficient is estimated at 0.06) was not significant to the total score of mindfulness (p > 0.05, LLCI = −0.29, ULCI = 0.16). As in previous research (60), this dimension was deleted from the model. The conscious action package did not perform well in the model. In the epidemic context, cognitive awareness and acceptance of inner experience are more important than focusing on the current action. In addition, the description and non-judgment dimensions of mindfulness have cross-loadings on psychological resilience, which was notable. Many researchers pointed out that when CFA involves personality, the cross-loadings between factors may reflect the extensive relationship between personality rather than the measurement problem; therefore, its theoretical significance should be considered (61, 62). Joshanloo et al. (63) believe that the cross-loadings close to or greater than 0.3 is an important factor in the structure. We modified the model according to the MI index. The results showed that the descriptive (path coefficient is estimated at 0.55) and non-judgment (path coefficient is estimated at 0.69) dimensions still indicated a higher load on the mindfulness factor, with psychological resilience cross-loadings of 0.22 and 0.33, respectively. Further analysis showed that both descriptive (p < 0.000, LLCI = 0.29, ULCI = 0.51) and non-judgment dimensions (p < 0.000, LLCI = 0.15, ULCI = 0.37) had significant effects on the psychological resilience path. In the epidemic context, this result indicates that college students can clearly perceive their inner experiences and accept them without judgment. This process has a particular theoretical relationship with the psychological resilience mechanism.

4 Discussion

This study explored the internal mechanisms of mindfulness on depression symptoms from the perspective of psychological resilience. The results showed that college students' psychological resilience played an intermediary role between mindfulness and depressive symptoms. This result verified the protective role of mindfulness and psychological resilience in the general population. They also solved the existing problem of lack of sample population representativeness in previous studies. The results of this study bolster existing literature on the depression status of college students in the context of closed management and COVID-19. The results can be leveraged to create and implement targeted interventions to improve mental health.

No significant differences were detected in mindfulness, psychological resilience, and depression symptoms among college students of different grades. This may be because the psychological development of college students of all grades is focused on the early adulthood stage. Thus, their psychological development levels are similar. No significant gender differences were found in mindfulness and psychological resilience. Men's

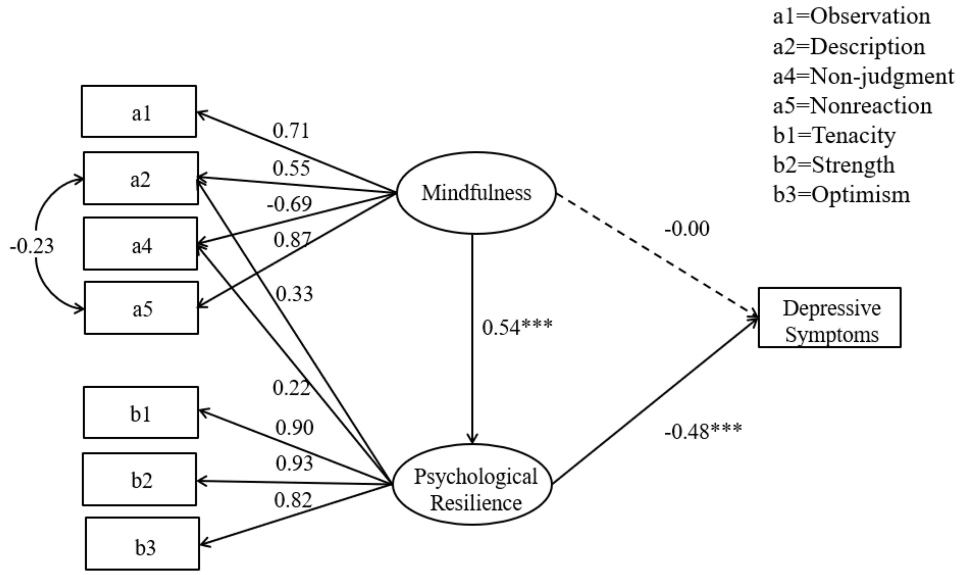

FIGURE 1
Mediation effect model of psychological resilience between mindfulness and depression symptoms. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

depression levels were higher than women's, which contradicts previous studies; early epidemic research indicates that young women are at a higher risk of mental health problems (49). Women have been found to have higher levels of depression and lower levels of psychological resilience than men (7, 48). Women's sensitivity to perceived pressure is bound to worsen their mental health due to anxiety about the epidemic and isolation. However, with the public's increased understanding and adaptation to the epidemic, its impact on women's mental health has gradually decreased. Recent studies have shown no significant gender differences in mindfulness or psychological resilience, consistent with the results of this study (64, 65). In addition, higher levels of depression symptoms among men in this study may be related to the more considerable adaptive pressure faced by male students. In Chinese culture, boys and men are less likely to actively seek social support (66), resulting in greater adaptive pressure. In addition, sports play a more obvious role in promoting boys' mental health (67), and the inability to carry out outdoor sports in an isolated environment may cause more psychological discomfort. This suggests that colleges and universities should actively focus on the impact of closed management on the mental health of male students. It should be noted that the effect of this result is small and should be verified using a larger sample or a more rigorous experimental design.

This study found that the depression symptom level of college students during the closed management period was slightly lower than under normal social conditions (58), which differs from previous studies. Previous studies have pointed out that the COVID-19 epidemic and its associated feelings of isolation have increased people's psychological problems to varying degrees. Isolated personnel have a high level of stress and different levels of depression symptoms, anxiety, and other emotions. The detection rate of depression has increased significantly since the epidemic outbreak (68, 69). This difference may be due to the increased publicity of the epidemic's effects by the government, schools, and health experts; China normalized the prevention and control of the epidemic, and college students obtained a better understanding of these measures (70, 71). This stabilizes the students' overall mood when facing closed management situations and enables them to adopt a positive self-regulation mode (72, 73). At the same time, repeated waves of infection have also created opportunities for college students to adapt after trauma (74). Their psychological resilience and mindfulness have played a positive role in their protection, and they can cope better with the epidemic's impact. Moreover, colleges and universities attach substantial importance to their students' mental health. These institutions are actively implementing a series of targeted measures during the epidemic prevention and control period. These measures may include conducting online individual and group psychological counseling, establishing a psychological hotline, introducing communication channels to understand student demands, gradually opening public areas based on the infection rates, and organizing sports competitions and physical exercise punch-in activities. All such measures can alleviate college students' psychological pressure during isolation. These measures significantly contribute to relieving depression symptoms and promoting mental health among college students (75, 76). On the premise that the isolation measures are reasonable and scientific, the isolated will feel

that they have been better protected, thereby reducing negative emotions and stress and improving their overall mental health.

The study found that college students' mindfulness was directly and negatively associated with individual depression symptoms during the closed management period. The higher the level of mindfulness, the fewer the depressive symptoms; this is consistent with previous research results (18, 19). As an important protective factor for mental health development, mindfulness significantly contributes to relieving depression and other negative emotions (11, 77). Tran et al. (78) believed that the most important mechanisms of mindfulness are decentering and non-attachment. "Decentering" means that individuals can shift their attention away from negative cognition and emotions and stop themselves from falling into a cycle of negative emotions. "Non-attachment" means accepting and not indulging in the inner experience. When an individual is worried about the epidemic or the future, mindfulness acts on attention distribution through decentering, making the individual focus on awareness and reducing the automatic response to negative emotions (79). Individuals with a high level of mindfulness are better at observing their surrounding environment outwards and identifying their inner experience inwards, which helps eliminate the persistent negative impact of the epidemic. When individuals can accept and not judge their inner emotions and ideas, it is helpful for them to actively self-regulate, block negative thinking, and prevent invasive rumination (80, 81). This can promote objective recognition of their own state, distinguish between "ideas" and "reality," and disassociate from the negative thinking mode (82–84). Acceptance and non-judgment are the core elements of mindfulness that improve emotions states (85, 86). This mode of thinking helps individuals maintain high mental health in an epidemic-pressured environment. In this study's model, the observation, description, non-judgment, and non-reaction dimensions of mindfulness have a higher degree of fit, which verifies the above mechanism. The conscious action dimension of mindfulness did not fit well in this model, which may be related to the multitrait pattern of mindfulness. The feature structure of mindfulness is not unidimensional; there are widely distributed and different mindfulness feature groups in the population (87, 88). The five dimensions—observation, description, conscious action, non-judgment, and non-reaction—have different levels in different mindfulness trait groups (89). Research also shows that mindfulness' conscious action is not significantly associated with long-term depressive symptoms (60). It is also possible that college students' actions are restricted to a certain extent in an isolated environment, and their conscious actions are, therefore, poorer (90).

Research has demonstrated that psychological resilience completely mediates mindfulness and depression symptoms; mindfulness can reduce the depressive symptoms of individuals by improving their psychological resilience. All dimensions of the model's psychological resilience played a significant role. The tenacity and strength of psychological resilience were slightly stronger than those of optimism. In other words, mindfulness has strengthened individual resources and tolerance for epidemics. According to previous studies, mindfulness can reduce automatic reactions, redundant thinking, rumination, and avoidance thinking by acknowledging one's thoughts, feelings, and evaluations. Simultaneously, psychological resilience can help cope with stressful environments by mobilizing psychological resources, increasing positive emotions, and achieving good adaptation. This is a process of recognizing and accepting emotions and improving mental health through emotion regulation strategies, consistent with mindfulness mechanisms (43). It also verifies Kumpfer's resilience framework, that is, psychological resilience mediates the impact of individual characteristics on adaptive results (30). The anterior radius of the mediation model shows that mindfulness is positively correlated with psychological resilience, consistent with previous studies (36). When individuals perceive and recognize the negative impact of an epidemic, they can improve their attention strategies through decentering to promote the development of psychological resilience. The attitude of non-attachment improves the individual's positive cognitive ability through acceptance and non-judgment (91), thereby improving their psychological resilience (92). The posterior radius of mediation shows that college students' psychological resilience is negatively correlated with their depressive symptoms, consistent with the findings of previous studies (93). People with high psychological resilience have more positive psychological traits. Thus, they are more resilient, powerful, and optimistic. They can overcome difficulties, have positive expectations for the future and the present, can focus more on positive experiences during the epidemic and closed management, actively adjust their emotional state and reduce negative emotional experiences, such as depression and anxiety (94, 95). In the context of an epidemic, a relatively monotonous living environment tests individuals' psychological resilience. The epidemic has resulted in several challenges, such as employment concerns and increased educational pressure. Highly psychologically resilient individuals use positive emotion regulation strategies, block the automatic response to risk factors, and actively and flexibly mobilize internal and external resources to cope with these pressures to avoid succumbing to negative emotions (32, 96).

The model's description and non-judgment dimensions of mindfulness have the relevant cross-loadings on psychological resilience. This may be related to similarities in psychological resilience and mindfulness mechanisms of action. First, mindfulness is based on the development of cognitive functions. Individual working memory and cognitive inhibition, in particular, are highly correlated with descriptive and non-judgmental levels (97). Furthermore, cognition is an important pathway for resilience. Secondly, the descriptive dimension

of mindfulness describes the observed experience with words, thereby reducing automatic and inappropriate responses. Non-judgment means adopting a non-evaluative attitude toward the experience. This helps reduce reactions to negative emotions and greatly reduces the pain caused by secondary reactions (98). Psychological resilience emphasizes using positive emotional regulation strategies to avoid automatic responses to negative emotions. Psychological resilience is highly similar to the descriptive and non-judgmental mechanisms of action. In addition, Burzler et al.'s research pointed out that the effect of mindfulness on depressive symptoms is primarily carried out by identifying emotions, accepting emotions, and adopting positive emotion regulation strategies (99). This provides another perspective on the cross-loading of the description and non-judgmental dimensions of resilience and mindfulness in the model. Future research can build non-judgmental, observational, and resilience models to further validate this mechanism through mindfulness intervention experiments.

In summary, mindfulness and psychological resilience should not be limited to clinical groups. Regular college students can also prevent external shocks by improving their mindfulness and psychological resilience. In the epidemic context, mindfulness and psychological resilience are important resources for the general population to maintain mental health. We should actively promote its protective role in minimizing the epidemic's impact on mental health. The mediation model shows that colleges and universities can introduce group counseling courses based on psychological resilience and mindfulness during epidemic prevention and control periods. Furthermore, the popularization of relevant psychological knowledge through online and offline psychological counseling and mental health lectures can help minimize the effects of depression. It is also necessary to nurture the internal psychological resources of college students through interventions such as meditation training and mindfulness intervention. This, in turn, will improve their psychological resilience, increase their ability to deal with stressful events, and improve their mental health. These measures are necessary to protect the students' mental health and reduce the risk of depression.

5 Limitations and future research directions

First, the study sample was from regular universities in China, with a high proportion of female students, which affects the generalization of the conclusions to a certain extent. Second, the study used self-reported data, which may have introduced recall and social desirability biases. Third, this study adopted a cross-sectional design, which cannot draw a causal inference between mindfulness and depression symptoms. Further studies can adopt a longitudinal research design to draw causal inferences and use more objective experimental methods to verify the protective mechanism of mindfulness and psychological resilience on depressive symptoms. Taking college students during the closed management period as the research object and setting up a control experiment of mindfulness intervention to explore the development trend of mindfulness, psychological resilience, and depression symptoms, so as to verify the protective effect of mindfulness and psychological resilience on mental health in the COVID-19 situation.

6 Conclusion

This study discusses the relationship between mindfulness, psychological resilience, and depressive symptoms within the context of COVID-19. Moreover, the study verifies the intermediary role of psychological resilience between mindfulness and depressive symptoms. The study found that the depression level of male students was slightly higher than female students under the closed management system. College students' mindfulness level was negatively associated with depression symptoms and positively associated with psychological resilience; thus, psychological resilience was negatively associated with depression symptoms and completely mediated the effect of mindfulness on depression symptoms. Colleges and universities can improve the mental health of college students affected by the epidemic through mindfulness interventions and meditation training.

