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# Validation of the Chinese version of the perceived medical school stress (PMSS) scale and analysis of the associated factors

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## Abstract

**Background** In recent decades, mental health and stress among medical students have become a global concern. Currently, China lacks a scale specifically designed to assess stress levels in medical school settings. This study aims to cross-culturally translate and adapt the Perceived Medical School Stress (PMSS) Scale into Chinese, evaluate its psychometric properties in medical schools, and analyze the associated factors of medical students' stress levels.

**Methods** Data collection for the Chinese version of the PMSS was conducted from October to November 2023, among medical students from selected medical schools in North and East China. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to evaluate the underlying factor structure. Content validity was assessed using the Content Validity Index (CVI). Criterion validity was evaluated with the Chinese version of the Perceived Stress Scale (PSS). Internal consistency was assessed by calculating Cronbach's alpha coefficient, McDonald's Omega coefficient, and test-retest reliability. Additionally, relationships between medical school stress and general demographic characteristics, insomnia severity, and self-efficacy were examined.

**Results** The final Chinese version of the PMSS supports a two-factor structure with 13 items, defined as "psychological stress and environment" and "resilience and expectations." The scale's Content Validity Index (CVI) was 0.980, with a criterion validity of 0.767. The Cronbach's alpha coefficient was 0.911, McDonald's Omega coefficient was 0.914, and the test-retest reliability was 0.794. Medical school stress levels showed significant differences based on gender and educational background ($P < 0.05$). Stress levels were positively correlated with insomnia severity and negatively correlated with self-efficacy.

**Conclusions** The Chinese version of the PMSS is a reliable and valid tool for assessing stress levels among medical students in Chinese medical schools. Female students and those pursuing graduate degrees report higher levels of medical stress. Insomnia severity and self-efficacy significantly influence stress levels among medical students.

**Keywords** Chinese medical student, Perceived stress, Reliability, Validity, Insomnia, Self-efficacy

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## Introduction

Stress is the mental or emotional pressure experienced when faced with unfavorable or demanding circumstances [1]. It can be either short-term or long-term. Short-term stress may be beneficial for memory, as it promotes the growth of new neurons. However, when stress becomes severe or prolonged, it can lead to mental anguish, impaired decision-making, and the development of various diseases [2, 3]. Medical students reportedly experience higher stress levels than the general population and students in other academic fields [3, 4].

Medical education is a rigorous and lifelong journey that can significantly impact students' mental and emotional well-being. This well-documented issue has been extensively studied in various countries [5, 6]. Medical students often experience high-stress levels, attributed to unique stressors inherent in their education [7–9]. These reasons include intense curricula, information overload, academic competition, high achievement expectations, grade anxiety, and financial problems, as well as teacher insensitivity to student needs. Stress experienced by medical students has been shown to negatively affect their well-being and mental health, leading to poorer academic performance and contributing to high rates of depression, burnout, suicidal ideation, and medical school dropout [10]. Studies have also demonstrated that stress can have a detrimental impact on the ethical and professional attitudes of medical students, resulting in decreased empathy towards patients [11]. Meanwhile, despite being aware of their stress, medical students are often reluctant to acknowledge their psychological problems, seek professional help, or address these issues effectively [12, 13]. Therefore, it is crucial to understand the factors impacting the mental well-being of medical students. This understanding will enable medical educators to develop awareness and preventive strategies, ultimately mitigating the negative effects of stress.

Although high levels of stress are commonly reported among medical students, few studies have been conducted in China to understand and measure the specific stressors that impact the mental health and quality of life of these students. There is a lack of widely used, specific tools to assess which life situations contribute to stress and to what extent they affect the mental health of medical students. Currently, the Chinese versions of the Perceived Stress Scale (PSS), the General Health Questionnaire (GHQ), and the Depression-Anxiety-Stress Scale (DASS-21) are the most commonly used tools for assessing stress and mental health among medical students in China. However, while these scales can assess stress, they are unable to differentiate between stress specific to medical school and general stress [14]. While various studies and tools have been employed to assess stress symptoms across clinical, academic, and general populations, there is a notable lack of specific assessments for stress within medical education. To address these shortcomings, we introduce the Perceived Medical School Stress Scale (PMSS), originally developed in English by Vitaliano et al. The PMSS is a validated and specialized tool for assessing stress levels in medical students, with an in-depth exploration of the factors contributing to stress. The English version of the scale demonstrates excellent psychometric properties, including satisfactory internal consistency reliability, test-retest reliability, and structural validity [7]. It has been adopted and widely used across various languages and cultures, including the US, the UK, Norway, Germany, Poland, Turkey, and Canada [7, 9, 15–18]. However, its application within the Chinese cultural context requires further adaptation, as well as additional reliability and validity testing.

