Original article

A study of the mental health status of Chinese medical students at risk of COVID-19 infection

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Abstract: *Background* — The COVID-19 pandemic and subsequent changes in health policies may have impacted the mental health of medical students in China.
Objective — This study aimed to assess the mental health status of Chinese medical students after adjustments to the country's pandemic response measures.
Methods — We conducted a cross-sectional online survey of 872 medical students using several standardized instruments: 7-item Generalized Anxiety Disorder (GAD-7), 9-item Patient Health Questionnaire (PHQ-9), 10-item Connor-Davidson Resilience Scale (CD-RISC-10), the Impact of Events Scale-Revised (IES-R), and the Simplified Coping Styles Questionnaire (SCSQ).
Results — The survey revealed that 25.0% of participants had anxiety symptoms, 35.7% had symptoms of depression, and 22.13% had post-traumatic stress disorder (PTSD). Significant influencing factors included education level, history of close contact with COVID-19 patients, personal history of infection, and physical health status ($p<0.05$). Multivariate logistic regression revealed that individuals with a history of COVID-19 were more likely to report mild anxiety; higher education was associated with moderate to severe anxiety, as well as mild, moderate, and severe depression; individuals with chronic medical conditions were more likely to report anxiety, depression, and PTSD (all statistically significant associations $p<0.05$).
Conclusion — Following policy adjustments in the context of the pandemic, medical students experienced significant mental health problems, such as anxiety, depression, and PTSD. Support efforts should involve upper-year students and students with chronic diseases, and should focus on strengthening resilience and positive coping skills.

Keywords: medical students, mental health, anxiety, depression, COVID-19.

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Introduction

Since the outbreak of the novel coronavirus disease (COVID-19) late in 2019, global socioeconomic stability and mental health of the public have faced unprecedented challenges. According to the World Health Organization (WHO), the number of new cases of major depressive disorder and anxiety disorders worldwide in 2020 reached 53 million and 76 million, respectively, representing a 25% increase compared with pre-pandemic levels [1]. As the virus evolved and herd immunity changed, many countries and regions gradually adjusted their pandemic control strategies. On December 7, 2022, the Chinese government announced 10 new measures to optimize its prevention and control policies. Following these adjustments, infection rates increased sharply in the short term [2] significantly impacting the mental health of the population. Research shows that during this period, the prevalence of anxiety and depressive symptoms among the Chinese population reached 30.1% and 55.7%, respectively [3].

Medical students, as future healthcare professionals, represent a critical population whose mental health requires close attention during the pandemic. Research shows that medical students often face heavy academic workloads, intense competition, and career-related anxiety, making them particularly vulnerable to mental health problems [4]. A study by Saraswati et al. in India [5] found that during the pandemic, medical students experienced elevated levels of anxiety and stress due to disruptions in education process and increased risk of infection. Chinese medical students experienced similar problems [6]. The increased risk of infection may have exacerbated preexisting mental health problems.

However, research on medical student mental health after the lifting of pandemic restrictions remains limited. Some scholars suggest that easing restrictions may help reduce negative emotions caused by prolonged isolation [3]. Yet medical students, due to the demands of their studies and future work environments, are at higher risk of infection and exposure to viruses. As a result, their mental health may evolve differently than that of the general population. Therefore, this study aims to assess the mental health of Chinese medical students during the early stages of policy relaxation, which will serve as a basis for further research.

Material and Methods

Study Design

This cross-sectional study was conducted on a random sample of medical students at Huzhou university, Huzhou, Zhejiang Province, China. Data collection was performed from December 2022 through January 2023, in accordance with China's pandemic policy adjustments. The study protocol was approved by the Ethics Committee of Huzhou University (approval number 202302-02), and all study participants were volunteers.

Sampling procedure and participant selection

This study used simple random sampling in accordance with epidemiological survey protocol. Participants were selected from 1,676 students majoring in Nursing, Oral Medicine, and Clinical Medicine at the College of Medicine during the 2022–2023 academic year. Inclusion criteria were current enrollment and voluntary participation with electronic informed consent. A diagnosed mental disorder was an exclusion criterion. Based on the college's electronic medical records, 15 students who met the exclusion criterion were excluded, leaving 1,661 eligible participants.

The administration provided an anonymized list containing only serial numbers, gender, and education level information. Using the RAND() function in Microsoft Excel 2019, the research team randomly selected 1,112 serial numbers (67.0% of the sample) and returned them to the administration, which then distributed survey invitations through the university's official communication platform, WeChat. The research team did not have access to any of the students' personal data or contact information.

An anonymous online survey was administered using Wenjuanxing (https://www.wjx.cn), and participants were required to complete all items before submitting. To increase response rates, the administration sent two reminder messages, one week apart, to non-respondents. A total of 896 students completed the survey (a response rate of 80.6%). After quality control for completion time and the availability of response templates, 872 valid questionnaires (97.3% validity rate) were retained. Although two reminder emails were sent to increase participation, no additional follow-up was conducted to avoid coercion. The total number of non-responders (n=216) was recorded but individual demographic data were anonymized. To assess representativeness, aggregated data (gender and education level) were compared between invited and responding students (see Supplementary *Table* S1). The results showed no significant differences, thereby indicating minimum non-response bias.

Questionnaire

The questionnaire consisted of two main sections.

Based on established methodologies from similar studies [7,8], the first section collected sociodemographic data relevant to mental health during and after the pandemic. These included gender, age, education level, place of residence, occupation, self-assessed physical health, daily time spent on pandemic-related news, history of close contact with COVID-19 patients, and personal or family history of COVID-19 infection.

The second section assessed mental health outcomes using validated instruments measuring resilience, anxiety, depression, post-traumatic stress disorder (PTSD), and coping strategies. The following scales were used:

(1) Resilience was assessed using the 10-item version of the Connor-Davidson Resilience Scale (CD-RISC-10) [9]. This instrument includes 10 items; each item is scored on a five-point scale ranging from 0 (not at all) to 4 (almost always).