Data availability statement

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

Author contributions

YJ designed the study and supervised the project. YJ and YY helped revise the manuscript. YY and YH analyzed the data. ZY drafted the manuscript and collected the data. FL and HM distributed questionnaires and screened participants. All authors have read and approved the final manuscript.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.991449/full#supplementary-material

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Anxiety, depression, psychological stress and coping style in medical postgraduates in southeastern China when restricted to commuting between the campus and hospital during the COVID-19 pandemic

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Background: As the COVID-19 epidemic was gradually brought under control, a new autumn semester began in 2020. How was the mental health of postgraduates as they experienced quarantine at home, only commuting between the school and hospital?

Methods: The research was conducted in a cross-sectional online survey in October 2020. The data were collected from 1,645 medical postgraduates (master's and doctoral students) by using the demographic information questionnaire, the Self-rating Depression Scale (SDS), the Self-rating Anxiety Scale (SAS), the Questionnaire on Psychological Stressors of Postgraduates (QPSP), the Simplified Coping Style Questionnaire (SCSQ) and the Social Support Rate Scale (SSRS). One-way ANOVA and Pearson correlation were used to explore the relationships among anxiety, depression, psychological stressors, social support and coping style. Structural equation modeling (SEM) was conducted to assess the mediation model.

Results: Among the total of 1,645 medical postgraduates, 21.6% (n = 356) had self-rated depression symptoms, and 9.4% (n = 155) had self-rated anxiety symptoms. The main disturbances they experienced were employment, academic and interpersonal pressure. The master of third grade students had the highest employment pressure, and the master of second grade students

had the highest academic and interpersonal pressure. Negative coping played a negative mediating role and social support played a positive mediating role in the relationships between perceived stress and anxiety (β = 0.027, $P < 0.01$; β = 0.124, $P < 0.01$) and depression (β = 0.016, $P < 0.01$; β = 0.193, $P < 0.01$).

Conclusion: Medical postgraduates in China restricted to studies on campus and in the hospital experienced psychological distress. Our results suggest that providing employment and learning guidance, while strengthening social support and guiding positive coping may be effective at improving the mental health of the medical graduate students, mediating their perceived stress and negative emotions.

KEYWORDS

anxiety, depression, psychological stress, coping style, medical postgraduates, COVID-19

1. Introduction

The restriction of several activities, school closures, and the lockdown of cities were measures implemented to cope with the outbreak of COVID-19 (1). Chaos, fear, isolation and social distancing, as well as the uncertainty of the virus, were always present. The sacrifices of medical workers globally finally relieved pressure in the fight against this major public health event (2). In addition to the medical staff, medical students are also an important force in the epidemic prevention and control in the future, so their mental health under the COVID-19 epidemic is also worthy of attention.

As the epidemic was gradually brought under control, a new autumn semester began in 2020. It was the first time that university students were welcomed back to school, but with restricted management; only those coming from regions without new positive COVID-19 patients could be approved to come back to school. School management has resulted in measures such as online and offline classes, daily reports and restriction to not to leave campus unless necessary. Previous studies have reported several cases of unbearable psychological stress among local residents living in epidemic regions and various psychological problems among university medical students (1, 3, 4). Depression symptoms, increased anxiety, and even suicidality developed among those students. It has been reported that medical staff and students were at moderate to high risk of psychological distress, among which, the detection rate of psychological distress among medical students was 30.9% (5).

COVID-19 is ongoing, and the persistent impact of the epidemic on university students, especially medical students, is not clear. Medical students are important resources for future public health. We are interested in their current mental health after they have experienced the COVID-19 outbreak and lived with COVID-19.

2. Background

Previous studies have shown that a professional medical career starts from the first day of entering medical school (6). Compared to students in other majors, medical students suffer more stress due to greater academic stress, more professional courses and more rigorous practical training (7). High rates of mental illness and psychological distress were found in medical students by Almojali (8) and were related to sleep disturbance. A systematic review outside North America indicated that medical students had a 7.7–65.5% prevalence of anxiety and a 6.6–66.5% prevalence of depression (9), and approximately 20.9% of Chinese medical students reported self-rated depression. The prevalence of anxiety among this group was approximately 19.6% in 2015 in Southwest China.

The mental health problems of medical school students seemed to become more common as they coped with the COVID-19 pandemic by performing social distancing (1, 10, 11). Usually, medical students need to spend a lot of time on clinical study and research in the hospital under the guidance of their mentors. Now students have to take causes online due to students learning online. They were forced to study at home and participate in distance learning. Several face-to-face tutorials, clinical clerkships and clinical exposure training had to be replaced by virtual reality tech-learning (12). These unprecedented changes and unique challenges have influenced the mental health and academic performance of medical students (13). A study found that 78.4% of medical graduate students believe that the COVID-19 pandemic has affected their studies to varying degrees (14). To some degree, medical students had to quickly adapt to new learning patterns, but some of them may not have succeeded, as everyone has their own coping style.

In the new autumn semester of 2020, most medical students returned to school and restarted their clinical clerkships. How was their mental health after experiencing quarantine at home and were now only commuting between the school and hospital? Some students may not have been able to return to school with most of their classmates, so how was their mental health?

Coping with stress is widely studied and refers to individual cognitive and behavioral strategies to master, reduce or tolerate the internal and external demands of stressful situations (4). Clinical exposure is characterized by chaos and high work demands, and future medical professionals, i.e., medical students, should be equipped with the ability to respond and react quickly and with strong resilience (15). Classen (16) reported that individuals who adopt a positive coping strategy usually have a fighting spirit and better emotional expression, which is considered to indicate better mental adjustment ability (17), which is an important competency for a health professional. Some studies have pointed out that individuals with a high degree of psychological distress will spend more time searching for information related to COVID-19, more frequently adopt a negative coping style, and report less social support (18). A number of undergraduates adopted passive strategies to deal with negative emotions, which affected their mental health (19). Compared with medical staff, the general population has a higher degree of psychological distress, and prefers to adopt negative responses to face the COVID-19 epidemic (20).

Social support, a positive factor, protects personal well-being and mental health (21). It refers to the care, love, and esteem that individuals can receive from others. Several studies have indicated that social support is a major cause of decreased negative psychological reactions such as depression and anxiety (19). It helps to decrease the harmful effects of negative events in life on physical health and emotional well-being when individuals cope with challenges (22).

The concept of stress resistance raised by Kobasa (23) showed that the influence of stressful events on human health or disease is related to individual personality traits, cognitive evaluation, coping style and social support. Research on this concept indicated that when experiencing the same stressful events, those who habitually employ a negative coping style are more likely to have psychological problems, and this concept has been convincing in nursing students in China (24). Worldwide, medical students who experienced the outbreak of COVID-19 were influenced by it.

At present, less attention has been paid to the psychological pain of medical graduate students when restricted to commuting between the campus and hospital during the COVID-19 pandemic, which might serve as the basis for the future mental health management of medical graduate students. We conducted a cross-sectional survey in Guangdong, southern China, to evaluate the incidence of anxiety and depression symptoms among postgraduate medical students; we hypothesized that there might be a mediating relationship of coping style and social support between their perceived stress and depression and anxiety symptoms. The goal is to provide targeted mental health education guidance to the graduate administration related to the hospital.

3. Materials and methods

3.1. Participants

The participants were recruited among full-time postgraduates of Southern Medical University, China. This online questionnaire survey was conducted in October 2020 and was distributed to the WeChat® chat group of every class by the instructors of each grade. The inclusion criteria were as follows: (a) students over the age of 18; (b) postgraduates in any major in medicine; and (c) students with the ability to understand and complete the questionnaire. The exclusion criteria were as follows: (a) students with a history of mental illness or mental disorders; and (b) students with serious physical illness who were unable to complete the questionnaire. The respondents were informed of the purpose of the survey when they agreed to fill out the questionnaire. Only full-time medical postgraduates with the ability to understand the meaning of each question and to communicate in Chinese were included in the survey. Those who refused to participate and were unable to understand the meaning of the questions were excluded.

3.2. Instruments

3.2.1. Demographic information questionnaire

The demographic section was designed by the research team to collect information on the general characteristics of medical postgraduates, including their gender, age, grade, place of residence, only child status, major subject, academic/professional degree and so on.

3.2.2. Self-rating Depression Scale

This scale was designed in 1965 by Zung (25) and was used to measure the severity of depression. The scale includes 20 items with 10 forward and 10 reverse scoring questions. Each item is scored on a 4-point Likert scale ranging from 1 to 4 according to the frequency of symptoms in the last week. The score of each item was calculated to obtain the raw score and the standard score multiplied by 1.25, with standard scores less than 53 were viewed as indicating no depression (26), and a higher score indicated more severe depression. The Cronbach's α coefficient was 0.89 in this study.

3.2.3. Self-rating Anxiety Scale

The SAS scale was designed in 1971 by Zung (27), and it can accurately reflect the subjective feelings of patients with anxious tendencies. The scale includes 20 self-report questions with 15 forward and 5 reverse scoring questions. Each item is scored on a 4-point Likert scale ranging from 1 to 4 according to the past 7 days. The score of each item was calculated to obtain the raw score and the standard score multiplied by 1.25, with standard scores less than 50 were viewed as indicating no anxiety (26), and a higher score indicated more severe anxiety. The Cronbach's α coefficient was 0.85 in this study.

3.2.4. Questionnaire on psychological stressors of postgraduates

The scale was designed by Cheng Lina (28). The scale was compiled according to the stressors of postgraduate students with 36 items and 7 dimensions, including academic pressure, interpersonal pressure, employment pressure, family pressure, marriage pressure, economic pressure and other pressure. Using the 5-point scoring method, from the "no", "light", "moderate", "heavy" and "very heavy" five aspects of the evaluation, successively recorded as 1, 2, 3, 4, 5 points. The scale has good reliability and validity and has been widely used in China (28, 29). The Cronbach's α coefficient and split-half reliability of the scale were 0.908 and 0.86, respectively.

3.2.5. Simplified coping style questionnaire

The scale was designed in 1998 by Xie Yaning (30) and contains 20 items divided into two dimensions: positive coping style (items 1–12) and negative coping style (items 13–20). The SCSQ score reflects the participant's coping style preferences; the higher the score on the corresponding subscale is, the higher the tendency to adopt this coping style. The SCSQ scale showed good reliability and validity (31); the Cronbach's α coefficient of the positive coping style subscale was 0.90, that of the negative coping style subscale was 0.70, and the overall Cronbach's α coefficient of the scale was 0.85.

3.2.6. Social Support Rate Scale

The scale was developed by Xiao Shuiyuan (32), a Chinese scholar at Shandong University, and was used to evaluate individuals' social support status. It has already been widely used in different studies in Chinese communities and shown to have good validity and reliability (33, 34). It contains 10 items and is divided into 3 dimensions, including subjective support, objective support and support utilization. Subjective support reflects the individual emotional experience of being respected, supported and understood in the community. Objective support reflects objective, visible or practical support received in the past. Support utilization reflects the pattern of behavior that an individual uses when seeking social support (34). Items are scored on a 4-point Likert scale. The score was summed, generating a final score ranging from 12 to 66; the higher scores are, the stronger the social support. In this study, the total Cronbach's α coefficient was 0.78.

3.3. Data analysis

Data were analyzed by SPSS 18.0 and AMOS 24.0 statistical software (IBM Inc.). Two independent sample *t*-tests were used to compare the differences in anxiety, depression, psychological stressors, social support and coping style by the binary variables, such as gender, place of residence and only child status. One-way ANOVA was used to explore the differences in anxiety, depression, psychological stressors, social support and coping style by the polytomous variables, such as age and grade. Pearson correlation was conducted to examine the relationships among depression, anxiety, psychological stressors, social support and coping style. Structural equation modeling (SEM) was conducted to assess the mediation model. The mediation effects were considered significant if the confidence intervals did not include the value of 0, and $P < 0.05$ was considered statistically significant.

4. Results

4.1. Participant characteristics

We invited 1,859 postgraduate students to fill in the questionnaire, but only 1,647 students completed all items, which also included 2 invalid questionnaires. Thus, the effective response rate is 88.5%. A total of 61.4% of the participants (n = 1010) were female, and approximately half of the postgraduates (51.5%) were ≤24 years old (n = 847). 47.3% (n = 778) postgraduates came from urban regions, and the rest came from rural regions. Postgraduates from the doctor grade accounted for 17.3% (n = 285). The first-year master's students accounted for most of the master's grade (n = 797, 48.4%).

4.2. Description of self-rated anxiety, self-rated depression, coping style, and social support

According to the scoring criteria, 356 (21.6%) medical postgraduates self-reported having depression symptoms, and 155 (9.4%) medical postgraduates self-reported having anxiety symptoms. The mean positive coping score was 20.32 ± 6.76, and the mean negative coping score was 7.04 ± 3.56. The total score for social support was 38.79 ± 6.75, that for subjective support was 21.76 ± 3.96, that for objective support was

8.82 ± 2.35, and that for utilization of support was 8.21 ± 2.02 (Table 1).

4.3. Differences in study variables among postgraduates with different characteristics

Female postgraduates had a higher SDS score than male postgraduates (44.21 ± 11.09 vs. 42.49 ± 11.6, $P < 0.05$). Postgraduates from the master of second grade had the highest SDS score (45.27 ± 12.63).

Postgraduates who lived in urban cities were more willing to positively cope with stress ($P < 0.05$). Only child postgraduates preferred a positive coping style (21.29 ± 7.04 vs. 19.91 ± 6.6, $P < 0.05$), with less social support than those who had a sister or brother (37.9 ± 6.95 vs. 39.16 ± 6.63, $P < 0.05$). Postgraduates ≤ 24 years old had the least social support (38.24 ± 6.34).

Postgraduates from different age groups experienced employment pressure, academic pressure and family pressure ($P < 0.05$). Postgraduates ≤ 24 years old had the highest employment pressure (2.39 ± 0.84), highest academic pressure (2.42 ± 0.65) and highest family pressure (1.92 ± 0.51). Postgraduates from different grades had employment pressure, academic pressure, interpersonal pressure and other pressure ($P < 0.05$). The master of third grade had the highest employment pressure (2.50 ± 0.85), and the master of second grade had the highest academic pressure (2.50 ± 0.69), highest interpersonal pressure (1.62 ± 0.69) and highest other pressure (1.79 ± 0.83) (Table 2).