This study aims to cross-culturally translate and adapt the PMSS Scale into Chinese, evaluate its psychometric properties in medical schools, and analyze the associated factors of medical students' stress levels.

## Materials and methods

### Research design and participants

From October to November 2023, we conducted a cross-sectional study involving medical students from various specialties at selected medical schools in Liaoning Province (northern China) and Shandong Province (eastern China). The study employed a convenience sampling approach and utilized WeChat, a popular social media platform in China, to administer an online survey via the professional platform "Questionnaire Star." The sample size required for instrument validation was calculated to be 5–20 times the total number of items [19]. Given that the study included 44 items, we initially collected 1,064 responses. After excluding 173 invalid questionnaires that did not meet the designated criteria, 891 questionnaires were included in the final analysis, resulting in a valid recovery rate of 83.74%. The survey was anonymous, and only 50 participants were asked to provide personal contact information to evaluate the reliability of the retest after three weeks. The study excluded invalid questionnaires based on three criteria: (1) a response time of less than 60 s; (2) identical answers to different questions; and (3) the same responses for both forward and reverse questions. All participants were native Mandarin speakers and provided informed consent to participate in the study. The research adhered to the ethical standards set by the Ethics Committee of Jinzhou Medical University (JZMULL2021009) and the Declaration of Helsinki of 1964 and its subsequent amendments.

### Translation and cultural adaptation

We obtained permission from Prof. Vitaliano to adapt the scale to the cultural context. Following Brislin's translation method, we employed a forward-backward translation approach [20]. In translating the PMSS into Chinese, we considered these suggestions and emphasized semantic equivalence. For instance, the term "medical school" in the original U.S. scale primarily refers to the "physician" profession. However, in China, "medical school" encompasses the entire medical institution, including various medical specialties. Therefore, item 6 was revised to reflect the specific context of medical specialties in Chinese medical schools: originally "This medical school is fostering a physician role at the expense of one's personality and interests," was revised to "This medical school is fostering a medical student role at the expense of one's personality and interests." Additionally, considering the diverse stressors across different specialties in Chinese medical schools, this scale will be used to further expand the study population and assess stress levels among medical students in these institutions. Similarly, the Polish version of the scale was utilized to measure stress levels among medical students at different stages and across various specialties, thereby expanding the study population [9].

We conducted a pre-survey with 20 medical students to verify the readability and comprehensibility of the translated scale items. The results indicated that the scale was easy to understand and complete, with an average completion time of approximately 3–5 min. Based on these findings, the Chinese version of the PMSS scale was developed.

### Instruments

#### *Questionnaire on general demographic characteristics*

A questionnaire assessing general demographic characteristics was developed based on the study's objectives and relevant literature. This questionnaire addressed variables such as gender, age, educational background, and field of specialization.

#### *Perceived medical school stress scale (PMSS)*

The PMSS was originally developed by Prof. Vitaliano's team to assess stress specific to medical students [7]. The scale, which is in English, consists of 13 items across two dimensions: "Psychological Stress and Environment" and "Resilience and Expectations." It uses a 5-point Likert scale, with item scores ranging from 0 to 4. The scale does not include reverse-scoring items; the total score is calculated by summing the individual item scores, with higher scores indicating greater perceived stress. In this study, the Cronbach's alpha coefficient for the PMSS was 0.908.

#### *Insomnia severity index (ISI)*

The Insomnia Severity Index (ISI) was developed by Bastien et al. in 2001 [21] to evaluate the severity of insomnia. The ISI uses a 5-point Likert scale, with each item scored from 0 to 4. Higher scores indicate greater severity of insomnia [22]. In this study, the Cronbach's alpha coefficient for the ISI was 0.921.

