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Understanding psychological symptoms among Chinese college students during the COVID-19 Omicron pandemic: Findings from a national cross-sectional survey in 2023☆

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ABSTRACT

During the Omicron pandemic in late 2022, this study surveyed Chinese students via an online questionnaire to assess their mental health status, prevalence of psychological symptoms, and associated factors. A nationwide cross-sectional survey of 4254 participants was conducted in seven regions of China from January 5 to February 9, 2023. Scales were utilized respectively to measure depressive symptoms, anxiety symptoms, post-traumatic stress disorder (PTSD) symptoms, and perceived social support. Descriptive, univariate, and multivariable analyses were performed to identify associated factors. Protective factors against depressive symptoms include regular exercise and robust social support networks, while risk factors involve excessive alcohol consumption, comorbidities, Omicron infection, and irregular sleep patterns. Risk factors for anxiety symptoms include comorbidities, Omicron infection, living alone, and irregular sleep patterns, while social support emerges as a protective factor. For PTSD symptoms, regular exercise and strong social support systems are identified as protective measures, with risks associated with comorbidities, Omicron infection, and poor sleep quality. Students are particularly vulnerable during the pandemic due to their lifestyle and academic pressures. It's essential to bolster their social support and promote healthier habits.

1. Introduction

In early December 2022, China faced a widespread Omicron outbreak of COVID-19, specifically BA.5 and BF.7 subvariants, impacting a huge population [1]. This is the largest outbreak of its kind to date. Historically, public health crises have damaged population health, and heightened societal vulnerability, leading to notable mental health challenges [2]. Despite global recovery efforts, ongoing COVID-19 impacts persist, with anxiety symptoms, depressive symptoms, and post-traumatic stress disorder (PTSD) symptoms obtained [3]. Factors like frequent testing, interaction-restricting policies, distressing

narratives, and extensive media coverage contribute to varying mental health challenges, exacerbating pre-existing conditions [4]. Given the widespread deterioration of students' mental health [5], particularly exacerbated by the Omicron wave, urgent attention must be redirected towards safeguarding their well-being. Research on mental health issues in China from early December 2022 to January 2023 has been limited, leaving a substantial gap in understanding the gravity of challenges confronting students.

The decision to focus on this demographic is underscored by their distinct characteristics and the heightened severity of psychological issues they face [5]. Chinese students aged 18–30 encounter unique

stressors, including academic pressures stemming from demanding coursework, stringent deadlines, and high expectations from peers, professors, and family [6]. Additionally, the close quarters in classrooms or dormitories can exacerbate feelings of social pressure, isolation, and performance anxiety symptoms. These stressors often contribute to a heightened susceptibility to mental health struggles compared to the general population. Furthermore, considering their significant representation in society, addressing the mental health needs of students becomes paramount. Therefore, through a nationwide cross-sectional study employing a questionnaire-based approach, our objective is to delve into the prevalence of psychological symptoms and pinpoint the underlying contributing factors. Ultimately, our research endeavors to provide actionable insights for promoting mental well-being amidst the urgent backdrop of this public health crisis.

2. Material and methods

2.1. Sampling and participants

The nationwide cross-sectional investigation was conducted in China from January 5 to February 9, 2023, with responses obtained from students across 31 provincial-level regions. We employed convenient and snowball sampling methods for online participant recruitment, supported by regional online recruitment advertising efforts on a university basis. The questionnaire was distributed via WeChat and Questionnaire Star (https://www.wjx.cn/), developed by a team of experts, and refined through literature review, group deliberations, testing, and piloting. Digital informed consent was obtained, and eligibility criteria included: 1) aged 18 or above; 2) Chinese students; 3) proficiency in Chinese; 4) ability to complete the questionnaire independently; 5) access to mobile communication equipment; 6) time to complete the questionnaire was no less than 120 s. Out of 10,623 respondents from seven regions of China (Northeast, North, East, South, Central, Northwest, and Southwest China), 4275 are students who received the survey link, among which 4254 met the criteria and were retained for analysis, yielding an effective rate of 99.5 %. The study was approved by the Ethics Review Committee of the Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China (CAMS&PUMC-IEC-2022-83).

2.2. Measures

2.2.1. Demographic characteristics

Self-reported demographic data, including age, gender, education, smoking and drinking status, pre-existing comorbidity, Omicron infection status, living arrangements, exercise habits, and sleep patterns, were collected.

2.2.2. Psychological status

2.2.2.1. Depressive symptoms. Assessed using the 9-item Patient Health Questionnaire (PHQ-9) [7], a self-rated scale gauging depressive symptoms over the past two weeks. Scores indicate normal (0–4), mild (5–9), moderate (10–14), and severe (15–27) [8]. Cronbach's alpha was 0.94 in this study compared to 0.80 in a relevant study [9].

2.2.2.2. Anxiety symptoms. Evaluated through the 7-item Generalized Anxiety Disorder Questionnaire (GAD-7), rating anxiety symptoms over the past two weeks [10]. Scores signify normal (0–5), mild (6–9), moderate (10–14), and severe (15–21) [11]. Cronbach's alpha was 0.97 in this study and 0.91 in a relevant study [12].

2.2.2.3. Post-traumatic stress disorder (PTSD) symptoms. Assessed by the 6-item Impact of Event Scale (IES-6), of 6 items in 3 categories: Intrusion (items 1, 3), Avoidance (items 4, 5), and Hyperarousal (items 2, 6), with

a total score ≥10 indicating positive PTSD symptoms [13]. Cronbach's alpha was 0.94 in this study, compared to 0.86–0.91 in a relevant study [14].

