

Mental health problems and correlates among 746 217 college students during the coronavirus disease 2019 outbreak in China

Original Article

*They contributed equally to this study.

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Abstract

Aims. Coronavirus disease 2019 (COVID-19) pandemic is a major public health concern all over the world. Little is known about the impact of COVID-19 pandemic on mental health in the general population. This study aimed to assess the mental health problems and associated factors among a large sample of college students during the COVID-19 outbreak in China.

Methods. This cross-sectional and nation-wide survey of college students was conducted in China from 3 to 10 February 2020. A self-administered questionnaire was used to assess psychosocial factors, COVID-19 epidemic related factors and mental health problems. Acute stress, depressive and anxiety symptoms were measured by the Chinese versions of the impact of event scale-6, Patient Health Questionnaire-9 and Generalized Anxiety Disorder-7, respectively. Univariate and hierarchical logistic regression analyses were performed to examine factors associated with mental health problems.

Results. Among 821 218 students who participated in the survey, 746 217 (90.9%) were included for the analysis. In total, 414 604 (55.6%) of the students were female. About 45% of the participants had mental health problems. The prevalence rates of probable acute stress, depressive and anxiety symptoms were 34.9%, 21.1% and 11.0%, respectively. COVID-19 epidemic factors that were associated with increased risk of mental health problems were having relatives or friends being infected (adjusted odds ratio = 1.72–2.33). Students with exposure to media coverage of the COVID-19 ≥ 3 h/day were 2.13 times more likely than students with media exposure < 1 h/day to have acute stress symptoms. Individuals with low perceived social support were 4.84–5.98 times more likely than individuals with high perceived social support to have anxiety and depressive symptoms. In addition, senior year and prior mental health problems were also significantly associated with anxiety or/and depressive symptoms.

Conclusions. In this large-scale survey of college students in China, acute stress, anxiety and depressive symptoms are prevalent during the COVID-19 pandemic. Multiple epidemic and psychosocial factors, such as family members being infected, massive media exposure, low social support, senior year and prior mental health problems were associated with increased risk of mental health problems. Psychosocial support and mental health services should be provided to those students at risk.

Introduction

In December 2019, novel pneumonia caused by coronavirus disease 2019 (COVID-19) was first reported in Wuhan, Hubei Province, China (Huang *et al.*, 2020; Hui *et al.*, 2020; Wang *et al.*, 2020a). Since COVID-19 was confirmed to be a human-to-human transmission (Qiu *et al.*, 2020), the rapid escalation of COVID-19 has led to the suspension of public transport in Wuhan from 23 January 2020 (http://www.gov.cn/xinwen/2020-01/23/content_5471751.htm). Since 24 January 2020, 31 provinces and autonomous regions in mainland China have activated the level 1 public health emergency responses to prevent the spread of COVID-19 (Bao *et al.*, 2020). A range of measures has been urgently taken, such as isolation of suspected and diagnosed cases, cancelling parties, extending holidays and suggesting that people stay at home. On 15 March 2020, the World Health Organization (WHO) declared the current outbreak of COVID-19 as a global pandemic (WHO, 2020). As of 20 June 2020, COVID-19 has spread rapidly and widely across the globe, which confirmed 8 525 042 patients and 456 973 deaths (China: 84 970 confirmed cases; 4645 deaths) with accordance to WHO's Situation Report-152.

Widespread outbreaks of fatal infectious diseases have a substantial negative impact on people's mental health and well-being (Bao *et al.*, 2020; Kang *et al.*, 2020; Xiang *et al.*, 2020a, 2020b; Xiao *et al.*, 2020). Concerns about the mental health and psychological

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adjustment of the public have been arising due to the COVID-19's quick widespread and high mortality (Kang *et al.*, 2020; Xiang *et al.*, 2020b). Several studies have shown widespread and profound psychosocial impacts of the COVID-19 epidemic on mental health, such as stress-related symptoms, depression and anxiety among small samples of medical staff and community residents in China (Cao *et al.*, 2020; Chang *et al.*, 2020; Lai *et al.*, 2020; Liu *et al.*, 2020; Qiu *et al.*, 2020; Wang *et al.*, 2020b, 2020c, 2020d). The above studies found that some influencing factors, including demographic information such as female gender (Chang *et al.*, 2020; Wang *et al.*, 2020b) and younger age (Chang *et al.*, 2020); COVID-19 epidemic related factors such as living in the middle region of China (near the centre of the epidemic) (Liu *et al.*, 2020; Qiu *et al.*, 2020), having relatives or acquaintances infected with COVID-19 (Cao *et al.*, 2020), having contacted with an individual with suspected COVID-19 or infected materials (Wang *et al.*, 2020b) and frequent exposure to information about COVID-19 on social media (Wang *et al.*, 2020d) were significantly associated with increased risk of COVID-19-related mental health problems. Moreover, previous studies about the psychological reactions among the Chinese general population (Ko *et al.*, 2006) or colleges students (Main *et al.*, 2011) during the epidemic of the severe acute respiratory syndrome (SARS) found that individuals who had been quarantined or indirectly exposed to SARS, gained inadequate social support, and used avoidant coping strategies, tended to experience more psychological symptoms.