4.4. Correlation analysis between self-rated depression, self-rated anxiety, psychological stress, coping style and social support in medical postgraduates

Correlation analysis showed that self-rated depression and self-rated anxiety were positively correlated with negative coping style ($r = 0.251$, $r = 0.275$, $P < 0.01$) and psychological pressure ($r = 0.585$, $r = 0.579$, $P < 0.01$) and negatively correlated with positive coping style ($r = -0.586$, $r = -0.467$, $P < 0.01$) and social support ($r = -0.484$, $r = -0.403$, $P < 0.01$). Social support was negatively correlated with psychological pressure ($r = -0.459$, $P < 0.01$) (Table 3).

TABLE 1 Demographic characteristics and the Self-rating Depression Scale (SDS) and Self-rating Anxiety Scale (SAS) scores among medical postgraduates (mean ± SD).

Variables	*N* (%)	SDS	SAS	Positive coping	Negative coping	Social support
Gender						
Male	635 (38.6%)	42.49 ± 11.6*	36.63 ± 9.1	20.23 ± 7.28	6.84 ± 3.84	38.41 ± 7.3
Female	1010 (61.4%)	44.21 ± 11.09	37.2 ± 8.75	20.38 ± 6.42	7.16 ± 3.38	39.02 ± 6.37
Age						
≤24	847 (51.5%)	44.0 ± 10.8	37.17 ± 8.43	20.35 ± 6.56	7.15 ± 3.6	38.24 ± 6.34*
25–29	706 (42.9%)	43.27 ± 11.82	36.8 ± 9.26	20.31 ± 6.89	6.94 ± 3.5	39.2 ± 7.14
≥30	92 (5.6%)	41.52 ± 11.86	36.52 ± 10.15	20.15 ± 7.65	6.763 ± 77	40.61 ± 6.85
Place of residence						
Urban	778 (47.3%)	43.24 ± 11.55	36.73 ± 9.44	20.94 ± 6.98*	7.10 ± 3.64	38.63 ± 6.96
Rural	867 (52.7%)	43.83 ± 11.1	37.2 ± 8.37	19.77 ± 6.52	6.98 ± 3.5	38.92 ± 6.56
Only child						
Yes	488 (29.7%)	43.08 ± 11.47	36.73 ± 9.13	21.29 ± 7.04*	7.02 ± 3.4	37.9 ± 6.95*
No	1157 (70.3%)	43.75 ± 11.25	37.08 ± 8.79	19.91 ± 6.6	7.04 ± 3.63	39.16 ± 6.63
Grade						
Master of first grade	797 (48.4%)	42.99 ± 10.18*	36.7 ± 8.01	20.39 ± 6.11	6.93 ± 3.46	38.42 ± 6.37
Master of second grade	278 (16.9%)	45.27 ± 12.63	37.44 ± 10.03	20.34 ± 6.24	7.53 ± 3.98	38.8 ± 6.86
Master of third grade	285 (17.3%)	44.07 ± 12.53	37.13 ± 9.73	19.96 ± 7.31	6.84 ± 3.67	39.22 ± 7.28
Ph.D. student	285 (17.3%)	42.93 ± 11.56	37.17 ± 9.2	20.47 ± 7.13	7.05 ± 3.29	39.37 ± 7.09

*$P < 0.05$.

TABLE 2 Comparison of different characteristic stressors among medical postgraduates.

Variables	*N* (%)	Employment pressure	Academic pressure	Economic pressure	Family pressure	Marriage pressure	Interpersonal pressure	Other pressure
Gender								
Male	635 (38.6%)	2.36 ± 0.90	2.37 ± 0.68	2.04 ± 0.63	1.9 ± 0.52	1.53 ± 0.72	1.52 ± 0.64	1.63 ± 0.74
Female	1010 (61.4%)	2.38 ± 0.83	2.43 ± 0.64	1.96 ± 0.59	1.89 ± 0.5	1.24 ± 0.49	1.48 ± 0.581	1.67 ± 0.73
Age								
≤24	847 (51.5%)	2.39 ± 0.84*	2.42 ± 0.65*	1.98 ± 0.6	1.92 ± 0.51*	1.34 ± 0.57	1.51 ± 0.59	1.64 ± 0.0.7
25–29	706 (42.9%)	2.39 ± 0.87	2.40 ± 0.66	2.02 ± 0.61	1.88 ± 0.5	1.36 ± 0.65	1.49 ± 0.63	1.68 ± 0.0.77
≥30	92 (5.6%)	1.98 ± 0.83	2.24 ± 0.65	1.90 ± 0.6	1.78 ± 0.56	1.35 ± 0.6	1.38 ± 0.49	1.54 ± 0.7
Place of residence								
Urban	778 (47.3%)	2.30 ± 0.86	2.33 ± 0.67	1.87 ± 0.59	1.83 ± 0.49	1.33 ± 0.6	1.44 ± 0.59	1.61 ± 0.73
Rural	867 (52.7%)	2.43 ± 0.85	2.47 ± 0.63	2.11 ± 0.6	1.96 ± 0.51	1.37 ± 0.61	1.55 ± 0.61	1.69 ± 0.73
Only child								
Yes	488 (29.7%)	2.29 ± 0.85	2.32 ± 0.66	1.88 ± 0.6	1.84 ± 0.49	1.35 ± 0.63	1.46 ± 0.61	1.63 ± 0.76
No	1157 (70.3%)	2.40 ± 0.86	2.44 ± 0.65	2.04 ± 00.6	1.92 ± 0.51	1.35 ± 0.6	1.51 ± 0.6	1.66 ± 0.72
Grade								
Master of first grade	797 (48.4%)	2.31 ± 0.83*	2.40 ± 0.64*	1.97 ± 0.59	1.92 ± 0.49	1.33 ± 0.58	1.45 ± 0.56*	1.57 ± 0.65*
Master of second grade	278 (16.9%)	2.47 ± 0.91	2.50 ± 0.69	2.05 ± 0.63	1.91 ± 0.55	1.44 ± 0.68	1.62 ± 0.69	1.79 ± 0.83
Master of third grade	285 (17.3%)	2.50 ± 0.85	2.41 ± 0.69	2.0 ± 0.6	1.89 ± 0.53	1.31 ± 0.54	1.55 ± 0.64	1.72 ± 0.79
Ph.D. student	285 (17.3%)	2.32 ± 0.88	2.32 ± 0.62	2.01 ± 0.62	1.83 ± 0.48	1.34 ± 0.66	1.46 ± 0.57	1.68 ± 0.76

*$P < 0.05$.

TABLE 3 Correlation analysis of the main indicated variables in medical postgraduates.

	Self-rated depression	Self-rated anxiety	Positive coping	Negative coping	Social support	Postgraduate pressure	Mean ± SD
Self-rated depression	1						43.41 ± 11.30
Self-rated anxiety	0.822**	1					36.86 ± 8.90
Positive coping	−0.586**	−0.467**	1				20.32 ± 6.77
Negative coping	0.251**	0.275**	0.092**	1			7.04 ± 3.57
Social support	−0.484**	−0.403**	0.464**	−0.159**	1		38.79 ± 6.75
Postgraduate pressure	0.585**	0.579**	−0.348**	0.384**	−0.459**	1	2.40 ± 0.66

**$P < 0.01$.

4.5. Mediating effects of coping style and social support on the relationships among psychological stress, self-rated depression, and self-rated anxiety

AMOS 24.0 software (IBM Inc.) was used to test and amend a hypothesized model using the maximum likelihood method of evaluating parameters. When self-rated anxiety was taken as the endogenous variable, the final model (Figure 1) had a satisfactory fit [x^2/df = 3.397, goodness-of-fit index (*GFI*) = 0.995, normed fit index (*NFI*) = 0.990, incremental fit index (*IFI*) = 0.993, comparative fit index (*CFI*) = 0.993, and root mean square error of approximation (*RMSEA*) = 0.038]. When self-rated depression was taken as the endogenous variable, the final model (Figure 2) had a satisfactory fit [x^2/df = 3.259, *GFI* = 0.995, *NFI* = 0.990, *IFI* = 0.993, *CFI* = 0.993, and *RMSEA* = 0.037].

Path analysis indicated that psychological stress had a direct effect on anxiety (β = 0.416, $P < 0.01$) and depression (β = 0.362, $P < 0.01$). At the same time, psychological stress, which was

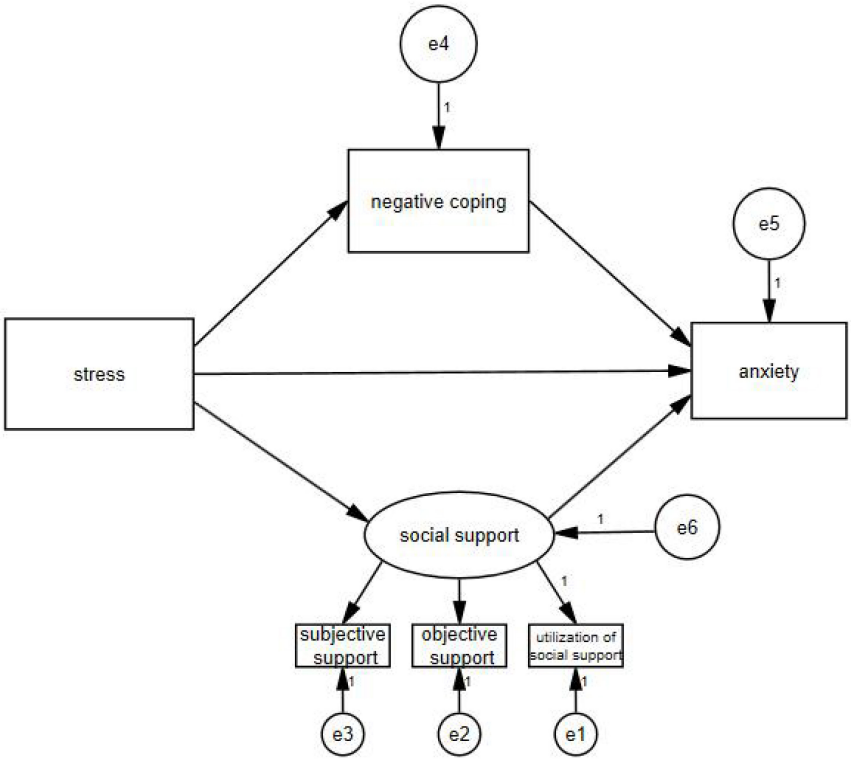

FIGURE 1
Final structural equation model on anxiety. e1–e6: the sign of the measurement error.

mediated by negative coping (β = 0.027, $P < 0.01$; β = 0.016, $P < 0.01$) and social support (β = 0.124, $P < 0.01$; β = 0.193, $P < 0.01$), also had indirect effects on self-rated anxiety and self-rated depression (**Table 4**).

5. Discussion

Medical postgraduates who experienced the COVID-19 outbreak and returned to school life for the first time were in a relatively negative mood, feeling anxious and depressed. Similar to studies reporting the psychological situation of medical students worldwide (35, 36), our study also showed that self-rated anxiety and depression were high. Female students were significantly more influenced than male students, and they had lower social support. Previous findings (37) illustrated that social networks are important to personal wellbeing and mental health and that people who are socially isolated and receive less social support are more likely to develop mental health problems. After the outbreak of COVID-19, school campus lockdown and restrictions on students leaving campus have been common. Beginning a new semester after such a pandemic is a new experience, and campus management may not be tailored to every student. More friendly and attentive services and psychological education or consultation should be arranged in universities that are locked down, especially for those who are isolated, who may feel more burnout and psychological distress.

Perceived stress, such as employment pressure, interpersonal pressure and academic pressure, was the main stressors among the medical postgraduates. Master's students who were looking for jobs had the most difficult time since several job fairs were delayed or even canceled, as companies were also influenced by the lockdown and social isolation. Online interviews (38) were reported to be strict, and interviewees were more nervous than for offline interviews and less satisfied with the virtual activity. Due to the employment pressure among students in graduating grades, emphasis should be placed on the important tasks of university management, vocational counseling, and interview training, and job-seeking subsidies should be provided.

The 2nd-year postgraduates faced interpersonal pressure. Online classes were the only way that medical postgraduates took classes. Students spent little time on activities with their other classmates aside from their roommates. Presentations and group seminars were held through a computer screen, as a kind of telecommunication. This was reported to be burdensome, leading to exhaustion and anxiety (39). Some surveys reported that medical students were not satisfied with online learning, while others reported that students had more

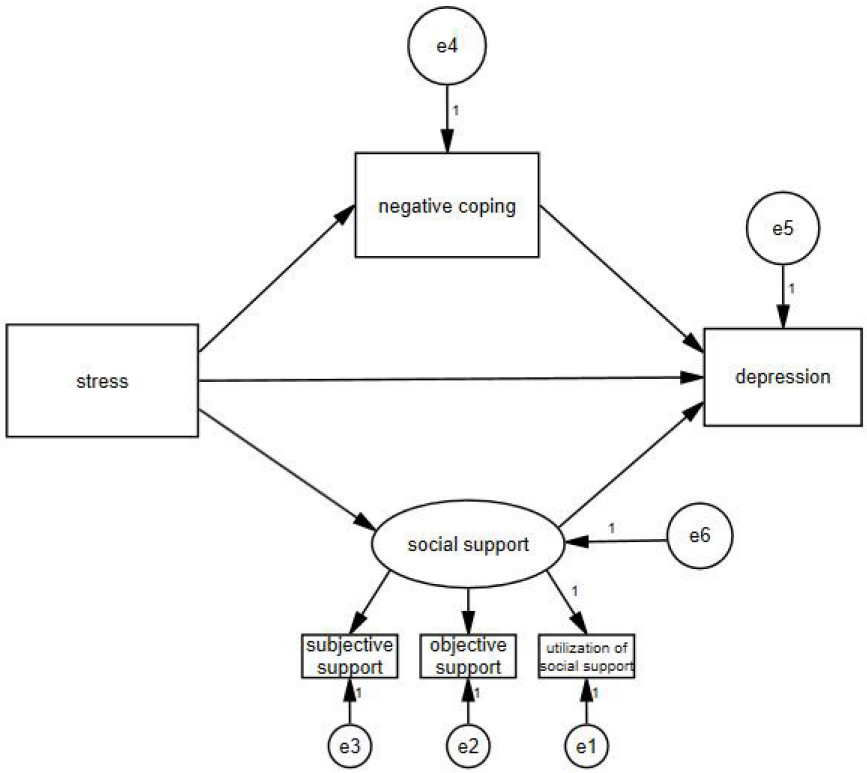

FIGURE 2
Final structural equation model on depression. e1–e6: the sign of the measurement error.