2.2.3. Perceived social support

Measured with the 2-item Perceived Social Support Scale (PSSS-2), recording emotional and material support on a scale of 0–10 [15]. The scale has a total score of 20, with emotional and material support each accounting for 10 points. The questions are: 1. How much support can you receive from your family/friends/colleagues when you need emotional support? 2. How much support can you receive from your family/friends/colleagues when you need material assistance (e.g., financial difficulties)? Higher scores indicate increased social support. Cronbach's alpha was 0.85 in this study, while a relevant study reported 0.90 [16].

2.2.4. Physical activity categories

In this study, participants in the physical activity categories are typically classified as follows: 1) Frequent exercisers: This group typically engages in exercise more than three times a week, with each session lasting 30 min or longer. Their activity intensity ranges from moderate to high and often includes aerobic exercises, strength training, or other high-intensity activities; 2) General exercisers: This group may exercise 1 to 2 times per week, with session durations also around 30 min. The types of activities they participate in may vary, but their frequency and intensity are lower compared to frequent exercisers; 3) Rare exercisers: Rare exercisers engage in physical activity infrequently, possibly only a few times a month or even less. Their activities tend to be of light to moderate intensity, such as walking or casual biking.

2.3. Statistical analysis

Descriptive analyses portrayed participants' characteristics and mental health. Chi-square and rank sum tests were used to assess the association between mental psychological status and potential factors. Binary logistic regression and ordinal logistic regression were utilized to calculate adjusted odds ratios (AOR) and 95 % confidence intervals (95 % CI) for factors associated with depressive symptoms, anxiety symptoms, and PTSD symptoms. A two-tailed P-value <0.05 denoted statistical significance. SPSS 26.0 and GraphPad Prism 9.0 facilitated statistical analyses and figure presentation.

3. Results

3.1. Demographic characteristics

A total of 4254 student questionnaires were analyzed (Table 1), showing a median age of 19 years (IQR = 18, 21) with 74.2 % female. Education levels were predominantly bachelor's degrees (87.6 %), followed by associate degrees or below (5.1 %), and master's or above degrees (7.4 %). Omicron infection statuses were reported as follows: not infected yet (16.5 %), infected during the study (1.5 %), already healed (68.2 %), and not tested (13.8 %). Psychological assessments included PHQ-9 scores with a median of 6 (IQR = 1, 9), GAD-7 scores with a median of 3 (IQR = 0, 7), and IES-6 scores with a median of 6 (IQR = 1, 11).

3.2. Psychological symptoms of students

Figs. 1 and 2 show that in our study cohort, the prevalence of depressive symptoms was determined to be 57.6 % (2452 out of 4254 participants, 95 % CI: 56.2%–59.1 %), comprising 1481 (34.8 %) mild, 493 (11.6 %) moderate, and 478 (11.2 %) severe cases. Anxiety symptoms were prevalent in 39.9 % (1267 out of 4254 participants, 95 % CI: 38.4%–41.4 %), with 1145 (26.9 %) mild, 382 (9.0 %) moderate, and 170 (4.0 %) severe cases observed among 1697 participants. The

Table 1

Sociodemographic and psychological characteristics of students (N = 4254).

Variable	M (IQR) or n (%)
Gender	
Male	1096 (25.8)
Female	3158 (74.2)
Education	
Associate or below	215 (5.1)
Bachelor	3725 (87.6)
Master or above	314 (7.4)
Age, years	19 (18, 21)
Smoking Status	
No	4054 (95.3)
Yes	200 (4.7)
Drinking Status	
No	3533 (83.1)
Yes	721 (16.9)
Pre-existing comorbidity	
No	4128 (97.0)
Yes	126 (3.0)
Status of Omicron infection	
Not yet	704 (16.5)
During the infection	63 (1.5)
Already healed	2901 (68.2)
Not testing	586 (13.8)
Living alone	
No	4140 (97.3)
Yes	114 (2.7)
Exercising status	
Rarely or less often	1040 (24.4)
Generally	1774 (41.7)
Frequently or always	1440 (33.9)
Staying up late	
Rarely or less often	659 (15.5)
Generally	1364 (32.1)
Frequently or always	2231 (52.4)
Perceived social support	16 (12, 19)
Emotional Support	8 (6, 10)
Material Support	8 (6, 10)

prevalence of PTSD symptoms was recorded at 31.0 % (1317 out of 4254 participants, 95 % CI: 29.6%–32.3 %). 77.8 % of the respondents had at least one PTSD symptom. The most severe PTSD domain among the respondents was intrusion: "I thought about it when I did not mean to" (68.7 %) and "Other things kept making me think about it" (68.7 %), then the hyperarousal and avoidance categories.

3.3. Univariate analysis

As shown in Table 2, regarding depressive symptoms, individuals with a master's degree or above (63.1 %) exhibited the highest prevalence, followed by bachelor's degree holders (57.5 %), and those with an associate degree or below (52.6 %) (χ^2 = 6.089, p = 0.048). Similarly, smokers (66.0 %) displayed a higher prevalence compared to non-smokers (34.0 %) (χ^2 = 6.007, p = 0.014). Likewise, individuals who consume alcohol (66.6 %) showed a higher prevalence compared to non-drinkers (33.4 %) (χ^2 = 28.381, p < 0.001). Moreover, individuals with pre-existing comorbidities (76.2 %) exhibited a substantially higher prevalence compared to those without comorbidities (23.8 %) (χ^2 = 18.301, p < 0.001). During the Omicron infection phase, individuals experiencing the infection (76.2 %) showed a notably higher prevalence of depressive symptoms compared to those who haven't been infected yet, already healed, or not tested (χ^2 = 27.902, p < 0.001). Living alone was associated with a slightly higher prevalence (67.5 %) compared to those who don't (χ^2 = 4.706, p = 0.030). Furthermore, individuals who exercise rarely or less often (63.9 %) displayed a higher prevalence compared to those who exercise generally or frequently (χ^2 = 37.224, p < 0.001). Lastly, staying up late frequently or always (66.7 %) was associated with a higher prevalence of depressive symptoms compared to those who stay up rarely or less often (36.3 %) or generally (53.1 %)

(χ^2 = 210.601, p < 0.001). Concerning social support (Z = 14.293, p < 0.001), the median value of the score in individuals with depressive symptoms (15, 11–18) was lower than those without this symptom (17, 14–20).