However, existing studies on the psychosocial impacts of COVID-19 epidemic have limitations, such as small sample sizes (Cao *et al.*, 2020; Chang *et al.*, 2020; Lai *et al.*, 2020; Liu *et al.*, 2020; Yang *et al.*, 2020), assessing single symptoms (Cao *et al.*, 2020; Liu *et al.*, 2020; Qiu *et al.*, 2020; Wang *et al.*, 2020d), unstandardised psychological measures used (Qiu *et al.*, 2020) and limiting factors associated with mental health included (Cao *et al.*, 2020; Chang *et al.*, 2020; Liu *et al.*, 2020). Large-scale epidemiological studies are needed to better understand the impact of COVID-19 on mental health and associated factors in the general population to inform effective intervention strategies.

The primary purpose of the current study was to assess mental health problems and epidemiological characteristics among a national sample of 746 217 college students during the COVID-19 outbreak in China. Standardised mental health measures were used to assess acute stress, depressive and anxiety symptoms. Our second purpose was to understand psychosocial and COVID-19 epidemic factors that may be associated with an increased risk of mental health problems.

Methods

Study design and study background

A cross-sectional and web-based survey was conducted from 3 to 10 February 2020. During this period, the total confirmed cases of COVID-19 in China increased from 17 205 to 42 638. Specifically, at 00:00 P.M. Beijing time on 3 February, the National Health Commission of the People's Republic of China announced 17 205 confirmed cases, 21 558 suspected cases and 361 deaths. By 12 o'clock midnight on 10 February, 31 provinces and autonomous regions on the Mainland China reported 42 638 confirmed cases, 21 675 suspected cases and 1016 deaths (http://en.nhc.gov.cn/DailyBriefing_4.html).

Participants and procedure

Participants were college students from 108 colleges and universities in Guangdong Province (the coastal province in South China with frequent population flow) and Jiangxi Province (nearby Hubei Province, the epicentre of the epidemic). During the survey, these college students stayed at home with their parents or relatives across the country for the Chinese New Year Festival. All the students in the target universities were invited to voluntarily participate in the survey through the network platform (http://www.togx.cn/step_50.html). An online questionnaire was administered to the students to measure psychosocial factors, COVID-19 epidemic related factors and mental health problems. Participants were asked to read the instructions about the purpose and methods to fill out the questionnaire carefully. Participants were also informed that the survey was anonymous, and they could get mental health services as needed from South China Normal University (<https://mp.weixin.qq.com/s/Lh2AD9HZ5JKkgP5SS9zekQ>). A total of 821 218 students participated in the survey, 75 001 did not complete the questionnaire or completed the questionnaire within a short time of 4 min, leaving 746 217 (90.9%) included in the analysis.

The study was approved by the Human Research Ethics Committee of South China Normal University (SCNU-PSY-2020-01-001). All the participants were assured of the confidentiality of their responses, electronic informed consents were obtained online, and all of them could withdraw from the survey at any time without any reason.

Measurements

Psychosocial factors

The following psychosocial factors were collected: gender, college year, cigarette smoking, alcohol use, media exposure to COVID-19 epidemic (h/day) and prior mental health problems as indicated by psychological counselling history before the COVID-19 outbreak.

Epidemic severity in the living province

The COVID-19 epidemic severity was divided into three levels according to the cumulative cases of each province before 1 March 2020 (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>). Three levels were as follows: severe, >10 000 confirmed cases (Hubei province); moderate, 1000–9999 confirmed cases (Guangdong, Henan, Hunan and Zhejiang provinces); mild, <1000 (all other provinces).

Exposure to COVID-19 cases

Four items were developed to assess an individual's exposure to the COVID-19. The details were as follows: (1) Was anyone confirmed or suspected with COVID-19 in your community/village? (2) Was anyone infected with COVID-19 among your friends? (3) Was anyone infected with COVID-19 among your relatives? (4) Was anyone infected with COVID-19 among your family members? For item 1, the answer was 'Yes' or 'No'; for items 2–4, the answer was rated from 1 to 4 (1 = 'Confirmed', 2 = 'Suspected', 3 = 'Nobody' and 4 = 'Do not know'). Because some categories of the items 2, 3 and 4 had very few respondents, we recorded these three items. Specifically, the original categories 1 and 2 being merged into a new category 1 (Confirmed or Suspected),

the original categories 3 and 4 were recorded into new category 2 (Nobody) and 3 (Do not know), respectively. Since the category of 'Confirmed or Suspected' still had very few participants within item 2, 3 and 4, so we merged these three items into a new item of 'relatives or friends being infected with COVID-19 (1 = Confirmed or Suspected, 2 = Nobody, 3 = Do not know)'.

