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Resilience as a predictor of mental health among medical students: a cross-sectional study using PLS-SEM

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Abstract

Introduction Resilience is recognized as a crucial psychological resource that enables individuals, particularly medical students, to cope with academic and emotional stress. Given the rising concern over students' mental health, this study aimed to investigate the relationship between resilience and psychological well-being among medical students.

Methods A cross-sectional, analytical study was conducted from March to May 2025 among medical students at Kerman University of Medical Sciences. Participants ($n = 385$) completed standardized questionnaires assessing resilience (Connor-Davidson Resilience Scale, CD-RISC) and mental health (Symptom Checklist-90-Revised, SCL-90-R). Data were analyzed using Pearson correlation coefficients and Partial Least Squares Structural Equation Modeling (PLS-SEM) to test both direct and moderated relationships.

Results The mean resilience score was 83.42 out of 125 (SD = 12.35), indicating a moderate to high level of resilience. The mean Global Severity Index (GSI) for mental health was 1.37 out of 4 (SD = 0.71), suggesting mild psychological symptoms. Pearson correlations showed significant negative relationships between resilience and GSI ($r = -0.45$, $p < 0.001$). PLS-SEM results confirmed that resilience may significantly predicted lower mental health symptoms ($\beta = -0.41$, $t = 9.14$, $p < 0.001$). Among resilience dimensions, "perception of competence" and "trust in one's instincts" had the strongest effects. Marital status moderated this relationship ($\beta = -0.11$, $p = 0.01$), indicating a possibly stronger protective effect for married students.

Conclusion Resilience may play a protective role against psychological distress among medical students. Specific dimensions such as perceived competence and trust in one's instincts appear particularly influential. Strengthening resilience, especially through social support mechanisms, may serve as a valuable strategy in promoting student mental health and academic performance. It is recommended that universities implement targeted resilience-building programs, such as peer support groups and stress management workshops, to enhance students' psychological well-being.

Keywords Resilience, Mental health, Medical students, Structural equation modeling, Psychological distress, Moderation

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Introduction

Mental health is a critical aspect of overall well-being, particularly for medical students facing intense academic, emotional, and professional challenges [1]. It is defined as a state in which individuals realize their abilities, cope with normal life stresses, work productively, and contribute to their communities [2]. High stress, academic overload, and emotional fatigue during medical education are linked to increased risks of anxiety, depression, burnout, and suicidal ideation [3, 4]. Ensuring medical students' psychological well-being is essential not only for their academic success but also for maintaining high standards of patient care [4].

Globally, medical students experience higher levels of psychological distress than non-medical peers [5, 6]. In low- and middle-income countries, including Iran, limited access to mental health services, cultural stigmas, and systemic pressures further exacerbate the issue [7]. Early identification of protective factors and preventive strategies is therefore critical [7].

Resilience, the ability to recover from adversity and adapt to stress, is a vital psychological resource that buffers against mental health deterioration [8, 9]. Resilient students cope effectively with academic and personal challenges, maintain emotional balance, and foster perseverance, empathy, and professional identity formation [10, 11].

In the Iranian context, cultural values such as collectivism, religious faith, and family support systems play a significant role in shaping how individuals perceive and cope with stress [12]. Spiritual and religious beliefs, in particular, are deeply embedded in Iranian society and can serve as critical sources of resilience. Despite increasing recognition of the importance of resilience in promoting mental health, research in this domain remains limited in Iran, especially studies that explore the influence of resilience within specific cultural and religious contexts. For instance, Parviniannasab et al. (2022) emphasized the mediating role of psychological capital in the relationship between spiritual well-being and mental health among nursing students in Iran, highlighting the unique interplay of socio-cultural and spiritual factors in psychological outcomes [13]. These findings underscore the importance of considering culturally rooted factors, especially spirituality, when examining resilience and mental health in Iranian medical students. However, such context-sensitive approaches have not been widely applied to resilience and mental health among Iranian medical students.

Most existing studies in this field have employed traditional regression-based techniques, which may not fully capture the complex, multidimensional nature of psychological constructs such as resilience and mental health. Furthermore, few studies have utilized Partial Least Squares Structural Equation Modeling (PLS-SEM), a robust multivariate analysis technique that allows for simultaneous estimation of latent variables and their interrelationships.

This study seeks to fill this research gap by investigating the impact of resilience on mental health among medical students at Kerman University of Medical Sciences in southern Iran, using a PLS-SEM approach. By modeling the direct and indirect paths between resilience and mental health outcomes, the study aims to provide a deeper understanding of how psychological strengths contribute to well-being in high-stress academic environments. The findings may offer valuable insights for curriculum developers, university counselors, and health policymakers in designing effective interventions to promote resilience and protect student mental health during medical training.

Theoretical framework

The concept of resilience has been widely studied in psychology as a dynamic process that enables individuals to successfully adapt in the face of adversity, trauma, or significant stressors [14]. It encompasses a set of cognitive, emotional, and behavioral skills that facilitate recovery and promote psychological well-being [15]. Within the context of medical education, resilience is especially critical, as students frequently encounter academic pressures, emotional demands, and ethical challenges that can adversely affect their mental health [16].

Several theoretical models explain how resilience functions as a protective factor for mental health [17, 18]. The Connor-Davidson Resilience Scale (CD-RISC) conceptualizes resilience as a multidimensional construct comprising five core dimensions: perception of competence, trust in one's instincts, positive acceptance of change and secure relationships, control, and spiritual influences [19]. Each of these dimensions contributes uniquely to an individual's capacity to cope with stressors and maintain psychological equilibrium [19, 20].

Perception of competence refers to an individual's belief in their ability to manage challenges effectively, which enhances self-efficacy and confidence in stressful situations [20, 21]. Trust in individual instincts relates to relying on intuition and judgment when navigating uncertain or complex scenarios [21, 22]. Positive acceptance of change and secure relationships involves embracing change as a natural part of life and seeking emotional support from trusted others [22, 23]. Control denotes the perception of having influence over life circumstances, which reduces feelings of helplessness [24]. Spiritual effects capture the role of faith or spiritual beliefs as sources of meaning and resilience [25].

