

The Effect of the Medical Education Environment on Medical Students' Academic Performance Through the Serial Mediating Roles of Mental Health and Learning Engagement

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Abstract: The aim of this study is to explore the relationship between the medical education environment and the academic performance of medical students. By further analyzing the roles of mental health and learning engagement in the medical education environment and academic performance, the mechanism by which the medical education environment affects academic performance is clarified. Using the questionnaire survey method, a questionnaire survey was conducted on 615 medical students. The "Medical Education Environment Scale", "Mental Health Scale", "Learning Engagement Scale", and "Medical Student Academic Performance Scale" were used to measure the educational environment, mental health, learning engagement, and academic performance of the medical students. SPSS and its macro program PROCESS were used to analyze and process the data, and the following results were obtained: (1) The medical education environment affects the academic performance of medical students. The better the educational environment, the better the academic performance of medical students. (2) Mental health has a mediating effect between the medical education environment and academic performance; learning engagement has a mediating effect between the medical education environment and academic performance. (3) The medical education environment affects the academic performance of medical students through the chain mediating effect of mental health and learning engagement. The study aims to improve the medical education environment and provide a theoretical basis for the improvement of medical students' academic performance.

Keywords: Medical education environment; Academic performance; Mental health; Learning engagement; Chain mediating effect

1. Introduction

The medical education environment, as the cradle for medical talent cultivation, plays a crucial role in students' growth and development [1-2]. A favorable learning environment not only helps students master medical professional knowledge but also promotes their moral and professional cultivation [3-4]. The medical education environment is mainly reflected in aspects such as the learning atmosphere, faculty strength, and teaching facilities. These environments influence students' academic performance by affecting their mental health status and learning engagement.

A favorable learning atmosphere can stimulate students' interest in learning and improve their mental health, thereby promoting their academic growth [5-6]. Schools should advocate a positive academic



atmosphere, encouraging students to study diligently and be innovative. At the same time, schools should hold various academic activities, lectures, and seminars to provide platforms for students to showcase their talents. Secondly, the faculty strength is the core component of the medical education environment for medical students. An excellent teaching team not only possesses profound medical theoretical knowledge but also has rich clinical practical experience. They can provide professional academic guidance to students and help them solve learning difficulties and problems [7-9]. In terms of teaching facilities, a high-quality medical school should have advanced medical laboratories, simulation teaching systems, and libraries, etc. These facilities can provide students with a practical environment in line with modern medicine and stimulate their learning interest and engagement, thereby improving academic performance [10-12]. Laboratories should have advanced and precise equipment to ensure that students' experimental operations comply with industry standards; simulation teaching systems can provide students with real medical scene simulation experiences to improve their clinical response capabilities; the library, as an important place for learning, should provide rich medical book resources and information query systems to meet students' different learning needs.