(2) Anxiety symptoms were assessed using the General Anxiety Disorder-7 (GAD-7) [10], with scores ranging from 0 to 21, where higher scores indicate greater severity.

(3) Depression symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9) [11] with scores ranging from 0 to 27.

(4) PTSD was assessed using the Impact of Event Scale-Revised (IES-R) [12], a widely used 22-item self-report instrument assessing three clusters: intrusion (obsessive thoughts), hyperarousal, and avoidance. Items are rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely).

(5) Coping skills were assessed using the 20-item Simplified Coping Style Questionnaire (SCSQ) [13]. The SCSQ includes two subscales: positive coping strategies (12 items) and negative coping strategies (8 items) rated on a 4-point Likert scale (0=not at all, 3=usually).

The results were interpreted as follows: (1) GAD-7: ≤4 (normal), 5-9 (mild), ≥10 (moderate to severe) anxiety [14]; (2) PHQ-9: ≤4 (normal), 5-9 (mild), ≥10 (moderate to severe) depression [15]; (3) IES-R: ≤23 (normal), 24-32 (mild), ≥33 (moderate to severe) PTSD [16].

The two-section structure of the questionnaire was strictly adhered to for all participants: demographic data were administered in a fixed order and validated scales were administered sequentially. No variations or conditional branching were implemented.

Table 1. Sociodemographic parameters of the study participants

Variables			
Continuous variables		*Mean±SD*	
Age, years		19.26±1.47	
Completion time, min		4.99±3.66	
Categorical variables		*N*	*%*
Gender	Male	282	32.3
	Female	590	67.7
Place of residence	Urban	439	50.3
	Rural	433	49.7
Education level	Freshman	550	63.0
	Sophomore	185	21.2
	Upper-year	137	15.8
Major	Clinical Medicine	419	48.0
	Oral Medicine	132	15.1
	Nursing	321	36.8
Daily time dedicated to COVID-19, h	< =1	348	39.9
	1~3	382	43.8
	> =3	142	16.3
Health status	Healthy	833	95.5
	Unhealthy	39	4.5
History of close contact with COVID-19 patients	No	219	25.1
	Yes	653	74.9
Personal history of COVID-19 infection	No	335	38.4
	Yes	537	61.6
History of COVID-19 infection in the household	No	156	17.9
	Yes	716	82.1

Table 2. Results of the multivariate logistic regression model for anxiety levels

		β	*S.D.*	*z*	*Wald* χ^2	*p*	*OR*	*95% CI*
Mild	Education level	0.196	0.106	1.841	3.388	*0.066*	1.216	0.987~1.498
	Personal history of COVID-19 infection	0.426	0.175	2.434	5.924	*0.015*	1.532	1.087~2.160
	Health status	0.774	0.358	2.161	4.672	*0.031*	2.168	1.075~4.374
	Intercept	-1.821	0.217	-8.404	70.626	*0.000*	0.162	0.106~0.248
Above moderate	Education level	0.530	0.260	2.039	4.156	*0.041*	1.700	1.021~2.831
	Personal history of COVID-19 infection	0.326	0.469	0.695	0.483	*0.487*	1.385	0.552~3.475
	Health Status	1.770	0.602	2.940	8.644	*0.003*	5.871	1.804~19.106
	Intercept	-4.639	0.610	-7.605	57.835	*0.000*	0.010	0.003~0.032

Reference category: normal level of symptoms.

Table 3. Results of the multivariate logistic regression model for depression levels

		β	*S.D.*	*z*	*Wald* χ^2	*p*	*OR*	*95% CI*
Mild	Education level	0.248	0.100	2.480	6.152	*0.013*	1.282	1.053~1.559
	History of close contact with COVID-19 patients	0.182	0.209	0.870	0.756	*0.385*	1.200	0.796~1.808
	Personal history of COVID-19 infection	0.363	0.183	1.989	3.956	*0.047*	1.438	1.005~2.058
	Health status	1.004	0.381	2.639	6.962	*0.008*	2.730	1.295~5.756
	Intercept	-1.581	0.224	-7.073	50.028	*0.000*	0.206	0.133~0.319
Above moderate	Education level	0.363	0.177	2.052	4.209	*0.040*	1.438	1.016~2.035
	History of close contact with COVID-19 patients	0.131	0.404	0.323	0.105	*0.746*	1.140	0.516~2.515
	Personal history of COVID-19 infection	0.324	0.345	0.939	0.881	*0.348*	1.382	0.703~2.716
	Health status	1.977	0.466	4.239	17.969	*0.000*	7.223	2.895~18.021
	Intercept	-3.325	0.429	-7.747	60.018	*0.000*	0.036	0.016~0.083

Reference category: normal level of symptoms.

Table 4. results of the multivariate logistic regression model for PTSD levels

		β	*S.D.*	*z*	*Wald* χ^2	*p*	*OR*	*95% CI*
Mild	Health Status	0.910	0.430	2.116	4.479	*0.034*	2.484	1.070~5.769
	Residence	0.568	0.220	2.585	6.684	*0.010*	1.765	1.147~2.716
	Intercept	-2.836	0.369	-7.676	58.920	*0.000*	0.059	0.028~0.121
Above moderate	Health status	1.179	0.413	2.858	8.165	*0.004*	3.253	1.448~7.305
	Residence	-0.073	0.224	-0.326	0.107	*0.744*	0.930	0.599~1.442
	Intercept	-1.961	0.348	-5.641	31.822	*0.000*	0.141	0.071~0.278

Reference category: normal level of symptoms.