#### *General self-efficacy scale (GSES)*

The General Self-Efficacy Scale (GSES), developed by Schwarzer et al., assesses an individual's self-confidence in their ability to handle setbacks and challenges [23]. The GSES utilizes a 4-point Likert scale, with item scores ranging from 1 to 4. Higher scores reflect greater self-efficacy. In this study, the Cronbach's alpha coefficient for the GSES was 0.941.

#### *Perceived stress scale (PSS)*

The PSS was developed by Cohen et al. in 1983 to measure an individual's perceived stress and ability to cope with stress, as well as related coping characteristics [24]. In this study, we used the PSS as the standard tool to validate the PMSS. This scale consists of 14 items divided into two dimensions. It utilizes a 5-point Likert scale, where items 4, 5, 6, 7, 9, 10, 12, and 13 are reverse-scored. Higher scores indicate greater perceived stress. In this study, the Cronbach's alpha coefficient for the PSS was 0.816.

### Statistical analysis

In this study, descriptive statistics for demographic characteristics, correlation analyses, and exploratory analyses were performed using SPSS (V26.0). Confirmatory factor analysis was conducted with AMOS (V26.0). Differences in PMSS scores across sociodemographic variables were evaluated using independent samples t-tests or one-way ANOVA. Bonferroni correction was applied for post-hoc pairwise comparisons, with a significance threshold set at $P < 0.05$.

## Results

### Descriptive statistics

A total of 891 medical students were included in the study. Of these, 271 (30.4%) were male and 620 (69.6%) were female. The average age of the participants was $20.2 \pm 2.1$ years. The sample comprised students with varying educational backgrounds, including undergraduates, degree upgraders (students advancing from a college or university to an undergraduate degree), and graduate students. Degree upgraders were well-represented in the medical school and were included in the study. The majority of participants were majoring in clinical medicine (41.8%) or nursing (35.2%), among other fields.

**Table 1** General information on participants($n=891$)

| Characteristic | *N* | *N* (%)/M ± SD |
|---|---|---|
| **Gender** | | |
| male | 271 | 30.4 |
| female | 620 | 69.6 |
| **Age** | 891 | 20.2 ± 2.1 |
| **educational background** | | |
| degree upgraders | 668 | 75 |
| undergraduate student | 175 | 19.6 |
| postgraduates | 48 | 5.4 |
| **Major** | | |
| Clinical Medicine | 372 | 41.8 |
| Nursing | 314 | 35.2 |
| Medical Imaging | 40 | 4.5 |
| Clinical Pharmacy | 24 | 2.7 |
| Rehabilitation Therapy | 48 | 5.4 |
| Dentistry | 30 | 3.4 |
| Other Major | 63 | 7.1 |

**Table 2** Comparison of scores between high and low PMSS subgroups in the Chinese version ($n=981$)

| Items | Low-score group ($n=219$), Mean (SD) | High-score group ($n=258$), Mean (SD) | t-test(df) | *p*-value |
|---|---|---|---|---|
| 1 | 1.30(0.760) | 2.95(0.799) | -22.973 | < 0.001 |
| 2 | 0.91(0.728) | 2.82(0.888) | -25.358 | < 0.001 |
| 3 | 0.99(0.889) | 2.98(0.885) | -24.398 | < 0.001 |
| 4 | 1.40(0.813) | 2.99(0.681) | -23.272 | < 0.001 |
| 5 | 1.43(1.122) | 3.18(0.842) | -19.408 | < 0.001 |
| 6 | 1.13(0.906) | 3.11(0.744) | -26.177 | < 0.001 |
| 7 | 2.26(0.839) | 3.14(0.472) | -14.465 | < 0.001 |
| 8 | 1.72(0.822) | 2.99(0.609) | -19.211 | < 0.001 |
| 9 | 1.21(0.731) | 2.87(0.810) | -23.434 | < 0.001 |
| 10 | 1.13(0.556) | 2.74(0.850) | -24.032 | < 0.001 |
| 11 | 1.39(0.777) | 2.93(0.726) | -22.343 | < 0.001 |
| 12 | 1.07(0.470) | 2.44(0.878) | -20.759 | < 0.001 |
| 13 | 1.15(0.930) | 3.11(0.848) | -23.854 | < 0.001 |

Further details on the demographic data are provided in Table 1.