Regarding the impact of the medical education environment on medical students' academic performance, the literature [13] aims to explore the influence of academic pressure and educational environment on medical students' quality of life and academic performance, and the survey results show that medical students face many challenges and bear significant academic pressure, even though they feel a favorable educational environment, these factors will negatively affect their learning performance. The literature [14] analyzes the relationship between educational environment, student participation, and academic achievement in medical education, and the survey results indicate that the educational environment directly affects emotional participation, and students' perception of learning and their self-evaluation of academic performance affect behavioral participation. The literature [15] analyzes medical students' perception of their learning environment, as well as the influence of motivation, learning strategies, and emotional intelligence on academic performance. The questionnaire results show that motivation is a significant predictor of academic achievement, followed by learning ability, emotional intelligence, and educational environment. The literature [16] aims to assess medical students' perception of their learning environment and analyze the relationship between their academic performance and perception. Using the Dundee Education Environment Preparation Scale (DREEM) questionnaire to assess students' perception of the teaching environment, the results show that using the DREEM scale helps understand students' views on the academic environment. The literature [17] aims to analyze the differences in test scores between students trained with an integrated organ system curriculum system and those with a traditional medical school curriculum system. The experimental results indicate that after introducing the integrated organ system curriculum, students' test scores have significantly improved. The literature [18] aims to evaluate the learning environment and learning methods of clinical-stage medical students, and the research results show that medical students have a more positive perception of the academic environment and tend to adopt more in-depth learning methods. The literature [19] points out that students' perception of the learning environment may help enhance their self-study readiness, thereby improving academic performance, and through investigation, this conclusion has been verified, and it is recommended that medical service education practitioners provide a supportive learning environment. Reference [20] presented the monitoring research results on the impact of the teaching environment of a medical education institution on students' academic performance and the quality of comprehensive ability cultivation, emphasizing that the learning environment is directly beneficial for cultivating students' professional clinical thinking ability and promoting the formation of their professional skills. Reference [21] aimed to assess the students' perception of the educational environment, learning methods, and their relationship with academic performance, and the research results indicated that students' perception of the educational environment is influenced by multiple factors, which may affect their academic performance. Reference [22] analyzed the positive impact of the learning environment on learning engagement, and the questionnaire results showed that a good learning environment helps to improve medical students' learning engagement, and the higher the level of the learning environment, the higher the degree of learning engagement of medical students. Reference [23] aimed to investigate the medical students' views on the educational environment at Jeddah Medical College, and the survey results indicated that students' evaluation of the medical course learning environment was generally positive, but students' perception of teaching faced deficiencies. Reference [24] used spatial measurement of Geographic Information System (GIS) to study the relationship between green space, students' socio-economic factors and academic performance, emphasizing that these factors would have an impact on students' academic performance and would be beneficial for providing a basis for landscape designers. Reference [25] investigated which self-regulated learning skills would affect students' academic performance during the first and second academic years of a medical school in the inland region of the United States, and the survey results indicated that peer learning

and seeking help behaviors had a positive impact on the academic performance of first and second-year students; review behaviors had a negative impact on students' grades. Reference [26] discussed responsibility and perception of the educational environment as independent and interacting predictive factors of medical students' academic performance in the Berg Learning Theory Model, and the research results showed that responsibility and perception of the educational environment could predict the performance of computerized assessment.

This study adopted the method of stratified cluster sampling to select medical undergraduates from a certain medical university as the research subjects. The questionnaire survey was conducted through online investigation in the form of Questionnaire Star. The questionnaire included general situation questionnaires, medical education environment scale, mental health scale, learning engagement scale, and medical students' academic performance scale, to assess the demographic characteristics of medical students and their levels of educational environment, mental health, learning engagement and academic performance. One-way analysis of variance and independent sample t-test were used to compare whether there were significant differences in the four variables among medical students with different demographic characteristics; Pearson correlation analysis was used to clarify the relationship between students' academic performance and related factors; regression analysis was used to explore the important factors affecting medical students' academic performance, and further explore the single mediating effect of mental health and learning engagement and the chain mediating effect between the medical education environment and academic performance. The chain mediating effect between mental health and learning engagement in the medical education environment and academic performance was verified using the non-parametric percentile Bootstrap method for bias correction.

2. Object and Method

2.1. Research Hypotheses

This study investigates the relationship between the medical education environment and the academic performance of medical students, and explores the mediating roles of mental health and learning engagement in this relationship to clarify their connection. Therefore, the following research hypotheses are proposed:

H1: There is a correlation among the four variables of medical education environment, academic performance, mental health, and learning engagement.

H2: The medical education environment can significantly predict the academic performance of medical students.

H3: Mental health may have a mediating effect between the medical education environment and the academic performance of medical students.

H4: Learning engagement may have a mediating effect between the medical education environment and the academic performance of medical students.

H5: Mental health and learning engagement may have a chain mediating effect between the medical education environment and the academic performance of medical students.