Statistical data processing

Categorical data were described using frequencies (%), and univariate analysis was conducted using the chi-squared test and Fisher's exact test. Based on the univariate analysis results, statistically significant variables were included in multivariate logistic regression models to identify sociodemographic and health-related factors associated with different levels of anxiety, depression, and PTSD symptoms (normal, mild, and above moderate). One-way analysis of variance (ANOVA) was employed to compare differences in resilience and positive/negative coping strategies among individuals with different levels of anxiety, depression, and PTSD symptoms. Tukey's post hoc test was performed for statistically significant results. Statistical data processing used R 4.4.1 software, while graphs were created using GraphPad Prism 9.0. A p-value of <0.05 was considered statistically significant.

Sociodemographic characteristics of the study participants

The study included 872 medical students with a mean age of 19.26 years (SD=1.47). Of these, 590 (67.7%) were women and 282 (32.3%) were men. The participants were enrolled in three academic majors: Clinical Medicine (419 students, 48.0%), Nursing (321 students, 36.8%), and Oral Medicine (132 students, 15.1%). Most participants were first-year medical students (63.0%) and reported good health (95.5%). Detailed characteristics are presented in *Table* 1.

Results

Anxiety levels among medical students

Univariate analysis revealed that freshmen (22.18% vs. 28.11%/32.11%), those without a history of COVID-19 (20.00% vs. 28.12%), and those in good health (24.01% vs. 46.15%) had lower rates of anxiety symptoms (shown in *Table* S2, *Figure* S1A). Multivariate logistic regression analysis (*Table* 2) showed that a history of infection (OR=1.532, 95% CI [1.087-2.160], p=0.015) and poor health status (OR=2.168, 95% CI [1.075-4.374], p=0.031) were statistically significantly associated with higher rates of mild anxiety symptoms. In contrast, higher education level was significantly linked with higher levels of above-moderate anxiety (OR=1.700, 95% CI [1.021-2.831], p=0.041), while poor health increased the risk of above-moderate anxiety as well (OR=5.871, 95% CI [1.804-19.106], p=0.003).

Depression levels among medical students

Univariate analysis revealed that medical students exhibited lower rates of depressive symptoms if they were freshmen (31.45% vs. 41.62%/44.53%), had no close contacts with COVID-19 patients (28.31% vs. 38.13%), had no history of COVID-19 infection (29.25% vs. 39.66%), and exhibited good physical health (34.21%

vs. 66.66%) (*Table* S3 and *Figure* S1B). The multivariate model (*Table* 3) showed that higher education level was significantly associated with mild depression (OR=1.282, 95% CI [1.053-1.559], p=0.013) and above-moderate depression (OR=1.438, 95% CI [1.016–2.035], p=0.040). History of infection was associated with mild depression (OR=1.438, 95% CI [1.005-2.058], p=0.047). Poor health was independently associated with both mild depression (OR=2.730, 95% CI [1.295-5.756], p=0.008) and above-moderate depression (OR=7.223, 95% CI [2.895-18.021], p<0.001). In contrast, close contacts were not statistically significantly associated with either mild or above-moderate depressive symptoms (all p>0.05).

PTSD prevalence among medical students

Medical students residing in urban areas (19.8% vs. 24.5%), as well as students with good physical health (21.1% vs. 43.6%), demonstrated a lower prevalence of PTSD symptoms (*Table* S4 and *Figure* S1C). Multivariate logistic regression analysis (*Table* 4) revealed that poor health was significantly associated with higher levels of PTSD symptoms. Specifically, it was linked with mild PTSD (OR=2.484, 95% CI [1.070-5.769], p=0.034) and moderate PTSD (OR=3.253, 95% CI [1.448-7.305], p=0.004).

Differences in resilience and positive coping strategies across groups with varying levels of anxiety, depression, and PTSD symptom severity

levels of anxiety, depression, and PTSD symptoms (ANOVA results are presented in *Tables* S5-S7; Tukey's post hoc test results are presented in *Tables* S8-S10). The analysis revealed that individuals with normal mental health had significantly higher resilience scores than those in the mild and above-moderate symptom groups across all three mental health indicators (p<0.001). Additionally, the mild symptom group showed significantly higher resilience than the above-moderate symptom group<0.001). Regarding positive coping strategies scores, the normal mental health individuals had significantly higher scores than the above-moderate symptom group (p<0.001). However, no statistically significant differences were observed between the normal group and the group with mild symptoms on measures of anxiety and PTSD.

