

A Study of the Fuzzy Effects of Psychological Stress on College Students' Performance in Physical Education Classes Based on Fuzzy Logic Modeling

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Abstract: To improve the effectiveness of physical education (PE) classroom teaching in higher education institutions, this study employs a fuzzy logic model to conduct a fuzzy assessment of college students' psychological stress and PE performance. Additionally, one-way analysis of variance (ANOVA) and independent samples t-tests are utilized to analyze differences in psychological stress and PE performance across gender, age, and major. Furthermore, correlation and regression analyses are conducted to explore the factors influencing college students' PE performance. The research results indicate that the psychological stress faced by college students primarily centers on future uncertainty and goal ambiguity, and significant differences exist in terms of age and gender ($P < 0.05$). The overall mean score for physical education class performance among the selected sample of college students is 4.01, which is at an above-average level. Significant differences in physical education class performance are observed across age, gender, and major ($P < 0.05$). Additionally, psychological stress was negatively correlated with physical education class performance, and competitive stress, time pressure, future uncertainty stress, and interpersonal conflict stress all had a negative impact on the total score of physical education class performance. This study provides a basis for improving college students' physical education class performance by addressing their psychological stress.

Keywords: fuzzy logic model; correlation analysis; regression analysis; psychological stress; physical education class performance

1. Introduction

Psychological stress is an unavoidable issue for everyone in today's society. Both internal conflicts and external environmental factors can have a significant impact on individuals, and severe stress may lead to the onset or exacerbation of various latent illnesses [1-3]. The effects of psychological stress vary among individuals. Some people, due to their stronger inner resilience, are less affected, while others have weaker stress-coping abilities, resulting in greater individual variability in how stress impacts their performance [4]. In recent years, the impact of psychological stress on students' classroom performance has become a research hotspot in the field of education [5]. Psychological stress among college students has a certain impact on classroom performance. Appropriate stress can motivate students to strive for excellence, while excessive stress may lead to a sense of loss and low morale in the classroom. The relationship between psychological stress and classroom performance among college students exhibits significant uncertainty and randomness, with some influencing factors characterized by ambiguity. Fuzzy logic methods, with their advantages in modeling problems involving uncertain information or uncertain relationships, have application value in analyzing the fuzzy effects of psychological stress on classroom performance [6-7].

Existing research indicates that psychological stress, whether academic or family-related, significantly affects students' academic performance; however, there remains significant debate over



whether this impact is positive or negative. Dendle et al. [8] investigated the effects of psychological stress on academic performance among medical students, correlating the results of the Kessler Psychological Distress Scale and the General Health Questionnaire with academic performance scores, and concluded that there is a weak correlation between psychological stress and academic performance. Deng et al. [9] examined the effects of academic and family stress on students' depression levels and academic performance, confirming through their research that academic and family stress can lead to depression in students, which has a negative impact on their learning performance and outcomes. Khan et al. [10] explored the impact of academic stress on student performance and conducted a survey analysis of a sample of 150 students. The results indicated that academic stress has a significant impact on student academic performance, and younger students experience greater academic stress than older students.