Perceived social support

The Scale of Perceived Social Support consists of 12 items to assess perceived social support from family, friends and significantly others. Each item is rated on a 7-point Likert-type scale from 1 (very strongly disagree) to 7 (very strongly agree) (Dahlem *et al.*, 1991; Zimet *et al.*, 1988). The total score ranges from 12 to 84 with a higher score indicating a greater level of perceived social support. Cronbach's α was 0.95 for this sample.

Acute stress

The impact of event scale-6 (IES-6) was applied to assess students' acute stress associated with COVID-19 in the past 7 days (Jalloh *et al.*, 2018; Thoresen *et al.*, 2010). The IES-6 is comprised of six items to measure intrusion, avoidance and hyperarousal. Each item is answered on a 5-point Likert scale from 0 (not at all) to 4 (extremely). The total score ranges from 0 to 24 with higher values indicating higher levels of acute stress. A total score of 9 was used as the cutoff point to screen clinical level of acute stress (Jalloh *et al.*, 2018). Cronbach's α was 0.80 in the current study.

Depressive symptoms

The 9-item Patient Health Questionnaire (PHQ-9) was used to measure students' depressive symptoms within two weeks (Kroenke *et al.*, 2001). Each item ranges from 0 (not at all) to 3 (nearly every day) with higher scores indicating higher levels of depression. The possible total score ranges from 0 to 27. The Chinese PHQ-9 has demonstrated a valid and reliable tool to screen depression in the general Chinese population (Wang *et al.*, 2014). A total score of 7 was used as the cutoff point to screen clinical depressive symptoms (Wang *et al.*, 2014). In the current study, Cronbach's α was 0.88.

Anxiety symptoms

The 7-item Generalized Anxiety Disorder Scale (GAD-7) was applied to assess anxiety symptoms. Each item is rated on a 4-point scale from 0 (not at all) to 3 (nearly every day) (Spitzer *et al.*, 2006). The Chinese version of the GAD-7 has shown high reliability and validity (Tong *et al.*, 2016). A GAD-7 score ≥ 7 was used as the cutoff point to screen clinical anxiety symptoms (Tong *et al.*, 2016). Cronbach's α was 0.92 for the current sample.

Statistical analyses

All analyses were performed using Statistical Package for Social Sciences (SPSS) version 25.0. Descriptive analyses were used to estimate means (M), standard deviations (s.d.), and prevalence rates of mental health problems. Univariate and hierarchical logistic regression analyses were performed to examine factors associated with mental health problems. The associations were presented using odds ratios (ORs) and their 95% confidence intervals (CIs) in unadjusted analyses and adjusted ORs (AORs)

and their 95% CIs in the adjusted analysis, respectively. Based on the previous studies (Monson, 1990; Registry, 2018), OR (AOR) in 1.2–1.5 and >1.5 were considered to be weakly and moderate to highly correlated, respectively. As the sample size was very large, all statistical significance was set to be $p < 0.001$ (two-sided tests) and OR (AOR) > 1.5 in the current study. For hierarchical logistic regression models, all independent variables with $p < 0.001$ and $OR \leq 1.5$ were put into layer 1 as covariates. Then, all independent variables with $p < 0.001$ and $OR > 1.5$ were entered in layer 2 as the key factors are associated with mental health problems. Finally, the potential interaction among those key factors was put into layer 3.

Results

Descriptive characteristics

Among 746 217 participants included in the analysis, 55.6% were female participants. Table 1 shows detailed sample characteristics, including gender, college year, smoking, alcohol intake, prior mental health problems, COVID-19 epidemic related information and perceived social support.

Prevalence rates of probable acute stress, anxiety and depressive symptoms

Among the participants included in the sample, 45% had probable acute stress, depressive or anxiety symptoms. The prevalence rates of probable acute stress, depressive and anxiety symptoms were 34.9%, 21.1% and 11.0%, respectively.

Figure 1 shows the commodities of probable acute stress, depressive and anxiety symptoms. Acute stress, depressive and anxiety symptoms were more likely to be comorbid (6.3%), followed by comorbidity of acute stress and depressive symptoms (5.5%), depressive and anxiety symptoms (3.3%), and acute stress and anxiety symptoms (0.9%).

Factors associated with probable acute stress, anxiety and depressive symptoms

Logistic regression analyses were conducted to examine the associations of mental health problems with psychosocial and COVID-19 epidemic related factors. In the univariate logistic regression (Table 2), having relatives or friends being infected was moderate to high and was significantly associated with increased risk of the three mental health problems ($OR = 1.78$ – 2.91), having confirmed or suspected cases in one's community or village were related to increased risk of anxiety and depressive symptoms ($OR = 1.55$ – 1.59). Students with >3 h exposure to media coverage of the COVID-19 each day were 2.13 times more likely than students with less media exposure (<1 h/day) to have probable acute stress. Individuals with low perceived social support were 4.92–5.97 times more likely than individuals with high perceived social support to have anxiety or depressive symptoms. In addition, prior mental health problems were also associated with increased odds of anxiety and depressive symptoms. Senior students and those who smoked were more likely to have anxiety symptoms.