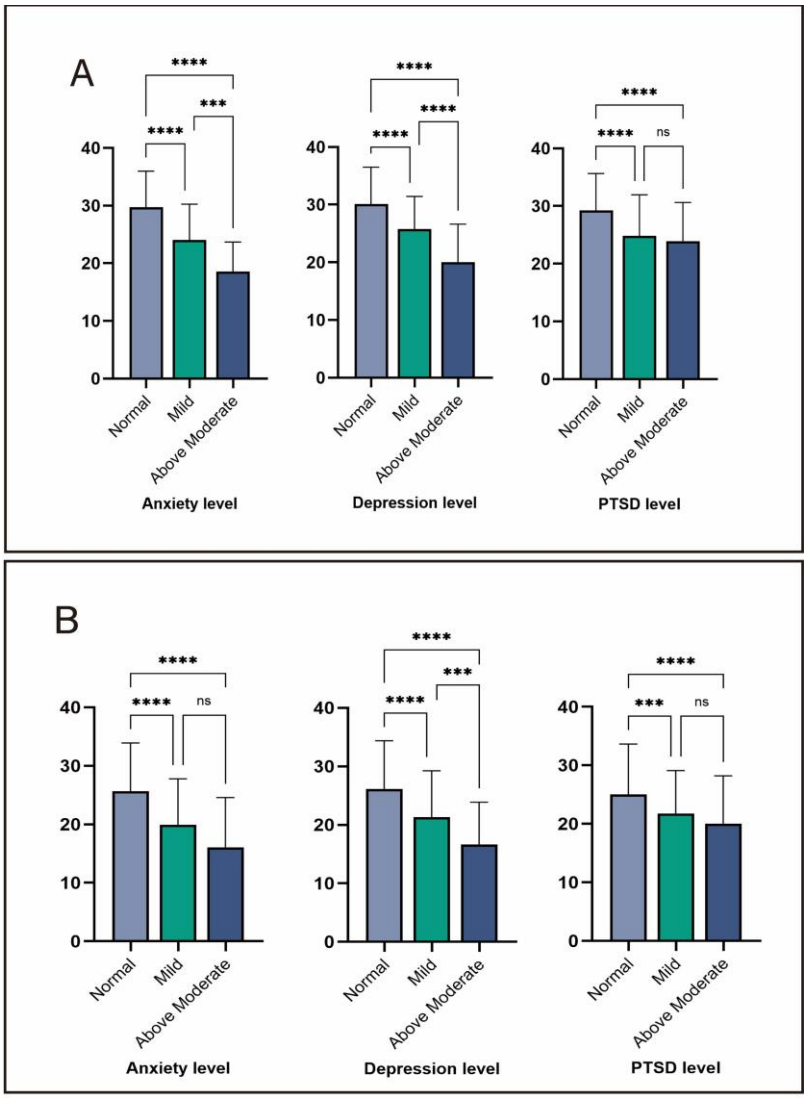

Figure 1. Distribution of CD-RISC-10 and SCSQ (positive coping strategies) scores according to the level of anxiety, depression, and PTSD. (A) Distribution of CD-RISC-10; (B) Distribution of SCSQ (positive coping strategies).

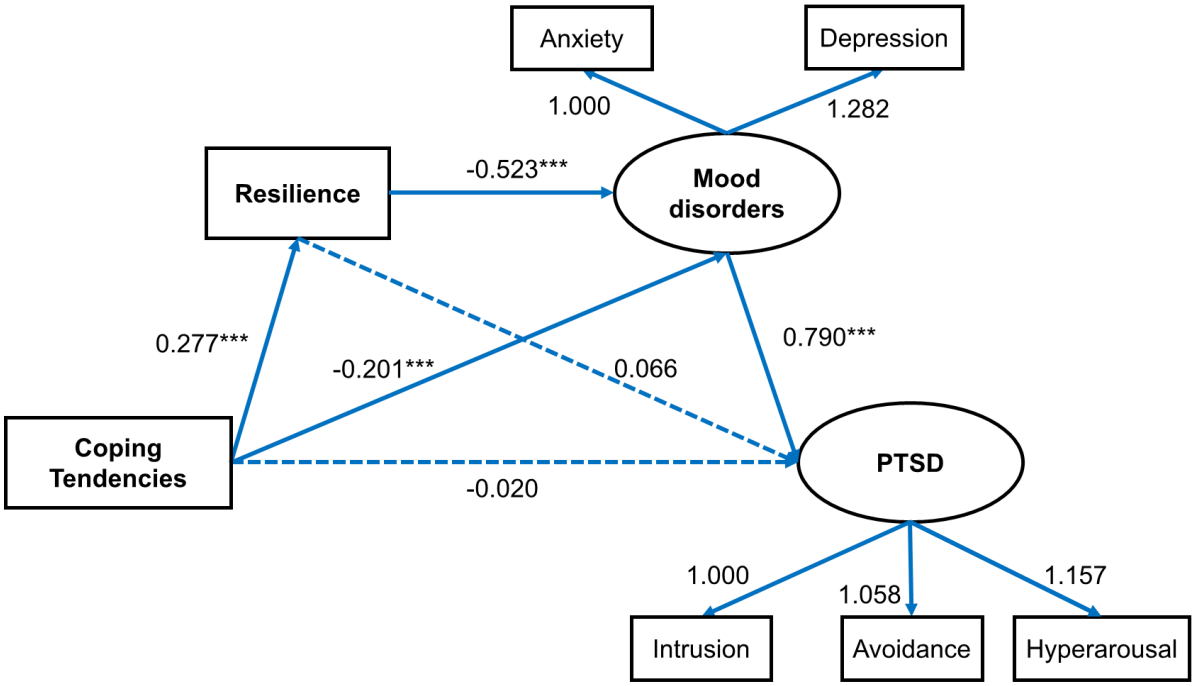

Figure 2. Sequential effects of coping strategies, stress resilience, mood disorders, and posttraumatic stress disorder. ***P<0.001.

Figure 1 illustrates the differences in resilience (*Figure* 1A) and positive coping strategies (*Figure* 1B) across groups with varying

Examining the relationships between mental health factors

To test the hypothesized relationships between mental health constructs, we used structural equation modeling (SEM) (see *Supplementary methods* section for hypothesis development). The model structure with standardized path coefficients is presented in *Figure* 2. The model fit the data satisfactorily, as evidenced by the following indices: CFI=0.955, TLI=0.946, SRMR=0.033, RMSEA=0.073. The results confirmed all hypothesized paths: positive coping was a significant positive predictor of resilience (β=0.277, p<0.001) and a significant negative predictor of mood disorders (β=-0.201, p<0.001). Resilience, in turn, was inversely associated with mood disorders (β=-0.523, p<0.001), which were strongly and directly associated with PTSD symptom severity (β=0.790, p<0.001). Descriptive statistics and bivariate correlations for all variables are presented in *Table* S11.

Discussion

The impact of pandemic-related policy changes on anxiety, depression, and PTSD symptoms in medical students

This study assessed the mental health of medical students after China's pandemic policy adjustments. We found lower rates of anxiety (25.0%) and depression (35.7%) compared with both pre-adjustment medical students (29.6%, 52.5%) [17] and the general population after the adjustment (30.1%, 55.7%) [3,6]. We hypothesize that their medical education served as a protective factor. Their expert knowledge potentially facilitated a more scientific interpretation of pandemic information protecting them from widespread psychological stress and promoting better understanding and confidence in national policies, thereby reducing the impact on their mental health.