### Item analysis

The Chinese version of the PMSS was divided into low and high subgroups after sorting in ascending order, and the cutoff scores were found to be 23 and 32 by descriptive statistics. An independent sample t-test was conducted to compare these subgroups. As shown in Table 2, the results indicated a statistically significant difference between the two groups ($P<0.05$). This finding demonstrates that the PMSS has good discriminant validity [25, 26], effectively distinguishing between responses from different participants.

The average scores for individual items in the Chinese version of the PMSS are presented in Table 3. A positive correlation between item scores and total scores was observed ($r=0.618–0.746$, $P<0.001$), indicating that the items are moderately to highly related to the overall scale [27]. When each item was omitted, Cronbach's α of the scale ranged from 0.902 to 0.909, which is slightly lower than Cronbach's α of the full scale (0.911). This suggests that the items exhibit good reliability and should be retained [28].

**Table 3** Diagnostic criteria and descriptive characteristics of Chinese PMSS scale items

| Items | Mean (SD) | Correlation between items and total score | *p*-value | Cronbach's α if the item was deleted |
|---|---|---|---|---|
| 1 | 2.02(0.97) | 0.707 | < 0.001 | 0.903 |
| 2 | 1.87(1.06) | 0.714 | < 0.001 | 0.903 |
| 3 | 2.00(1.10) | 0.735 | < 0.001 | 0.902 |
| 4 | 2.13(0.94) | 0.703 | < 0.001 | 0.903 |
| 5 | 2.39(1.15) | 0.628 | < 0.001 | 0.909 |
| 6 | 2.04(1.07) | 0.746 | < 0.001 | 0.902 |
| 7 | 2.67(0.71) | 0.618 | < 0.001 | 0.907 |
| 8 | 2.33(0.82) | 0.665 | < 0.001 | 0.905 |
| 9 | 1.98(0.96) | 0.715 | < 0.001 | 0.903 |
| 10 | 1.85(0.90) | 0.732 | < 0.001 | 0.902 |
| 11 | 2.11(0.89) | 0.727 | < 0.001 | 0.902 |
| 12 | 1.68(0.82) | 0.698 | < 0.001 | 0.904 |
| 13 | 2.15(1.12) | 0.703 | < 0.001 | 0.904 |

### Validity analysis

#### *Content validity*

The content validity of the Chinese version of the Perceived Medical School Stress Scale was assessed using an expert evaluation method [29]. The expert panel comprised seven members, including two psychologists and five medical professionals. The content validity analysis results showed that the Item-Level Content Validity Index (I-CVI) ranged from 0.857 to 1.000, and the Scale-Level Content Validity Index (S-CVI/UA) was 0.980, indicating that the content validity of the questionnaire is relatively high [30, 31].

#### *Structural validity*

**Exploratory factor analysis (EFA)** Before conducting EFA, the sample ($n=446$) was assessed for factorability. Bartlett's test of sphericity [32]yielded a $\chi^2$ value of 22,927.670 ($P<0.001$), and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy [33] was 0.927, exceeding the minimum acceptable value of 0.6. Principal Component Analysis (PCA) with orthogonal rotation was performed, resulting in the extraction of two factors with eigenvalues greater than 1 [34]. The cumulative variance explained by these two factors, as supported by the scree

plot, was 60.630%. All items were loaded onto a single factor, as detailed in Table 4.

**Confirmatory factor analysis (CFA)** In Sample 2 ($n = 445$), confirmatory factor analysis (CFA) was conducted to validate the results of the EFA or to further assess the model's fit [35]. The fit indices for the two-factor model are presented in Table 5: $\chi^2 = 191.063$, degrees of freedom (df) = 64, $\chi^2/df = 2.985$, Root Mean Square Error of Approximation (RMSEA) = 0.067, Normed Fit Index (NFI) = 0.934, Tucker-Lewis Index (TLI) = 0.945, Goodness-of-Fit Index (GFI) = 0.934, and Comparative Fit Index (CFI) = 0.955. An acceptable model fit was defined by the criteria of $\chi^2/df < 5$, RMSEA < 0.08, and NFI, TLI, GFI, and CFI > 0.90 [36]. The standardized path analysis results are illustrated in Fig. 1.