TABLE 4 The total, direct and indirect effects of the exogenous variables on the endogenous variables.

Endogenous variables	Effect decomposition	Exogenous variables		
		Postgraduate pressure	Negative coping	Social support
Anxiety	Total effect	0.567	0.071	−0.236
	Direct effect	0.416	0.071	−0.236
	Indirect effect	0.151	0.000	0.000
Depression	Total effect	0.571	0.043	−0.366
	Direct effect	0.362	0.043	−0.366
	Indirect effect	0.209	0.000	0.000

Total effect = direct effect + indirect effect.

control over educational content (40). Some students were working in the hospital, wearing masks in the ward, inpatients and outpatient clinics. A survey reported that people had difficulty communicating with masks (41). Their voice had to be raised, and the mask could cause sweating. The presence of only eye and vocal contact may not be persuasive when a trainee doctor communicates with his or her patients.

The master of second grade experienced high academic pressure. Medical postgraduates usually start their thesis proposal in the 2nd year, and several projects should be completed in the hospital. Although these students were not locked down on the university campus, their decreased interchange with patients, disruptions to medical care and stricter ward management made the thesis study process slow. Moderate-to-high academic stress (42) was reported to be quite common among college students during the COVID-19 pandemic, affecting their study attitudes.

Studying medicine has highly professional demands and academic requirements (43). Appropriate coping and support from family, classmates and universities could mediate personal perceived stress. In our study, coping style and social support played a mediating role between perceived stress and

anxiety/depression. Positive coping style and social support reduced the impact of perceived stress on depression and anxiety, while negative coping strengthened the impact of perceived stress on depression and anxiety. Receiving sufficient social support or engaging in positive coping could help individuals manage depression and anxiety.

The unpredictable nature of the COVID-19 epidemic reshaped the social order and daily routines. The ability to cope with uncertainty and engage in positive coping were basic abilities that doctors and citizens living with the COVID-19 pandemic should have (15, 44). Medical postgraduates face more pressure than undergraduates, and in the literature on medical students, self-care ability, self-efficacy and optimism have been shown to be important to their resilience. Many of these postgraduates will become part of the medical health workforce, and we suggest that more theory-based interventions and resilience strengthening be performed during the epidemic. Perhaps we can carry out psychological interventions, such as cognitive behavioral therapy, based on the characteristics of medical graduate students. During the COVID-19 pandemic, online psychosocial interventions can effectively improve individual symptoms of anxiety, depression, and stress (45).

6. Conclusion

This study successfully explored the mental health impact of the COVID-19 pandemic on current medical postgraduates restricted to campus hospital studies. The results showed that postgraduates troubled by employment, academic and interpersonal stress were more likely to have anxiety and depression, and may need further mental health support and learning guidance. As COVID-19 continues, the social support and guiding the positive coping of the medical graduate students will need to be strengthened in the future to alleviate their perceived stress and negative emotions.

7. Limitations

Our study focused on the metal health of medical postgraduates and we found that pressure and negative coping style were risk factors to depression and anxiety. However, this study is a cross-sectional study, which cannot reveal the causal direction of the relationship between anxiety, depression, social support, and coping styles. Future prospective cohort studies are needed to explore the long-term psychological impact of COVID-19 on medical postgraduates. In addition, relevant factors that might influence the findings of the study, such as student's field of study, family/social support were not investigated in the current study. Future studies are needed to determine the effect of these confounders on medical student's psychological distress.

Data availability statement

The original contributions presented in this study are included in this 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 Biomedical Ethics Committee of Southern Medical University. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

GH and YC: study design. TT, QZ, and YW: data collection, analysis, and interpretation. TT, WL, QZ, and YH: drafting of the manuscript. YY and XW: critical revision of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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The relationship between schizotypal personality features and mind wandering among college students during COVID-19 pandemic: A moderator of depression

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Introduction: Although the impact of the COVID-19 pandemic on people's mental health has been well documented in many studies, the schizotypal personality features in the general population have not received sufficient attention.

Methods: Study 1 is a longitudinal study tracking changes in schizotypal personality features among college students during the COVID-19 pandemic. A total of 153 Chinese college students were assessed using the Schizotypal Personality Questionnaire. Study 2 explored the relationship between schizotypal personality features, mind wandering, and depression. A total of 557 college students completed the Schizotypal Personality Questionnaire, the Beck Depression Inventory, and the Mind-Wandering Questionnaire during the COVID-19 pandemic.

Results: Study 1 results showed that the scores from later stages in the pandemic were significantly higher than those from the initial stages on each dimension of schizotypal personality, which means that the schizotypal personality features became more obvious during the COVID-19 pandemic. Study 2 results showed that there was a positive correlation between schizotypal personality features, depression, and mind wandering.

Discussion: Depression played a moderating role in the relationship between schizotypal personality features and mind wandering. The schizotypal

personality features of college students increase during COVID-19; it has a positive relationship with mind wandering; depression moderates the relationship. We discussed these findings and provided some suggestions about future research.

KEYWORDS

COVID-19 pandemic, schizotypal personality features, mind wandering, depression, college student

Introduction

On 11 March 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 as a pandemic (WHO-Media-Briefing) (1). The pandemic outbreaks may pose risks to people's mental health; both the perception of the pandemic information and social isolation are thought to lead to negative health conditions (2) and trigger a range of psychological problems (3), such as anxiety, depression, and traumatic stress disorder (4). The studies also suggested that COVID-19 could predict increased outbreaks and the prevalence of psychosis (5).

Given the effects of social isolation measures to prevent infection in people during the pandemic, we believe that schizotypal personality features in the general population are a concern. Schizotypal personality is defined as "a pervasive pattern of detachment from social relationships and a restricted range of expression of emotions in interpersonal settings" in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) (6). Pedrero argued schizotypal personality features represent a "set of subclinical psychotic experiences and traits that do not reach a clinical threshold and are distributed throughout the general population" (7). Raine developed the Schizotypal Personality Questionnaire (SPQ) to assess the schizotypal personality features, and Chinese researchers demonstrated it can effectively evaluate Chinese college students' psychological problems (8).

We speculate that these features may become salient during the COVID-19 pandemic. Some studies found that social isolation to prevent the spread of the virus caused reduced communication frequency, less social support, fewer friends, and more social anxiety (9). People were more likely to have psychiatric problems, such as somatic delusions and delusions when they were in isolation or loneliness conditions (10). When COVID-19 broke out, some scholars worried that the number of people with schizotypal personality disorders would rise (11, 12). It is worth noting that the pandemic as a stress event may also increase the likelihood of schizotypal personality features in the general population at psychiatric risk, who have certain personality features similar to those of schizotypal personality disorders (13) and are more likely to report experiencing higher levels of stress during the pandemic (14).

Not all people with schizotypal personality features experiencing stressful or major negative events eventually end up with the schizotypal personality disorder (15), however, it is more likely to lead to the onset of psychosis when having a diathesis (a biological predisposition) developing schizophrenia combined with environmental factors (e.g., the experience of a major psychosocial stressor) (16). Therefore, we chose the SPQ to examine the impact of the COVID-19 pandemic on Chinese college students. The schizotypal personality features provide a relatively comprehensive picture of how people's mental health status changes under the influence of the pandemic (17).

Social trauma can trigger acute and transient episodes of schizotypal personality features, and college students are a population at high risk for negative mental health effects during the pandemic (18). Studies have shown that social isolation may lead to psychotic episodes (19); however, little consideration has been given to the impact of COVID-19 on susceptible populations who are at risk for psychosis (17).

Previous research has demonstrated that maladaptive personality features are significantly associated with mind wandering and that people with high schizotypal personality features in the general population experience more mind-wandering situations (20, 21). The fact that schizophrenia and mind wandering both involve reduced sensitivity to ongoing events in the external world suggests they may be closely related. Therefore, it is possible that the processing deficits associated with schizophrenia are related to levels of mind wandering (22).

Moreover, the college students' emotion state during the pandemic should also be a concern. Some studies suggest that the relationship appears to be reciprocal: When a negative mood was induced, people's minds also tended to wander more (23–25). Based on this evidence, Ottaviani et al. (26) suggested that the relationship between mind wandering and depression is bidirectional. Depression is the typical negative emotion that is easily triggered in the desolate condition of solitude (27).

To prevent the spread of the epidemic, Chinese colleges and universities generally adopted strict isolation measures. Students were required to stay on campus or even in dormitories, and their lives were greatly restricted. In this case, they were usually in a lonely state, which might increase the possibility of depression. Some studies have shown that the degree of

social isolation during the COVID-19 pandemic is associated with depression (28). We found that a dynamic model of mind wandering can predict depression, while interventions for mind wandering have been shown to alleviate depression symptoms (29).

Emotional disorder was found to be associated with mind wandering, and inducing negative emotions could interfere with attention, increase the frequency of distraction, and reduce the possibility of participating in subsequent tasks in the condition of attention deficit (30). The likelihood of depression significantly increased during the COVID-19 pandemic (31). The previous study showed that the impairment of original switching attention indicates higher depressive symptoms, while higher depressive symptoms indicate worse selectivity and switching attention. Depressed individuals paid more attention to the stimulation with negative content than ones with neutral or positive content (32). These findings suggest a link between depression and mind wandering.

Additionally, Fontenelle et al. (33) found that negative emotions induced during the period of the COVID-19 pandemic aggravated the symptoms of schizotypal personality. A study showed that non-clinical Chinese college students with schizotypal personality features reported a higher level of depression compared with their peers (34).

Based on the above analysis, we hypothesized that the increasing schizotypal personality features would be reported by the Chinese college students in the later stages of the COVID-19 pandemic than those in the initial stages (Study 1). We also hypothesized that the schizotypal personality features would be associated with mind wandering and that the relationship would be moderated by depression.

Study 1

Method

Participants and procedure

This study was carried out in the background of the COVID-19 pandemic. We aimed to explore the impact of the pandemic on schizotypal personality features in the general population. We focus on changes in people's mental adaptive functioning in the context of natural reactions to the COVID-19 pandemic, rather than the direct effect of infection. Hence, we recruited participants according to two criteria. The first one is that the potential participants live in areas where the severity level of the outbreak has not been identified as infectious; the second one is the potential participants themselves and their family members and friends have not contracted COVID-19. Additionally, we took into account the major physical illnesses and psychological disorders, including experience with psychotherapy, as well as conditions such as attention and depression disorders before the pandemic. We excluded these potential factors, which would affect research variables, making sure that the participants in this survey had daily living abilities and healthy living conditions before the outbreak of the COVID-19 pandemic. Due to the difficulties of sampling during the period of the epidemic, the convenience sampling method was adopted. We used an online self-reported survey, *So jump*, to collect data. We posted links to online surveys in colleges and universities in northwest China and promised to pay each participant a certain amount of money (10 Yuan). The research plan was approved by the Institutional Review Committee of Northwest Normal University. After signing the informed consent form, a total of 410 college students who engaged in online learning under the condition of home confinement volunteered to participate in the study. Any invalid questionnaires were deleted according to two criteria: (1) the questionnaires were accomplished in less than 180 s; (2) the questionnaire was not filled in at one of the two time points. The final sample comprised 153 college students. On 15 December 2019, we collected the first batch of data before the COVID-19 pandemic broke out. We asked the subjects whether they had a history of genetic diseases and conducted a simple intelligence test. On 26 November 2020, we collected the second batch of data, and the subjects were the same as those in the first batch of data. However, due to the epidemic situation, we could only take the form of an online questionnaire collection, and thus a large number of subjects were lost. Finally, our sample consists of 153 subjects.

Measurements

Schizotypal Personality Questionnaire (SPQ)

We used the Schizotypal Personality Questionnaire (SPQ) to assess changes in schizotypal personality features during the COVID-19 pandemic. Its validity has been demonstrated among Chinese college students (35). The SPQ contains subscales for all nine schizotypal symptoms (17), i.e., ideas of reference, excessive social anxiety, odd beliefs or magical thinking, unusual perceptual experiences, odd or eccentric behavior, no close friends, odd speech, constricted affect, and suspiciousness. The responses of NO and YES were scored as 1 and 2, respectively. There were a total of 74 items (e.g., Do you sometimes feel that things you see on TV or read in the newspaper have a special meaning for you?). The higher the score, the more obvious the features of schizotypal personality. In this study, Cronbach's α coefficients of the nine dimensions of schizotypal personality were in a range of 0.72–0.83, and the total Cronbach's α coefficient was 0.87.

Data analysis

Data were analyzed using SPSS 24.0. The paired-samples *t*-test was used to compare the differences in each dimension of SPQ between the same groups of subjects at two time points.

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Results

Demographic data

A total of 153 participants were included in the final statistical analysis. Among them, 39.87% were male and 60.13% were female. The mean age of the samples was 21.79 years old (M_{age} = 21.79, SD = 2.76), and the age range was 18–23 years. Among them, there were 107 undergraduates (69.93%) and 46 postgraduates (30.07%).

Paired-samples *t*-test on each dimension of schizotypal personality

The schizotypal personality features of the college students in the initial and later stages of the pandemic were assessed using the paired-samples *t*-test. The results showed that there were significant differences in the total score and dimension scores of schizotypal personality between the two time points (see Table 1), and the scores in the later stage were significantly higher than ones in the initial stage, which means that the college students' schizotypal personality features became more prominent during the pandemic. Furthermore, we did not find any significant differences in participants' gender and educational backgrounds on these dimensions.

TABLE 1 Paired-samples *t*-test on each dimension of schizotypal personality (*N* = 153).