Spiritual influences, especially in Iran, encompass the role of religious beliefs, connection to God, and spiritual

practices (e.g., prayer, reading holy texts), which provide a sense of meaning, purpose, and emotional security during hardship [26]. These influences are often deeply rooted in personal and cultural identity, making them especially relevant in shaping medical students' resilience in Iran [27].

In the demanding environment of medical education, these dimensions can buffer against psychological distress by fostering adaptive coping strategies and emotional regulation. The stress-buffering hypothesis posits that resilience mitigates the negative impact of stress on mental health, thereby reducing risks of anxiety, depression, and burnout [28].

Furthermore, the application of Partial Least Squares Structural Equation Modeling (PLS-SEM) enables the examination of both the direct effects of resilience on mental health and the interrelations among its dimensions, allowing a nuanced understanding of the construct's protective role.

By integrating these theoretical perspectives, this study hypothesizes that resilience positively predicts mental health outcomes in medical students, with each dimension contributing significantly to overall psychological well-being.

Hypothesis development

Based on the theoretical framework and the Connor-Davidson Resilience Scale (CD-RISC), the following hypotheses are proposed:

Main Hypothesis;

H1*:* Resilience is negatively associated with mental health symptom severity (GSI) among medical students:

H1a: Perception of competence is negatively associated with mental health symptom severity (GSI) among medical students.
H1b: Trust in one's instincts is negatively associated with mental health symptom severity (GSI) among medical students.
H1c: Positive acceptance of change and secure relationships is negatively associated with mental health symptom severity (GSI) among medical students.
H1d: Control is negatively associated with mental health symptom severity (GSI) among medical students.
H1e: Spiritual influences are negatively associated with mental health symptom severity (GSI) among medical students.

Moderation Hypotheses;

H2: The relationship between resilience and mental health is moderated by age.
H3: The relationship between resilience and mental health is moderated by gender.
H4: The relationship between resilience and mental health is moderated by marital status.
H5: The relationship between resilience and mental health is moderated by place of residence.
H6: The relationship between resilience and mental health is moderated by employment status.

These moderation hypotheses aim to explore whether the strength or direction of the relationship between resilience and mental health varies across different demographic groups. The conceptual model of the study, including moderating demographic variables, is illustrated in Fig. 1.

Methods

Study design and setting

This quantitative study employed a descriptive-analytical, cross-sectional design. Data collection and analysis were carried out during the actual study period, from March to May 2025, after which the manuscript was prepared and submitted. The target population included all medical students enrolled at Kerman University of Medical Sciences (KUMS), located in southern Iran. The study aimed to examine the predictive role of resilience on mental health among this student population using structural equation modeling (PLS-SEM).

Kerman University of Medical Sciences (KUMS) is one of the oldest and most prominent academic health institutions in southeastern Iran. KUMS plays a vital role in training healthcare professionals, conducting medical research, and delivering health services to a broad region across the south and southeast of the Iran.

Participants and sampling

The study sample consisted of 385 medical students selected using a proportionate stratified random sampling method. The required sample size was calculated using Cochran's formula [29], which is suitable for estimating sample size in large populations with a known confidence level and margin of error. The formula is as follows:

$$\eta_0 = \frac{Z^2\ p\ (1-p)}{d^2}$$

Where:

- Z = 1.96 (corresponding to a 95% confidence level).
- p = 0.5 (assumed proportion for maximum variability).

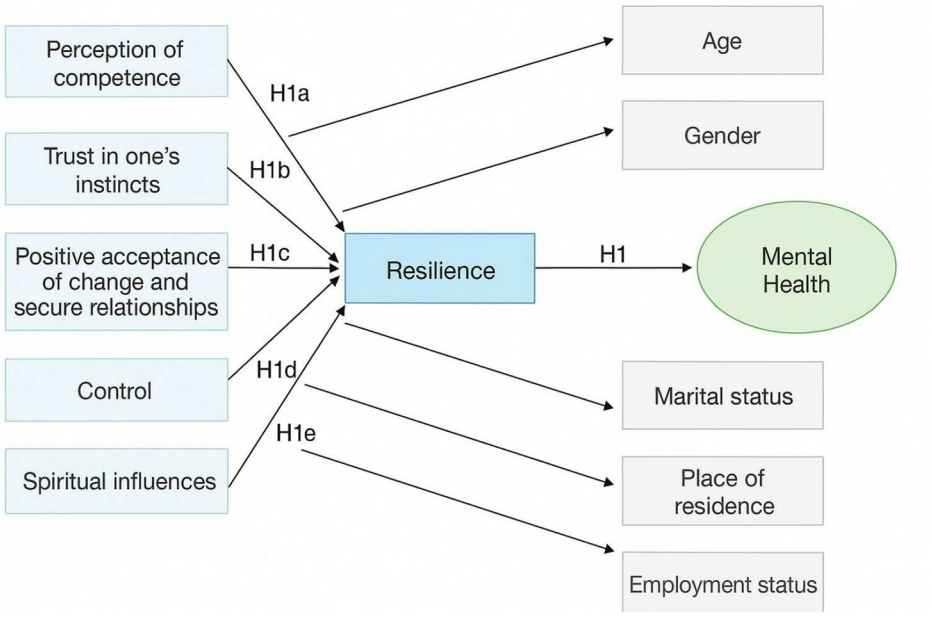

Fig. 1 Conceptual model of the study

- d = 0.05 (margin of error).

Substituting these values:

$$\eta_0 = \frac{(1.96)^2 \ 0.5 \ (1-0.5)}{(0.05)^2} = 384.16 \Rightarrow 385$$

Thus, a sample size of 385 participants was determined to ensure sufficient statistical power and precision. To further justify this sample size, a post hoc statistical power analysis was conducted using G*Power 3.1 software. Based on the model's effect size ($f^2 = 0.10$), an alpha level of 0.05, and 6 predictors in the main regression model, the achieved power (1–β) was 0.95. This indicates that the sample size of 385 was sufficient to detect small to moderate effects with high statistical power.