#### *Criterion validity*

In this study, the Pearson correlation coefficient between the PMSS and the PSS was 0.767 ($P < 0.001$), indicating strong criterion validity for the PMSS scale using the PSS as the standard for validation.

#### Reliability analysis

Various methods were employed to assess the internal consistency of the scale, including Cronbach's alpha coefficient, McDonald's Omega coefficient, split-half reliability coefficient, and test-retest reliability [28]. The reliability analysis of the 13 items in the Chinese version of the PMSS demonstrated good internal consistency, with an overall Cronbach's alpha coefficient of 0.911. The Cronbach's alpha coefficients for the two factors were 0.899 and 0.851, both exceeding the minimum acceptable value of 0.7. Additionally, the McDonald's Omega coefficient was 0.914, further supporting the scale's reliability. Additionally, the split-half reliability coefficient of the PMSS was 0.859, indicating a high degree of stability and consistency. The test-retest reliability, conducted three weeks later with 50 participants, was 0.794, with a correlation coefficient exceeding 0.7, further demonstrating good stability and minimal influence of time [27].

#### Analysis of factors associated with stress in medical schools

The Chinese version of the Perceived Medical School Stress Scale did not reveal statistically significant differences across different medical specialties. However, analysis of 891 data points showed significant differences related to gender and educational background, as detailed in Table 6. Specifically, female medical students reported significantly higher stress levels than their male counterparts ($P = 0.002 < 0.05$). Additionally, medical students with higher academic degrees perceived greater stress than degree upgraders, with the difference being statistically significant ($P = 0.003 < 0.05$). The Chinese version of the PMSS was also found to be positively correlated with the Insomnia Severity Index ($r = 0.504$, $P < 0.001$) and negatively correlated with general self-efficacy ($r = -0.108$, $P < 0.001$).

Bold values correspond to statistically significant correlations ($P < 0.05$).

Pairwise differences [a] were $P < 0.05$ (Bonferroni corrected).

**Table 4** Factor loadings of EFA for the Chinese version of the PMSS ($n = 446$)

| Item | Factor1 | Factor2 |
|---|---|---|
| 6 | 0.782 | |
| 1 | 0.764 | |
| 4 | 0.760 | |
| 11 | 0.699 | |
| 10 | 0.698 | |
| 9 | 0.692 | |
| 7 | 0.669 | |
| 12 | 0.641 | |
| 8 | 0.636 | |
| 5 | | 0.871 |
| 13 | | 0.804 |
| 2 | | 0.790 |
| 3 | | 0.761 |

## Discussion

### Chinese version of the perceived medical school stress scale

This study represents the first translation of the PMSS into Chinese. The Chinese version of the PMSS underwent slight modifications from the original version and was validated with a larger sample of Chinese medical students. The findings demonstrate that the Chinese version of the PMSS exhibits strong reliability and validity. Overall, the item analysis, content validity, construct validity, criterion validity, and reliability analysis all demonstrated satisfactory results. Therefore, the Chinese version of the PMSS is deemed suitable for use among Chinese medical students. In this study, the mean PMSS score among Chinese medical students was 27.22 ± 8.8, indicating a higher overall stress level compared to reports from medical students in other countries such as the UK, Germany, Poland, Norway, and the US [37].

**Table 5** The Chinese version of the PMSS index fit ($n = 445$)

| $\chi^2$ | df | $\chi^2$ /df | RMSEA | NFI | TLI | GFI | CFI |
|---|---|---|---|---|---|---|---|
| 191.063 | 64 | 2.985 | 0.067 | 0.934 | 0.945 | 0.934 | 0.955 |