As for anxiety symptoms, females (38.7 %) displayed a higher prevalence compared to males (43.3 %) (χ^2 = 7.318, p = 0.007). Smokers (51.0 %) and drinkers (45.6 %) showed higher prevalence compared to non-smokers and non-drinkers, respectively (χ^2 = 10.800, p = 0.001; χ^2 = 11.925, p = 0.001). Besides, individuals with comorbidities (39.3 %) exhibited higher prevalence compared to those without comorbidities (58.7 %) (χ^2 = 19.217, p < 0.001). During the Omicron infection phase, individuals experiencing the infection (61.9 %) showed a notably higher prevalence of anxiety symptoms compared to other groups (χ^2 = 20.426, p < 0.001). Those who frequently or always exercise (37.2 %) showed lower prevalence (χ^2 = 7.117, p = 0.028). Individuals who frequently or always stay up late (46.2 %) exhibited higher prevalence compared to those who stay up rarely or less often (22.0 %) or generally (38.2 %) (χ^2 = 126.755, p < 0.001). Concerning social support (Z = −16.949, p < 0.001), the median value of the score in individuals with anxiety symptoms (14, 10–17) was lower than those without it (17, 14–20).

Regarding PTSD symptoms, individuals with a master's degree or above (39.2 %) exhibited the highest prevalence, followed by bachelor's degree holders (30.4 %), and those with an associate degree or below (29.3 %) (χ^2 = 10.805, p = 0.005). Besides, individuals with pre-existing comorbidities (42.9 %) displayed a significantly higher prevalence compared to those without comorbidities (30.6 %) (χ^2 = 8.600, p = 0.003). During the Omicron infection phase, individuals experiencing the infection (58.7 %) exhibited a significantly higher prevalence compared to other groups (χ^2 = 23.107, p < 0.001). Moreover, individuals who frequently or always stay up late (35.6 %) had a significantly higher prevalence compared to those who stay up rarely or less often (19.3 %) or generally (29.0 %) (χ^2 = 66.862, p < 0.001). Concerning social support (Z = −8.333, p < 0.001), the median value of the score in individuals with PTSD symptoms (15, 11–18) was lower than those without it (16, 12–20).

It is worthy of note that during the univariate variable analysis, age was utilized as the primary factor for matching to mitigate the confounding effect of age.

3.4. Multivariate logistic regression analysis

In Fig. 2, several factors demonstrate positive associations with depressive symptoms, including drinking (AOR = 1.39, P = 0.001), pre-existing comorbidity (AOR = 2.01, P = 0.002), infection status (AOR = 2.71, P = 0.002), healing status (AOR = 1.34, P = 0.001), and staying up late (general AOR = 1.74, P < 0.001; frequent or always AOR = 3.16, P < 0.001). Conversely, exercise (AOR = 0.75, P = 0.002) and perceived social support (AOR = 0.91, P < 0.001) demonstrate negative correlations with depressive symptoms.

Anxiety symptoms, as depicted in Fig. 2, exhibit positive associations with pre-existing comorbidity (AOR = 1.85, P = 0.002), infection status (AOR = 2.68, P = 0.001), healing status (AOR = 1.24, P = 0.019), and staying up late (general AOR = 1.93, P < 0.001; frequent or always AOR = 2.95, P < 0.001). Conversely, perceived social support (AOR = 0.89, P < 0.001) displays a negative correlation with anxiety symptoms.

Furthermore, Fig. 2 indicates positive correlations of PTSD symptoms with pre-existing comorbidity (AOR = 1.60, P = 0.013), infection status (AOR = 2.89, P < 0.001), and staying up late (general AOR = 1.64, P < 0.001; frequent or always AOR = 2.24, P < 0.001). Conversely, exercise (AOR = 1.27, P = 0.010) and perceived social support (AOR = 0.95, P < 0.001) demonstrate negative associations with PTSD symptoms in students.