Fuzzy logic can fully utilize expert experience to summarize data, offering high flexibility and being widely applied in the assessment of student academic performance [11]. Voskoglou [12] developed a fuzzy model to evaluate students' knowledge and skills, successfully conducting detailed quantitative and qualitative analyses of group performance and providing fuzzy evaluations of individual students' abilities, and provided examples of the practical application of fuzzy logic methods. Yadav et al. [13] proposed a student academic performance evaluation system based on fuzzy logic technology, which can adaptively adjust training based on individual students' learning progress. Through comparative studies, the evaluation of student performance using fuzzy logic technology was found to be more effective than existing traditional evaluation methods. Petra et al. [14] applied fuzzy logic evaluation methods to analyze students' annual performance, and compared the results of fuzzy expert systems with conventional methods. The study indicated that the evaluation results from fuzzy expert systems are more accurate and objective, as they can identify the underlying causes of students' deficiencies. Aziz et al. [15] proposed a performance evaluation method based on fuzzy logic, which comprehensively considers students' attendance rates, total class time, and classroom exam scores, and fuzzifies continuous assessments and test scores, thereby providing a more precise evaluation of student performance. Mathew et al. [16] proposed a new performance evaluation method using fuzzy logic technology and demonstrated its effectiveness through simulation experiments, showing that the proposed fuzzy logic-based evaluation method outperforms traditional methods. Aruna et al. [17] developed a fuzzy logic model and combined Python and Anaconda to implement fuzzy logic rule inference and comprehensive analysis. The study found that the proposed method can more accurately assess student performance when dealing with fuzzy data and uncertain conditions. Barlybayev et al. [18] proposed a fuzzy logic model for scientifically and effectively evaluating student performance. The research results indicate that this model can provide fairer, more accurate, and personalized evaluations, better reflecting the complexity and multifaceted nature of student performance. Bakar et al. [19] utilized fuzzy logic evaluation methods to discover that in online open courses, more valuable online assessment scores and more valuable online self-study time contribute to improved final exam scores. Accurate evaluation results help students adjust their study time independently to improve academic performance. Valosek et al. [20] designed a student psychological stress reduction program based on transcendental meditation and compared it with a control group in terms of English language arts academic performance. The research data showed that 69% of the meditation students improved their academic performance by one level, while only 33% of the control group students achieved such performance. A non-stationary fuzzy neural network inference system simulates changes in expert group and individual expert opinions, demonstrating the ability to learn from generated rules to produce optimal classification models. Hidayah et al. [21] combined fuzzy logic with neural networks to predict and classify student learning performance. Results indicated that the hybrid model achieved optimal classification performance when combining three parameter values: student interest, aptitude, and motivation, with a tested RMSE value of 0.256.

In summary, a scientifically sound method for evaluating student classroom performance is the fuzzy scoring method, which can be widely applied to teaching management in various types of schools, playing a positive role in stimulating student learning motivation and achieving scientific teaching management.

This study investigates the mechanism by which psychological stress among college students influences their performance in physical education classes, based on a fuzzy logic model. First, the fuzzy logic model was employed to effectively assess the psychological stress and physical education class performance of college students. ANOVA one-way analysis of variance and independent samples t-tests were used to explore the differences in psychological stress and physical education class performance across demographic variables such as gender, age, and major. Subsequently, a correlation analysis was conducted between psychological stress and physical education class performance, yielding preliminary conclusions. Finally, regression analysis was utilized to further investigate the impact of psychological stress on physical education class performance.

2. Research on the ambiguous impact of psychological stress on physical education class performance

This paper uses a fuzzy logic model to assess the impact of psychological stress on college students' performance in physical education classes. Based on this assessment, it explores the relationship between psychological stress and performance in physical education classes among college students.

2.1. A fuzzy logic assessment model of psychological stress and physical education class performance

2.1.1. Fuzzy Sets and Linguistic Variables

To apply fuzzy logic, we first need to define fuzzy sets. Given a domain U , if there exists a mapping $u_A : U \rightarrow [0,1]$, then u_A determines a fuzzy subset A of U , where u_A is called the membership function of A . $u_A(x)$, ($x \in U$) indicates the degree to which x belongs to the fuzzy subset A , which is called the membership degree of x to A , denoted as $A(x)$. That is, for the input value X and the output value Y , there is a certain range, and the domain U formed by the output values Y of the research object can be divided into multiple fuzzy subsets.

The domain U is divided into multiple intervals, each of which represents a fuzzy subset. $[a,b]$, $[b,c]$, and $[c,d]$ are all fuzzy subsets. Within the domain U , any input value X can find its membership degree in the membership function $[0,1]$, and the closer it is to 1, the higher the membership degree. That is, if X is in the fuzzy subset $[b,c]$, its membership degree is 1, meaning it is completely in A . However, if it belongs to $[a,b]$ or $[c,d]$, it does not completely belong to A , and its membership degree must be determined based on the function.

In daily life, when language is used as the value of a variable, this variable is called a linguistic variable. A language variable can be represented as $(U, X, T(x), G, M)$, where U is the domain of the language variable, X is the language variable, $T(x)$ is the language set of X , G is the grammar rules, and M is the semantic rules.