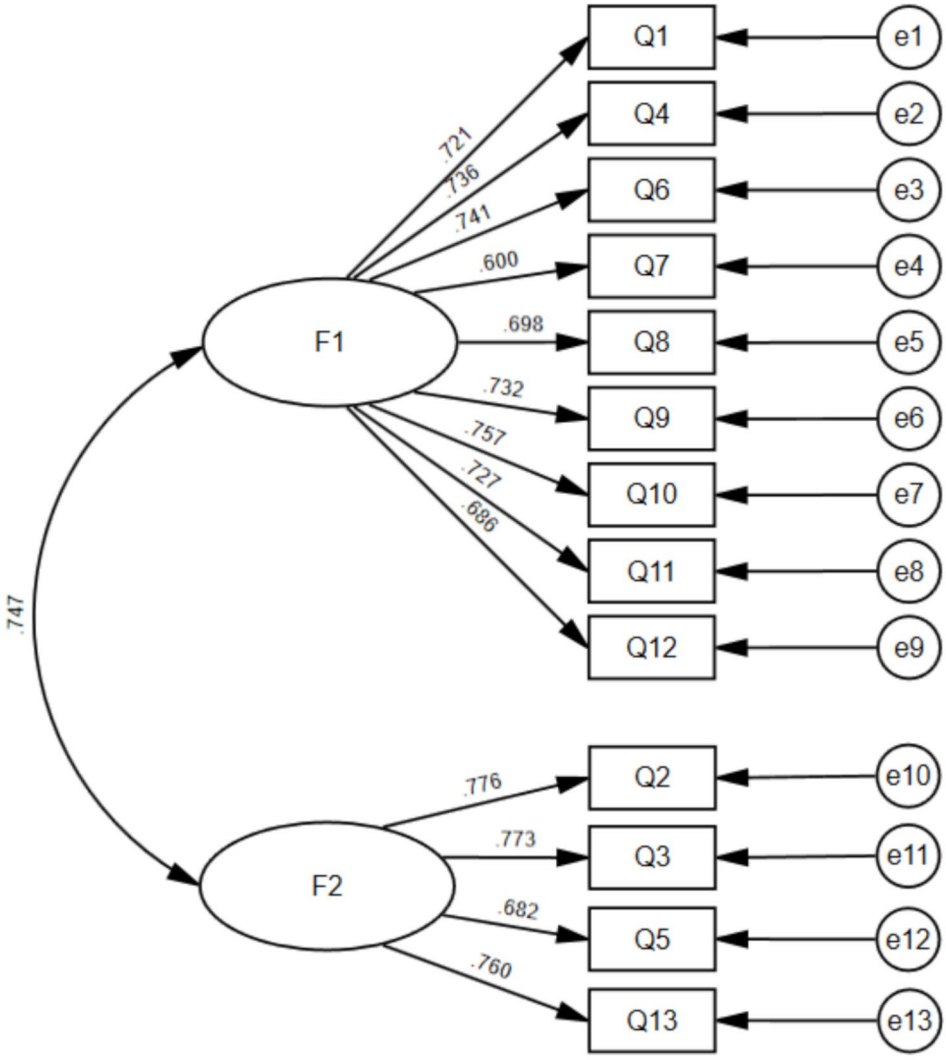


**Fig. 1** Standardized two-factor structural model for the Chinese version of PMSS($n=445$). F1(Psychological Stress and Environment), F2(Resilience and Expectations). Please see the discussion section for more details

This disparity may be attributed to the intense academic expectations and competitive pressures faced by Chinese medical students. Although medicine is regarded as a prestigious profession in China, the job market remains highly competitive. Additionally, challenges within the Chinese healthcare system, such as high workplace stress and strained doctor-patient relationships, further exacerbate the medical school stress experienced by Chinese medical students. In contrast, studies have shown that medical students in Norway, Germany, and the United States report higher overall satisfaction with working conditions, pay, and job satisfaction, which may contribute to their lower levels of medical school stress compared to their counterparts in China [37–39]. To address this issue, future research should focus on identifying the factors contributing to higher stress levels among Chinese medical students through larger, multicenter prospective studies. Additionally, implementing appropriate and timely interventions is crucial.