2.2. Survey Participants

The research employed a stratified cluster sampling method, selecting medical students from a certain medical university based on their grade as the stratification factor. Two classes were randomly selected from each grade. To ensure the rigor of the statistics, this study first used the sample size estimation formula in health statistics to estimate the sample size, and then conducted a sampling survey.

$$\text{Sample size estimation formula: } N = \frac{Z_{\alpha}^2 \pi(1-\pi)}{\delta^2}.$$

Here, π is the estimated proportion of the target outcome group in the overall population, δ is the allowable error, and α is the significance level. By referring to relevant literature, the incidence rate of poor academic performance among medical students fluctuates between 15% and 22%. Therefore, we take 18.12% for calculation. That is, $\pi = 0.1812$, the allowable error δ is set at 5%, the significance level $\alpha = 0.05$. Based on the simple random sampling sample size calculation formula, the sample size is 226 cases. Considering that there are invalid and unanswered questions in the questionnaire survey, a conservative effective response rate of 80% is set. Then, the adjusted sample size required is 282 cases. Since the efficiency of stratified cluster sampling is lower than that of simple random sampling, the design effect value is set at 1.5 for further adjustment. Finally, the required sample size to be completed is 423 cases. In total, 615 cases of data were collected, invalid questionnaires were excluded, and a total of 595 valid questionnaires were obtained, with a questionnaire validity rate of

96.75%. The average age of the respondents is 20.60 ± 1.47 years old.

2.3. Research Tools

(1) Self-compiled general information questionnaire

This questionnaire includes demographic variables such as gender, age, grade, major, parents' educational background, and family economic status.

(2) Medical Education Environment Scale (DREEM)

This scale was developed by the University of Dundee in the UK and translated and revised by China Medical University [27]. It consists of 5 dimensions: learning perception, teacher perception, academic perception, environmental perception, and social perception, with a total of 50 items. Each item uses the Likert 5-point rating method, where "very disagree" is scored 0, "disagree" 1, "uncertain" 2, "agree" 3, "very agree" 4, and the total scale has 9 items with reversed scoring. The total score is 200 points. This scale is widely used in related research. The internal consistency reliability coefficient of the total scale in this study is 0.962.

(3) Mental Health Scale (CCSMHS)

This scale was compiled by the research team of the "Chinese College Students' Mental Health Assessment System" of the Ministry of Education and includes 12 dimensions: somatization, anxiety, depression, inferiority, social withdrawal, social aggression, sexual psychology, paranoia, obsession, dependence, impulsivity, and psychopathic tendency. The scale has 104 items, each item is answered on 5 levels: 1 = no, 2 = occasionally, 3 = sometimes, 4 = often, 5 = always. The higher the score, the lower the mental health level of college students; the lower the score, the higher the mental health level. The reliability of the questionnaire is 0.69, and the validity coefficient is 0.79. The total score is the sum of 104 individual items, reflecting the severity of the condition.

(4) Learning Engagement Scale (UWES-S)

This study selected the Chinese version of the UWES-S learning engagement scale, which includes 6 items of energy, 5 items of motivation, and 6 items of concentration, totaling 3 dimensions and 17 items [28]. It uses the Likert 5-point rating method, from "very disagree" to "very agree" represented by 1 to 5. The total score ranges from 17 to 85 points. A score of 60 or above indicates high learning engagement of students, a score of 50 to 59 indicates medium learning engagement, and a score below 50 indicates low learning engagement. The internal consistency reliability coefficient of the total scale in this study is 0.958.

(5) Academic Performance Scale (MAPS)

This study used the self-compiled academic performance scale, which includes three dimensions: learning attitude, learning behavior, and academic performance, with a total of 52 questions. It uses the Likert 5-point rating method, from "very disagree" to "very agree" represented by 1 to 5. The total score is 210 points. The higher the score, the better the academic performance atmosphere. The internal consistency reliability coefficient of the total scale in this study is 0.965.

2.4. Quality Control

In the early stage, through the collection and reading of relevant domestic and foreign literature, and by referring to existing research experiences and results, the relevant plan for this study was designed to lay the foundation for the subsequent activities.

In the middle stage, psychology experts were invited to provide suggestions and guidance for the previously designed research plan, thereby further optimizing the initial plan and facilitating a scientific and smooth research path.

Questionnaire distribution: The investigators received unified training, understood the ideas and requirements of the survey, and clearly explained the purpose and significance of the survey when distributing the questionnaires, informed the precautions and privacy confidentiality to ensure that the sample group could fill out the questionnaires truly and effectively and provide true information. The questionnaires were collected on the spot after distribution.