2.1.2. Membership function

When applying fuzzy logic, the first step is to determine the membership function. Common methods for determining membership functions are as follows:

(1) Fuzzy statistical method

This refers to a judgment of whether a certain element U_i in the domain U belongs to the fuzzy subset A in the domain U , where the fuzzy subset A is a variable set defined by the researcher. Through n experiments, the frequency f_n of element U_i appearing in fuzzy subset A is statistically determined. As the number of experiments n approaches infinity, f_n converges to a more accurate value, which represents the membership degree of U_i in fuzzy subset A .

(2) Exemplification method

Given a finite number of values of U_i , these values are used to estimate and construct the membership function corresponding to the fuzzy subset on the domain.

(3) Assignment method

This involves determining the membership function based on the long-term experience of experts in the field being studied.

(4) Binary comparison sorting method

This involves pairwise comparisons of the various aspects of the research object to determine the differences between them, thereby establishing the order of classification and inferring the membership relationships.

(5) Comprehensive Weighting Method

For the domain U of the research object, each fuzzy subset is assigned a weight value, which is then combined using a composite method to obtain the membership function.

Common membership functions include:

(1) Rectangular Distribution:

$$A(x) = \begin{cases} 0, & x < a \text{ Or } x > b \\ 1, & a \leq x \leq b \end{cases} \quad (1)$$

(2) Trigonometric functions:

$$A(x) = \begin{cases} 0, & x < a \cup x > d \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ 1, & b \leq x \leq c \\ \frac{d-x}{d-c}, & c \leq x \leq d \end{cases} \quad (2)$$

(3) Trigonometric functions:

$$A(x) = \begin{cases} \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{c-x}{c-b}, & b \leq x \leq c \\ 0, & x < a \text{ Or } x > c \end{cases} \quad (3)$$

(4) Normal distribution:

$$A(x) = \begin{cases} 1, & x \leq a \\ e^{-\left(\frac{x-a}{e}\right)^2}, & x > a \end{cases} \quad (4)$$

$$A(x) = e^{-\left(\frac{x-a}{e}\right)^2} \quad (5)$$

$$A(x) = \begin{cases} 0, & x \leq a \\ 1 - e^{-\left(\frac{x-a}{e}\right)^2}, & x > a \end{cases} \quad (6)$$

This method uses trapezoidal and triangular membership functions to express the fuzzy process. Trapezoidal functions are used to fuzzify the data, and triangular functions are used to represent the fuzzy scores.

The trapezoidal membership function is:

$$\mu(x; a, b, c, d) = \begin{cases} 0, & x < a \\ \frac{x-a}{b-a}, & a \leq x \leq b; \\ 1, & b \leq x \leq c \\ \frac{x-c}{d-c}, & c \leq x \leq d \\ 0, & x > d \end{cases} \quad (7)$$

The triangular membership function is:

$$\mu(x; a, b, c) = \begin{cases} \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{c-x}{c-b}, & b < x \leq c \\ 0, & x < a \text{ Or } x > c \end{cases} \quad (8)$$

In the formula, a, b, c, d is a real number.

2.1.3. Fuzzy Rules

A rule base is a collection of fuzzy logic rules. Different fuzzy rules are formulated for different experiments, so fuzzy rules are an indispensable step in fuzzy reasoning, as they specify the relationship between conditions and results. The commonly used fuzzy logic expression is the If-Then rule, i.e., If + precondition, Then + result.

2.1.4. De-blurring

In order to convert fuzzy outputs into precise outputs, defuzzification is also required. In this study, the centroid averaging method was used for defuzzification to convert fuzzy values into precise values. The centroid averaging method calculates the output value as the x-coordinate of the center of the area enclosed by the membership functions and the x-coordinate, with the following formula:

$$Z = \frac{\int \mu(x) \cdot x \cdot dx}{\int \mu(x) \cdot dx} \quad (9)$$

The area enclosed by the membership function and the X -axis can be calculated using the formula, and then the precise membership curve can be obtained by comparing the areas, thereby achieving the defuzzification process.

2.2. Research Methods and Process

2.2.1. Test subjects

This study used cluster random sampling to select 5,214 college students from four universities in Province G as subjects. Among them, 2,340 were female and 2,874 were male. The subjects' ages ranged from 17 to 22, with an average age of $M = 20.54$ and $SD = 1.46$. The subjects' majors were mainly in science and engineering and humanities and social sciences.