#### Reasonable explanations for differences from the original scale

The original PMSS scale comprised two factors and 13 items: Factor 1, 'Psychological Stress and Environment,' and Factor 2, 'Resilience and Expectations.' However, item 13, 'My financial situation worries me,' was not included in the two primary dimensions but was retained separately due to its high relevance for most students. In this study, item 13 was incorporated into the second dimension, 'Resilience and Expectations.' This modification reflects the significant impact of financial concerns on medical students. The extended duration of medical education necessitates long-term financial support from families, and Chinese medical students generally

**Table 6** Comparison of the Chinese version of PMSS among participants with different characteristics

| Characteristic | Mean (SD) | *P*-value | Pairwise differences [a] |
|---|---|---|---|
| **Gender** | | 0.002 | |
| male | 27.10(9.869) | | |
| female | 27.27(8.262) | | |
| **educational background** | | **0.003** | |
| degree upgraders (1) | 26.68(8.859) | | |
| undergraduate student (2) | 28.42(8.547) | | **(3)> (1)** |
| Postgraduates (3) | 30.33(7.407) | | |
| **Major** | | 0.146 | |
| Clinical Medicine | 26.29(9.013) | | |
| Nursing | 28.07(8.234) | | |
| Medical Imaging Technology | 27.83(7.324) | | |
| Clinical Pharmacy | 27.21(8.638) | | |
| Rehabilitation Therapy | 28.90(10.423) | | |
| Dentistry | 26.17(6.934) | | |
| Other Major | 27.27(9.960) | | |

have limited income sources while studying. Resilience, defined as the ability to adapt to challenges, pressures, and adversities positively, plays a crucial role in regulating mental and physical well-being [40]. However, students from economically disadvantaged backgrounds often demonstrate lower levels of psychological resilience [41]. These students may experience cognitive biases related to poverty and develop an inferiority complex due to financial hardships. Additionally, their resilience can be further diminished by their parents' educational practices, societal attitudes, and peer influences, leading to a sense of learned helplessness and reduced psychological resilience. Incorporating financial concerns into the 'Resilience and Expectations' dimension aligns with the observed relationship between economic status and resilience. In contrast, during the validation of the scale in other European countries, the developers employed the same factor structure as the original authors. This discrepancy is largely attributed to cultural differences between European, American, and Asian contexts. The adjustment of dimensions in this study not only addresses the real concerns of students but also results in a more streamlined and concise scale structure.

### Differences in medical school stress between genders

In this study, female medical students reported significantly higher levels of medical school stress compared to their male counterparts ($P = 0.002 < 0.05$). This finding is consistent with the results of additional studies by Roberts et al. [42]. We consider that the high levels of stress experienced by female medical students in medical school may be attributed to their increased competitiveness, greater focus on achieving higher exam scores, and heightened concern about their performance. As a result, they may be more likely to exhibit symptoms of stress and depression, even if mild, and tend to engage in less physical exercise [43, 44]. However, Roberts and Kunttu et al. reported differing results, concluding that there is no significant difference in medical school stress between male and female medical students [45, 46]. This discrepancy could be due to variations in curricula, study populations, or measurement methods. Additionally, gender differences may reflect contemporary changes in medical schools, with an increasing number of women entering the field. Given the low number of males in this study, further research is needed to explore gender differences in medical school stress.

### Differences in medical school stress across educational backgrounds

This study revealed significant differences in medical school stress among participants with varying educational backgrounds. Specifically, master's degree students reported higher levels of stress compared to degree upgraders (students promoted from a college to a bachelor's degree) and bachelor's degree students (see Table 5). This finding contrasts with previous research, which often shows that students in lower academic years experience higher stress levels compared to those in higher years [47–49]. Typically, first-year medical students face the highest stress due to unfamiliarity with school procedures, time management challenges, and difficulties in social adjustment. In contrast, degree upgraders, having successfully adapted to the transition from college to undergraduate studies, may be better equipped to handle the medical school environment, resulting in lower stress levels. Master's degree students, on the other hand, report higher stress levels, which may be attributed to their transition from a non-clinical to a clinical environment, as well as heightened expectations regarding clinical skills [50–52]. Additionally, during the final stages of their education, master's students may experience increased stress due to academic pressures and dissatisfaction with their psychosocial environment, which could further exacerbate their stress perception.