During the multivariate variable analysis, age was employed as the primary factor for matching to mitigate the confounding effect of age. Fig. 3.
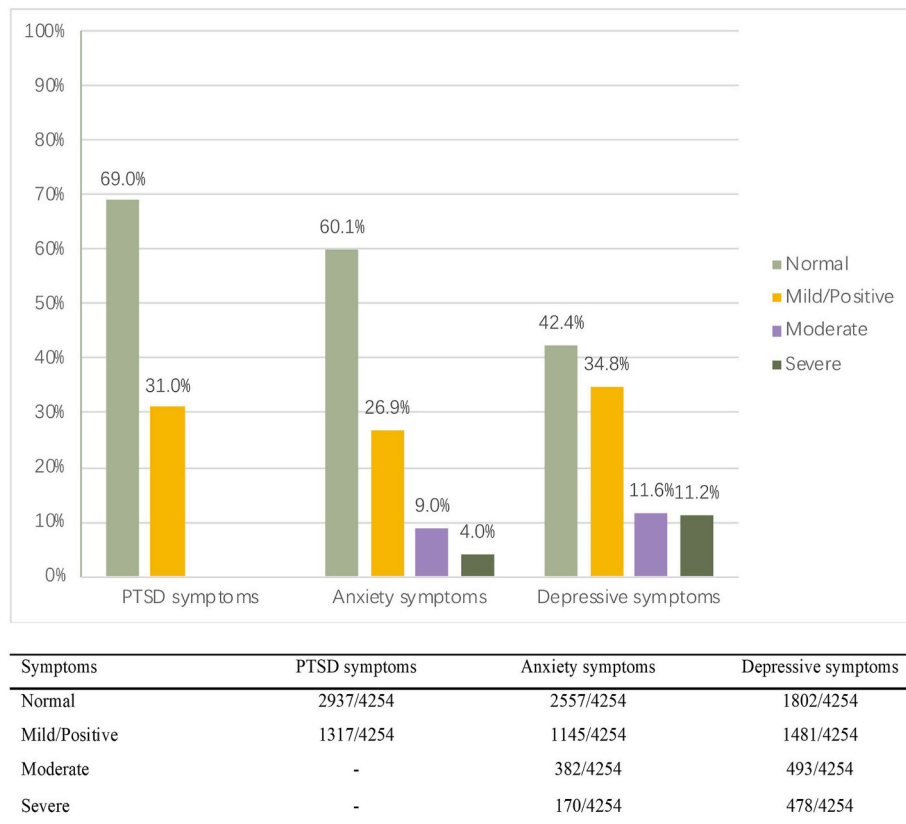
Symptoms	PTSD symptoms	Anxiety symptoms	Depressive symptoms
Normal	2937/4254	2557/4254	1802/4254
Mild/Positive	1317/4254	1145/4254	1481/4254
Moderate	-	382/4254	493/4254
Severe	-	170/4254	478/4254

**Fig. 1.** Psychological status of students (N = 4254).

4. Discussion

A nationwide investigation examined depressive symptoms, anxiety symptoms, and PTSD symptoms among Chinese college students during the Omicron pandemic surge at the beginning of 2023. The prevalence of depressive symptoms (57.6 %), anxiety symptoms (39.9 %), and PTSD symptoms (31.0 %) exceeded previous rates among college and high school students reported in various studies conducted between 2020 and 2021 [17–20]. These findings underscore the substantial psychological challenges faced by Chinese college students during this period, especially due to certain habitual characteristics under mental pressure, which often leads to staying up late, drinking, or lack of exercise. Besides, students with chronic conditions are less likely to seek regular medical care, making them more vulnerable and at greater risk. Additionally, due to the stigma surrounding mental illness, they may be less inclined to seek psychological counseling voluntarily.

This study revealed a significant association between staying up late and depressive symptoms, anxiety symptoms, and PTSD symptoms among Chinese students, with 84.5 % reporting irregular sleep habits. Disruptions to circadian rhythms and dysregulation of neurotransmitters like serotonin and dopamine contribute to mood disorders. Therefore, chronic sleep deprivation amplifies stress, impairs cognitive function, and exacerbates symptoms linked to psychological issues [21]. The consequences include decreased academic performance, impaired cognitive function, reduced quality of life, and an increased risk of severe psychological disorders over time. In reality, students encounter numerous challenges that contribute to staying up late, including academic pressure, social engagements, and smartphone temptations. Research by Owens et al. found that academic pressure is a significant factor contributing to insufficient sleep among adolescents and young adults [22]. Lund et al. observed that social engagements can lead to disturbed sleep patterns in college students [21]. For example, students may stay up late attending social events or engaging in social activities,

impacting their ability to maintain a regular sleep schedule. Exelmans and Van den Bulck explored the impact of bedtime mobile phone use on sleep in adults, highlighting the role of smartphone temptations in sleep disturbances [23]. For instance, students often use smartphones before bed, leading to delayed sleep onset and reduced overall sleep duration. To address these issues, schools can implement educational programs to raise awareness about healthy sleep habits and provide stress management resources such as counseling services. As for dormitory management, the school can create conducive sleep environments and organize activities to promote social interaction. At home, family support plays a crucial role, with parents communicating with students, understanding their academic pressures, and helping establish healthy sleep habits. Collaborative efforts among schools, dormitories, and families are essential in fostering a culture of healthy sleep habits among students.

Pre-existing comorbidities, such as chronic health conditions [24], also correlate positively with depressive symptoms, anxiety symptoms, and PTSD symptoms. Managing a chronic illness while balancing academic responsibilities can lead to heightened stress, anxiety, and feelings of isolation among students. The constant need for medication, dietary restrictions, and regular medical appointments can disrupt daily routines and create additional pressure, affecting students' ability to focus, engage socially, and maintain a positive outlook. Educational institutions need to recognize and address the psychological challenges faced by students with chronic illnesses by providing comprehensive support services, including counseling, peer support groups, and accommodations for academic needs [25]. By fostering a supportive and inclusive environment, schools can empower students to navigate their health challenges effectively while achieving academic success and maintaining their mental well-being.