	In the initial stage of the pandemic (M ± SD)	In the late stage of the pandemic (M ± SD)	*t*
SPQ	1.52 ± 0.16	1.75 ± 0.11	−15.91***
Ideas of reference	1.42 ± 0.22	1.62 ± 0.21	−8.20***
Unusual perceptual experiences	1.46 ± 0.25	1.66 ± 0.25	−7.06***
Odd beliefs or magical thinking	1.13 ± 0.19	1.73 ± 0.22	−24.87***
Odd or eccentric behavior	1.46 ± 0.25	1.87 ± 0.20	−15.64***
Odd speech	1.54 ± 0.21	1.76 ± 0.20	−9.58***
No close friends	1.64 ± 0.22	1.83 ± 0.18	−8.46***
Excessive social anxiety	1.44 ± 0.28	1.71 ± 0.22	−10.44***
Suspiciousness	1.57 ± 0.26	1.72 ± 0.26	−5.10***
Constricted affect	1.60 ± 0.26	1.88 ± 0.17	−11.74***

***$P < 0.001$.

Discussion

We evaluated the mental adaptive functioning of the college students using the SPQ, which is a common way to understand schizotypal personality in the general population. In fact, the concept of personality and its disorders has become increasingly central to the understanding of mental illness. Hence, schizotypal personality features are used to evaluate whether college students maintain healthy psychological functions to successfully adjust to the sudden outbreak of the pandemic. The results showed that the college students' psychological adaptive functioning became worse amidst COVID-19, with more obvious features of schizotypal personality, and the range of such a negative effect is very wide, involving the various dimensions of schizotypal personality and its total level. This is consistent with previous research on anxiety, depression, and traumatic stress in the British general population during the COVID-19 pandemic. Compared with the population before the pandemic, people during the pandemic had higher levels of anxiety, depression, and traumatic symptoms, and the prevalence of mental health problems also increased (36, 37). This has also been confirmed in a comparative study of the impact of the COVID-19 pandemic on the mental health of the German and British general populations. In this study, the researcher also used the SPQ and found that 25% of German and British respondents reported a subjective deterioration of overall mental symptoms, and 20–50% of German and British respondents reached the clinical critical value of depression and dysthymia symptoms and anxiety, indicating that a customized intervention system was needed to support most of the public (38). However, another Chinese longitudinal study showed that although the young's psychological distress had been prevalent over the course of COVID-19, it had reduced after the peak of the pandemic (39). On the contrary, our study found the psychological disorder became more severe in the later period. One possible explanation is that the two studies used different indicators to assess psychological outcomes. Schizotypal personality features in our study are a latent and deep psychological construct and are considered a prototype characterized by impairments in identity, self-direction, empathy, and/or intimacy, along with specific maladaptive traits in the domains of psychoticism and detachment (40), which reflect the comprehensive and lasting effect of the pandemic.

Our research provides support for such a dominant conclusion and focuses more on how to prevent the adverse impact of the COVID-19 pandemic. Compared with the adult population, college students generally do not need to worry about work and economic problems when they are in social isolation. In Chinese families, parents provide for their living expenses during college, so college students rarely feel the same financial and job pressures as adults. For young students, the greatest impact of the pandemic on them may be the dramatic reduction in social communication, since social activities are the

main aspect of young adult life. It is difficult for them to adapt to such changes in lifestyle.

Studying is the main task of college students, and attention is the key psychological factor to ensure the smooth progress of studying. Given that the COVID-19 pandemic has a negative influence on the psychological functioning of college students, we are interested in exploring in Study 2 whether the pandemic further predicts their mind wandering. Moreover, Study 2 examined the moderating effect of emotions, such as depression, on the relationship between schizotypal personality features and mind wandering.

Study 2

Method

Participants and procedure

This cross-sectional study was conducted on Chinese university students in the context of the COVID-19 pandemic. Data collection was conducted from 26 November 2020. Use an online, self-reported survey (*So jump*). A total of 600 college students completed the three questionnaires after signing informed consent forms, and they volunteered to participate in the study and completed the questionnaire. All questions related to the survey were managed using the *So jump* platform, and a shareable link was generated to help 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. After deleting the invalid questionnaires, the final sample consisted of 557 college students.

Measurements

In Study 2, we adopted the same SPQ used in Study 1. Moreover, we adopted two other scales to measure mind wandering and depression.

Mind-Wandering Questionnaire (MWQ)

The participants' mind wandering was assessed using the MWQ, which is a self-reported questionnaire with 12 items (e.g., I have difficulty maintaining focus on simple or repetitive work) designed to assess levels of mind wandering. Items were rated on a 5-point scale ranging from 1 (almost never) to 5 (almost always). The total score was the sum of the 12 items, with higher scores indicating more mind wandering. The study from Chinese scholars demonstrated that MWQ is appropriate in the context of China (41). In this study, Cronbach's α coefficient was 0.77.

Beck Depression Inventory (BDI)

Depression of the participants was evaluated using the Chinese version of the BDI (42), which is a 21-item self-rated scale that evaluates key symptoms of depression. The statements provided express feelings common to depression (e.g., guilt, low self-worth, and suicidal ideation). Items are scored on a 4-point scale (1 = most and 4 = least), with total scores ranging from 21 to 84, and higher scores indicate greater depressive severity. In this study, Cronbach's α coefficient was 0.86.

Data analysis

Data were analyzed using SPSS 24.0. After counting some of the items in reverse, we used descriptive statistics to calculate the means and standard deviations of schizotypal personality features, mind wanderings, and depression. We also used Harman's single-factor test to examine common method biases between the variables. We then explored the relationships between schizotypal personality features, mind wandering, and depression in the correlation analysis model. Furthermore, we used PROCESS 3.3 Model 1 to conduct multiple linear regression analysis to examine the predictive effects of schizotypal personality features and depression on mind wandering, especially the moderating effect of depression on the association by simple slope analysis.

Results

Demographic data

A total of 557 participants were included in the final statistical analysis. Among them, 31.80% were male and 68.20% were female, with 462 of them being undergraduate students (82.90%) and 95 of them being postgraduate students (17.10%). The ages of the participants ranged from 18 to 33 years (M_{age} = 22.00, SD = 2.86).

Common method biases

The Harman single-factor assessment was used to test common method biases (43). All 107 items were included in an exploratory factor analysis, and the results showed that 31 factors with eigenvalues greater than 1 were obtained under the condition of non-rotation of factors, and the cumulative interpretation rate was 63.26%. Among them, the variance of the first-factor explanation was 16.14% or less than the critical value of 40%, indicating that there were no serious common method biases.

TABLE 2 Descriptive statistics and correlation analysis of schizotypal personality features, mind wanderings, and depression (N = 557).

	M	*SD*	1	2	3	4	5	6	7	8	9	19	11	12
1. MW	3.00	0.58	–											
2. D	0.46	0.34	0.42***	–										
3. SPQ	1.33	0.17	0.45***	0.56***	–									
4. IR	1.47	0.25	0.31***	0.39***	0.73***	–								
5. OBMT	1.40	0.26	0.05	0.15**	0.46***	0.41***	–							
6. UPE	1.26	0.22	0.20***	0.33***	0.66***	0.50***	0.52***	–						
7. OEB	1.20	0.26	0.29***	0.42***	0.71***	0.40***	0.24***	0.45***	–					
8. OS	1.37	0.25	0.40***	0.44***	0.76***	0.46***	0.22***	0.44***	0.58***	–				
9. NCF	1.27	0.22	0.35***	0.40***	0.67***	0.32***	0.09*	0.24***	0.45***	0.40***	–			
10. ESA	1.49	0.31	0.40***	0.38***	0.74***	0.50***	0.15**	0.33***	0.41***	0.50***	0.53***	–		
11. S	1.28	0.25	0.41***	0.50***	0.80***	0.59***	0.26***	0.41***	0.54***	0.50***	0.55***	0.54***	–	
12. CA	1.23	0.22	0.41***	0.47***	0.76***	0.40***	0.14**	0.33***	0.48***	0.62***	0.65***	0.60***	0.58***	–

*$p > 0.05$; **$p > 0.01$; ***$p > 0.001$.
MW, mind wandering; D, depression; SPQ, Schizotypal Personality Questionnaire; IR, ideas of reference; OBMT, odd beliefs or magical thinking; UPE, unusual perceptual experiences; OEB, odd or eccentric behavior; OS, odd speech; NCF, no close friends; ESA, excessive social anxiety; S, suspiciousness; CA, constricted affect.

Correlation analysis of schizotypal personality features, mind wanderings, and depression

The descriptive statistics results and correlation coefficients between the variables are presented in Table 2. The results showed that mind wandering was significantly positively correlated with schizotypal personality features as well as depression, indicating that as schizotypal personality and depression become more severe, mind wanderings are more. Meanwhile, schizotypal personality features and depression also have a significant positive correlation, which indicates that an increase in schizotypal personality is accompanied by an increase in depressive symptoms. Moreover, there was no significant gender difference on each variable except for depression ($M_{male} \pm SD_{male} = 0.50 \pm 0.35$, $M_{male} \pm SD_{female} = 0.44 \pm 0.34$, $t = 2.16$, $p = 0.031$), and there was no significant correlation between age and these variables, except for a very weak correlation with suspiciousness ($r = 0.09$, $p = 0.044$).

Predictive effect of SPQ on MW and moderator of depression

After the variables were centralized, with SPQ and each of its dimensions as a separate predictive variable and MW as a dependent variable, as well as gender and age as controlled variables, we examined the 10 moderating models of depression on the relationship between SPQ and MW. All the moderating effects were demonstrated to be valid (see Table 3). Taking the SPQ as an example, the results of the PROCESS Model 1 showed that MW was significantly predicted by the SPQ and depression separately and was also predicted by their interaction. The statistic index reached the level of moderating effect, which suggests that depression has a moderating effect on the relationship between APQ and MW. Furthermore, simple slope analysis was used to test the specific mechanism of the moderator of depression. According to the standard of mean plus or minus one standard deviation, the depression score was divided into high- and low-score groups. The predictive effects of SPQ on MW for the two groups were then examined. The results showed that there were significant relationships between SPQ and MW in the low and high depression groups, but the predictive strength was different in the two groups (Figure 1). The moderating effects of depression were also demonstrated by the association between all dimensions of SPQ and MW (see Table 3 and Figures 2–10). All simple slope figures showed mind wanderings of individuals with a high depression level were more than individuals with a low depression level in both high and low groups of SPQ and subscale scores. However, the specific moderating effects showed three kinds of trends. The first kind of trend was that mind wanderings became more from the low group to the high group of SPQ and subscale scores in both high and low depression levels. However, the strength of low depression was stronger than that of high depression. Such trends include SPQ, OS, ESA, S, and CA (Figures 1, 6, 8–10). The second kind of trend showed that the higher the SPQ and subscale scores, the more mind wanderings there were for individuals with a low depression level, while there were no significant relationships for individuals with a high depression level. IR, UPE, OEB, and NCF showed such a trend (Figures 2, 4, 5, 7). The third kind of trend was the opposite of the second. The higher the SPQ and subscale scores, the fewer the mind

TABLE 3 Hierarchical regression analysis of Schizotypal Personality Questionnaire (SPQ) and depression (D) predicting mind wandering (MW) (N = 557).

	β	t	[BootLLCI, BootULCI]	Δ R^2	F	$B_{simple\ slope}$		t
SPQ	1.00	6.88***	[0.71, 1.29]					
D	0.56	7.00***	[0.41, 0.72]					
SPQ × D	−1.53	−4.56***	[−2.16, −0.93]	0.03	20.81***	Low D	1.53	8.38***
						High D	0.48	2.52*
IR	0.37	3.86***	[0.18, 0.55]					
D	0.66	9.27***	[0.53, 0.80]					
IR × D	−0.78	−3.16**	[−1.23, −0.34]	0.01	10.00**	Low D	0.64	5.03***
						High D	0.10	0.81
OBMT	−0.03	−0.40	[−0.20. 0.13]					
D	0.74	11.19***	[0.62, 0.87]					
OBMT × D	−0.61	−2.55*	[−1.06, −0.18]	0.01	6.52*	Low D	0.17	1.49
						High D	−0.24	−2.04*
UPE	0.20	1.80	[−0.03, 0.41]					
D	0.72	10.22***	[0.58, 0.86]					
UPE × D	−0.70	−2.48*	[−1.25, −0.22]	0.01	6.17*	Low D	0.44	2.84**
						High D	−0.04	−0.32
OEB	0.39	4.12***	[0.19, 0.61]					
D	0.70	9.67***	[0.56, 0.84]					
OEB × D	−0.97	−4.18***	[−1.39, −0.54]	0.02	17.47***	Low D	0.72	5.22***
						High D	0.06	0.58
OS	0.61	6.40***	[0.41, 0.79]					
D	0.59	8.12***	[0.45, 0.72]					
OS × D	−0.80	−3.17**	[−1.28, −0.32]	0.01	10.08**	Low D	0.88	6.67***
						High D	0.61	2.67**
NCF	0.62	5.74***	[0.41, 0.84]					
D	0.65	8.91***	[0.52, 0.78]					
NCF × D	−1.01	−3.40***	[−1.54, −0.50]	0.02	11.59***	Low D	0.97	6.21***
						High D	0.27	1.94
ESA	0.49	6.68***	[0.33, 0.64]					
D	0.61	8.77***	[0.48, 0.75]					
ESA × D	−0.78	−3.77***	[−1.15, −0.41]	0.02	14.22***	Low D	0.76	7.79***
						High D	0.22	2.10*
S	0.63	6.43***	[0.40, 0.84]					
D	0.58	7.73***	[0.44, 0.73]					
S × D	−0.86	−3.84***	[−1.30, −0.46]	0.02	14.76***	Low D	0.92	7.07***
						High D	0.33	2.84**
CA	0.80	7.41***	[0.58, 1.01]					
D	0.61	8.48***	[0.48, 0.74]					
CA × D	−1.42	−5.36***	[−1.90, −0.94]	0.04	28.75***	Low D	1.29	8.40***
						High D	0.80	7.41***

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

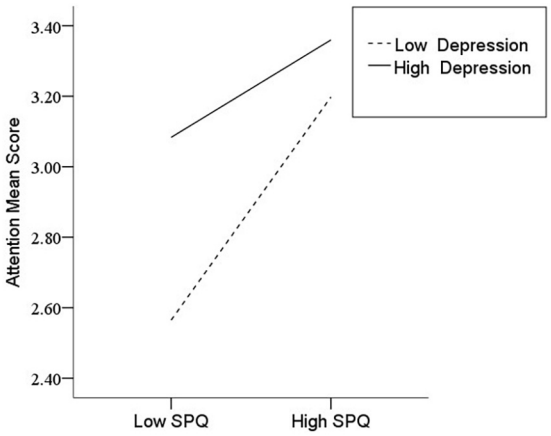

FIGURE 1
Interaction between Schizotypal Personality Questionnaire (SPQ) and depression (D) on mind wandering (MW).