### Correlation

In our study, the Perceived Medical School Stress Scale score was positively correlated with the Insomnia Severity Index ($r = 0.504$, $P < 0.001$), indicating that higher levels of perceived medical school stress are associated with greater insomnia severity [53]. Heightened anxiety and stress can result in increased sympathetic activation and greater sleep arousal, negatively impacting sleep architecture [54]. This results in a more challenging internal sleep environment and exacerbates sleep deprivation among

students [55]. Stress and anxiety are major sources of sleep deprivation among medical students. Additionally, the study found a negative correlation between perceived medical school stress and general self-efficacy ($r$ = -0.108, $P<0.001$). Higher self-efficacy was associated with lower perceived stress among medical students [56]. Self-efficacy is a crucial concept in the social cognitive approach and is associated with various behavioral outcomes. A robust sense of self-efficacy not only enhances performance but also strengthens an individual's ability to adapt to their environment, overcome challenges, and increase personal resilience [57]. While self-efficacy itself may serve as an effective adaptive strategy for managing stress and anxiety, evidence suggests that its impact may be limited. In a study by Heinen et al., medical students demonstrated higher scores on the Measuring the Self-Efficacy Scale compared to both the validation sample and the general student population [58]. This finding may be attributed to medical students possessing greater personal resources compared to many others. Despite this, personal resources alone appear insufficient to mitigate the stress experienced by students, as evidenced by the continued prevalence of stress among medical students. Therefore, educational institutions must implement interventions at the institutional level or within the environmental elements of their programs, rather than focusing solely on enhancing students' resources, such as coping strategies or self-efficacy [59].

### Limitations

Several limitations should be acknowledged in this study. First, the assessment focused primarily on medical students from northern medical schools, which may not fully represent the diversity of medical students across the country. Second, there was a disproportionate number of female students compared to male students. While this reflects the higher proportion of female students in Chinese medical schools, it may limit the generalizability of the findings to male medical students. Future research should consider a more balanced gender sample and explore stress levels across different regions and institutions to improve the representativeness of the results. Third, the study relied on self-reported data for stress assessment, which may be influenced by social desirability effects and individual subjective biases, introducing potential bias. Therefore, future research could reduce this limitation by incorporating more objective data or combining multiple data collection methods.

## Conclusions

The Chinese version of the PMSS scale consists of 13 items, supports a two-factor structure, and demonstrates good validity and reliability. It has been culturally adapted to better align with the context of Chinese medical schools. Unlike commonly used general stress assessment scales, the PMSS is specifically designed for medical students, making it more relevant for screening within medical school environments. The study found significant correlations between stress levels and factors such as insomnia severity, self-efficacy, and other various characteristics. Specifically, higher levels of perceived medical school stress were positively correlated with greater insomnia severity and negatively correlated with general self-efficacy. Master's degree students reported higher stress levels than degree-upgraders and bachelor's degree students, while female students experienced significantly higher stress levels compared to their male counterparts. These findings suggest that medical students' stress is influenced by various social and educational factors. Considering these factors, early screening and identification of students who are particularly susceptible to stress could contribute to the development of targeted mental health intervention strategies and educational management measures.

#### Abbreviations

| | |
|---|---|
| PMSS | Perceived Medical School Stress Scale |
| EFA | Exploratory factor analysis |
| CFA | Confirmatory factor analysis |
| PSS | Perceived Stress Scale |
| GHQ | General Health Questionnaire |
| DASS-21 | Depression-Anxiety-Stress Scale |
| ISI | Insomnia Severity Index |
| GSES | General Self-Efficacy Scale |
| CVI | Content Validity Index |
| PCA | Principal Component Analysis |
| RMSEA | Root Mean Square Error of Approximation |
| IFI | Incremental Fit Index |
| TLI | Tucker-Lewis Index |
| CFI | Comparative Fit Index |
| GFI | Goodness-of-Fit Index |

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#### Author contributions

Z: Writing-original manuscript, writing-review or editing, conceptualization, data management, methodology, formal analysis, Validation. L: Writing-Reviewing or editing, conceptualization, data management, methodology, supervision. Z, Z, X: data management. All authors contributed to this study and approved the final submitted manuscript.

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#### Data availability

The datasets generated and/or analysed during the current study are not publicly available due to Chinese people being relatively secretive about their lives and thoughts, although informed consent was obtained from study subjects before the survey and the findings were largely reported. But are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
The study was approved by the Medical Ethics Committee of Jinzhou Medical University (Ethical approval number: JZMULL2021009). All procedures adhered to the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent amendments. We declare that informed consent was obtained from all participants.

**Consent for publication**
Not Applicable.

**Competing interests**
The authors declare no competing interests.

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