To obtain a representative sample, proportionate stratified random sampling was used based on the three major phases of medical education at Kerman University of Medical Sciences (KUMS):

I. Basic sciences phase
II. Physiopathology phase
III. Clinical clerkship and internship phase

The sample size required from each academic phase was calculated according to the proportion of students enrolled in each phase. Within each stratum, participants were selected through simple random sampling using student ID numbers and a random number table.

Inclusion and exclusion criteria

To ensure the validity and generalizability of the findings, the following inclusion and exclusion criteria were applied:

Inclusion Criteria: Participants were eligible to participate in the study if they met all of the following conditions:

1. Being a medical student enrolled in one of the academic phases (basic sciences, physiopathology, clinical clerkship, or internship) at Kerman University of Medical Sciences during the first semester of the 2024–2025 academic year.
2. Having completed at least one full semester of medical training to ensure sufficient exposure to academic stressors.
3. Being within the typical age range for university students (18 years or older).
4. Willingness to participate in the study and provide informed consent.
5. Ability to understand and respond to the study questionnaire (in Persian).

Exclusion Criteria: Students were excluded from the study if they met any of the following criteria:

1. Refusal to participate or withdrawal of consent at any stage of the research.
2. Current diagnosis of a psychiatric disorder (e.g., major depressive disorder, generalized anxiety disorder, bipolar disorder) as recorded in

university health records or self-reported during screening.
3. History of significant neurological conditions, such as epilepsy, multiple sclerosis, traumatic brain injury, or any condition that could interfere with cognitive or emotional functioning.
4. Presence of chronic physical illnesses (e.g., diabetes, cancer, autoimmune diseases) that may independently affect psychological well-being.
5. Completion of the questionnaire with missing or inconsistent responses that would impair data analysis.

These exclusion criteria were purposefully applied to control for clinical confounders that might independently influence mental health outcomes, such as chronic illness or psychiatric diagnoses. This approach allowed us to better isolate the role of resilience within a psychologically and physically stable student population. However, we acknowledge that these criteria may introduce a degree of selection bias and limit the generalizability of the findings to broader or more clinically diverse student populations. Therefore, caution is advised when extrapolating these results to students with complex medical or psychological conditions.

Instruments

Data collection was carried out using a structured questionnaire comprising three sections; The first section included a researcher-designed demographic questionnaire that collected basic participant information such as age, gender, marital status (single/married), place of residence (dormitory, with family, or independent), and employment status (employed/unemployed). These variables were used both for descriptive analysis and as potential moderating factors in the structural model.

The second section consisted of the Connor-Davidson Resilience Scale (CD-RISC), a validated 25-item self-report instrument designed to measure resilience across five dimensions: Perception of competence (8 items), Trust in individual instincts (7 items), Positive acceptance of change and secure relationships (5 items), Control (3 items), and Spiritual effects (2 items). Each item is rated on a 5-point Likert scale ranging from 1 (not true at all) to 5 (true nearly all the time), yielding a total score between 25 and 125. Based on the total score, resilience levels are classified as: very low [25–45], low (46–66), moderate (67–87), high (88–108), and very high (109–125). The CD-RISC has been previously validated in Iranian populations and cultural settings. For example, Kalbasi and Zahabion (2019) assessed its psychometric properties among university students in Iran and reported acceptable internal consistency (Cronbach's alpha = 0.84) [30]. The Persian version was adapted through forward-backward translation, reviewed by bilingual experts, and pilot-tested to ensure cultural and linguistic appropriateness. In the present study, a pilot test was also conducted on a subsample of 30 students prior to the main data collection. The internal consistency of the Persian version of CD-RISC was re-evaluated, yielding a Cronbach's alpha of 0.87, indicating good reliability in the current sample.

The third part consisted of the standardized mental health questionnaire (Symptom Checklist-90-Revised, SCL-90-R). This instrument includes 90 items that assess nine major dimensions of psychological symptoms, including: Depression (13 items), Anxiety (10 items), Somatization (11 items), Obsessive-Compulsive symptoms (10 items), Interpersonal Sensitivity (9 items), Hostility (6 items), Phobic Anxiety (7 items), Paranoid Ideation (6 items), and Psychoticism (10 items), along with 7 additional items. Responses are rated on a 5-point Likert scale (none, a little, moderately, quite a bit, extremely), scored from 0 to 4 to reflect symptom severity. The frequency and percentage for each dimension were calculated based on the categorization of items. To compute the Global Severity Index (GSI), the total score from all 90 items was summed and divided by the number of items (90). Based on this index, an average score ≤ 0.5 indicates no psychological symptoms (psychologically healthy), 0.51 to 1.5 reflects mild symptoms, 1.51 to 2.5 indicates moderate symptoms, and scores above 2.5 suggest severe psychological distress. The Persian version of the SCL-90-R has been extensively validated in numerous Iranian studies, confirming its reliability and validity in this cultural context. For example, Akhavan Abiri and Shairi (2020) reported a test-retest reliability coefficient of 0.97, and sensitivity, specificity, and overall accuracy of 0.94, 0.98, and 0.96, respectively [31]. In the present study, a pilot test was also conducted on a subsample of 30 students before the main data collection, and the internal consistency of the SCL-90-R was assessed, yielding a Cronbach's alpha of 0.94, indicating excellent reliability in the current sample.

Procedures

After obtaining ethical approval from the Research Ethics Committee of Kerman University of Medical Sciences and securing informed consent from participants, data collection was carried out in a structured and ethical manner. All eligible students were informed in advance about the study and invited to participate voluntarily. The objectives of the study, the nature of the questions, and the confidentiality of the data were clearly explained to them in a transparent and comprehensible manner. Participants were also explicitly informed about any potential risks, including possible emotional discomfort from responding to sensitive questions related to mental

health and stress. They were advised that they could skip any question they felt uncomfortable answering or withdraw from the study at any time without penalty. On the designated data collection day, printed questionnaires were distributed and collected in person during scheduled class sessions. A trained member of the research team, who had received instruction on ethical data collection procedures, supervised the process to ensure consistency and accuracy. The researcher provided necessary guidance while ensuring that participants could complete the forms privately and without pressure. Informed written consent was obtained from all participants prior to questionnaire distribution. They were explicitly assured that participation was voluntary, their responses would remain anonymous, and the collected data would be used solely for academic research purposes. All questionnaires were completed and returned on the same day to minimize response bias and maximize response rates.