In the multivariate logistic regression with a hierarchical approach, all independent variables with $p < 0.001$ and $OR \leq 1.5$ in the univariate logistic regression (Table 2) were put into layer 1 as covariates except the variable of living place at the survey

Table 1. Sample characteristics (*N* = 746 217)

Variable	No. (%)
Gender	
Male	331 613 (44.4)
Female	414 604 (55.6)
Age (years)	
<18	27 640 (3.7)
18–19	252 616 (33.9)
20–21	327 639 (43.9)
22–23	120 142 (16.1)
24–25	14 925 (2.0)
≥26	3255 (0.4)
College year	
Freshman	279 469 (37.5)
Sophomore	218 457 (29.3)
Junior	164 206 (22.0)
Senior	72 734 (9.7)
Graduate	11 351 (1.5)
Ever smoking	
Never	673 314 (90.2)
Yes	72 903 (9.8)
Ever alcohol use	
Never	472 923 (63.4)
Yes	273 294 (36.6)
Prior mental health problems	
No	719 316 (96.4)
Yes	26 901 (3.6)
Living place at the survey ^a	
Far from the epidemic place (Hubei)	258 181 (34.6)
Near the epidemic place (Hubei)	482 700 (64.7)
In the epidemic-place (Hubei)	5336 (0.7)
COVID-19 epidemic severity in the living province ^b	
Mild	559 979 (75.0)
Moderate	180 902 (24.2)
Severe	5336 (0.7)
Confirmed or suspected cases in the community or village	
No	709 794 (95.1)
Yes	36 423 (4.9)
Relatives or friends being infected with COVID-19	
Nobody	449 954 (60.3)
Don't know	285 914 (38.3)
Confirmed or suspected	10 349 (1.4)
Exposure to media coverage of the COVID-19	
<1 h/day	253 691 (34.0)
1–2 h/day	356 500 (47.8)

(Continued)

Table 1. (Continued.)

Variable	No. (%)
≥3 h/day	136 026 (18.2)
Perceived social support (<i>M</i> ± <i>s.d.</i>) ^c	59.8 ± 11.7
High	129 290 (17.3)
Medium	457 824 (61.4)
Low	159 103 (21.3)

COVID-19, coronavirus disease 2019.

^aFar from the epidemic place (Hubei), others; near the epidemic place (Hubei), Anhui, Henan, Hunan, Jiangxi, Shaanxi and Chongqing; in the epidemic-place (Hubei), Hubei.^bSevere: >10 000 confirmed cases (Hubei province); moderate: 1000–9999 confirmed cases (Guangdong, Henan, Hunan and Zhejiang provinces); mild: <1000 (all other provinces).^cLow, score ≤ 48 (<Mean – 1 *s.d.*); medium, score = 49–71 (Mean ± 1*s.d.*); high, score ≥ 72 (>Mean + 1 *s.d.*).

because living place at the survey and the COVID-19 epidemic severity in the living province were highly correlated (contingency coefficient $r = 0.77$, $p < 0.001$). Multivariate and hierarchical logistic regression showed that having relatives or friends being infected was still moderate to high and was significantly associated with increased risk of the three mental health problems (AOR = 1.72–2.33). Students with more than 3 h exposure to media coverage of the COVID-19 each day were 2.13 times more likely than students with less media exposure (<1 h/day) to have probable acute stress. Individuals with low perceived social support were 4.84–5.98 times more likely than individuals with high perceived social support to have anxiety and depressive symptoms. In addition, senior year and prior mental health problems were also associated with increased odds of anxiety or/and depressive symptoms. In layer 3 of multivariate and hierarchical logistic regression, the potential interactions among the key factors were not statistically significant.

Discussion

This study is a large-scale web-based survey to investigate the prevalence and associated factors of probable acute stress, depressive and anxiety symptoms among 746 217 college students during the COVID-19 outbreak in China. Our major findings are summarised below. First, mental health problems are quite common in college students during the COVID-19 epidemic, with about 45% of the participants having probable clinical acute stress, depressive or anxiety symptoms. The prevalence rates of probable acute stress, depressive and anxiety symptoms were 34.9%, 21.1% and 11.0%, respectively. Second, relatives or friends being infected with COVID-19 were significantly associated with increased odds for probable acute stress, depression and anxiety. Third, more than 3 h exposure to media coverage of the COVID-19 each day was associated with increased risk of probable acute stress. Fourth, individuals with low perceived social support were 4.84–5.98 times more likely than individuals with high perceived social support to have anxiety and depressive symptoms. Fifth, multiple other factors such as senior year, and prior mental health problems were also associated with increased odds of depressive or/and anxiety symptoms.