Data input, collection and organization: Trained personnel used a double-input method to ensure the accuracy of data input. When the missing items in the questionnaire exceeded 10%, the questionnaire was excluded. After data input was completed, a portion of the questionnaires were randomly selected for verification and inspection.

2.5. Data Collection and Analysis

Carefully review all the returned questionnaires, eliminate the invalid ones that do not follow the required answers, randomly mark the results, or omit certain questions, and then uniformly code all the valid questionnaires. Subsequently, enter them into Excel and conduct preliminary sorting.

Use SPSS 21.0 statistical software to conduct statistical analysis of the data. In this study, the statistical description is expressed as the mean $\pm$ standard deviation ($X \pm S$); the reliability analysis calculates the Cronbach's α coefficient; in the single-factor analysis, the comparison between the two groups is conducted using the t-test, the comparison among multiple groups is conducted using the F test and the Kruskal-Wallis test (K-W test), and the pairwise comparison among multiple groups is conducted using the q test. Correlation analysis uses Pearson correlation analysis. Mediation analysis uses SPSSamos 22.0, and the mediation effect test uses the deviation-corrected non-parametric percentile Boot-strap method. $P < 0.05$ indicates statistically significant differences.

3. Results

3.1. Analysis of Common Method Bias

Common method bias refers to a systematic error that may occur due to the same data sources, measurement environments, and project backgrounds, where there is an artificial co-variance between the predictor variables and the criterion variables. Since this study collected data for all four variables using the Questionnaire Star form, it is necessary to conduct a common method bias analysis and test for the corresponding scales before data analysis. The analysis was conducted using the Harman single-factor test method, and the results showed that there were 10 factors with characteristic roots greater than 1, and the variance explained by the first factor was 36.82%, which was less than the critical value of 40%. Therefore, it can be inferred that this study does not have a serious common method bias.

3.2. Descriptive Statistical Analysis

(1) Demographic Characteristics of Medical Students

This study took undergraduate medical students currently enrolled in a certain medical college as the research subjects. A total of 615 questionnaires were distributed. After strict screening, those with logical errors in the answers, deliberate incorrect responses or regular patterns of answering, or with a large number of missing items were excluded. Eventually, 595 valid questionnaires were retrieved, with an effective recovery rate of 96.75%. The demographic characteristics of the medical students are shown in Table 1. The average age of the 595 included medical students was 20.60 ± 1.47 years old. Among them, there were 265 males (44.5%) and 330 females (55.5%). The ratio of males to females was similar to that of the survey sample.

Table 1. The results of the demographic characteristics of medical students

Tested feature	Categories	Frequency	Percentage
Gender	Male	265	44.5%
	Female	330	55.5%
Grade	Freshman	199	33.4%
	Sophomore	209	35.1%
	Junior	187	31.4%
To be an only child	Yes	152	25.5%
	No	449	75.5%

(2) Descriptive statistics of each variable

Descriptive statistics were conducted on the data of the four variables: medical student educational environment, academic performance, mental health, and learning engagement. The results of the descriptive statistics for each scale are shown in Table 2. The overall scores of the medical students participating in this study in terms of educational environment, academic performance, mental health, and learning engagement were all above the theoretical median. This indicates that the medical students participating in this study have a favorable educational environment, academic performance, and learning engagement, but they also have relatively serious mental health problems.

Table 2. Descriptive statistical analysis of each scale

Variable	M±SD	Minimum	Maximum
Education environment	105.23±16.784	50	200
Mental health	300.05±50.225	104	520
Learning input	45.25±27.126	17	85
Academic performance	107.49±20.116	52	210

(3) Analysis of differences of each variable in terms of demographic variables

To investigate the differences of the four variables (education environment, academic performance, mental health, and learning engagement) among genders, an independent sample t-test was conducted using SPSS. The results of the gender differences are shown in Table 3. There were significant differences in the education environment and mental health variables between genders ($t(595) = -5.858$, $p < 0.001$; $t(595) = -3.225$, $p < 0.01$). Girls perceived the education environment and academic performance to be significantly higher than those of boys. There were no significant differences in mental health and learning engagement variables between genders ($t(595) = -0.211$, $p > 0.05$; $t(595) = -0.525$, $p > 0.05$).