Statistical analysis

Data analysis was conducted using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach with SmartPLS (a software for PLS-SEM) version 4.0.9.6. This method was chosen due to its suitability for predictive modeling, its ability to manage complex models involving multiple latent variables and observed indicators, and its robustness with smaller sample sizes. Furthermore, PLS-SEM was preferred over covariance-based SEM (CB-SEM) because the primary objective of this study was to predict endogenous constructs and explore complex relationships, including moderation effects, rather than to confirm a well-established theoretical model.

The analysis followed a two-step procedure. In the first step, the measurement model (outer model) was evaluated to assess the reliability and validity of the constructs [32]. Indicator reliability was verified through factor loadings, with values ≥ 0.70 considered acceptable [33]. Internal consistency was assessed using both Cronbach's alpha and composite reliability (CR), with thresholds of 0.70 or higher [32]. Convergent validity was confirmed if the Average Variance Extracted (AVE) for each construct was ≥ 0.50 [34]. Discriminant validity was assessed using both the Fornell-Larcker criterion and the Heterotrait-Monotrait ratio (HTMT) [35], ensuring that each latent variable was sufficiently distinct from the others.

In the second step, the structural model (inner model) was analyzed to test the study hypotheses. Prior to interpretation, multicollinearity was checked using the Variance Inflation Factor (VIF), with acceptable values being below 5 [36]. The significance of hypothesized paths was determined through a bootstrapping procedure to estimate standard errors, t-values, and confidence intervals [37]. The model's explanatory power was evaluated using the coefficient of determination (R^2), where values of 0.25, 0.50, and 0.75 were interpreted as weak, moderate, and substantial, respectively [38]. Effect sizes (f^2) were interpreted according to Cohen's guidelines for structural equation models, where 0.02 indicates a small effect, 0.15 medium, and 0.35 large [39]. These values may differ from correlation coefficients due to the inclusion of multiple predictors and model complexity. Additionally, the model's predictive relevance was assessed using the Stone-Geisser Q^2 statistic obtained via the blindfolding procedure, where Q^2 values greater than zero indicated acceptable predictive relevance [40].

Although PLS-SEM does not traditionally rely on global model fit indices like the Root Mean Square Error of Approximation (RMSEA) or the Comparative Fit Index (CFI), recent developments have introduced approximate model fit criteria for PLS-SEM [41]. In this study, model fit was assessed primarily using the Standardized Root Mean Square Residual (SRMR), with additional reference to the Normed Fit Index (NFI) and the Chi-square statistic (χ^2), as generated by SmartPLS 4. An SRMR value below 0.08 was considered indicative of good model fit. While RMSEA, CFI, and the Non-Normed Fit Index/Tucker-Lewis Index (NNFI/TLI) are more commonly used in covariance-based SEM, their reference values (e.g., RMSEA < 0.08, CFI and NNFI > 0.90, and $\chi^2/df < 3$) are reported here for comparison purposes, in line with established thresholds [42]. However, interpretations of these indices in the context of PLS-SEM should be made with caution.

In the correlation analysis section, effect sizes based on Pearson's r were interpreted using Cohen's criteria, where r values around 0.50 represent large effects, 0.30 medium, and 0.10 small [39]. However, in line with recommendations for psychological research, correlations in the range of 0.40–0.45 and above were also considered strong and practically meaningful.

Moderation hypotheses (involving age, gender, marital status, residence, and employment status) were tested by creating interaction terms between resilience and each moderator. These moderators were selected based on theoretical and empirical evidence suggesting their potential influence on mental health outcomes and resilience. Marital status was included because it can affect social support systems, which may buffer stress and thus modulate the impact of resilience on mental health. Employment status influences financial stability and daily stress levels, which can interact with an individual's resilience capacity. Age and gender have been widely reported in the literature as important demographic factors that shape coping mechanisms and psychological resilience. Additionally, residence type, whether living in a dormitory, with family, or independently, affects environmental stressors and social networks that can moderate the

Table 1 Frequency distribution of participants by demographic variables ($n = 385$)

Variable	Category	Frequency	Percentage
Age (years)	18–22	139	36.10
	23–27	154	40.00
	28–32	60	15.60
	33–37	32	8.30
Gender	Male	158	41.00
	Female	227	59.00
Marital status	Single	293	76.10
	Married	92	23.90
Place of Residence	Dormitory	212	55.10
	Non-Dormitory	173	44.90
Employment Status*	Employed	116	30.10
	Unemployed	269	69.90

* Having a legitimate and independent source of income

Table 2 Mean and standard deviation of resilience and mental health, along with their dimensions, in the studied students

Variable	Score Range	Mean	Standard Deviation
Resilience (Total)	**25–125**	**83.42**	**12.35**
Perception of competence	8–40	27.13	4.50
Trust in individual instincts	7–35	23.07	3.96
Positive acceptance of change and secure relationships	5–25	16.83	3.02
Control	3–15	10.72	2.10
Spiritual effects	2–10	5.67	1.54
Mental Health (GSI – SCL – 90 – R)	0–4	1.37	0.71

relationship between resilience and mental health. Therefore, these variables were chosen to explore how different social and demographic contexts might influence the predictive role of resilience. The moderation effects were evaluated using the bootstrapping method to determine their statistical significance at the 0.05 level.

All statistical procedures adhered to a 95% confidence level, and data analyses were interpreted accordingly.