2.2.2. Research Tools

(1) Perceived Stress Scale (CPSS)

The Perceived Stress Scale (CPSS) was used to measure psychological stress among college students in this study. The scale consists of two dimensions: tension and loss of control. The tension dimension is divided into five factors: task load stress, competitive stress, time pressure, interpersonal conflict stress, and future uncertainty stress. The loss of control dimension includes five factors: goal ambiguity, resource scarcity, external constraints, uncontrollable outcomes, and lack of self-efficacy. The scale comprises a total of 20 items. Each dimension has 10 items, with the sense of helplessness dimension using reverse scoring. The scale uses a 5-point scoring system, where 1 represents "never" and 5 represents "very much." The total score for both dimensions constitutes the overall stress perception level. A higher stress perception level score indicates a more severe degree of stress perception. The internal consistency coefficient of this scale is 0.83, with the internal consistency coefficients for the two subscales being 0.86 and 0.82, respectively.

(2) Physical Education Classroom Performance Scale

This study used a self-developed Physical Education Classroom Performance Scale for college students. The scale includes 11 factors, 2 dimensions, and 30 items. Among these, 5 factors—movement standardization, skill proficiency, physical fitness level, tactical awareness, and progress—constitute the technical skills dimension, while 6 factors—participation enthusiasm, teamwork spirit, competitive attitude, safety and rule awareness, willpower, and sports ethics—constitute the comprehensive literacy

dimension. The scale uses a 5-point scoring method, with higher scores indicating better physical education class performance and lower scores indicating poorer performance. In this study, the Cronbach's α coefficient for the scale was 0.88, indicating good internal consistency, with internal consistency coefficients of 0.91 and 0.84 for the two subscales, respectively.

(3) Procedure

In this study, the test was conducted anonymously. Participants completed the questionnaire according to the instructions, and after completing the questionnaire, they were given a small gift as a token of appreciation. The order of completing the Perceived Stress Scale questionnaire and the Physical Education Classroom Performance Scale was balanced across participants.

3. Empirical research and analysis of results

This chapter conducts an empirical assessment of the current situation of psychological stress and physical education class performance among college students based on a fuzzy logic model, and uses correlation analysis and regression analysis methods to analyze the actual impact of psychological stress on physical education class performance.

3.1. Research on the Current State of Psychological Stress Among College Students

3.1.1. Descriptive statistics of psychological stress among college students

The descriptive statistics of the overall characteristics of psychological stress among college students are shown in Table 1. The mean score for the total psychological stress scale was 2.65, with a standard deviation of 0.84, indicating that the psychological stress levels of the sample were moderately low. From the perspective of the tension dimension, the mean score for future uncertainty stress was the highest at 3.01, while the mean score for task load stress was the lowest at 2.46. The mean and standard deviation values for the five factors in this dimension range from 2.46 to 3.01 and 0.79 to 0.96, respectively. In the dimension of loss of control, the mean values for the five factors range from 2.32 to 2.8, while the standard deviation is controlled within the range of 0.65 to 0.93. The factors of psychological stress among college students in the sample were ranked as follows: future uncertainty stress > goal ambiguity > interpersonal conflict stress > competitive stress > sense of uncontrollable outcomes > lack of self-efficacy > time pressure > task load stress > external constraints > resource scarcity. This indicates that the psychological stress faced by college students is primarily concentrated on future uncertainty and goal ambiguity, with future uncertainty stress scoring the highest and goal ambiguity ranking second.

Table 1. Descriptive statistics on the overall characteristics of psychological stress.

Dimension	Factor	Number of items	Average value	Standard deviation
Tense feeling	Task load pressure	2	2.46	0.81
	Competitive pressure	2	2.73	0.96
	Sense of time urgency	2	2.54	0.79
	Interpersonal conflict stress	2	2.85	0.84
	Future uncertainty pressure	2	3.01	0.92
Sense of loss of control	Ambiguity of goals	2	2.89	0.87
	Sense of insufficient resources	2	2.32	0.65
	Sense of external constraints	2	2.44	0.75
	The sense of uncontrollability of the result	2	2.67	0.82
	Lack of self-efficacy	2	2.58	0.93
Total psychological stress table of college students		20	2.65	0.84

3.1.2. Analysis of differences in psychological stress among college students

To further investigate whether there are significant differences in college students' psychological stress levels across demographic variables, this section employs one-way ANOVA [22] and independent samples t-tests [23] to examine the relationships between demographic variables such as gender, age, and major, and psychological stress.