Table 3. Differences in gender differences in variables

Variable	Gender	M±SD	t
Education environment	Male	102.46±15.221	-5.858***
	Female	128.44±16.629	
Mental health	Male	298.36±48.446	-0.211
	Female	303.44±47.652	
Learning input	Male	44.62±26.644	-0.525
	Female	45.78±27.111	
Academic performance	Male	105.22±19.956	-3.225**
	Female	115.44±20.005	

In order to explore the differences of the four variables (educational environment, academic performance, mental health, and learning engagement) across grades, a variance analysis was conducted using SPSS. The results of the grade differences are shown in Table 4. There were significant differences in educational environment, academic performance, mental health, and learning engagement across grades ($F(2,595) = 30.125$, $P < 0.001$; $F(2,595) = 36.626$, $P < 0.001$; $F(2,595) = 62.005$, $P < 0.001$; $F(2,595) = 58.056$, $P < 0.001$). According to the post-hoc comparison results, it can be seen that educational environment and mental health showed a trend of increasing first and then decreasing in grades (senior two > senior one > senior three). Compared with senior three students, students in senior one and senior two had higher academic performance and learning engagement levels.

Table 4. The differences in the grade in each variable

Variable	Gender	M±SD	F	Hindsight
Education environment	Freshman	100.52±15.225	30.125***	Sophomore> Freshman> Junior
	Sophomore	103.87±15.263		
	Junior	93.56±15.255		
Mental health	Freshman	299.62±17.055	36.626***	Sophomore> Freshman> Junior
	Sophomore	305.99±16.271		
	Junior	290.055±17.72		
Learning input	Freshman	49.75±17.66	62.005***	Freshman> Junior Sophomore> Junior
	Sophomore	50.02±16.71		
	Junior	42.79±22.02		
Academic performance	Freshman	120.98±29.15	58.056***	Freshman> Junior Sophomore> Junior
	Sophomore	126.22±33.12		
	Junior	110.52±28.77		

In order to explore the differences among the four variables - educational environment, academic performance, mental health, and learning engagement - in terms of whether one is an only child, an independent sample t-test was conducted using SPSS. The results of the differences in whether one is an only child are shown in Table 5. The educational environment showed a significant difference in the variable of whether one is an only child ($t(595) = -2.245$, $p < 0.05$), and non-only children perceived a significantly better educational environment than only children; there were no significant differences in academic performance, mental health, and learning engagement in the variable of whether one is an only

child ($t(595) = -0.178, p > 0.05$; $t(595) = 0.551, p > 0.05$; $t(595) = -0.672, p > 0.05$).

Table 5. Whether the variables are the only ones

Variable	To be an only child	M±SD	t
Education environment	YES	105.51±15.253	-2.245*
	NO	126.72±14.775	
Mental health	YES	297.45±49.425	-0.178
	NO	298.51±48.556	
Learning input	YES	44.75±25.658	0.551
	NO	40.62±24.795	
Academic performance	YES	105.23±20.001	-0.672
	NO	106.46±21.223	

3.3. Correlation Analysis

This study examines the relationships among the educational environment, academic performance, mental health, and learning engagement of medical students. It conducts correlation analyses on these four variables and their respective dimensions. Since the variables and dimensions of this study do not follow a normal distribution, Spearman correlation analysis was employed to test each variable and its dimensions. Table 6 presents the results of the correlation analysis among the variables.

The Spearman correlation analysis shows that the educational environment of medical students is significantly positively correlated with mental health ($r = 0.521$), learning engagement ($r = 0.644$), and academic performance ($r = 0.525$) ($p < 0.01$); mental health is significantly positively correlated with learning engagement ($r = 0.688$) and academic performance ($r = 0.552$) ($p < 0.01$); and learning engagement is significantly positively correlated with academic performance ($r = 0.573$) ($p < 0.01$). Therefore, there is a correlation among the four variables: educational environment, academic performance, mental health, and learning engagement. Hypothesis H1 is thus established.