Results

A total of 385 medical students participated in the study. Descriptive statistics for demographic variables are presented in Table 1. The mean age of the participating students was 22.43 ± 1.25 years, with the majority (40.00%) falling within the 23–27 age group. Among participants, 227 (59.00%) were female and 158 (41.00%) were male. Most students were single (293, 76.10%) and the majority lived in dormitories (212, 55.10%). Additionally, 116 students (30.10%) were employed while studying (Table 1).

Table 2 presents the mean and standard deviation (SD) for the total scores of resilience and mental health, along with their dimensions. The mean resilience score was 83.42 out of 125 (SD = 12.35), indicating a moderate to high level. The mean Global Severity Index (GSI) score for mental health was 1.37 out of 4 (SD = 0.71), reflecting mild psychological symptoms overall (Table 2).

Pearson correlation coefficients indicated significant associations between resilience and mental health. As hypothesized, higher levels of resilience and its subcomponents were significantly associated with better mental health. Since higher scores on the GSI reflect more severe symptoms, this protective relationship is reflected by negative correlations. The strongest inverse correlation was observed between "perception of competence" and GSI ($r = -0.48$, $p < 0.001$, interpreted as a strong and practically meaningful effect size), followed by "trust in one's instincts" ($r = -0.40$, $p < 0.001$, strong effect), "positive acceptance of change and secure relationships" ($r = -0.37$, $p < 0.001$, moderate-to-strong effect), "control" ($r = -0.32$, $p < 0.001$, moderate effect), and "spiritual influences" ($r = -0.28$, $p < 0.001$, small-to-moderate effect). These results suggest that, within psychological constructs, correlations of moderate to higher magnitude are generally considered strong and meaningful, reinforcing the protective role of resilience against psychological distress (Table 3).

Before model estimation, key assumptions were tested. Item-level outer loadings for all indicators are presented in Supplementary Table S1. Most indicators met or exceeded the recommended threshold of 0.70, and those slightly below still contributed meaningfully to their respective constructs. Composite reliability values ranged from 0.78 to 0.91 for all latent variables, and average variance extracted (AVE) values exceeded 0.50, establishing convergent validity. For the two-item Spiritual influences construct, both items demonstrated acceptable loadings (0.71 and 0.75; see Table S1), with

Table 3 Pearson correlations between resilience dimensions and mental health

Variables	1	2	3	4	5	6	7
Resilience (Total)	1	---	---	---	---	---	---
Perception of competence	0.89*	1	---	---	---	---	---
Trust in one's instincts	0.83*	0.68*	1	---	---	---	---
Positive acceptance & relationships	0.78*	0.64*	0.59*	1	---	---	---
Control	0.70*	0.53*	0.50*	0.58*	1	---	---
Spiritual influences	0.58*	0.46*	0.42*	0.40*	0.36*	1	---
Mental Health (GSI)	−0.45*	−0.48*	−0.40*	−0.37*	−0.32*	−0.28*	1

r; Pearson Correlation Coefficient. All correlations are statistically significant at $p < 0.001$

Table 4 Fornell–Larcker criterion for discriminant Validity*

Construct	1	2	3	4	5	6
Perception of competence	**0.79**	---	---	---	---	---
Trust in one's instincts	0.68	**0.76**	---	---	---	---
Positive acceptance & relationships	0.64	0.59	**0.78**	---	---	---
Control	0.53	0.50	0.58	**0.77**	---	---
Spiritual influences	0.46	0.42	0.40	0.36	**0.73**	---
Mental Health (GSI)	−0.48	−0.40	−0.37	−0.32	−0.28	**0.75**

* Diagonal values are the square roots of AVE, exceeding inter-construct correlations, supporting discriminant validity

Table 5 Discriminant validity assessment using Heterotrait-Monotrait (HTMT) Ratios*

Construct	1	2	3	4	5	6
Perception of competence	---	---	---	---	---	---
Trust in one's instincts	0.74	---	---	---	---	---
Positive acceptance & relationships	0.70	0.65	---	---	---	---
Control	0.58	0.55	0.61	---	---	---
Spiritual influences	0.49	0.46	0.44	0.39	---	---
Mental Health (GSI)	0.52	0.45	0.41	0.36	0.32	---

* HTMT values are reported as absolute ratios; therefore, all coefficients appear positive regardless of the direction of the underlying correlations

CR = 0.78 and AVE = 0.53, meeting recommended benchmarks for construct reliability and validity. Discriminant validity was further evaluated by reporting the Fornell–Larcker criterion (Table 4) and the Heterotrait-Monotrait ratio (HTMT) (Table 5). Although correlations among resilience sub-dimensions were moderate to high (e.g., 0.68 between perception of competence and trust in one's instincts), all square roots of AVE on the diagonals exceeded the inter-construct correlations, and all HTMT values were below the conservative threshold of 0.85. This indicates that the constructs, while conceptually related, remain statistically distinct (Tables 4 and 5).

The bootstrapping procedure was conducted with 5000 iterations to obtain stable estimates of standard errors and t-values. Furthermore, predictive relevance of the model was assessed using the Stone-Geisser Q^2 statistic obtained through the blindfolding procedure. All Q^2 values for the endogenous constructs were greater than zero, confirming acceptable predictive relevance.

Model fit was evaluated with PLS-SEM appropriate indices. The standardized root mean square residual (SRMR) was 0.06, indicating good fit. Other global fit indices ($\chi^2/df = 1.53$; RMSEA = 0.04; CFI = 0.94; NNFI/TLI = 0.93; NFI = 0.91; RMS_theta = 0.10) were also calculated, but these are designed for covariance-based SEM and should not be over interpreted in the PLS-SEM context.

The Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis supported all main and sub-hypotheses. Resilience was significantly associated with better mental health outcomes. This association is represented by a negative path coefficient ($\beta = -0.41$, $t = 9.14$, $p < 0.001$), due to the reverse scoring of the GSI. In examining the five sub-hypotheses (H1a–H1e), all dimensions of resilience demonstrated significant contributions to mental health. Specifically, perception of competence (H1a) was significantly associated with better mental health ($\beta = -0.33$, $p < 0.001$), as was trust in one's instincts (H1b) ($\beta = -0.28$, $p < 0.001$). Positive acceptance of change and secure relationships (H1c) also showed a meaningful relationship ($\beta = -0.23$, $p < 0.001$), while control (H1d) had a smaller but significant effect ($\beta = -0.19$, $p < 0.001$). Spiritual influences (H1e) were weakly but significantly associated with improved mental health ($\beta = -0.16$, $p < 0.001$). These findings confirm that each resilience dimension individually contributes to mental health outcomes among medical students.