(1) Comparison of age-related differences in psychological stress among college students

This study divided college students into three age groups: 17–18 years old, 19–20 years old, and 21–22 years old. The results of the one-way ANOVA analysis of psychological stress among college

students of different ages are shown in Table 2.

Significant differences ($P < 0.05$) were observed in overall psychological stress and two dimensions across different age groups, indicating that psychological stress levels vary across age groups. Notably, there was a significant difference in scores between students aged 21–22 and those aged 19–20, which may be attributed to increased psychological stress as college students approach graduation. Overall, psychological stress levels tend to increase with age.

Table 2. The differences in psychological stress among college students of different ages.

Variable		M±SD	F	P
Tense feeling	17-18 years old	2.42±0.92	1.573	0.024*
	19-20 years old	2.50±0.87		
	21-22 years old	2.84±0.89		
Sense of loss of control	17-18 years old	2.51±0.78	1.425	0.002**
	19-20 years old	2.68±0.89		
	21-22 years old	2.92±0.94		
Overall scale of psychological stress	17-18 years old	2.47±0.78	1.312	0.013*
	19-20 years old	2.59±0.89		
	21-22 years old	2.88±0.94		

(2) Comparison of psychological stress differences among college students of different majors

To understand the impact of different majors on college students' psychological stress, an independent samples t-test was conducted with major as the dependent variable and psychological stress as the independent variable. The results are shown in Table 3. It can be seen that, on the total psychological stress scale and its various sub-dimensions, college students majoring in humanities and social sciences had slightly higher average scores than those majoring in science and engineering or arts and physical education. However, these differences did not reach statistical significance ($P > 0.05$), indicating that the impact of different majors on college students' psychological stress is not significant.

Table 3. Comparison of the differences in psychological stress among different majors.

Scale name	Majors	M±SD	t	P
Tense feeling	Humanities and social sciences	2.46±0.95	0.645	0.417
	Science and engineering	2.34±0.87		
	Art and sports	2.42±0.89		
Sense of loss of control	Humanities and social sciences	2.82±0.84	0.149	0.782
	Science and engineering	2.77±0.82		
	Art and sports	2.75±0.81		
Overall scale of psychological stress	Humanities and social sciences	2.58±0.91	0.568	0.654
	Science and engineering	2.54±0.88		
	Art and sports	2.51±0.90		

(3) Comparison of Gender Differences in Psychological Stress Among College Students

In terms of gender, an independent samples t-test was conducted with gender as the dependent variable and psychological stress as the independent variable to explore the impact of different gender conditions on psychological stress among college students. The results of the independent samples t-test for gender differences are shown in Table 4. It can be seen that there are significant differences between male and female students in the total psychological stress scale and its sub-dimensions ($P < 0.05$). However, in the tension dimension, female students have higher psychological stress than male students, while in the sense of loss of control dimension, male students have higher average scores, with significant gender differences ($P < 0.01$), indicating that gender has a significant impact on psychological stress among college students.

Table 4. Comparison of the differences in psychological stress among different gender.

Scale name	Gender	M±SD	t	P
Tense feeling	Female	2.63±0.86	2.745	0.012*
	Male	2.37±0.91		
Sense of loss of control	Female	2.74±0.98	-2.541	0.009**
	Male	2.89±0.87		
Overall scale of psychological stress	Female	2.49±0.81	2.648	0.015*
	Male	2.73±0.75		

3.2. Research on the Current Status of College Students' Performance in Physical Education Classes

3.2.1. Descriptive statistics of college students' performance in physical education classes

The descriptive statistical results of college students' physical education class performance are shown in Table 5. The mean score of the total physical education class performance scale for college students is 4.01, which is higher than the theoretical median of 3, indicating that college students' physical education class performance is at an above-average level. The average scores for each dimension factor range from 3.69 to 4.32. When sorted from highest to lowest average score, the order is as follows: safety and rule awareness, sportsmanship, participation enthusiasm, teamwork spirit, progress, movement standardization, tactical awareness, physical fitness level, competitive attitude, skill proficiency, and willpower. Among these, Safety and Rule Awareness had the highest score with an average of 4.32, indicating that college students in the sample have a high level of awareness regarding safety and rules in physical activities. Willpower had the lowest score with an average of only 3.69, suggesting that college students in the sample need to further improve their willpower in physical activities. Overall, the performance of college students in physical education classes in the sample was relatively good.