To our knowledge, this is the largest study of mental health problems in college students during the epidemic of infectious diseases. In this study, we used standardised measures to assess mental health problems and found that about 45% of participants

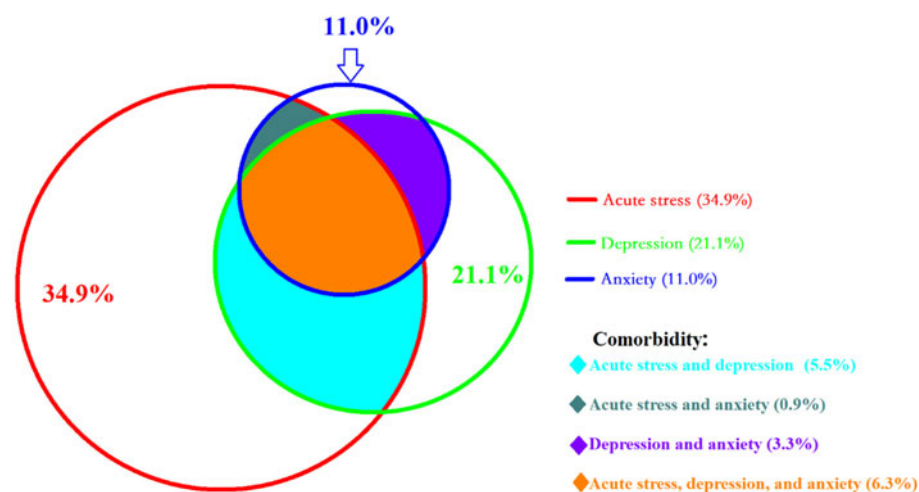


Fig. 1. Comorbidity among acute stress, depression and anxiety ($N = 746\,217$).

Table 2. Factors associated with probable acute stress, depression and anxiety using univariate logistic regression analyses among 746 217 Chinese college students

Variable	Acute stress OR (95% CI)	Depression OR (95% CI)	Anxiety OR (95% CI)
Gender			
Male	1	1	1
Female	0.91 (0.90–0.91)***	1.23 (1.22–1.25)***	1.00 (0.98–1.01)
Age (years)			
<18			
18–19	0.99 (0.96–1.01)	1.01 (0.98–1.04)	0.97 (0.93–1.01)
20–21	1.14 (1.11–1.17)***	1.06 (1.02–1.09)	1.12 (1.08–1.17)***
22–23	1.27 (1.23–1.31)***	1.10 (1.06–1.13)***	1.26 (1.21–1.31)***
24–25	1.39 (1.33–1.45)***	1.06 (1.01–1.11)	1.31 (1.23–1.40)***
≥26	1.43 (1.33–1.54)***	0.93 (0.85–1.02)	1.26 (1.13–1.41)***
College year			
Freshman	1	1	1
Sophomore	1.15 (1.14–1.16)***	1.11 (1.10–1.13)***	1.21 (1.18–1.23)***
Junior	1.22 (1.21–1.24)***	1.15 (1.13–1.17)***	1.31 (1.29–1.34)***
Senior	1.30 (1.28–1.32)***	1.32 (1.29–1.34)***	1.57 (1.53–1.61)***
Graduate	1.44 (1.38–1.49)***	1.23 (1.17–1.28)***	1.51 (1.43–1.60)***
Ever smoking			
Never	1	1	1
Yes	1.27 (1.25–1.29)***	1.38 (1.35–1.40)***	1.57 (1.53–1.60)***
Ever alcohol use			
Never	1	1	1
Yes	1.20 (1.19–1.21)***	1.40 (1.38–1.41)***	1.44 (1.41–1.46)***
Prior mental health problems			
No	1	1	1
Yes	1.12 (1.09–1.15)***	2.26 (2.20–2.31)***	2.38 (2.31–2.45)***
Living place at the survey^a			
Far from the epidemic place (Hubei)	1	1	1
Near the epidemic place (Hubei)	1.01 (1.00–1.02)	0.94 (0.93–0.95)***	0.93 (0.92–0.95)***

(Continued)

Table 2. (Continued.)

Variable	Acute stress OR (95% CI)	Depression OR (95% CI)	Anxiety OR (95% CI)
In the epidemic-place (Hubei)	1.08 (1.02–1.15)	1.03 (0.97–1.10)	1.13 (1.04–1.22)
COVID-19 epidemic severity in the living province ^b			
Mild	1	1	1
Moderate	0.99 (0.98–1.00)	1.10 (1.09–1.11)***	1.12 (1.10–1.14)***
Severe	1.07 (1.01–1.13)	1.10 (1.03–1.17)	1.21 (1.12–1.32)***
Confirmed or suspected cases in the community or village			
No	1	1	1
Yes	1.21 (1.19–1.24)***	1.55 (1.51–1.58)***	1.59 (1.55–1.64)***
Relatives or friends being infected with COVID-19			
Nobody	1	1	1
Don't know	1.26 (1.25–1.27)***	1.67 (1.65–1.69)***	1.75 (1.72–1.77)***
Confirmed or suspected	1.78 (1.71–1.85)***	2.62 (2.52–2.73)***	2.91 (2.77–3.05)***
Exposure to media coverage of the COVID-19			
<1 h/day	1	1	1
1–2 h/day	1.66 (1.64–1.68)***	0.98 (0.97–0.99)	1.06 (1.05–1.08)***
≥3 h/day	2.13 (2.10–2.16)***	1.09 (1.07–1.10)***	1.32 (1.29–1.34)***
Perceived social support ($M \pm s.d.$) ^c			
High	1	1	1
Medium	1.11 (1.10–1.13)***	2.32 (2.27–2.36)***	2.24 (2.18–2.30)***
Low	1.29 (1.27–1.31)***	4.92 (4.81–5.02)***	5.97 (5.79–6.14)***