In addition to the statistical significance, effect sizes (f^2) were calculated to assess the practical significance of the resilience dimensions on mental health outcomes. The effect sizes ranged from small to medium, with the largest effect observed for the "perception of competence" dimension ($f^2 = 0.16$), indicating a meaningful impact. Other dimensions showed small to moderate effects, reinforcing the protective role of resilience components against psychological distress. Importantly, the overall effect size of resilience on mental health was medium ($f^2 = 0.22$), highlighting the substantial practical significance of resilience as a protective factor against psychological distress.

Among the demographic moderators, only marital status significantly moderated the relationship between resilience and mental health ($\beta = -0.11$, $p = 0.01$, $f^2 = 0.04$). The interaction term indicated that the protective effect of resilience on reducing mental health symptoms was slightly stronger among married students compared to their single counterparts. However, given the small effect size, this moderation should be interpreted with

Table 6 Path coefficients and moderation analysis results for the structural model

Path	Standardized Coefficient (β)	*P*-value	Effect Sizes (f^2)	Result
Resilience → Mental Health Symptom Severity (GSI)	−0.41	< 0.001	0.22	Supported
Perception of competence → Mental Health Symptom Severity (GSI)	−0.33	< 0.001	0.16	Supported
Trust in one's instincts → Mental Health Symptom Severity (GSI)	−0.28	< 0.001	0.12	Supported
Positive acceptance & relationships → Mental Health Symptom Severity (GSI)	−0.23	< 0.001	0.10	Supported
Control → Mental Health Symptom Severity (GSI)	−0.19	< 0.001	0.08	Supported
Spiritual influences → Mental Health Symptom Severity (GSI)	−0.16	0.004	0.05	Supported
Marital Status * Resilience → Mental Health Symptom Severity (GSI)	−0.11	0.01	0.04	Supported (small effect, stronger in married students)

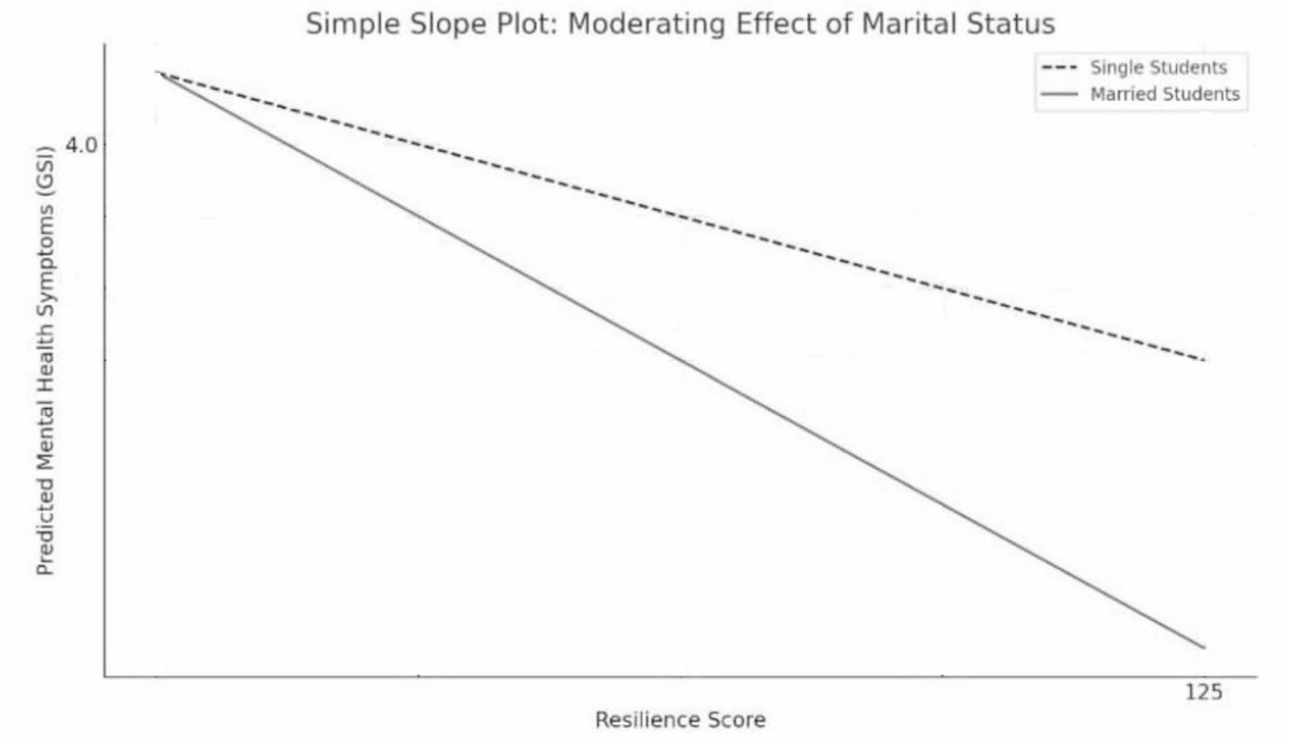

Fig. 2 Effect of Resilience on Mental Health by Marital Status

caution. For other demographic moderators (age, gender, place of residence, and employment status), no significant moderating effects were found (Table 6).

To better illustrate the moderation effect, a simple slope plot was generated. As shown, the protective association between resilience and mental health symptoms was stronger for married students, indicating a steeper negative slope compared to single students (Fig. 2).

It is important to note that these results are based on data collected from a single university in Iran, which may influence their applicability in other cultural or institutional settings.

Figure 3 shows the results of the structural model along with the path coefficients between the dimensions of resilience and mental health (Fig. 3).