Also, the well-established positive correlation between alcohol consumption and depressive symptoms suggests complex implications. The phenomenon of students drinking alcohol is a multifaceted issue that often stems from their coping mechanisms for stress. Many students turn
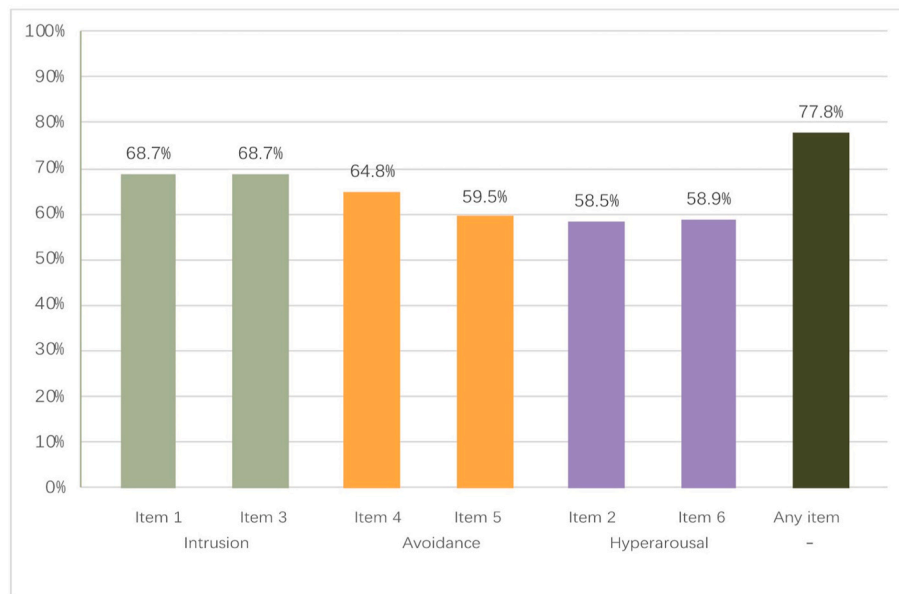
Domain	Item	Percentage
Intrusion	Item 1	2921/4254
	Item 3	2923/4254
Avoidance	Item 4	2755/4254
	Item 5	2553/4254
Hyperarousal	Item 2	2490/4254
	Item 6	2504/4254
Any Item		3311/4254

Fig. 2. Percentage of students with each IES-6 symptom (N = 4254) IES: Impact of event scale; Intrusion refers to the involuntary and distressing re-experiencing of traumatic events; Avoidance involves efforts to avoid reminders of the traumatic event or situations that may trigger distressing memories or emotions associated with the trauma; Hyperarousal refers to a heightened state of physiological and psychological arousal that persists beyond the traumatic event.

to alcohol as a means to alleviate the pressures of academic workload, social expectations, and personal challenges [26]. However, the consumption of alcohol presents a duality characterized by both perceived benefits and detrimental effects. On the one hand, some research suggests that alcohol can serve as a temporary stress reliever for students, providing a sense of relaxation and escape from their daily stressors [27]. This indicates that moderate alcohol consumption can lead to feelings of euphoria and decreased inhibitions, offering students a brief respite from their overwhelming responsibilities. On the other hand, the negative consequences of alcohol consumption among students often outweigh any perceived benefits. Excessive drinking can lead to impaired judgment, cognitive deficits, and increased risk-taking behaviors, jeopardizing academic performance, personal relationships, and overall well-being [28]. Moreover, alcohol abuse has been linked to long-term health issues, including liver damage, addiction, and mental health disorders. In short, while it is true that alcohol may provide temporary relief from stress, the potential harms associated with its consumption far outweigh any short-term benefits. Therefore, efforts to address student drinking should focus on promoting healthier coping mechanisms for stress, such as seeking social support, practicing mindfulness techniques, and engaging in physical activity. Additionally, comprehensive alcohol education programs and accessible support services should be implemented to raise awareness about the risks of

excessive drinking and provide resources for those in need of assistance. By prioritizing prevention and intervention strategies, universities can create a safer and healthier environment for their students to thrive academically and personally [29,30].

During the Omicron pandemic, infection was positively linked to depressive symptoms, anxiety symptoms, and PTSD symptoms, consistent with prior research on infectious diseases' psychological impact [31]. Individuals testing positive faced heightened fear and distress, which were intensified by concerns about virus transmission and exacerbated by media coverage and public discourse that can cause intrusive thoughts [32], while those who experienced severe symptoms during the acute infection can encounter even greater distress and worries about potential complications. Besides, stressors or events may trigger psychological symptoms, and fear of relapse can contribute to anxiety symptoms [33]. To address these impacts, providing timely psychological support, including teletherapy and online groups, is crucial. What is more, plentiful psychoeducational resources can empower individuals to recognize and manage emotional needs during recovery.

Perceived social support is associated with reduced depressive symptoms, anxiety symptoms, and PTSD symptoms among Chinese college students. This support, encompassing both material and emotional assistance, helps students cope with challenges and reduces the risk of psychological issues. Emotional support, characterized by

Table 2
Univariate analysis of associated factors of depressive symptoms, anxiety symptoms, and PTSD symptoms.