95% CI, 95% confidence interval; COVID-19, coronavirus disease 2019; OR, odds ratio; each independent variable was analysed one by one against probable acute stress, depression and anxiety.

*** $p < 0.001$.

Bold: $p < 0.001$ and OR > 1.5 were considered to have scientific and public health significance.

^aFar from the epidemic place (Hubei), others; near the epidemic place (Hubei), Anhui, Henan, Hunan, Jiangxi, Shaanxi and Chongqing; in the epidemic-place (Hubei), Hubei.

^bSevere: $> 10\,000$ confirmed cases (Hubei province); moderate: 1000–9999 confirmed cases (Guangdong, Henan, Hunan and Zhejiang provinces); mild: < 1000 (all other provinces).

^cLow, score ≤ 48 ($< \text{Mean} - 1 \text{ s.d.}$); medium, score = 49–71 ($\text{Mean} \pm 1 \text{ s.d.}$); high, score ≥ 71 ($> \text{Mean} + 1 \text{ s.d.}$).

had probable clinical acute stress, depressive or anxiety symptoms for the COVID-19 epidemic in China. Probable acute stress was the most common problem (34.9%) followed by depressive symptoms (21.1%) and anxiety (11.0%). There were differences in the prevalence of probable acute stress, depression and anxiety in our study. This finding is consistent with the systematic review (Rogers *et al.*, 2020), which revealed that prevalence rates of the psychiatric consequences of all forms of coronavirus infection were different during the acute illness. The possible reason is that these mental diseases had different pathological mechanisms. For example, acute stress is associated with both increased activity in the salience network and the default mode network (Van *et al.*, 2017); the brain changes that have been identified in depressive disorders, such as the amygdala and sub-genual anterior cingulate are hyperactive, while the insula and dorsal lateral prefrontal cortex are hypoactive (Malhi and Mann, 2018); the amygdala seems to be a crucial structure for anxiety, and has consistently been found to be activated in anxiety-provoking situations (Holzschneider and Mulert, 2011). Notably, the rates of depressive and/or anxiety symptoms are much higher than those reported among college students in Asia during (Cao *et al.*, 2020; Chang *et al.*, 2020; Tang *et al.*, 2020) and before the COVID-19 epidemic (Cuttilan *et al.*, 2016). The prevalence of

probable depression was determined to be 9.0% among 2501 undergraduate students (Tang *et al.*, 2020) and probable anxiety was reported to be 3.6% among 7143 college students (Cao *et al.*, 2020). In a systematic review (Cuttilan *et al.*, 2016), the authors found that the prevalence rates of depressive and anxiety symptoms in Asian college students were 11% and 7.04%, respectively. Potential explanations of the different results among these studies could be due to the differences in sampling, assessment time, measures and cut-off scores. The high prevalence of mental health problems among college students all over the country during the COVID-19 epidemic should get public health attention. Psychosocial support and mental health services should be provided to college students, especially those who are at high risk as discussed below.

In our study, we found multiple psychosocial and COVID-19 epidemic related factors are associated with an increased risk of mental health problems among college students. The major COVID-19 epidemic related factor associated with an increased risk of mental health problems was family members/relatives or friends being infected with COVID-19. Our finding is consistent with one relatively small study of college students, which found a significantly higher risk of emotional and anxiety disorders among college students who had relatives or friends being

Table 3. The key factor associated with probable acute stress, depression and anxiety using hierarchical logistic regression analyses among 746 217 Chinese college students