Discussion

The present study explored the relationship between resilience and mental health among medical students, offering valuable insight into psychological functioning in a highly demanding academic environment. The observed overall levels of resilience suggested that students possess moderate to high psychological adaptability, while mental health status generally reflected mild

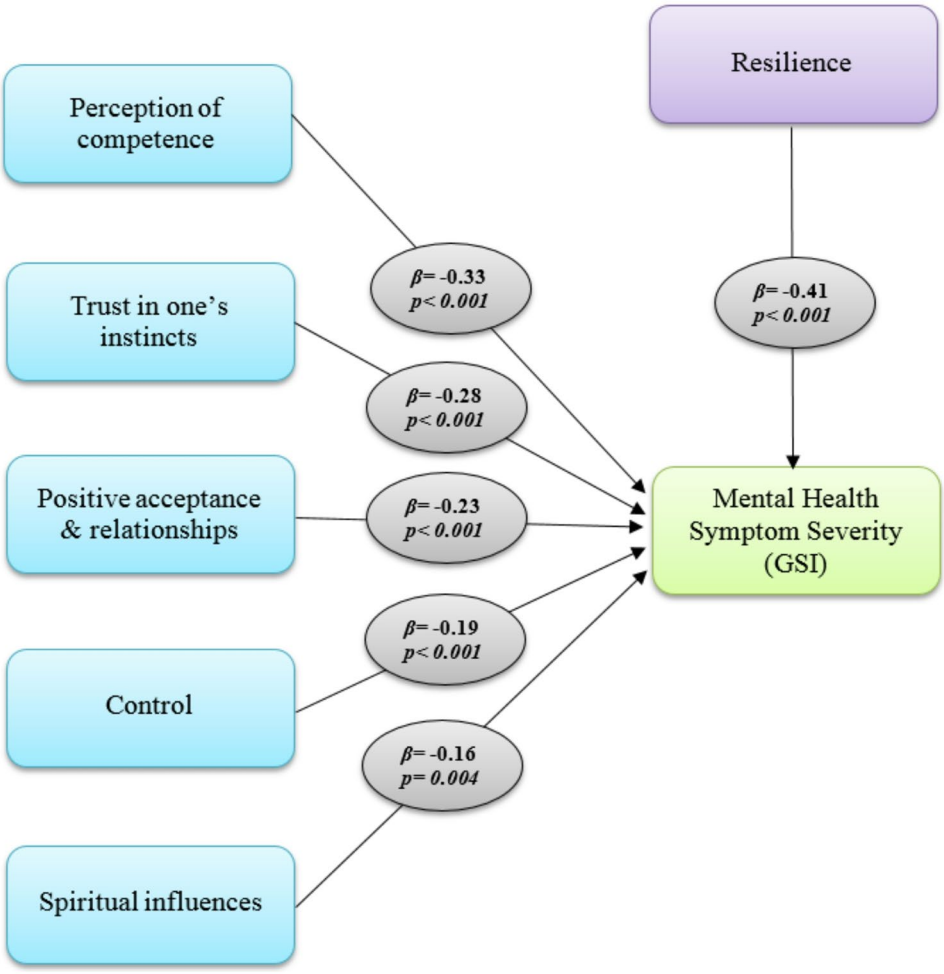

Fig. 3 Structural Model Results Showing Path Coefficients between Resilience Dimensions and Mental Health

distress. These findings are in line with the general pattern found in prior research, though slight variations may exist due to differences in academic stressors, support systems, and institutional environments [11, 43–45].

Several studies have similarly reported that medical students often demonstrate moderate resilience. For example, Tempski et al. (2015) emphasized that resilience is an essential trait for medical students facing academic and emotional challenges, and found comparable resilience profiles across Brazilian and U.S. cohorts [11]. Likewise, Jafarianamiri et al. (2022) identified that the majority of Iranian nursing students scored within the moderate range of resilience, suggesting cultural parallels in coping tendencies [43]. A study by Saad and Ali (2025) also confirmed that Pakistan medical students often maintain moderate resilience despite exposure to chronic academic stressors [44]. These consistent findings suggest that while resilience is present, it may not be fully protective unless actively supported and strengthened.

Regarding mental health, our findings align with those of Dyrbye et al. (2006), who documented mild to moderate symptoms of distress - such as anxiety and somatization - among U.S. medical students, particularly during preclinical training [45]. Moreover, a study by Quek et al. (2019) found that Asian medical students frequently experience elevated psychological symptoms despite outward signs of functionality, indicating an undercurrent of emotional burden [3]. The general comparability of these patterns points to the universality of stress across medical education systems and highlights the need for targeted mental health strategies.

The central finding of a negative association between resilience and psychological symptoms aligns with a growing body of literature. For instance, Herrman et al. (2011) posited that resilience serves as a buffer against stress-related disorders, and more empirical studies, such as those by Yu and Zhang (2007), confirm that resilience significantly predicts lower levels of depression and anxiety among university students [46, 47]. Similarly, Du et al. (2024) demonstrated that emotional competence and self-efficacy - both components of resilience

- are inversely related to emotional exhaustion in medical trainees [48].

Importantly, our finding that specific dimensions of resilience, such as perception of competence and trust in one's instincts - had the strongest inverse relationships with mental health symptoms supports prior conceptualizations. For example, Campbell-Sills et al. (2006) identified perceived control and problem-solving confidence as critical mechanisms by which resilience mitigates psychological distress [49]. These dimensions not only promote adaptive coping but also foster internal validation, which may be especially critical in performance-driven fields like medicine.

Moreover, the observed overall effect size of resilience on mental health ($f^2 = 0.22$) was moderate and supports the practical significance of this relationship. This magnitude is comparable to or slightly larger than the effects reported in previous studies among university and medical student populations. For example, the recent meta-analysis by Luo et al. (2025) reported a pooled correlation of $r \approx -0.39$ (equivalent to medium effect) between trait resilience and negative mental health indicators (such as depression or anxiety) in adolescents and young adults [50]. While not directly reporting f^2, this correlation aligns with medium-sized effects in SEM contexts. Additionally, resilience and well-being among medical students at Semmelweis University were significantly correlated, and regression models explained large proportions of variance ($R^2 \approx 0.43–0.64$), again consistent with medium effect sizes seen in our SEM results [51]. These comparisons reinforce the relevance and generalizability of our findings across Hungarian academic settings.