Variable	Depressive symptoms (PHQ-9)		χ^2/Z	P	Anxiety symptoms (GAD-7)		χ^2/Z	P	PTSD symptoms (IES-6)		χ^2/Z	P
	No	Yes			No	Yes			No	Yes		
Gender			0.054	0.817			7.318	**0.007**			0.434	0.510
Male	461 (42.1)	635 (57.9)			621 (56.7)	475 (43.3)			748 (68.2)	348 (31.8)		
Female	1341 (42.5)	1817 (57.5)			1936 (61.3)	1222 (38.7)			2189 (69.3)	969 (30.7)		
Education			6.089	**0.048**			1.004	0.605			10.805	**0.005**
Associate or below	102 (47.4)	113 (52.6)			127 (59.1)	88 (40.9)			152 (70.7)	63 (29.3)		
Bachelor	1584 (42.5)	2141 (57.5)			2249 (66.4)	1476 (39.6)			2594 (69.6)	1131 (30.4)		
Master or above	116 (36.9)	198 (63.1)			181 (57.6)	133 (42.4)			191 (60.8)	123 (39.2)		
Smoking Status			6.007	**0.014**			10.800	**0.001**			3.583	0.058
No	1734 (42.8)	2320 (57.2)			2459 (60.7)	1595 (39.3)			2811 (69.3)	1243 (30.7)		
Yes	68 (34.0)	132 (66.0)			98 (49.0)	102 (51.0)			126 (63.0)	74 (37.0)		
Drinking Status			28.381	**<0.001**			11.925	**0.001**			3.708	0.054
No	1561 (44.2)	1972 (55.8)			2165 (61.3)	1368 (38.7)			2461 (69.7)	1072 (30.3)		
Yes	241 (33.4)	480 (66.6)			392 (54.4)	329 (45.6)			476 (66.0)	245 (34.0)		
Pre-existing comorbidity			18.301	**<0.001**			19.217	**<0.001**			8.600	**0.003**
No	1772 (42.9)	2356 (57.1)			2505 (41.3)	1623 (58.7)			2865 (69.4)	1263 (30.6)		
Yes	30 (23.8)	96 (76.2)			52 (60.7)	74 (39.3)			72 (57.1)	54 (42.9)		
Status of Omicron infection			27.902	**<0.001**			20.426	**<0.001**			23.107	**<0.001**
Not yet	350 (49.7)	354 (50.3)			457 (64.9)	247 (35.1)			491 (69.7)	213 (30.3)		
During the infection	15 (23.8)	48 (76.2)			24 (38.1)	39 (61.9)			26 (41.3)	37 (58.7)		
Already healed	1182 (40.7)	1719 (59.3)			1720 (59.3)	1181 (40.7)			2013 (69.4)	888 (30.6)		
Not testing	255 (43.5)	331 (56.5)			356 (60.8)	230 (39.2)			407 (69.5)	179 (30.5)		
Living alone			4.706	**0.030**			2.731	0.098			2.505	0.114
No	1765 (42.6)	2375 (57.4)			2497 (60.3)	1643 (39.7)			2866 (62.3)	1274 (37.7)		
Yes	37 (32.5)	77 (67.5)			60 (52.6)	54 (47.4)			71 (69.2)	43 (30.8)		
Exercising status			37.224	**<0.001**			7.117	**0.028**			1.088	0.580
Rarely or less often	375 (36.1)	665 (63.9)			621 (59.7)	419 (40.3)			727 (69.9)	313 (30.1)		
Generally	734 (41.4)	1040 (58.6)			1032 (58.2)	742 (41.8)			1230 (69.3)	544 (30.7)		
Frequently or always	693 (48.1)	747 (51.9)			904 (62.8)	536 (37.2)			980 (68.1)	460 (31.9)		
Staying up late			210.601	**<0.001**			126.755	**<0.001**			66.862	**<0.001**
Rarely or less often	420 (63.7)	239 (36.3)			514 (78.0)	145 (22.0)			532 (80.7)	127 (19.3)		
Generally	640 (46.9)	724 (53.1)			843 (61.8)	521 (38.2)			968 (71.0)	396 (29.0)		
Frequently or always	742 (33.3)	1489 (66.7)			1200 (53.8)	1031 (46.2)			1437 (64.4)	794 (35.6)		
Perceived social support	17 (14, 20)	15 (11, 18)	14.293	**<0.001**	17 (14, 20)	14 (10, 7)	−16.949	**<0.001**	16 (12, 20)	15 (11, 18)	−8.333	**<0.001**
Emotional Support	8 (7, 10)	8 (5, 9)	13.928	**<0.001**	8 (6,10)	7 (5, 9)	−15.872	**<0.001**	8 (6, 10)	8 (5, 9)	−7.592	**<0.001**
Material Support	9 (7, 10)	8 (6, 10)	12.420	**<0.001**	9 (7, 10)	7 (5, 9)	−15.846	**<0.001**	8 (6, 10)	8 (6, 10)	−8.064	**<0.001**
Age, years	19 (18, 21)	20 (19, 21)	3.697	**<0.001**	19 (18, 21)	20 (19, 21)	3.893	**<0.001**	19 (18, 21)	20 (19, 21)	3.975	**<0.001**