Table 5. Descriptive statistics of performance in physical education class.

Dimension	Factor	Number of items	Average value	Standard deviation
Technical skills	Standardization of actions	3	3.95	0.85
	Skill proficiency	3	3.74	0.76
	Physical fitness level	3	3.86	0.71
	Tactical awareness	3	3.91	0.69
	Extent of progress	3	4.17	0.74
Comprehensive quality	Participation enthusiasm	2	4.23	0.82
	Teamwork spirit	3	4.19	0.79
	Competitive attitude	2	3.78	0.74
	Safety and rule awareness	3	4.32	0.78
	Willpower quality	3	3.69	0.84
	Sports ethics	2	4.25	0.89
Total performance table of physical education class of college students		30	4.01	0.83

3.2.2. Analysis of differences in college students' performance in physical education classes

This section also employs one-way ANOVA and independent samples t-tests to examine the differences in physical education performance among college students based on variables such as age, major, and gender.

(1) Comparison of age differences in physical education performance among college students

Using one-way ANOVA, the results of age differences in physical education performance among college students are shown in Table 6. There were extremely significant differences ($P < 0.01$) in the overall performance levels of college students across different age groups, with scores ranging from lowest to highest as follows: 17–18 years old ($M = 3.75$), 19–20 years old ($M = 3.94$), and 21–22 years old ($M = 4.03$). In terms of the various dimensions of physical education performance, the lowest scores were obtained by students aged 17–18, followed by those aged 19–20, while the highest scores were

obtained by students aged 21–22. Significant differences at the 0.001 level and 0.01 level were observed between different age groups in the technical skills and comprehensive literacy dimensions, respectively. Post-hoc multiple comparisons (LSD) revealed that there were extremely significant differences between students aged 17–18 and those aged 19–20 and 21–22 in the overall physical education performance scale and the two sub-dimensions, with the scores of 17–18-year-old university students significantly lower than those of the other two age groups. However, there were no significant differences in the average scores between the 19-20 and 21-22 age groups ($P > 0.05$). Overall, older students scored higher, indicating that physical education performance levels among college students increase with age.

Table 6. Differences in physical education class performance among students of different ages.

Variable		M±SD	F	P	LSD
Technical skills	17-18 years old	4.07±0.72	7.584	0.000***	2>1, 3>1
	19-20 years old	4.28±0.69			
	21-22 years old	4.39±0.64			
Comprehensive quality	17-18 years old	3.55±0.78	8.152	0.004**	2>1, 3>1
	19-20 years old	3.78±0.81			
	21-22 years old	3.92±0.66			
Total performance table of physical education class	17-18 years old	3.75±0.63	8.053	0.002**	2>1, 3>1
	19-20 years old	3.94±0.68			
	21-22 years old	4.03±0.61			

(2) Comparison of Differences in Physical Education Class Performance Among College Students of Different Majors

Using major as the independent variable and physical education class performance as the dependent variable, an independent samples t-test was conducted to determine the differences in physical education class performance levels among college students of different majors, as shown in Table 7. It can be seen that, in terms of overall physical education performance and each dimension, the scores of students majoring in humanities and social sciences and those majoring in science and engineering are very similar, while the scores of students majoring in arts and physical education are significantly higher than those of the other two categories. There are significant differences in physical education performance levels among college students from different majors ($p < 0.05$), indicating that the type of major has a significant impact on physical education performance.

Table 7. Differences in physical education class performance stress among different majors.