Our results indicate that students with a high education level demonstrated higher levels of anxiety and depressive symptoms, which is consistent with Shao's findings [18]. These students are more likely to undergo clinical rotations, where they are often exposed to high-risk healthcare environments. Challenges such as long work hours, sleep deprivation, and limited clinical experience may contribute to elevated stress levels in medical students [19]. In addition to clinical rotations, they also face important career milestones, including taking important national licensing exams, competitive residency placement processes, and beginning a clinical career. Recent studies conducted during the COVID-19 pandemic revealed elevated levels of anxiety in this group due to these career-related challenges [20]. The post-pandemic period, characterized by increased risk of infection, has likely introduced additional uncertainty and anxiety into these already stressful career-defining stages [21]. This is consistent with findings that career-related uncertainty and the pressure of important examinations are significant factors contributing to psychological stress among medical students [22]. However, potential non-response bias should be considered, as students who did not complete the survey may differ in their levels of psychological distress or pandemic experience, which may slightly influence the observed estimates. However, comparison of aggregated demographic data (gender and educational level) between invited and responding students revealed no significant differences, suggesting that the magnitude of such bias was likely negligible. Furthermore, medical students who did not contract COVID-19 reported lower levels of anxiety and depressive symptoms. Numerous studies deminstrated that infected individuals are at a significantly higher risk of developing mental disorders such as anxiety and depression vs. their uninfected peers [23]. Uninfected

individuals may have been vaccinated earlier, reducing both the risk of infection and the associated psychological burden [24]. Furthermore, long-term physical consequences of infection, such as fatigue and sleep disorders, may further exacerbate the risk of depression and anxiety [25].

We also established that chronic illnesses were associated with poorer mental health outcomes. Previous research findings suggested that persistent physical discomfort, pain, and functional limitations associated with chronic illnesses may increase vulnerability to anxiety and depression [26, 27]. Conversely, anxiety and depressive symptoms may exacerbate the progression and severity of chronic conditions. Furthermore, prolonged stress associated with managing a chronic illness may lead to dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, leading to abnormal secretion of cortisol [28]. This neuroendocrine dysregulation resembles the HPA axis dysfunction observed in patients with PTSD [29], suggesting that HPA axis alterations may serve as a biological pathway linking chronic illness to PTSD symptoms.

The protective role of resilience and positive coping strategies

Our results suggest that medical students with higher levels of anxiety, depression, or PTSD symptoms tend to have lower scores on resilience and positive coping strategies. This implies that resilience and positive coping strategies may help protect medical students from psychological stress and support their mental well-being. Resilience is defined as the ability to adapt and recover from adversity or trauma by drawing on internal and external resources [30]. Highly resilient individuals are better able to cope with negative emotions and maintain a positive outlook during challenging times. This allows them to view challenges as opportunities for personal growth while remaining focused and motivated. In contrast, positive coping strategies aim to improve well-being and strengthen social support networks [31]. For medical students, this may include building strong relationships with peers to collaboratively address academic and clinical challenges, thereby creating opportunities for mutual support and encouragement. These social and emotional resources may improve overall well-being and the ability to cope with stress.

Our analysis also revealed that better mental health outcomes were associated with higher resilience and more extensive use of positive coping strategies. These traits may act as protective factors supporting psychological health in challenging environments. This is consistent with previous research [32,33] and highlights the importance of providing mental health support to medical students. In addition to existing counseling and education programs [34], future efforts should include training in resilience skills and positive coping strategies in the medical school curriculum. For senior students and students with chronic illnesses, individualized guidance, such as career planning and self-management support [35,36], may help them prepare for the future and improve overall well-being.

This study has several limitations. First, the sample was drawn from students at a single medical school, and the overrepresentation of female participants may limit the generalizability of the results. Second, a cross-sectional study does not allow for causal inferences. Third, although the administration sent reminder messages to increase participation, non-respondents may have differed from those who responded in their psychological state or level of engagement, potentially biasing the results. Finally, the data were based solely on self-reports without accounting for clinical diagnoses, thereby potentially introducing measurement bias.

Conclusion

The study revealed that after China adjusted its pandemic policies, many medical students reported psychological symptoms, including anxiety, depression, and PTSD. Those most affected were senior students, those in close contact with COVID-19 patients, those previously infected, and students with chronic health conditions. Future support efforts should focus on these high-risk groups by providing targeted psychological services, resilience training, and mental health promotion activities tailored to their needs.

Conflict of interest

The authors declare no conflicts of interest.

Disclosure of generative AI use

Generative artificial intelligence was not used in the preparation of this manuscript.

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Ethical approval

This study protocol was reviewed and approved by the Biomedical Research Ethics Committee of Huzhou University (202302-02). In accordance with the ethical principles outlined in the Declaration of Helsinki, all participants provided digital informed consent, ensuring their voluntary participation and understanding of the goal and procedures of the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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Supplement

Supplementary methods

To facilitate subsequent analyses, we made the following adjustments. First, to assess coping strategies, we standardized scores for both positive and negative coping styles using z-scores. Coping tendency was then determined by calculating the difference between the standardized scores for positive and negative coping styles. A difference greater than 0 indicates a preference for positive coping, while a negative value suggests a preference for negative coping [37]. Second, we categorized symptoms of anxiety and depression as mood disorders [38] to combine these measures. The latent factor of mood disorders was represented by two indicator variables, while PTSD symptoms were represented by three indicator variables.

We employed Mplus 8.0 to construct a structural equation model to examine the relationships between resilience, mood disorders, PTSD symptoms, and coping tendency. Based on previous research [39-43], we proposed the following hypotheses and a theoretical model presented in *Figure S2*:

H 1: Positive coping positively predicts resilience;
H 2: Positive coping negatively predicts mood disorders;
H 3: Positive coping negatively predicts PTSD symptoms;
H 4: Resilience negatively predicts mood disorders;
H 5: Resilience negatively predicts PTSD symptoms;
H 6: Mood disorders positively predict PTSD symptoms.