compassionate listening and heartfelt encouragement from loved ones, is pivotal in bolstering students' resilience. It fosters a sense of understanding and reduces feelings of isolation during periods of stress. Conversely, material support, encompassing financial assistance and resource accessibility, mitigates external stressors that might intensify mental health challenges. Establishing robust social support networks is crucial for addressing psychological challenges among Chinese students [34]. Community-based programs and school interventions should be implemented, advocating for family and peer support. These initiatives can be particularly effective in promoting emotional support by creating environments where students feel safe to share their experiences and seek help. Furthermore, social media platforms can facilitate peer networks and provide access to psychological resources, fostering resilience and overall well-being among students [35,36]. Educators and healthcare providers can receive training to identify and address student psychological issues [37], for stigma about psychological problems, notably in societies like China, may deter students from seeking help [38]. By enhancing both emotional and material support, we can
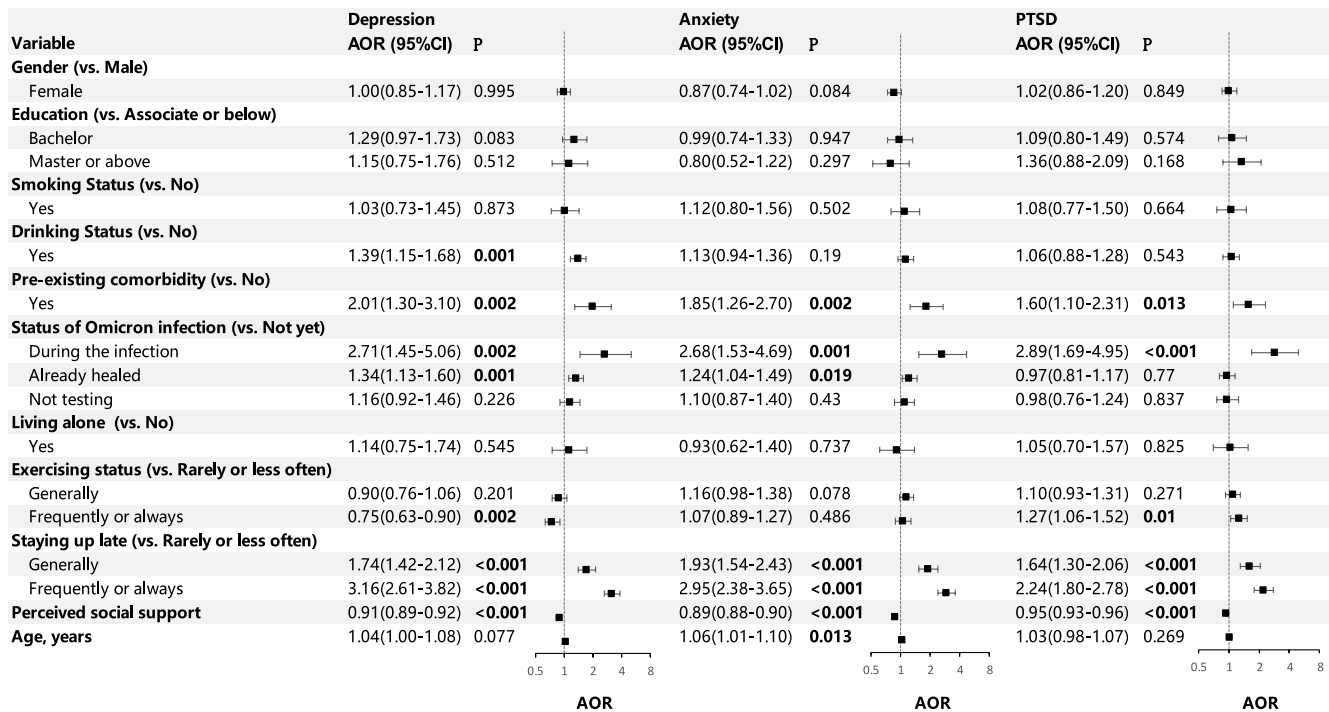
Variable	Depression AOR (95%CI)	P		Anxiety AOR (95%CI)	P		PTSD AOR (95%CI)	P	
Gender (vs. Male)									
Female	1.00(0.85–1.17)	0.995		0.87(0.74–1.02)	0.084		1.02(0.86–1.20)	0.849	
Education (vs. Associate or below)									
Bachelor	1.29(0.97–1.73)	0.083		0.99(0.74–1.33)	0.947		1.09(0.80–1.49)	0.574	
Master or above	1.15(0.75–1.76)	0.512		0.80(0.52–1.22)	0.297		1.36(0.88–2.09)	0.168	
Smoking Status (vs. No)									
Yes	1.03(0.73–1.45)	0.873		1.12(0.80–1.56)	0.502		1.08(0.77–1.50)	0.664	
Drinking Status (vs. No)									
Yes	1.39(1.15–1.68)	**0.001**		1.13(0.94–1.36)	0.19		1.06(0.88–1.28)	0.543	
Pre-existing comorbidity (vs. No)									
Yes	2.01(1.30–3.10)	**0.002**		1.85(1.26–2.70)	**0.002**		1.60(1.10–2.31)	**0.013**	
Status of Omicron infection (vs. Not yet)									
During the infection	2.71(1.45–5.06)	**0.002**		2.68(1.53–4.69)	**0.001**		2.89(1.69–4.95)	**<0.001**	
Already healed	1.34(1.13–1.60)	**0.001**		1.24(1.04–1.49)	**0.019**		0.97(0.81–1.17)	0.77	
Not testing	1.16(0.92–1.46)	0.226		1.10(0.87–1.40)	0.43		0.98(0.76–1.24)	0.837	
Living alone (vs. No)									
Yes	1.14(0.75–1.74)	0.545		0.93(0.62–1.40)	0.737		1.05(0.70–1.57)	0.825	
Exercising status (vs. Rarely or less often)									
Generally	0.90(0.76–1.06)	0.201		1.16(0.98–1.38)	0.078		1.10(0.93–1.31)	0.271	
Frequently or always	0.75(0.63–0.90)	**0.002**		1.07(0.89–1.27)	0.486		1.27(1.06–1.52)	**0.01**	
Staying up late (vs. Rarely or less often)									
Generally	1.74(1.42–2.12)	**<0.001**		1.93(1.54–2.43)	**<0.001**		1.64(1.30–2.06)	**<0.001**	
Frequently or always	3.16(2.61–3.82)	**<0.001**		2.95(2.38–3.65)	**<0.001**		2.24(1.80–2.78)	**<0.001**	
Perceived social support	0.91(0.89–0.92)	**<0.001**		0.89(0.88–0.90)	**<0.001**		0.95(0.93–0.96)	**<0.001**	
Age, years	1.04(1.00–1.08)	0.077		1.06(1.01–1.10)	**0.013**		1.03(0.98–1.07)	0.269	

Fig. 3. Forest plots on the correlation between potentially associated factors and symptoms like depressive symptoms, anxiety symptoms, and PTSD symptoms.

significantly improve the mental health outcomes for students, thereby reducing the incidence of depressive symptoms, anxiety, and PTSD.