Variable	Majors	M±SD	F	P	LSD
Technical skills	Humanities and social sciences	4.02±0.84	7.187	0.000***	3>2, 3>1
	Science and engineering	3.98±0.76			
	Art and sports	4.35±0.75			
Comprehensive quality	Humanities and social sciences	3.97±0.63	1.659	0.043*	3>2, 3>1
	Science and engineering	4.02±0.67			
	Art and sports	4.13±0.84			
Total performance table of physical education class	Humanities and social sciences	3.96±0.74	3.751	0.024**	3>2, 3>1
	Science and engineering	4.01±0.65			

	Art and sports	4.26±0.68			
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(3) Comparison of gender differences in college students' physical education performance

An independent samples t-test was used to determine the differences in college students' physical education performance levels between genders, with the results shown in Table 8. Significant differences were found between male and female students in both the overall physical education performance scale and its sub-dimensions, with t-values of 3.607, 3.021, and 3.462, respectively. The differences between male and female students in the overall physical education performance scale and the comprehensive quality dimension reached a significant level ($P < 0.05$), while the differences in the technical skills dimension reached a highly significant level ($P < 0.01$). In terms of scores, the average scores for male students on the overall physical education performance scale and the technical skills and comprehensive quality sub-dimensions were 3.93, 4.24, and 3.75, respectively, while the average scores for female students were 3.68, 3.97, and 3.52, respectively. It is evident that male students had higher average scores than female students, indicating that male students were more engaged in physical education activities.

Table 8. Differences in physical education class performance among different gender.

Scale name	Gender	M±SD	t	P
Technical skills	Male	4.24±0.87	3.607	0.001***
	Female	3.97±0.78		
Comprehensive quality	Male	3.75±0.76	3.021	0.007**
	Female	3.52±0.74		
Total performance table of physical education class	Male	3.93±0.64	3.462	0.002**
	Female	3.68±0.57		

3.3. Correlation analysis between psychological stress and physical education class performance

To investigate the relationship between college students' physical education class performance and psychological stress at the sample universities, a correlation analysis was conducted between physical education class performance and its two dimensions, and psychological stress (X) and its 10 factors. The results of the correlation analysis are shown in Table 9. Among these, X1–X10 represent task load stress, competitive stress, time pressure, interpersonal conflict stress, future uncertainty stress, goal ambiguity, resource scarcity, external constraint, uncontrollability of outcomes, and lack of self-efficacy. Y1 and Y2 represent the two dimensions of physical education class performance: technical skills and comprehensive qualities. X and Y represent the total scores for psychological stress and physical education class performance, respectively.

From the correlation analysis results, it can be seen that the correlation coefficients between the total score for physical education class performance and the 10 variables of psychological stress are mostly above 0.4, indicating that there is a certain correlation between college students' physical education class performance and psychological stress. The correlation coefficients for technical skills and comprehensive qualities are both greater than 0.7, indicating a very high correlation, so there may be a possibility of multicollinearity. The correlation coefficients for competitive pressure, task load pressure, time urgency, and interpersonal conflict pressure are all greater than 0.7, so there is a high likelihood of multicollinearity. The correlation coefficients for task load pressure on technical skills and comprehensive qualities are both greater than 0.5, indicating that task load pressure has a relatively minor impact on physical education class performance. The correlation coefficients between the 10 variables of psychological stress and the variables of technical skills and comprehensive qualities in physical education class performance are all less than 0, indicating that psychological stress is negatively correlated with physical education class performance.

Table 9. Correlation analysis of psychological stress and PE class performance.

	Y1	Y2	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X
Y1	1													
Y2	0.758**	1												
Y	0.963**	0.827**	1											
X1	-0.517**	-0.596**	-0.495**	1										
X2	-0.586**	-0.424**	-0.575**	0.704**	1									
X3	-0.545**	-0.538**	-0.552**	0.526**	0.473**	1								
X4	-0.536**	-0.561**	-0.559**	0.628**	0.706**	0.373**	1							
X5	-0.612**	-0.447**	-0.595**	0.674**	0.757**	0.372**	0.656**	1						
X6	-0.378**	-0.264**	-0.369**	0.651**	0.664**	0.568**	0.475**	0.523**	1					
X7	-0.484**	-0.323**	-0.475**	0.684**	0.682**	0.527**	0.591**	0.679**	0.614**	1				
X8	-0.523**	-0.487**	-0.504**	0.642**	0.676**	0.592**	0.573**	0.617**	0.625**	0.691**	1			
X9	-0.462**	-0.547**	-0.516**	0.654**	0.621**	0.585**	0.631**	0.628**	0.632**	0.674**	0.653**	1		
X10	-0.575**	-0.508**	-0.541**	0.643**	0.625**	0.661**	0.643**	0.685**	0.629**	0.636**	0.682**	0.679**	1	
X	-0.548**	-0.363**	-0.531**	0.883**	0.881**	0.705**	0.764**	0.825**	0.789**	0.793**	0.774**	0.739**	0.827**	1