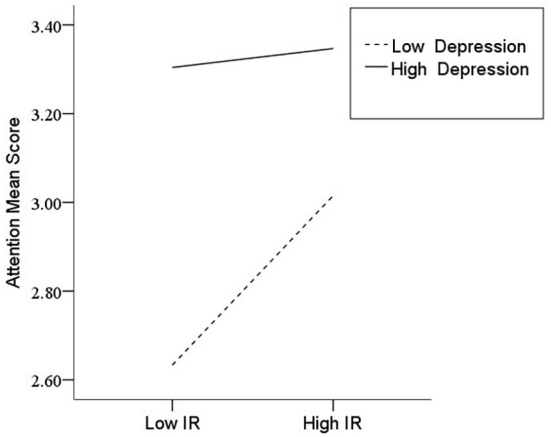

FIGURE 2
Interaction between ideas of reference (IR) and depression (D) on mind wandering (MW).

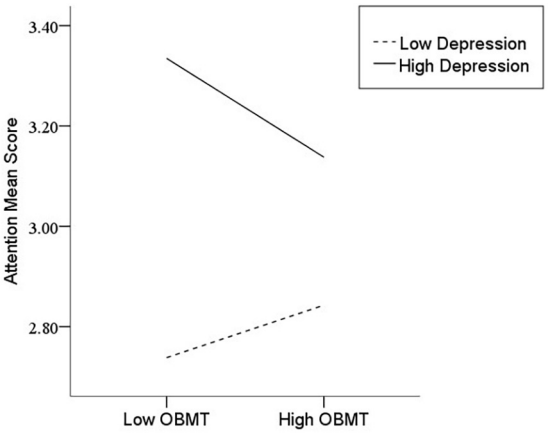

FIGURE 3
Interaction between odd beliefs or magical thinking (OBMT) and depression (D) on mind wandering (MW).

wanderings for individuals with a high depression level, while there were no significant relationships for individuals with a low depression level. Only OBMT showed such a trend (**Figure 3**). It is a special case.

Discussion

Our study supports the hypothesis that depression moderated the relationship between schizotypal personality features and mind wandering during the COVID-19 pandemic; specifically, the relationship between different schizotypal personality features and mind wandering differed at high and low depression levels. In previous studies, the relationships between any two variables between schizotypal personality, depression, and attention have been demonstrated. However, the relationship among the three variables has not been explored, especially for Chinese college students in the context of the COVID-19 pandemic. Thus, there is little understanding of the relationship between these variables. These limitations of previous research imply that researchers have regarded mental health as a negative outcome caused by the COVID-19 pandemic but ignored its role in predicting other psychological functions or aspects of life, such as attention, which is an essential factor in the college students' study.

Moreover, previous research overlooked the mutual impacts of different mental health problems. In Study 2, we found that more severe schizotypal personality features and depression symptoms were accompanied by more mind wanderings; both schizotypal personality features and depression could predict mind wandering; and depression further played a moderating role in the relationship. While this result is consistent with existing research (44), it fills a gap in the literature, i.e., it demonstrates that personality features and mood have close links with cognitive ability and that different types of mental health problems have interactive effects. In this study, schizotypal personality features were regarded as the individual's preexisting mental maladaptive functioning, while depression was regarded as a current emotional problem induced by the environment. These two kinds of mental health problems showed a complex interactional influence on cognitive qualities such as attention. With a change in the degree of depression, the association between an individual's inherent maladaptive functioning and cognitive quality also changes. This result can more specifically explain the psychological mechanisms of individuals in the temporary social situation of coping with the COVID-19 pandemic.

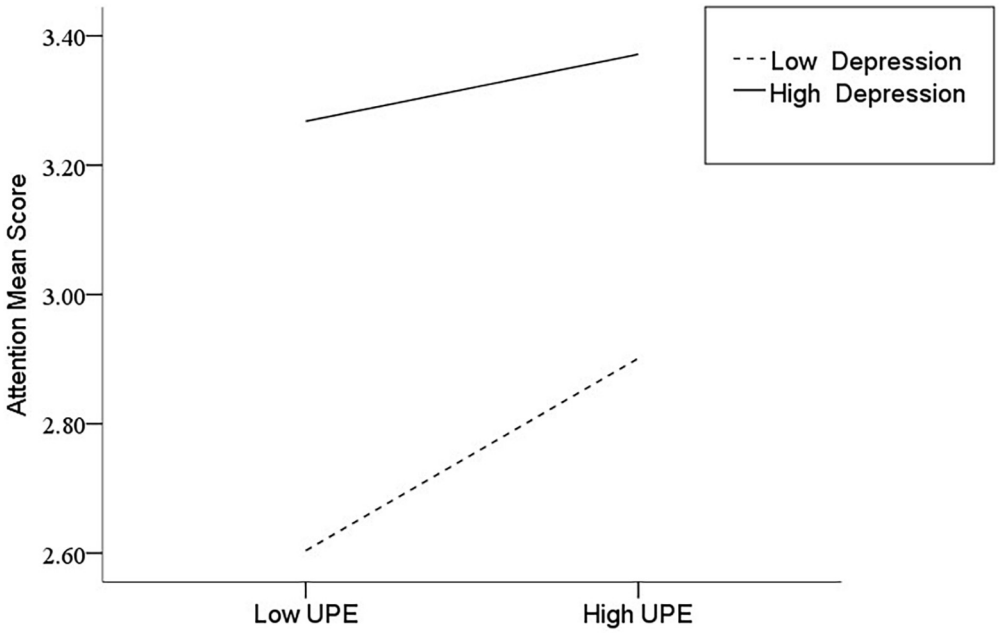

FIGURE 4
Interaction between unusual perceptual experiences (UPE) and depression (D) on mind wandering (MW).

General discussion and future research directions

The COVID-19 pandemic has caused tremendous loss and trauma to people around the world, with devastation ongoing. Therefore, we need an in-depth and comprehensive understanding of the impact of this pandemic on society and people. Taking into account the life changes of the Chinese college students during the period of the COVID-19 pandemic, our research focuses on the relationship between psychological adaptive functioning (e.g., schizotypal personality features), negative mood (e.g., depression), and learning quality (e.g., mind wandering). The results show the college students' schizotypal personality features became more obvious in the post-pandemic period than before. It indicates that students have difficulties coping with the dramatic life changes caused by the sudden outbreak of COVID-19. Schizotypal personality features, depression, and mind wandering have positive correlations with each other, indicating the worse schizotypal personality features and depression are associated with more mind wanderings. Furthermore, both schizotypal personality features and depression can predict mind wandering, and depression plays a moderating role in the relationship between schizotypal personality features and mind wandering.

According to our sampling standard, we selected the participants who live in the low-risk area and have no family members or friends who are infected with COVID-19. They appear to be in a seemingly safe state and have not been directly affected by the pandemic except for the defensive measures that limit their social interaction. However, they still face dramatic life changes, such as online learning in the condition of social isolation instead of social entertainment and interpersonal communication. Such a situation might cause difficulty in mental adaptation.

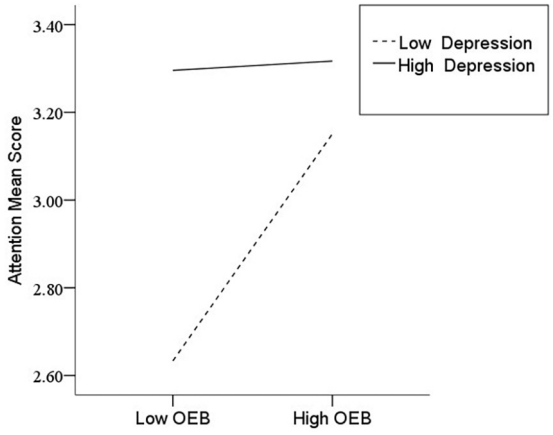

FIGURE 5
Interaction between odd or eccentric behavior (OEB) and depression (D) on mind wandering (MW).

Mental health is defined as "Mental health or peace of mind is a sense of acceptance and balance that comes from having a strong system of friendship and sound social relationships

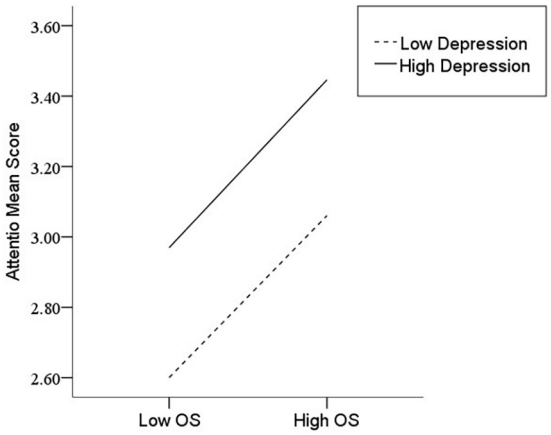

FIGURE 6
Interaction between odd speech (OS) and depression (D) on mind wandering (MW).

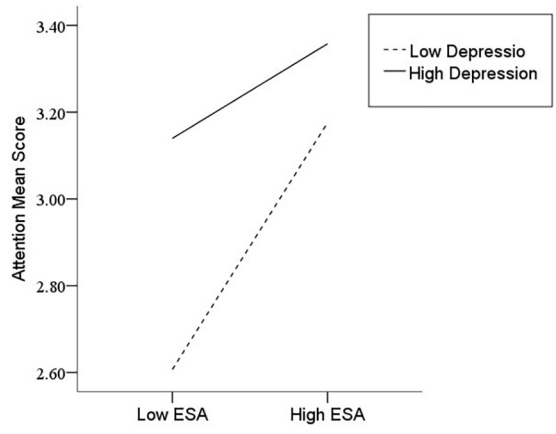

FIGURE 8
Interaction between excessive social anxiety (ESA) and depression (D) on mind wandering (MW).

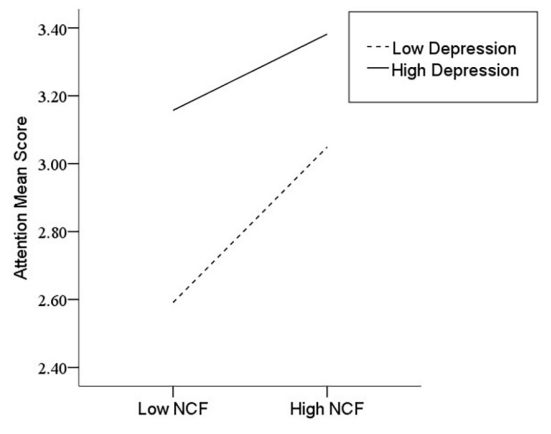

FIGURE 7
Interaction between no close friends (NCF) and depression (D) on mind wandering (MW).

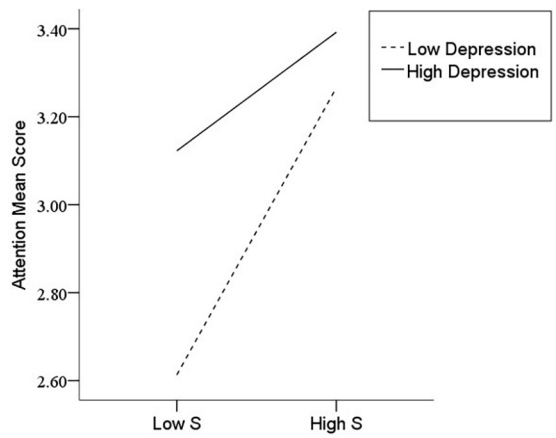

FIGURE 9
Interaction between suspiciousness (S) and depression (D) on mind wandering (MW).

that allow people to be the best they can be (45)." Sudden social conditions, such as COVID-19, will upset the balance to a certain extent. People's social interaction is drastically reduced, and social support is reduced, which will lead to the possibility of more mental problems. Previous studies have found that individual features such as schizotypal personality features may mediate mental health outcomes related to COVID-19 (46).

Social isolation is a restrictive measure taken by many countries to control the spread of COVID-19. However, it was found that this measure has a potential negative impact on people's mental health and adaptation functioning. Our speculation is consistent with the views of some scholars who attribute the negative effect of the pandemic on psychological outcomes to social isolation, which reduces life satisfaction and leads to mental health problems (47). Therefore, these factors may increase the risk of students developing personality disorders and emotional problems during the pandemic, as well as mind wandering. However, some researchers argued that having schizotypal personality features may be beneficial for both physical and mental health in the context of the COVID-19 pandemic because the preference for solitude by individuals with these personality features would lead to a low risk of COVID-19 transmission and could insulate them from distress given that loneliness is normally not distressing for them (46). Future studies should examine the links between schizotypal personality features and other life aspects to distinguish the different effects of schizotypal personality features.

Some studies have documented the difference between pre-COVID-19 and post-COVID-19 college students when exploring student changes during COVID-19. They considered the impact of COVID-19 on students longitudinally, and they

documented changes in students' lives as well as protective and risk factors leading to psychiatric risk. The results imply that targeted support interventions addressing life skills and improving coping in stressful situations early on may decrease the likelihood of adverse psychological outcomes in young adults later (48).

Moreover, in contrast to studies that regarded psychological problems as dependent variables, our research explored the predictive role of mental health problems on people's life quality, such as students' mind wandering, which may be related to their study. Moreover, we hypothesized that the COVID-19 outbreak would lead to different types of mental health problems, which have complex interactions and further affect people's quality of life. Students are susceptible to depression, and it has been proven that stress may be a predictor thereof (49). Therefore, we suggested that the COVID-19 pandemic did not only induce students' pre-existing personality disorder features but also cause emotional distress. In other words, personality disorder features have different relationships with students' mind wandering under different mood conditions. Study 2 verified our hypothesis that both the preexisting mental adaptive problems of personality, such as schizotypal personality features, and temporary emotional problems, such as depression, could predict students' mind wandering, and that emotional state can also moderate the relationship between schizotypal personality features and mind wandering.