Apart from this support, frequent exercise has also been linked to lower rates of depressive symptoms and PTSD symptoms [39]. Regular physical activity is believed to positively impact mental well-being through various mechanisms, including the release of endorphins, which are natural mood lifters, and the reduction of stress hormones such as cortisol [40]. Engaging in exercise also promotes better sleep quality, enhances self-esteem, and provides a sense of accomplishment [41], all of which are crucial factors in combating depressive symptoms and PTSD symptoms. However, in many academic environments, the emphasis on academic achievement often overshadows the promotion of sports and physical activity. Evidence from extensive population studies in China unveils concerning trends: only 22 % of school students engage in daily physical activity lasting 60 min or more, with a declining trend. Moreover, a striking 85.8 % spend over 2 h per day in sedentary behaviors, resulting in diminished physical fitness. Merely 3 in 10 students meet national physical fitness standards, while adherence to recommended physical activity guidelines ranges from 15 % to 34 % [6]. However, research conducted in Western countries indicates that about 80 % of adolescents are estimated to spend at least 30 min·d−1 being active, while Chinese students generally devote less time to sports and physical activity than their counterparts [42]. Several factors contribute to this difference. Firstly, there is often greater value placed on academic success than on physical fitness in China [43] where exercising can only be promoted if it is proven to be beneficial for studying [44]. This heavy emphasis on academic achievement and the competitive nature of China's education system results in students spending more time studying and less time engaging in extracurricular activities like sports. According to the PISA 2018 results, students in Shanghai, China, reported some of the highest homework hours among participating countries. In particular, it was noted that students in Shanghai spent an average of 13.8 h per week on homework, which is significantly higher than the average in many other countries [45]. On the other hand, in countries like the United States, sports are an integral part of the culture, with widespread participation in organized sports leagues and recreational activities [46]. Furthermore, the availability and accessibility of

sports facilities differ between China and Western countries. While urban areas in China have seen significant development in recent years, there is still a shortage of sports facilities, especially in schools. In contrast, many schools in Western countries have well-equipped gymnasiums, sports fields, and recreational areas, making it easier for students to participate in sports [47]. Addressing this disparity requires a multifaceted approach involving government policies, educational reforms, and community engagement initiatives. By promoting a culture of physical activity, improving access to sports facilities, and integrating sports into the curriculum, China can encourage more students to lead active and healthy lifestyles. Following the COVID-19 pandemic, Chinese higher education institutions have strengthened their commitment to student mental health by offering various counseling services. The Ministry of Education, in collaboration with sixteen other departments, has introduced the "Strategic Plan for the Enhancement of Student Mental Health in the New Era (2023–2025)", aimed at improving the quality of mental health education. Additionally, the Ministry has emphasized the importance of establishing mental health curricula and fostering a positive psychological state among students.

5. Limitation

Several constraints within the scope of this study warrant delicate consideration. Firstly, the cross-sectional design inherently lacks a temporal dimension, thereby limiting its capacity for establishing causal relationships. Secondly, on a technical note, the backend of the Star platform questionnaire was unable to track the number of individuals who selected "no" in the informed consent section. Consequently, the count of refusals from eligible participants couldn't be accurately recorded. An additional limitation of this study lies in the a wide range of the participants' ages, which could have significant implications for the findings for the potential of age as a moderating variable warrants further investigation. Future research is encouraged to explore this dimension to enhance the understanding of the research topic. Furthermore, the study opted for an online survey due to the diminishing impact of the pandemic, aiming to swiftly capture the mental health status of a wide population. However, the utilization of

convenience and snowball sampling methods introduces biases inherent in non-probabilistic sampling, thereby constraining the generalizability of the findings to a broader student demographic. Additionally, selection bias could be present, as individuals experiencing heightened stress due to the Omicron outbreak might be more inclined to respond to the questionnaire, potentially inflating the prevalence of PTSD symptoms observed in the study. Besides, there are more females than males which might lead to selection bias due to gender differences. Fortunately, our sample encompassed students from all seven geographic regions in China, which could enhance the representation of PTSD symptom prevalence and associated factors within the population. Moreover, a limitation of this study is the inability to ascertain the response rate of students who received the survey link, as the research design was primarily focused on measuring the effective rate. This lack of data on response rates may limit the generalizability of the findings to the broader student population.

6. Conclusion

The heightened prevalence of depressive, anxiety, and PTSD symptoms during the Omicron pandemic underscores the urgent need for tailored psychological interventions for students in China. Their distinctive lifestyle habits and academic environments make them particularly susceptible to psychological distress during this challenging period. Strengthening their social support networks and promoting healthier lifestyle habits are imperative strategies to mitigate these issues and foster resilience among students.

CRediT authorship contribution statement

You Xin: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Tianrui Ren:** Resources, Project administration, Methodology, Investigation, Data curation. **Xu Chen:** Methodology, Investigation, Funding acquisition, Formal analysis. **Xin Liu:** Funding acquisition, Formal analysis, Data curation, Conceptualization. **Yijin Wu:** Funding acquisition, Formal analysis, Data curation, Conceptualization. **Shu Jing:** Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ling Zhang:** Funding acquisition, Formal analysis, Data curation, Conceptualization. **Zhenwei Dai:** Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ye Wang:** Visualization, Validation, Supervision, Resources, Project administration, Methodology, Conceptualization. **Xiaoyou Su:** Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Glossary

Intrusion	The involuntary and distressing re-experiencing of traumatic events.
Avoidance	Efforts to avoid reminders of the traumatic event or situations that may trigger distressing memories or emotions associated with the trauma.
Hyperarousal	A heightened state of physiological and psychological arousal that persists beyond the traumatic event.

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