Table 6. Correlation analysis results between variables

Variable	1	2	3	4
1.Education environment	1.000	0.521**	0.644**	0.525**
2.Mental health	0.521**	1.000	0.688**	0.552**
3.Learning input	0.644**	0.688**	1.000	0.573**
4.Academic performance	0.525**	0.552**	0.573**	1.000

3.4. Regression Analysis

The above verified the correlations among the educational environment, mental health, learning engagement, and academic performance. To further explore the relationships among these variables, a regression analysis was conducted on each variable. The educational environment, mental health, and learning engagement were included as predictor variables, while academic performance, mental health, and learning engagement were included as dependent variables. The regression analysis results among the variables are shown in Table 7. According to the regression analysis results, the educational environment of medical students can significantly positively predict academic performance, mental health, and learning engagement ($p < 0.001$), with explanatory rates of 28.8%, 40.8%, and 27.6% respectively; mental health of medical students can significantly positively predict academic performance and learning engagement ($p < 0.001$), with explanatory rates of 47.7% and 32.2% respectively; learning engagement of medical students can significantly positively predict academic performance ($p < 0.001$), with an explanatory rate of 29.1%. Hypothesis H2 is thus established.

Table 7. Regression analysis of variables

Dependent variable	Predictor variable	β	t	R	R ²	F
Academic performance	Education environment	0.531	28.662***	0.531	0.288	818.895***
	Mental health	0.692	44.005***	0.531	0.477	1905.956***
	Learning input	0.542	29.211***	0.692	0.291	855.875***
Learning input	Education environment	0.528	28.235***	0.542	0.276	799.068***
	Mental health	0.566	31.235***	0.528	0.322	979.968
Mental health	Education environment	0.641	38.755***	0.566	0.408	1444.925

3.5. Mediation Effect Analysis

(1) The mediating role of medical students' learning engagement between the educational environment and academic performance

Determine the influence of the independent variable (educational environment) on the mediating variable (mental health, learning engagement). With gender, grade, and whether they are the only child as control variables, the educational environment and mental health as independent variables, and learning engagement as the dependent variable, a multiple regression analysis was conducted. Table 8 shows the test results of the medical students' learning engagement model.

After controlling for gender, grade, and whether they are the only child, the educational environment of medical students has a significant positive predictive effect on learning engagement ($\beta = 0.595$, $t = 17.011$, $p < 0.001$). After controlling for gender, grade, whether they are the only child, and the educational environment, the mental health of medical students has a significant positive predictive effect on learning engagement ($\beta = 0.402$, $t = 12.858$, $p < 0.001$). From the above table, it can be seen that medical students' learning engagement has a significant positive predictive effect on academic performance. Therefore, medical students' learning engagement plays a mediating role between mental health and academic performance. Also, from the third step of the table, it can be known that the impact of medical students' mental health on academic performance is significant. Thus, medical students' learning engagement plays a partial mediating role between mental health and academic performance, and hypothesis H4 is established.

Table 8. The medical students study the results of the model test

Variable	Step1		Step2		Step3	
	β	t	β	t	β	t
Gender	0.116	2.611**	0.000	0.013	0.042	1.166
Grade	0.085	1.922	-0.025	-0.658	0.015	0.388
To be an only child	-0.075	-1.642	-0.078	-2.031	-0.025	-0.641
Education environment			0.595	17.011***	0.488	15.088***
Mental health					0.402	12.858***
R ²	0.041		0.355		0.497	
adjust R ²	0.032		0.345		0.491	
F	3.702***		46.788***		72.109***	

(2) The mediating role of medical students' mental health in the relationship between educational environment and academic performance

Taking gender, grade, and whether being an only child as control variables, educational environment as the independent variable, and mental health as the dependent variable, a regression analysis was conducted. Table 9 shows the test results of the mental health model for medical students. After controlling for gender, grade, and whether being an only child, the educational environment of medical students has a significant positive predictive effect on mental health ($\beta = 0.277$, $t = 6.68$, $p < 0.001$). Therefore, mental health plays a mediating role between the educational environment and academic performance of medical students. As mentioned earlier, mental health also has a significant positive predictive effect on academic performance. Thus, the mental health of medical students plays a partial mediating role between the educational environment and academic performance, and hypothesis H3 is established.