Table S1. Comparison of invited and responding students in terms of their gender and education level

Variable	*Category*	*Invited (n=1,112)*	*Respondents (n=896)*	χ^2	*p-value*
Gender	Male	351	289	0.152	*p>0.05*
	Female	761	607		
Education level	Freshman	649	556	1.713	*p>0.05*
	Sophomore	251	189		
	Upper-year	212	151		

We observed no significant differences between invited students and respondents in terms of gender or education level, suggesting minimum non-response bias.

Table S2. Univariate analysis of anxiety symptom level among medical students

Variables	*Total (n=872)*	*Normal (n=654)*	*Mild (n=196)*	*Above Moderate (n=22)*	*Statistic*	*P*
Gender					χ^2=3.60	*0.166*
Male	282 (32.34)	221 (78.37)	57 (20.21)	4 (1.42)		
Female	590 (67.66)	433 (73.39)	139 (23.56)	18 (3.05)		
Major					χ^2=3.57	*0.467*
Clinical medicine	419 (48.05)	316 (75.42)	11 (2.63)	92 (21.96)		
Oral medicine	132 (15.14)	97 (73.48)	6 (4.55)	29 (21.97)		
Nursing	321 (36.81)	241 (75.08)	5 (1.56)	75 (23.36)		
Education level					-	*0.021*
Freshman	550 (63.07)	428 (77.82)	11 (2.00)	111 (20.18)		
Sophomore	185 (21.22)	133 (71.89)	3 (1.62)	49 (26.49)		
Upper-year	137 (15.71)	93 (67.88)	8 (5.84)	36 (26.28)		
Place of residence					χ^2=5.71	*0.058*
Urban	439 (50.34)	343 (78.13)	84 (19.13)	12 (2.73)		
Rural	433 (49.66)	311 (71.82)	112 (25.87)	10 (2.31)		
History of close contact with COVID-19 patients					χ^2=3.41	*0.182*
No	219 (25.11)	170 (77.63)	47 (21.46)	2 (0.91)		
Yes	653 (74.89)	484 (74.12)	149 (22.82)	20 (3.06)		
Personal history of COVID-19 infection					χ^2=7.27	*0.026*
No	335 (38.42)	268 (80.00)	60 (17.91)	7 (2.09)		
Yes	537 (61.58)	386 (71.88)	136 (25.33)	15 (2.79)		
History of COVID-19 infection in the household					χ^2=2.87	*0.238*
No	156 (17.89)	121 (77.56)	34 (21.79)	1 (0.64)		
Yes	716 (82.11)	533 (74.44)	162 (22.63)	21 (2.93)		
Health status					χ^2=15.39	*<0.001*
Healthy	833 (95.53)	633 (75.99)	182 (21.85)	18 (2.16)		
Unhealthy	39 (4.47)	21 (53.85)	14 (35.90)	4 (10.26)		
Daily timed dedicated to COVID-19, h					χ^2=5.20	*0.268*
< =1	348 (39.91)	257 (73.85)	7 (2.01)	84 (24.14)		
1~3	382 (43.81)	289 (75.65)	8 (2.09)	85 (22.25)		
> =3	142 (16.28)	108 (76.06)	7 (4.93)	27 (19.01)		

χ^2: Chi-squared test; -: Fisher's exact test.

Table S3. Univariate analysis of depression symptom level among medical students

Variables	*Total (n=872)*	*Normal (n=561)*	*Mild (n=255)*	*Above Moderate (n=56)*	*Statistic*	*P*
Gender					χ^2=3.17	*0.205*
Male	282 (32.34)	193 (68.44)	74 (26.24)	15 (5.32)		
Female	590 (67.66)	368 (62.37)	181 (30.68)	41 (6.95)		
Major					χ^2=1.69	*0.792*
Clinical medicine	419 (48.05)	276 (65.87)	28 (6.68)	115 (27.45)		
Oral medicine	132 (15.14)	82 (62.12)	7 (5.30)	43 (32.58)		
Nursing	321 (36.81)	203 (63.24)	21 (6.54)	97 (30.22)		
Education level					χ^2=12.75	*0.013*
Freshman	550 (63.07)	377 (68.55)	28 (5.09)	145 (26.36)		
Sophomore	185 (21.22)	108 (58.38)	16 (8.65)	61 (32.97)		
Upper-year	137 (15.71)	76 (55.47)	12 (8.76)	49 (35.77)		
Place of residence					χ^2=5.44	*0.066*
Urban	439 (50.34)	298 (67.88)	113 (25.74)	28 (6.38)		
Rural	433 (49.66)	263 (60.74)	142 (32.79)	28 (6.47)		
History of close contact with COVID-19 patients					χ^2=6.90	*0.032*
No	219 (25.11)	157 (71.69)	51 (23.29)	11 (5.02)		
Yes	653 (74.89)	404 (61.87)	204 (31.24)	45 (6.89)		
Personal history of COVID-19 infection					χ^2=9.76	*0.008*
No	335 (38.42)	237 (70.75)	80 (23.88)	18 (5.37)		
Yes	537 (61.58)	324 (60.34)	175 (32.59)	38 (7.08)		
History of COVID-19 infection in the household					χ^2=5.52	*0.063*
No	156 (17.89)	113 (72.44)	36 (23.08)	7 (4.49)		
Yes	716 (82.11)	448 (62.57)	219 (30.59)	49 (6.84)		
Health status					χ^2=26.61	*<0.001*
Healthy	833 (95.53)	548 (65.79)	238 (28.57)	47 (5.64)		
Unhealthy	39 (4.47)	13 (33.33)	17 (43.59)	9 (23.08)		
Daily timed dedicated to COVID-19, h					χ^2=5.14	*0.273*
< =1	348 (39.91)	218 (62.64)	28 (8.05)	102 (29.31)		
1~3	382 (43.81)	246 (64.40)	18 (4.71)	118 (30.89)		
> =3	142 (16.28)	97 (68.31)	10 (7.04)	35 (24.65)		

χ^2: Chi-squared test.