Generally, the COVID-19 pandemic caused worse mental health conditions and further affected other aspects of life (50–52). We have only explored one unique aspect of it, and there is a long way to go.

Limitations and future research directions

This study has several limitations. First, case study 1, although longitudinal, examined only changes in schizotypal personality, whereas case study 2 was a cross-sectional design and lacked experimental or longitudinal evidence, so no conclusions were drawn about the causal relationship between schizotypal personality and depression in terms of mind wandering; alternatively, the associations of these variables are likely to be interpreted in the opposite direction to what we would expect. Scholars have concluded that it is unclear whether mind wandering is a risk factor for depression or a consequence of depression and that there is evidence that mind wandering predicts severe depressive symptoms and severe depressive symptoms predict mind wandering (53). Therefore, future research must further define the nature of these relationships. Second, in consideration of potential factors confounding the findings, we controlled the possible influence of some key potential factors, such as physical and psychological impairment before the outbreak of the novel coronavirus pandemic and whether or not they were infected with coronavirus, and we ensured that the participants in our study could perform their daily lives and live in normal conditions. But there are still some potential factors that may confound our findings. Third, we did not further explore what effects distraction would have on students, e.g., weaker learning in online classes (54), which will be the focus of our next study. Finally, China's anti-epidemic measures are very effective and strict, which is very different from Western countries. It is possible to find different relationships between these variables across countries. Therefore, this moderating effect needs to be supported by evidence from other countries. How to effectively maintain students' mental and psychological health and reduce their mind wandering under a normalized epidemic will be an important new research topic.

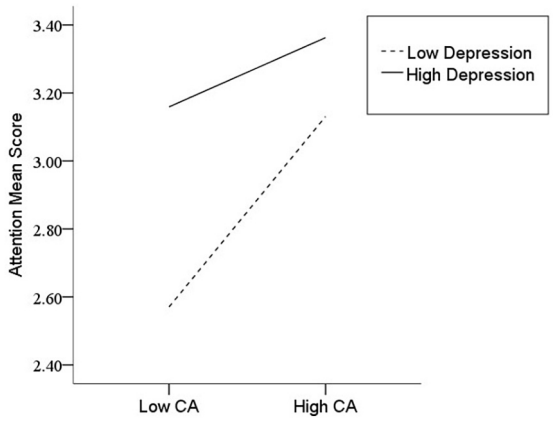

FIGURE 10
Interaction between constricted affect (CA) and depression (D) on mind wandering (MW).

Moreover, the underlying key factors causing mental health problems in the pandemic, such as social isolation or death anxiety, must be further explored in future research. First, as far as social isolation is concerned, in order to prevent the spread of the virus, the implementation of restrictive interpersonal communication measures would increase the chance of being alone and thus exacerbate people's sense of loneliness. Research has found that loneliness has a negative influence on mental health and is the main factor inducing depression (55). It is necessary to consider whether social isolation is the fundamental cause of the adverse effects of the pandemic on mental health and the association between various related variables. Given that social and interpersonal relationships are the basic conditions for the existence of human society and are essential for an individual's normal life, it is reasonable to think that the limitation of social communication would lead to mental health problems. However, there is still a lack of specific research to support this speculation. Another potential influencing factor is death anxiety. People are now more likely to feel the threat of

death due to social media. Thus, could the fear of COVID-19 be the origin of mental health problems? Studies have shown that fear of death cannot only predict anxiety related to COVID-19 but also serve as a predisposing factor to explain various mental health problems (49). However, there is still a lack of empirical research on the effects of these potential factors. Therefore, subsequent researchers must further discuss these issues in the context of a pandemic, e.g., what is the fundamental cause of harm in a pandemic, the deprivation of social communication, or the fear of death? Are there other important factors that explain the negative influence of pandemics as a psychological mechanism? How do these factors influence each other? At present, the related research on the impact of the COVID-19 pandemic on people's mental health or living conditions has not specifically distinguished the social or psychological properties of the pandemic but has broadly discussed the effect of the pandemic. Therefore, future research should pay special attention to these key variables.

Conclusion

The COVID-19 pandemic triggers the Chinese college students' schizotypal personality features. Both schizotypal personality features and depression can predict mind wandering, and depression has a moderating effect on the relationship between schizotypal personality features and mind wandering. These findings highlight that the negative influence of the COVID-19 pandemic on mental health is lasting and complex.

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 in Human Research Committee of the School of Psychology at the Northwest Normal University in China. Written Informed consent was obtained from all individual participants included in the study.

Author contributions

GZ and SL designed the experiments and performed the data analyses. SL, QZ, FX, HL, SY, YD, and XL recruited participants and collected the data. GZ, SL, XG, and YC wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Association between psychological capital and depressive symptoms during COVID-19: The mediating role of perceived social support and the moderating effect of employment pressure

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Introduction: The Coronavirus Disease 2019 (COVID-19) pandemic affects individuals' mental health that can result in fear of getting COVID-19 infection and depression. Prior research has demonstrated that both psychological capital and perceived social support are related to the severity of depression. Yet no study explored the direction of associations between these factors. This undermines the validity of psychological capital as a basis for health interventions.

Methods: This study aimed to explore the association between psychological capital, perceived social support, employment pressure, and depressive symptoms during COVID-19. A cross-sectional design was employed in a sample of 708 Chinese senior medical students who were asked to complete an online questionnaire survey.

Results: Results indicated that psychological capital negatively predicts depressive symptoms ($\beta = -0.55$, $p < 0.001$); perceived social support plays a mediating role in the impact of psychological capital on depressive symptoms (indirect = −0.11, $SE = 0.02$, $p < 0.001$, 95%CI [−0.16, −0.07]), and these associations were moderated by employment pressure. Medical students with high employment pressure, the negative impact of psychological capital on depressive symptoms was statistically significant ($\beta = -0.37$, $SE = 0.05$, $p < 0.001$, 95% CI [−0.046, −0.27]); when the perceived employment pressure was low, the negative effect of psychological capital on depressive symptoms, although significant, was stronger ($\beta = -0.49$, $SE = 0.04$, $p < 0.001$, 95% CI [−0.57, −0.40]).

Discussion: The current study highlights that it is of great significance to address Chinese medical students' employment pressure and improve their mental health during the COVID-19 epidemic.

KEYWORDS

psychological health, depression, employment pressure, medical students, moderated mediation

Introduction

The employment of college graduates concerns individual careers, family harmony, and the socioeconomic future of society as a whole. Research at home and abroad shows that employment pressure is one of the main stressors of college students (1). According to the 2021 Health Statistical Yearbook of China (2), from 2016

to 2020, there were about 5.96 million new graduates of ordinary higher medical specialties in China, however, the number of health personnel in China increased by about 2.3 million during this period. The increment of medical graduates far exceeds the number of new accommodators in medical and health institutions, and the employment situation of medical students is tight. In 2020, Coronavirus Disease 2019 (COVID-19) spread worldwide, becoming a major public health event with severe consequences on human life and health. In order to stop the spread of COVID-19, the government has taken measures to delay students' return to school and hold online job fairs, which make it difficult for students to find a job and employment pressure is exacerbating (3). Previous study showed that medical students with high levels of concern about the negative impact of COVID-19 on their employment were more likely to report poor sleep quality (4). In the face of global changes brought upon by the pandemic, there is an urgent need to address the psychological wellbeing of medical students with uncertain employment prospects.

Depression and psychological capital

Depression is the most common health problems, and it is also one of the crucial factors in mental health (5). A cross-sectional study carried out in early 2020 (hence reflecting attitudes in the context of COVID-19) showed that the prevalence of depression in China was 20.1% (6), indicative of the severe impact of the pandemic on depression in the country. In a systematic review of depressive symptoms among medical students during the COVID-19 pandemic, the overall prevalence of depressive symptoms among medical students was reported to be higher than that in other university students (7). Psychological capital refers to a positive psychological state in the process of individual growth and development, including four dimensions of self-efficacy, optimism, resilience, and hope (8, 9).

Psychological capital can predict depression (10). The broaden-and-built theory denotes that psychological resources (e.g., psychological capital) can help individuals form positive emotion regulation strategies against negative emotions (11). Previous study on veterinary medicine interns has also shown that psychological capital plays a protective role in resisting depressive symptoms (12). The depressive symptoms in the early stages of clinical depression are easily overlooked, thus missing the opportunity to prevent progression to clinical depression in time. Psychological capital intervention (PCI) can improve the symptoms of depression (13), which further shows the positive effects of psychological capital on depressive symptoms. Therefore, the current study assumed that psychological capital might be inversely related to depressive symptoms.

Perceived social support as a mediator

Perceived social support, which is defined as an individual's expectation and evaluation of social support (14). Many studies have shown a positive correlation between perceived social support and psychological capita (15). Empirical studies also found that the psychological capital of volunteers has a positive predictive effect on perceived social support (16). Besides, physicians with higher levels of psychological capital are likely to perceive and take advantage of emotional or material support from leaders, colleagues, and family members (17). In addition, perceived social support was found to be significantly associated with elevated risk for depression (18). Higher levels of perceived social support were associated with lower depression symptoms during the COVID-19 pandemic (19). Taken together, based on these findings, our study aimed to clarify if perceived social support has a mediating effect on the relationship between psychological capital and depressive symptoms of senior medical students during a major epidemic.

Employment pressure as a moderator

As mentioned above, psychological capital may relieve the depression degree of depression symptoms. However, not all medical students who have a high level of psychological capital relieve equally in their degree of depression symptom, in which employment pressure might play an important role. Employment pressure is considered an individual's cognitive evaluation of the relationship between himself and the environment and the impact of this relationship in the current employment climate. Ego-depletion theory denoted that people's mental resources are limited (20). When faced with employment pressure, individuals will mobilize internal resources to cope with stress; if internal resources are not supplemented in time, the access process is blocked after depletion, which will cause mental health damage. Based on this theory, individuals with high psychological capital have more positive resources to cope with employment pressure, while individuals with low psychological capital are more vulnerable to employment pressure. Research shows that the higher the psychological capital is associated with less perceived employment pressure and better mental health (8, 21). Therefore, this study hypothesized that during the COVID-19 epidemic, the employment pressure of senior medical students would significantly moderate the relationship between psychological capital and depressive symptoms.

The present study

The present study aimed to investigate the influence of employment pressure, psychological capital comprehensively, and perceived social support on medical students' depressive symptoms and uncover potential mechanisms underlying the links to provide an empirical basis for effective intervention and improvement of medical students' depressive symptoms when facing job hunting. We hypothesized that: (1) psychological capital would have a negative predictive effect on depressive symptoms; (3) perceived social support mediates the relationship between psychological capital and depression symptoms (H2); and (4) employment pressure moderates the relationship between psychological capital and depression symptoms (H3).

Materials and methods

Participants and procedure

This study adopted a cross-sectional design, using self-administered questionnaires online. According to the current

requirements of COVID-19 prevention and control, we recruited 1,025 senior medical students at the Medical College of Chengdu by convenient random sampling from December 2020 to March 2021. Exclusion criteria for data included: (1) answers to questionnaire questions were incomplete, (3) answers time were under 150s, and (4) answers "no" in the last question of the questionnaire: "Did you answer this questionnaire seriously?." A total of 312 questionnaires with "No" answers were rejected. Five respondents were removed from the dataset for a completion time under 150's.

We collected 1,025 questionnaires, but only 708 responses were valid, and the effective recovery rate was 69.1%.There were 445 female students (62.9%) and 263 male students (37.1%). The subjects were 19–38 years old (23.14 ± 3.062). 30.8% of the subjects were from cities and 69.2% from rural areas; 68.1% of the subjects are undergraduates, and 31.9% of the subjects are specialties. All study procedures were approved by the Ethics Committee of Chengdu Medical College. Before formally filling in the questionnaire, each subject needs to understand the informed consent form of this study, and then can formally answer the questionnaire after consent. All participants were anonymous and data were kept confidential. Participants who agreed with the informed consent before the online questionnaire survey can undertake the formal task and be compensated after completing the Sichuan Provincial Science and Technology Department Project (20ZDYF2396).

Measures

Depression

Depressive symptoms were measured by the Self-rating Depression Scale (SDS) developed by Zung and William (22). The scale can directly reflect the individual's depressive symptoms, and it is convenient to use. There are 20 items on the subjective feelings of depression. Each item is divided into four grades according to the frequency of symptoms to assess the severity of depressive symptoms. The severity of depressive symptoms is divided into mild depressive symptoms, moderate depressive symptoms, and severe depressive symptoms, with scores of 50–59, 60–69, and 70 or more, respectively. In this study, Cronbach's α coefficient was 0.84, KMO is 0.865, Bartlett's spherical test data p-value is at the significance level.

Psychological capital

The Positive Psychological Capital Questionnaire (PPQ) (23) has passed the reliability and validity test, and the internal consistency coefficient is 0.90, which has good structural validity. The questionnaire included four dimensions of self-efficacy, resilience, optimism, and hope, with a total of 26 questions. Questions 1–7 represent self-efficacy, questions 8–14 represent resilience, questions 15-20 represent optimism, and questions 21–26 represent hope. A seven-point Likert Scale was adopted for each question. "1" represents strongly disagree, and "7" represents strongly agree. In this study, Cronbach's α coefficient was 0.81, KMO is 0874, Bartlett's spherical test data p-value is at the significance level.

Perceived social support

Perceived social support was measured *via* the Chinese version of the Perceived Social Support Scale (PSSS) (24). The scale includes three dimensions of family support (items 3, 4, 8, 11), peer support (items 6, 7, 9, 12), and other forms of support (items 1, 2, 5, 10), with a total of 12 items, using 7-point scoring method (1–7 points). The total score of the scale reflects the individual's perception of social support. 12–36 points represent low support level, 37–60 points represent medium support level, 61–84 points represent high support level. The scale includes 12 self-rating items. In this study, Cronbach's α coefficient was 0.78, KMO is 0.833, Bartlett's spherical test data p-value is at the significance level.