Table 9. The results of the medical health model test

Variable	Step1		Step2	
	β	t	β	t
Gender	-0.045	-0.955	-0.097	-2.188*
Grade	-0.045	-0.962	-0.091	-2.135*
To be an only child	-0.138	-2.999**	-0.138	-3.117**
Education environment			0.277	6.68***
R ²	0.038		0.105	
adjust R ²	0.029		0.095	
F	3.626***		9.655***	

(3) Chain mediation effect test

According to the third step of the learning engagement model test table, the influence of the medical education environment on learning engagement remained significant after adding the variable of mental

health. Therefore, the medical education environment affects learning engagement through mental health, that is, mental health is the mediating variable between the educational environment and learning engagement, playing a partial mediating role.

Combining the previous results, it can be concluded that mental health and learning engagement have a chain mediating effect between the medical education environment and academic performance. The indirect effect was tested using the PROCESS macro program of the SPSS software package, using the Bootstrap method, with 5000 replications, and setting a 95% confidence interval. Table 10 is the Bootstrap indirect effect analysis, and Figure 1 is the chain mediating effect test result. The total indirect effect was 0.554, accounting for 55.07% of the total effect (the total effect was 1.006), and its Bootstrap 95% confidence interval did not contain 0, indicating that the two mediating variables of mental health and learning engagement have a significant partial mediating effect between the medical education environment and academic performance, and hypothesis H5 is established.

The mediating effect includes the indirect effects generated by three pathways: The first pathway is medical education environment → mental health → academic performance, with an indirect effect value of 0.137, and the confidence interval does not contain a value of 0, indicating that mental health has a significant mediating effect between the medical education environment and academic performance; The second is medical education environment → learning engagement → academic performance, with an indirect effect of 0.338, and the confidence interval does not contain a value of 0, indicating that learning engagement has a significant mediating effect between the medical education environment and academic performance; The third is medical education environment → mental health → learning engagement → academic performance, with an effect value of 0.079, and the confidence interval does not contain a value of 0, indicating that this pathway has a significant mediating effect.

The significance of the differences between the indirect effects of different pathways was tested through pairwise comparisons. It was found that the Bootstrap 95% confidence interval of comparison 1 (the difference between indirect effect 1 and indirect effect 2) contained 0, indicating that there was no significant difference between indirect effect 1 and indirect effect 2. Comparisons 2 (the difference between indirect effect 1 and indirect effect 3) and comparison 3 (the difference between indirect effect 2 and indirect effect 3) had Bootstrap 95% confidence intervals that did not contain 0, indicating that the differences among the three groups of indirect effects were significant.

Table 10. Bootstrap mediation effect analysis

	Indirect effect	SE	95%CI		Relative intermediation effect
			UL	LL	
Total indirect effect	0.554	0.055	0.456	0.661	55.07%
Indirect effect 1	0.137	0.026	0.085	0.172	13.62%
Indirect effect 2	0.338	0.048	0.201	0.402	33.60%
Indirect effect 3	0.079	0.013	0.021	0.065	7.85%
Ind1-Ind2	-0.201	0.058	-0.221	0.005	Insignificance
Ind1-Ind3	0.058	0.025	0.022	0.115	Significance
Ind2-Ind3	0.259	0.039	0.105	0.251	Significance