Variable	Acute stress: AOR (95% CI) ^a		Depression: AOR (95% CI) ^b		Anxiety: AOR (95% CI) ^c	
	Layer 2	Layer 3	Layer 2	Layer 3	Layer 2	Layer 3
Students						
Freshman	-	-	-	-	1	1
Sophomore	-	-	-	-	1.17 (1.15–1.20)***	1.17 (1.15–1.20)***
Junior	-	-	-	-	1.30 (1.27–1.34)***	1.30 (1.27–1.33)***
Senior	-	-	-	-	1.68 (1.63–1.73)***	1.68 (1.63–1.74)***
Graduate	-	-	-	-	1.98 (1.84–2.13)***	2.00 (1.86–2.16)***
Ever smoking						
Never	-	-	-	-	1	1
Yes	-	-	-	-	1.17 (1.15–1.20)***	1.17 (1.14–1.20)***
Prior mental health problems						
No	-	-	1	1	1	1
Yes	-	-	2.03 (1.98–2.09)***	1.80 (1.66–1.95)***	2.12 (2.05–2.19)***	2.04 (1.82–2.30)***
Infected cases in the community or village						
No	-	-	1	1	1	1
Yes	-	-	1.35 (1.32–1.38)***	1.37 (1.27–1.48)***	1.38 (1.34–1.43)***	1.46 (1.31–1.62)***
Relatives or acquaintances being infected with COVID-19						
Nobody	1	1	1	1	1	1
Don't know	1.27 (1.26–1.28)***	1.22 (1.20–1.25)***	1.49 (1.47–1.51)***	1.53 (1.47–1.59)***	1.56 (1.53–1.58)***	1.65 (1.56–1.75)***
Confirmed or suspected	1.70 (1.63–1.77)***	1.72 (1.60–1.85)***	2.21 (2.11–2.30)***	2.22 (1.94–2.54)***	2.39 (2.27–2.51)***	2.33 (1.94–2.80)***
Exposure to media coverage of the COVID-19						
<1 h/day	1.0	1	-	-	-	-
1–2 h/day	1.71 (1.69–1.73)***	1.67 (1.64–1.69)***	-	-	-	-
≥3 h/day	2.16 (2.13–2.19)***	2.13 (2.09–2.17)***	-	-	-	-
Perceived social support^d						
High	-	-	1	1	1	1
Medium	-	-	2.25 (2.21–2.30)***	2.26 (2.20–2.32)***	2.22 (2.15–2.28)***	2.23 (2.15–2.32)***
Low	-	-	4.81 (4.71–4.92)***	4.84 (4.70–4.98)***	5.66 (5.49–5.83)***	5.98 (5.75–6.23)***
Interaction						
Relatives or friends being infected with COVID-19 × Exposure to media coverage of the COVID-19						
Nobody × <1 h/day	-	1	-	-	-	-
Don't know × 1–2 h/day	-	1.07 (1.04–1.09)***	-	-	-	-
Don't know × ≥3 h/day	-	1.03 (1.00–1.05)	-	-	-	-
Confirmed or suspected × 1–2 h/day	-	0.99 (0.90–1.08)	-	-	-	-
Confirmed or suspected × ≥3 h/day	-	0.97 (0.87–1.09)	-	-	-	-
Prior mental health problems × Perceived social support						
No × High	-	-	-	1	-	1
Yes × Medium	-	-	-	1.11 (1.02–1.22)	-	1.04 (0.93–1.17)
Yes × Low	-	-	-	1.22 (1.12–1.35)***	-	1.01 (0.89–1.13)

(Continued)

Table 3. (Continued.)

Variable	Acute stress: AOR (95% CI) ^a		Depression: AOR (95% CI) ^b		Anxiety: AOR (95% CI) ^c	
	Layer 2	Layer 3	Layer 2	Layer 3	Layer 2	Layer 3
Infected cases in the community or village × Perceived social support						
No × High	–	–		1	–	1
Yes × Medium	–	–		0.98 (0.90–1.06)	–	0.98 (0.88–1.10)
Yes × Low	–	–		0.99 (0.91–1.09)	–	0.90 (0.80–1.01)
Relatives or friends being infected with COVID-19 × perceived social support						
Nobody × High	–	–		1		1
Don't know × Medium	–	–		0.98 (0.94–1.02)	–	0.97 (0.91–1.03)
Don't know × Low	–	–		0.96 (0.92–1.01)	–	0.90 (0.84–0.95)***
Confirmed or suspected × Medium	–	–		1.00 (0.87–1.16)	–	1.09 (0.89–1.32)
Confirmed or suspected × Low	–	–		0.97 (0.83–1.13)	–	0.94 (0.77–1.15)
Students × Prior mental health problems						
Freshman × No	–	–	–	–	–	1
Sophomore × Yes	–	–	–	–	–	1.05 (0.97–1.13)
Junior × Yes	–	–	–	–	–	1.04 (0.95–1.13)
Senior × Yes	–	–	–	–	–	0.93 (0.84–1.03)
Graduate × Yes	–	–	–	–	–	0.88 (0.71–1.09)
Smoking × Prior mental health problems						
Never × No	–	–	–	–	–	1
Yes × Yes	–	–	–	–	–	1.01 (0.94–1.10)
R ²	0.039	0.039	0.093	0.093	0.091	0.091
0<chk this>						

95% CI, 95% confidence interval; COVID-19, coronavirus disease 2019; AOR, adjusted odds ratio; the key factors and the potential interaction among those factors were entered into the logistic regression model.

*** $p < 0.001$.

Bold: $p < 0.001$ and OR > 1.5 were considered to have scientific and public health significance.

^aVariables of gender, age, students' grade, ever smoking, ever alcohol use, prior mental health problems, infected cases in the community or village and perceived social support were put into layer 1 as covariates for model of probable acute stress.