Employment pressure

Employment pressure was measured by the Employment Cognition Evaluation Scale (25). This five-point Likert scale consists of two items, which measure challenge cognitive assessment and threat cognitive assessment.

Statistical analysis

In this study, IBM SPSS version 17 was utilized to analyze the descriptive statistics. Descriptive analyses were performed using frequency, percentage, and mean ± standard deviation (SD). Means and standard deviations were used to represent continuous variables. One-way analysis of variance (ANOVA) and t-tests were used to compare differences between groups. Pearson's correlation coefficient was used to examine the associations between the study variables. Models 4 and 5 in PROCESS version 3.3 developed by Hayes (26) were used to analyses the mediating effect of perceived social support and the moderating effect of employment pressure. We calculated 95% confidence intervals (CIs) based on a 5,000 bootstrap resampling.

Results

Common method variance test

The data may suffer from common-method variance since the data collected are electronic self-reports. To mitigate the variance, we completed data collection anonymously and reversed scoring some items (27). After data collection, Harman's univariate factor analysis was used to test whether there were common-method variances. The results showed 17 factors with eigenvalues >1, and the variation explained by the first factor was 17.5%, which was less than the critical standard of 40.0% (28). This shows that there is no serious common-method variance in the data of this study.

Descriptive statistics and correlation analysis

Descriptive statistics results are shown in Table 1. Pearson correlation analysis showed that depressive symptoms, psychological capital, perceived social support and perceived employment pressure correlated significantly. There is a positive correlation between psychological capital and perceived social support ($r = 0.57$, $p < 0.01$) and a negative correlation between employment pressure ($r = -0.31$, $p < 0.01$) and depressive symptoms ($r = -0.57$, $p < 0.01$).

TABLE 1 Means, standard deviations, *T*-test, and ANOVA test among study variables.

	Variable	*N*	Psychological capital	Perceived social support	Employment pressure	Depressive symptoms
Sex	Male	263	111.83 ± 16.944	51.59 ± 10.689	5.96 ± 1.906	48.21 ± 5.277
	Female	445	111.02 ± 18.365	54.26 ± 10.745	5.65 ± 1.348	47.59 ± 5.098
t			−0.583	3.20***	−2.546**	−1.548
Educational background	Undergrade	482	115.4 ± 19.215	55.57 ± 11.631	5.71 ± 1.503	46.55 ± 5.075
	Junior college	226	102.6 ± 9.942	48.36 ± 6.432	5.88 ± 1.744	50.54 ± 4.243
t			9.442***	0.873***	−1.272	−10.279***
Permanent residence	City	284	114.39 ± 19.335	55.08 ± 11.94	5.77 ± 1.538	46.64 ± 5.422
	Rural	424	109.26 ± 16.474	52.05 ± 9.781	5.76 ± 1.617	48.61 ± 4.843
t			3.788***	3.692***	0.125	−5.046***
Monthly living expenses (¥)	<500	32	107.72 ± 11.229	49.03 ± 8.006	6.03 ± 1.909	50.28 ± 3.401
	501–1,500	395	113.97 ± 18.571	54.92 ± 10.95	5.77 ± 1.544	46.76 ± 5.061
	1,501–3,000	191	107.63 ± 17.076	51.6 ± 10.539	5.76 ± 1.523	48.85 ± 4.909
	>3,000	90	108.79 ± 16.253	51.07 ± 10.289	5.66 ± 1.768	49.4 ± 5.615
F			6.826***	7.711***	0.447	13.98***

***$p < 0.001$; **$p < 0.01$.

In addition, Table 2 shows a negative correlation between perceived social support and depressive symptom ($r = -0.48$, $p < 0.01$).

Mediation analysis

We controlled for the effect of age and analyzed the mediating role of perceived social support in the impact of psychological capital on depressive symptoms. The results showed that psychological capital negatively predicts depressive symptoms ($\beta = -0.55$, $p < 0.001$), Hypothesis 1 was thus accepted; psychological capital positively predicts perceived social support ($\beta = 0.54$, $p < 0.001$). When psychological capital and perceived social support are used as predictors of depressive symptoms at the same time, psychological capital negatively predicts depressive symptoms ($\beta = -0.44$, $p < 0.001$), and perceived social support can also negatively predict depressive symptoms ($\beta = -0.20$, $p < 0.001$). The results of mediating analysis showed that perceived social support plays a mediating role in the impact of psychological capital on depressive symptoms ($\beta_{\text{indirect}} = -0.11$, $SE = 0.02$, $p < 0.001$, 95%CI [−0.16, −0.07]), excluding 0, indicating that perceived social support and was the mediating variables for the psychological capital of medical students to influence depressive symptoms, which accounted for 20.1% of the total effect, as shown in Table 3, Hypothesis 2 was thus accepted.

Moderated mediation model

Taking psychological capital as the independent variable, depressive symptoms as the outcome variable, perceived social support as the mediator variable, and perceived employment pressure as the moderating variable, the model was analyzed with model 5 of the PROCESS macro. The overall model is statistically significant

TABLE 2 Means, standard deviations, and correlations among study variables.

Variable	M ± SD	1	2	3	4
1. Psychological capital	111.32 ± 17.84	1			
2. Perceived social support	53.27 ± 10.79	0.57**	1		
3. Employment pressure	5.77 ± 1.58	−0.31**	−0.21**	1	
4. Depressive Symptoms	47.82 ± 5.17	−0.57**	−0.48**	0.21**	1

**$p < 0.01$.

($r^2 = 0.37$, $F_{(df=702)} = 83.42$, $p < 0.001$). The direct effect of psychological capital on depressive symptoms is statistically significant ($\beta = -0.43$, $p < 0.001$). In the case of perceived high employment pressure (1 SD above the mean), the negative impact of psychological capital on depressive symptoms is statistically significant ($\beta = -0.37$, $SE = 0.05$, $p < 0.001$, 95% CI[−0.46, −0.27]); when the perceived employment pressure is low (1 SD below the mean), the negative effect of psychological capital on depressive symptoms, although significant, was stronger ($\beta = -0.49$, $SE = 0.04$, $p < 0.001$, 95% CI[−0.57, −0.40]). In addition, the direct ($\beta = -0.19$, $p < 0.001$) and indirect effects ($\beta = -0.10$, $p < 0.001$, 95% CI [−0.15, −0.06]) of perceived social support on depressive symptoms are both statistically significant, as shown in Figure 1, and Hypothesis 3 was accepted.

Discussion

The mediating role of perceived social support

The study showed that psychological capital was positively correlated with perceived social support, and negatively correlated with perceived employment pressure and depressive symptoms, while

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TABLE 3 Bootstrap results of the mediating effect of perceived social support.

Effect type	Effect value	Boot SE	Bootstrap 95%CI		Proportion of relative effect
			Lower limit	Upper limit	
Total effect	−0.55	0.03	−0.61	−0.50	100%
Direct effect	−0.44	0.04	−0.51	−0.37	79.93%
Indirect effect	−0.11	0.02	−0.16	−0.07	20.07%

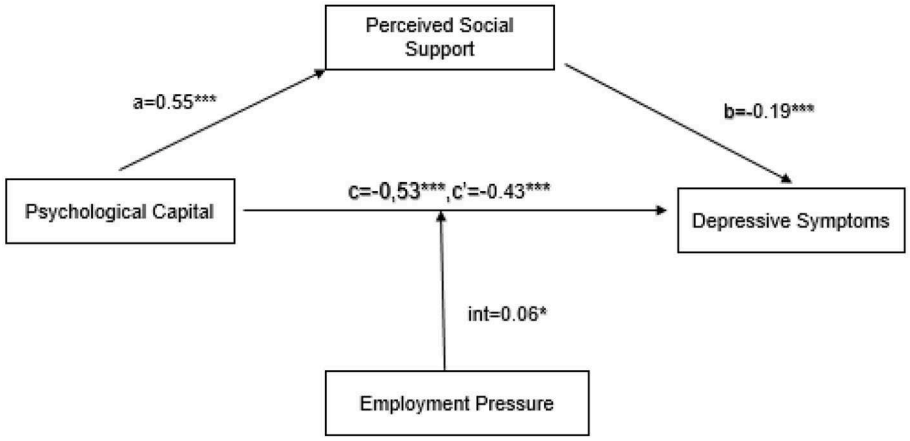

FIGURE 1
The moderated mediation model. ***$p < 0.001$, *$p < 0.05$.

perceived social support was negatively correlated with depressive symptoms (10); in the relationship between the two, perceived social support acted as a mediator, which showed that perceived social support provides more paths consistent with previous studies (10, 29). In addition, the study revealed that perceived social support partially mediated the effect of depressive symptoms alleviated by psychological capital. In other words, psychological capital can act as a protective factor further combat depression by increasing perceived social support. According to the conservation of resources theory, psychological capital as a psychological resources, could promote youths to pursue wellbeing, even when these youths were under the pressure of life (30), as previous study shows that occupational stress can indirectly affect depressive symptoms through psychological capital (31). The current study indicates that medical students with higher levels of psychological capital are likely to be better able to cope with problems from academic and employment, to perceive and take advantage of emotional or material support from schools, teachers, classmates, and family members, and to against negative emotions. The results of the current study may contribute to a more nuanced understanding of the broaden-and-built theory (11).

Previous studies have proved that quarantine during COVID-19 can result in mental health problems (32, 33), since the time interval of the online questionnaire was from December 2020 to March 2021 when many places in China advocated staying put during Spring Festival (34). Influenced by COVID-19 as a population-wide stressor, all dimensions of individual psychological capital (hope, resilience, optimism, and self-efficacy) were affected to weaken its protective effects on the deterioration of mental health. Therefore, in the context of COVID-19, this study suggested that senior medical students need not only to have higher psychological capital to maintain mental health, but also to enhance their perception of social support, and to actively face their environment. At the same time, this result also provided practical guidance for educators and counselors in the detection and potentially prevented the exacerbation of depression.

However, perceived social support was implemented in the current study as a surrogate measure of actual social support. The correlation between the two was low, and their effect on individual mental health was different (35). From the existing research, the actual social support had no consistent and beneficial effect on the individual's mental health, and may even become a burden to the individual (36). Therefore, what was worth further investigation was how the actual social support impacts mental health in the case of sudden public health emergencies such as COVID-19.

The moderating effect of perceived employment pressure

The findings showed that the perceived employment pressure of senior medical students had a statistically significant moderating effect on psychological capital and depressive symptoms under COVID-19. Improving psychological capital of individuals can promote their mental health and relieve depression (37). Interestingly, the study found that the influence of psychological capital may not be the same at all levels of depressive symptoms. The alleviating effect of psychological capital on depressive symptoms is contingent on one's level of perceived employment pressure.

Senior medical students under the condition of perceived high employment pressure, psychological capital plays a greater role in. alleviating of depressive symptoms. However, for medical students with perceived low employment pressure, the beneficial effect of psychological capital is enhanced. These findings corroborated with previous research (5). Seligman pointed that positive psychological resources which act as buffers or coping mechanisms could help mitigate potentially stressful situations (38). Therefore, effective and sufficient individual resources can buffer or weaken the negative outcomes caused by employment stress, and reduces the damage to mental health. This result implies that appropriate and moderate perceived employment pressure can improve an individual's mental health.

Existing studies agree that the mental health status of students in clinical medicine is worse than that of non-clinical students (39). Previous study suggests that the components of psychological capital can be learned and strengthened through deliberate interventions (12, 40). Therefore, it is necessary to strengthen career planning guidance for clinical students in medicine, improve the level of psychological capital, and alleviate psychological problems such as depression caused by employment pressure. The observation that higher depressive symptoms are associated with low psychological capital and perceived lower employment pressure is not adequately explored in the current study and should be examined in the future.

Conclusion

Our findings indicated that psychological capital and perceived social support have a close relationship with depressive symptoms, and perceived social support plays a mediated role between psychological capital and depressive symptoms. Therefore, we recommend that the practitioners of psychological counseling and education be aware of the importance of psychological capital and social support and utilize these resources to mitigate the development and exacerbation of depression. Second, perceived employment pressure moderates the effect of psychological capital on depressive symptoms. Under perceived high employment pressure, psychological capital can predict depressive symptoms, which suggests that psychological capital on mental health cannot be ignored under high employment pressure.

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 Sichuan Research Center of Applied Psychology, Chengdu Medical College. The patients/participants provided their written informed consent to participate in this study.

Author contributions

PT and GY did study design and data collection. YH and XL analyzed data, drafted, and submitted this manuscript together. PT, GY, JY, and HB revised the manuscript. All authors contributed to manuscript checking and approval the final manuscript.

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Conflict of interest

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

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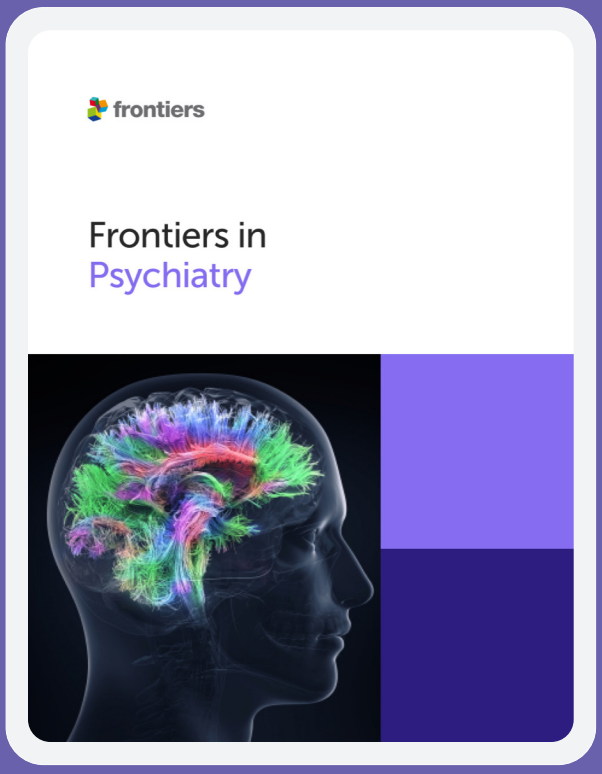

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