The moderating role of marital status adds an important contextual layer. Married students experienced a slightly stronger protective effect of resilience on mental health, a pattern supported by studies suggesting that intimate partnerships provide emotional regulation and buffering against stress. Robles et al. (2014) found that emotional support from spouses significantly enhances stress recovery, while Kiecolt-Glaser and Newton (2001) showed that marital satisfaction is linked with improved psychological resilience [52, 53]. Although marital status was treated as a binary variable in this study, the underlying mechanisms, such as social support, emotional availability, and financial stability, were not directly measured. Future research could assess these factors more directly to test the proposed pathways. One potential mechanism underlying this moderation effect is the enhanced availability of consistent emotional and instrumental support in married life, which may facilitate more adaptive coping strategies. According to the social support buffering hypothesis, social support acts as a protective factor that mitigates the negative effects of stress by promoting effective coping and reducing emotional distress. Social support from a spouse can act as a co-regulator of emotional responses, reduce perceived stress, and reinforce self-efficacy, factors known to synergize with resilience. Moreover, the stable and reciprocal nature of marital relationships provides ongoing access to resources such as empathy, advice, and tangible help, which can strengthen individuals' capacity to manage psychological challenges. Overall, while marital status may influence the resilience–mental health relationship, its effect is modest and should be interpreted with this limitation in mind. These findings suggest that interventions targeting social support, including peer mentorship or couple-based stress management, could strengthen resilience-based outcomes, although further research measuring the specific contributing factors is warranted.

In sum, this study affirms that resilience serves as a key protective factor for mental health among medical students, particularly when reinforced by supportive relationships. Future programs should not only aim to enhance students' internal coping resources but also address the broader social and academic environments that shape resilience expression.

Policy implications and recommendations

Given the significant association between resilience and better mental health - particularly among married students - it may be beneficial for educational policymakers and university administrators to consider the following approaches:

- Incorporating resilience training into the medical curriculum, with an emphasis on enhancing students' sense of competence and trust in their own instincts.
- Organizing workshops and support groups to help students develop adaptive coping strategies, especially targeting single students who may have less access to natural social support networks.
- Providing psychological counseling services that include the assessment and strengthening of resilience as part of a proactive approach to student mental health.
- Designing tailored interventions that account for marital status and other demographic characteristics, ensuring that support services are responsive to the diverse needs of student subgroups.

Limitation

This study had several limitations. First, the cross-sectional design limits the ability to infer causality between resilience and mental health outcomes. This means that while associations can be identified, the directionality and temporal sequence of these relationships remain uncertain. Second, the reliance on self-reported data may

introduce response bias. In particular, common method bias could have inflated the observed relationships due to the use of a single data collection method for both predictors and outcomes. Participants might have responded in a socially desirable manner or been influenced by their current mood, potentially affecting the accuracy of their responses. Third, the sample was drawn from a single university in Iran, which inherently limits the generalizability of the findings to other cultural, regional, or institutional contexts. This geographic and institutional specificity might restrict the applicability of the results to medical students in different environments. Fourth, the application of strict exclusion criteria, such as omitting students with diagnosed psychiatric disorders, may introduce selection bias, potentially leading to an overestimation of resilience levels and underestimation of mental health challenges in the broader medical student population. This selection bias should be carefully considered when interpreting the results, as it may affect the representativeness of the findings. Future research should consider conducting sensitivity analyses to evaluate the impact of such exclusions on study outcomes and aim to include more diverse samples from multiple institutions and regions. Fifth, potential confounding variables such as academic year, prior mental health history, and socioeconomic status were not controlled in this study, which may have influenced the observed associations. Future studies should account for these factors to better isolate the true effects of resilience on mental health.

Conclusion

This study investigated the relationship between resilience and mental health among medical students, highlighting both the overall impact and the specific contributions of resilience sub dimensions. The findings confirmed a significant negative association, indicating that higher resilience is associated with lower levels of psychological symptoms. Among the five dimensions, perception of competence and trust in one's instincts had the strongest protective effects. Additionally, marital status moderated this relationship, suggesting that the protective role of resilience in reducing mental health symptoms is more pronounced among married students. These results underscore the critical role of resilience in promoting psychological well-being in medical education contexts.

Suggestions for future research

Future research may benefit from exploring several directions. Longitudinal and mixed-methods designs could help illuminate the causal relationships and temporal dynamics between resilience and mental health more comprehensively. While longitudinal studies allow for examining changes over time and potential causal pathways, mixed-methods approaches can combine quantitative data with qualitative insights to capture the complexity of resilience as experienced by students. Qualitative approaches might offer deeper insights into how various components of resilience manifest and function in students' daily lives. Additionally, intervention-based studies could be valuable in evaluating the effectiveness of programs aimed at enhancing resilience and promoting mental well-being. Comparative research involving students from different academic disciplines or cultural backgrounds may also shed light on possible variations in the resilience–mental health relationship.

Abbreviations

PLS-SEM	Squares Structural Equation Modeling
CD-RISC	Connor-Davidson Resilience Scale
SCL-90-R	Symptom Checklist-90-Revised
GSI	Global Severity Index
KUMS	Kerman University of Medical Sciences

Supplementary Information

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Supplementary Material 1

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Authors' contributions
AB, FK and ARY designed the study and prepared the initial draft. AB contributed to data collection and analysis. ARY, FK and AB supervised the entire study and finalized the article. All authors have read and approved the manuscript.

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Data availability
All data is presented as part of the tables or figures. De-identified datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study is approved by the Kerman University of Medical Sciences Ethics Committee under ID number IR.KMU.REC.1403.605. All methods were carried out in accordance with relevant guidelines and regulations. Written informed consent was obtained from all subjects and/or their legal guardians.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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