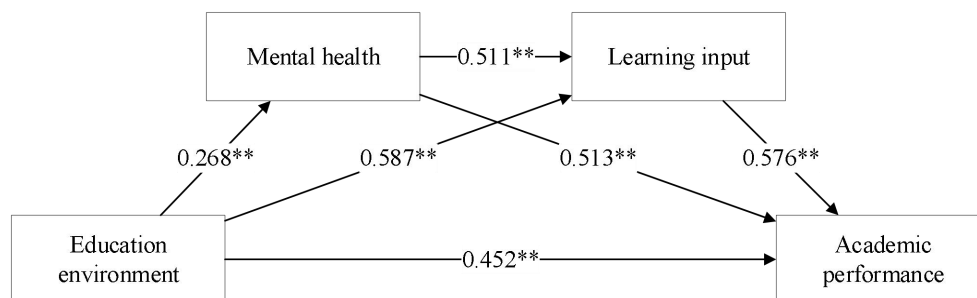


Figure 1. The chain mediation effect test results

4. Discussion

Through a survey of 615 medical students, this study revealed how the medical education environment affects the academic performance of medical students. Regression analysis found that the medical education environment significantly positively predicts the academic performance of medical students. This result further validates the previous research conclusions on academic performance, that is, the better the educational environment for medical students, the clearer their learning goals will be,

and their academic performance will be improved. The results of the mediation effect test indicated that the partial mediation effect of mental health and learning engagement, as well as the chain-like mediation effect between them, were all significant.

(1) The mediating effect of mental health. This study found that the medical education environment affects the academic performance of medical students through mental health, which is consistent with the hypothesis of this study. A good medical education environment helps medical students alleviate anxiety and loneliness, thereby improving their academic performance. The time and space for medical students to interact cannot be determined, and it cannot guarantee effective communication and interaction. Therefore, the educational environment, to some extent, compensates for the interaction relationship, and this compensatory care will affect the emotional, cognitive, behavioral patterns, and interpersonal communication patterns of medical students, influencing their development and adaptation in all aspects of their psychology [29].

(2) The mediating effect of learning engagement. When students have a deeper understanding of their chosen major and a more positive emotional experience, their learning behavior will also be more engaged. This study further verified Erikson's theory of self-integrity, after establishing a good medical environment, students showed higher levels of learning engagement to achieve their development goals in the learning field. At the same time, the medical education environment may affect students' implicit learning attitudes. When students deeply identify with the medical profession, they will also have a positive learning attitude towards medicine, and thus exhibit more focused learning behaviors. Learning engagement and academic performance are two completely different learning states. High learning engagement is usually accompanied by high academic performance. Therefore, the higher the medical students' sense of identity and belonging to the medical education environment, the more time and energy they will invest in professional learning, thereby improving their academic performance.

(3) The chain-like mediating effect of mental health and learning engagement. The self-verification theory holds that once an individual forms a self-concept, they will strive to prove these concepts to confirm the correctness of their self. Individuals with negative self-concepts will seek negative feedback, while those with positive self-concepts will seek positive feedback. At the same time, individuals with high mental health levels are more likely to experience autonomy, that is, they have a certain degree of control over the achievement of academic goals. This autonomy can prompt individuals to have genuine learning interest and a sense of self-worth, thereby helping to maintain their learning engagement level. Empirical research also shows that students with higher mental health levels usually exhibit more positive and engaged learning attitudes and behaviors. Therefore, the better the medical education environment is, the higher the mental health level of students will be, the more learning engagement there will be, and it will help improve the academic performance level of medical students.

5. Conclusion

This study explores the effects of mental health and learning engagement in the educational environment and learning engagement of medical students. It mainly examines the internal mechanisms of medical students' personality traits and mental health from a cognitive perspective, providing some ideas for improving the mental health level of medical students and enhancing their psychological adjustment abilities. The limitations of this study lie in that although the sample size meets the statistical requirements, it is still relatively small, which may affect the applicability of the conclusions. At the same time, this study uses cross-sectional data, and there are certain limitations in verifying causality. Future research can adopt a longitudinal research design to further verify the causal relationship. This study has certain significance in the mental health education of medical students. Firstly, attention should be paid to the cultivation of good personality traits of medical students, as a good personality is the foundation of their mental health; secondly, mental health education should be actively carried out to enhance self-confidence and core self-evaluation; finally, the cultivation of psychological resilience should be emphasized, so as to be able to recover quickly in the face of difficulties, improve psychological tolerance, and increase protective factors for mental health.

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