Table S4. Univariate analysis of PTSD symptom level among medical students

Variables	*Total (n=872)*	*Normal (n=679)*	*Mild (n=101)*	*Above Moderate (n=92)*	*Statistic*	*P*
Gender					χ^2=2.75	*0.253*
Male	282 (32.34)	229 (81.21)	27 (9.57)	26 (9.22)		
Female	590 (67.66)	450 (76.27)	74 (12.54)	66 (11.19)		
Major					χ^2=3.13	*0.537*
Clinical medicine	419 (48.05)	335 (79.95)	37 (8.83)	47 (11.22)		
Oral medicine	132 (15.14)	102 (77.27)	16 (12.12)	14 (10.61)		
Nursing	321 (36.81)	242 (75.39)	39 (12.15)	40 (12.46)		
Education level					χ^2=6.93	*0.140*
Freshman	550 (63.07)	436 (79.27)	48 (8.73)	66 (12.00)		
Sophomore	185 (21.22)	135 (72.97)	28 (15.14)	22 (11.89)		
Upper-year	137 (15.71)	108 (78.83)	16 (11.68)	13 (9.49)		
Place of residence					χ^2=7.46	*0.024*
Urban	439 (50.34)	352 (80.18)	38 (8.66)	49 (11.16)		
Rural	433 (49.66)	327 (75.52)	63 (14.55)	43 (9.93)		
History of close contact with COVID-19 patients					χ^2=1.14	*0.566*
No	219 (25.11)	175 (79.91)	25 (11.42)	19 (8.68)		
Yes	653 (74.89)	504 (77.18)	76 (11.64)	73 (11.18)		
Personal history of COVID-19 infection					χ^2=5.97	*0.051*
No	335 (38.42)	273 (81.49)	37 (11.04)	25 (7.46)		
Yes	537 (61.58)	406 (75.61)	64 (11.92)	67 (12.48)		
History of COVID-19 infection in the household					χ^2=1.00	*0.607*
No	156 (17.89)	126 (80.77)	15 (9.62)	15 (9.62)		
Yes	716 (82.11)	553 (77.23)	86 (12.01)	77 (10.75)		
Health status					-	*0.004*
Healthy	833 (95.53)	657 (78.87)	93 (11.16)	83 (9.96)		
Unhealthy	39 (4.47)	22 (56.41)	8 (20.51)	9 (23.08)		
Daily timed dedicated to COVID-19, h					χ^2=3.31	*0.507*
< =1	348 (39.91)	278 (79.89)	35 (10.06)	35 (10.06)		
1~3	382 (43.81)	297 (77.75)	41 (10.73)	44 (11.52)		
> =3	142 (16.28)	104 (73.24)	16 (11.27)	22 (15.49)		

χ^2: Chi-squared test; -: Fisher's exact test.

Table S5. One-way ANOVA results of CD-RISC-10 and SCSQ scores at different anxiety levels

Sample	Term	df	SUMSQ	MEANSQ	Statistic	*P*-value
CD-RISC-10	Anxiety level	2	7,049.6151	3,524.80753	91.371	<0.001
	Residuals	869	33,523.1877	38.57674		
SCSQ-positive	Anxiety level	2	6,339.7911	3,169.89557	47.542	<0.001
	Residuals	869	57,940.7777	66.67523		
SCSQ-negative	Anxiety level	2	127.5478	63.77391	2.027	0.132
	Residuals	869	27,343.5336	31.46552		

Table S6. One-way ANOVA results of CD-RISC-10 and SCSQ scores at different depression levels

Sample	*Term*	*df*	*SUMSQ*	*MEANSQ*	*Statistic*	*P-value*
CD-RISC-10	Depression level	2	7,262.35206	3,631.176029	94.730	<0.001
	Residuals	869	33,310.45069	38.331934		
SCSQ-positive	Depression level	2	7,391.61350	3,695.806752	56.455	<0.001
	Residuals	869	56,888.95530	65.464851		
SCSQ-negative	Depression level	2	16.35377	8.176884	0.259	0.772
	Residuals	869	27,454.72765	31.593473		

Table S7. One-way ANOVA results of CD-RISC-10 and SCSQ scores at different PTSD severity levels

Sample	*Term*	*df*	*SUMSQ*	*MEANSQ*	*Statistic*	*P-value*
CD-RISC-10	PTSD level	2	3,589.28264	1,794.64132	42.169	<0.001
	Residuals	869	36,983.52011	42.55871		
SCSQ-positive	PTSD level	2	2,667.68825	1,333.84413	18.813	<0.001
	Residuals	869	61,612.88055	70.90090		
SCSQ-negative	PTSD level	2	77.94434	38.97217	1.236	0.291
	Residuals	869	27,393.13708	31.52260		

Table S8. Tukey's post-hoc test to compare scores between different groups with different anxiety levels

Comparison		*Mean difference*	*SE of difference*	*95.00% CI of difference*	*Adjusted P-value*
CD-RISC-10	Normal vs. mild	5.744	0.5058	4.557 to 6.932	<0.0001
	Normal vs. above moderate	11.16	1.346	7.998 to 14.32	<0.0001
	Mild vs. above moderate	5.414	1.397	2.136 to 8.693	0.0003
SCSQ-positive	Normal vs. mild	5.689	0.6649	4.128 to 7.250	<0.0001
	Normal vs. above moderate	9.562	1.77	5.407 to 13.72	<0.0001
	Mild vs. above moderate	3.873	1.836	-0.4370 to 8.184	0.0884

Table S9. Tukey's post-hoc test to compare scores between different groups with different depression levels

Comparison		*Mean difference*	*SE of difference*	*95.00% CI of difference*	*Adjusted P-value*
CD-RISC-10	Normal vs. mild	4.348	0.4676	3.250 to 5.445	<0.0001
	Normal vs. above moderate	10.04	0.8677	8.002 to 12.08	<0.0001
	Mild vs. above moderate	5.692	0.9137	3.546 to 7.837	<0.0001
SCSQ-positive	Normal vs. mild	4.788	0.6111	3.353 to 6.222	<0.0001
	Normal vs. above moderate	9.519	1.134	6.857 to 12.18	<0.0001
	Mild vs. above moderate	4.732	1.194	1.929 to 7.535	0.0002