^bVariables of gender, age, students' grade, ever smoking, ever alcohol use, COVID-19 epidemic severity in the living province, and exposure to media coverage of the COVID-19 were put into layer 1 as covariates for model of probable depression.

^cVariables of age, ever alcohol use, COVID-19 epidemic severity in the living province and exposure to media coverage of the COVID-19 were put into layer 1 as covariates for model of probable anxiety.

^dLow, score ≤ 48 ($< \text{Mean} - 1 \text{ s.d.}$); medium, score = 49–71 ($\text{Mean} \pm 1 \text{ s.d.}$); high, score ≥ 71 ($> \text{Mean} + 1 \text{ s.d.}$).

infected with COVID-19 (Cao *et al.*, 2020). We also found that confirmed or suspected cases in the community or village were significant, albeit weakly associated with increased risk of anxiety and depressive symptoms (AOR = 1.2–1.5). However, we did not find significant and meaningful associations of epidemic severity in the living province near the epicentre (Hubei) with mental health problems in the multivariate regression. These findings support the conclusion that the spread of psychological distress was pervasive all over the country irrespective of the actual severity of the risk (Yang *et al.*, 2020) except individuals who had family members/relatives or friends being infected with COVID-19. For individuals who had family members/relatives or friends being infected with COVID-19, they may have to witness the fear, pain, hardship and even death from families/relatives or

friends, and even they may also experience more psychological distress. Specific attention should be given to individuals who have family members/relatives or friends being infected.

It should be noted that mass exposure to media coverage of the COVID-19 was associated with an increased risk of probable acute stress and anxiety symptoms. Students exposed to media coverage of the COVID-19 ≥ 3 h/day were >2 times more likely to have probable acute stress than those who were exposed to <1 h/day. This finding is supported by previous studies (Neria and Sullivan, 2011; Holman *et al.*, 2014; Wang *et al.*, 2020b, 2020d). One potential explanation is that mass media exposure can raise quickly awareness about new threats because individuals have difficulty in finding trustworthy and helpful sources of information with too much of mixed information (Chan *et al.*, 2018).

Particularly, Silver and colleagues found a strong association between attack-related media exposure and acute stress symptoms (Holman *et al.*, 2014). Although further research is warranted, it may be crucial to provide the public with reliable and accurate information. It may also be important for individuals to avoid over mass media exposure to reduce the negative psychological impact of the COVID-19 epidemic.

Low perceived social support was significantly associated with increased risk for anxiety and depressive symptoms. Our finding is consistent with the previous finding that people with low perceived social support was at high risk of psychological pressure, while high perceived social support has a positive effect on anxiety and stress during the COVID-19 epidemics (Cao *et al.*, 2020; Xiao *et al.*, 2020). Therefore, psychosocial support from family, friends, schools and the community may be important to maintain individuals' psychological well-being and health during the COVID-19 epidemic (Shigemura *et al.*, 2020; Zhai and Du, 2020).

Consistent with previous studies of college studies, we also found that multiple psychosocial factors such as senior year (Cao *et al.*, 2020) and prior mental health problems (Pejovic *et al.*, 2009; Liu *et al.*, 2019) were associated with mental health problems. Obviously, freshman tends to have less academic pressure and less worry about future employment (Cao *et al.*, 2020; Sprung and Rogers, 2020). These factors should also be taken into consideration for effective psychosocial intervention during the COVID-19 epidemic.

Several potential limitations should be noted in the current study. First, although our sample is large and participants lived across the country during the survey, all the students were originally sampled from 108 colleges and universities in Guangdong and Jiangxi provinces. About 80% lived in the two provinces and only a small proportion of students who lived in the epicentre (Wuhan). It is uncertain whether our findings could be generalised to all students all over the country, especially the students who lived in Wuhan. Second, based on an online survey, we could not have the exact response rate except the rate of valid questionnaire because some students may fail to pay attention to the information in time and miss the survey. Third, no causality could be made between COVID-19 and mental health problems as the cross-sectional design. Finally, although the measurements used in the current study have satisfactory psychometric properties, they are self-report for screening rather than clinical diagnosis.

This large-scale survey of college students in China demonstrates that about 45% students have probable acute stress, anxiety or depressive symptoms during the COVID-19 epidemic. Multiple COVID-19 epidemic and psychosocial factors, such as family members being infected, massive media exposure, low social support, female gender and prior mental health problems are associated with increased risk of mental health problems. These findings may have important implications for prevention, psychosocial intervention and future research. Importantly, mental health services should be provided to those college students at risk for psychological symptoms. In addition, providing social support and reducing social/digital media volume about COVID-19 may be important social measures for psychological well-being among youth.

Availability of data and materials. Please contact PhD Fang Fan at fangfan@scnu.edu.cn for data supporting the findings of the current study.

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QY and JJ participated in data collation and reviewed the manuscript. FF and XL designed the study, supervised the data analysis and critically revised the manuscript. All authors read and approved the final manuscript. The authors would like to thank all participants and schools for their collaboration and assistance in data collection.

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Ethical standard. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees.

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