Table S10. Tukey's post-hoc test to compare scores between different groups with different PTSD levels

Comparison		*Mean difference*	*SE of difference*	*95.00% CI of difference*	*Adjusted P-value*
CD-RISC-10	Normal vs. mild	4.41	0.6957	2.777 to 6.044	<0.0001
	Normal vs. above moderate	5.35	0.7248	3.648 to 7.051	<0.0001
	Mild vs. above moderate	0.9394	0.9402	-1.268 to 3.147	0.5776
SCSQ-positive	Normal vs. mild	3.299	0.898	1.190 to 5.407	0.0007
	Normal vs. above moderate	4.987	0.9355	2.791 to 7.183	<0.0001
	Mild vs. above moderate	1.688	1.214	-1.161 to 4.537	0.3459

Table S11. Descriptive statistics and correlations between studied variables

				Mean	*SD*	*1*	*2*	*3*	*4*	*5*
1. Resilience				28.177	6.825	-				
2. PTSD				13.881	13.730	-0.365**	-			
3. Coping strategies				0.456	0.498	0.217**	-0.172**	-		
4. Anxiety				1.287	0.553	-0.394**	0.504**	-0.222**	-	
5. Depression	1.445	0.696	-0.389**	0.540**		-0.260**		0.582**		-

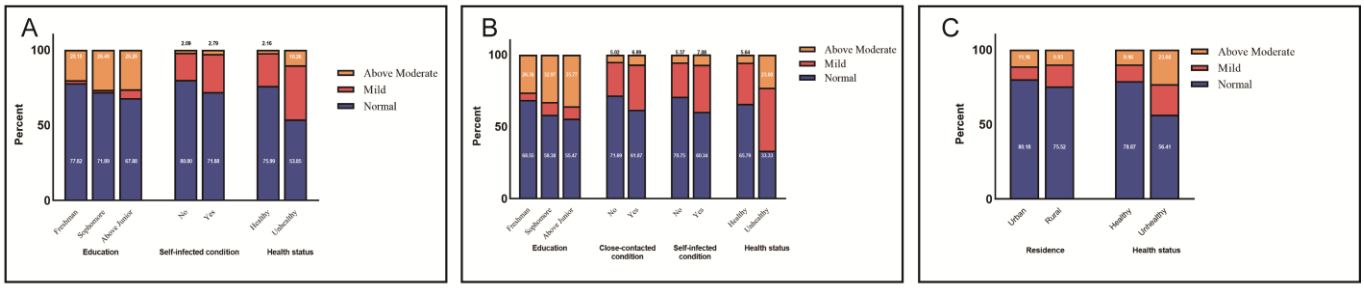

Figure S1. Percentage stacked bar chart of anxiety, depression, and PTSD levels by demographic characteristics among medical students. (A) Anxiety levels; (B) depression levels; (C) PTSD levels.

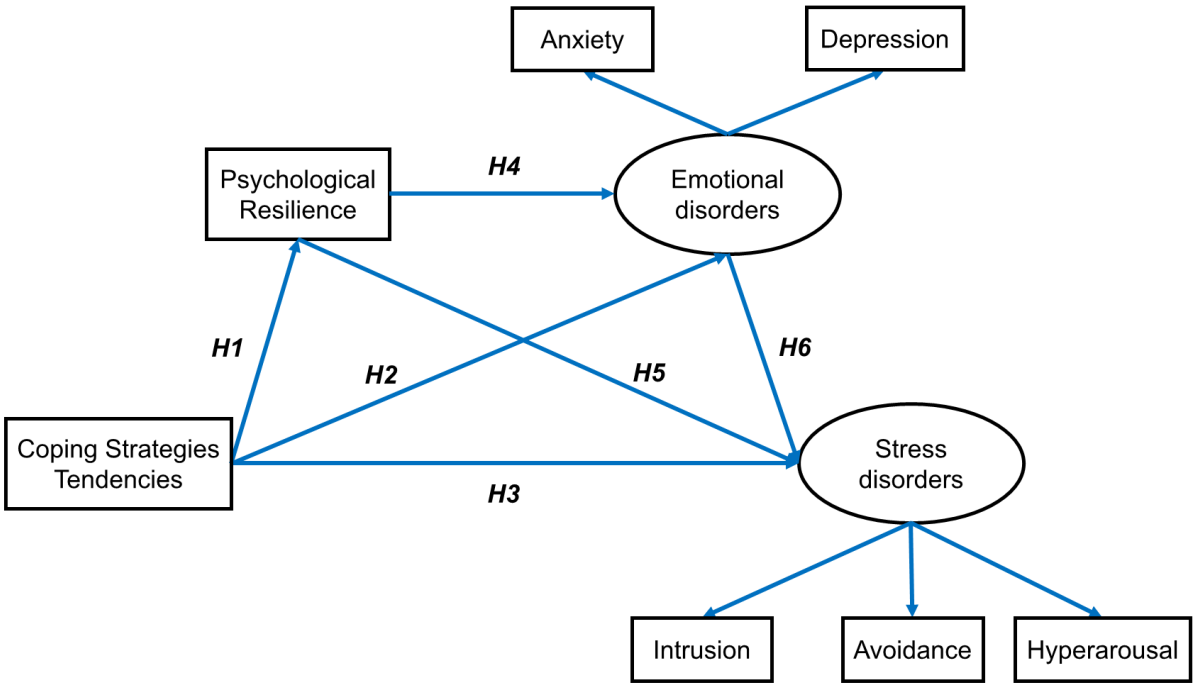

Figure S2. Proposed structural model of the relationship between coping tendencies, resilience, mood disorders, and PTSD.