3.4. Regression analysis of psychological stress and physical education class performance

To better study the factors influencing college students' performance in physical education classes at the sample universities, this section specifically uses the 10 dimensions of psychological stress as independent variables and employs stepwise regression analysis. The results of the regression analysis are shown in Table 10.

It can be seen that competitive stress, time pressure, future uncertainty stress, and interpersonal conflict stress all have a negative impact on the total score of physical education class performance. Therefore, it can be concluded that:

(1) Competitive pressure has a negative impact on the total score of physical education class performance, indicating that the greater the competitive pressure, the lower the total score of physical education class performance. In practical situations, when college students face significant competitive pressure, they are exposed to high levels of competitive pressure over an extended period, leading to deteriorating mental states and consequently declining physical education class performance, resulting in a continuous decrease in the total score of physical education class performance.

(2) Time pressure has a significant negative impact on the dependent variable of overall physical education performance scores, meaning that the higher the time pressure score, the lower the overall physical education performance scores. In practical situations, the greater the time pressure experienced by college students, the worse their living environment becomes, leading to an increase in overall psychological pressure and a decline in their psychological comprehensive qualities. This results in a gradual decrease in their physical education technical skills and comprehensive qualities, thereby affecting the decline in their overall physical education performance scores.

(3) Future uncertainty pressure has a significant negative impact on the dependent variable of total physical education class performance scores, indicating that the higher the future uncertainty pressure score, the lower the total physical education class performance score. In actual situations, the stronger the uncertainty about the future among college students, the more negative emotions they have toward the future, leading to greater stress. Under the social pressure of approaching graduation, college students

find it difficult to cope with the various pressures brought by graduation, resulting in a gradual decline in their sports technical skills and overall literacy, which in turn affects their overall sports class performance scores.

(4) Interpersonal conflict stress has a significant negative impact on the dependent variable of total physical education class performance scores, indicating that the higher the interpersonal conflict stress score, the lower the total physical education class performance score. In actual situations, when college students face significant stress in interpersonal relationships, they cannot escape the pressure brought by the complex interpersonal networks they are currently in and must confront high interpersonal conflict stress, which causes their physical education class performance to decline continuously, thereby affecting the decline in their total physical education class performance scores.

Table 10. Regression results of physical education class performance.

Model		Unstandardized coefficient <i>B</i>	Standard error	Standardized coefficient	t	P
1	(Constant)	112.451	2.496		43.122	0.000***
	X2	-2.35	0.259	-0.495	-9.074	0.000***
2	(Constant)	117.124	3.418		33.457	0.000***
	X2	-1.657	0.328	-0.351	-5.035	0.000***
	X3	-1.438	0.429	-0.234	-3.328	0.002**
3	(Constant)	107.53	4.341		24.314	0.000***
	X2	-1.882	0.329	-0.395	-5.683	0.000***
	X3	-1.713	0.426	-0.274	-3.947	0.000***
	X4	-0.839	0.221	-0.203	3.572	0.003**
4	(Constant)	117.416	4.325		24.251	0.000***
	X2	-1.422	0.379	-0.294	-3.656	0.000***
	X3	-1.275	0.461	-0.206	-2.732	0.012*
	X4	-0.864	0.228	-0.241	4.087	0.000***
	X5	-1.035	0.395	-0.228	-2.504	0.019*
Dependent variable: Total score of PE class performance						

4. Conclusion

This study investigates the mechanisms underlying the influence of psychological stress on college students' physical education performance based on a fuzzy logic model.

The mean and standard deviation of the total psychological stress score for the selected sample of college students were 2.65 and 0.84, respectively, indicating a moderately low level of stress. Through comparison, it was found that future uncertainty and goal ambiguity are the primary sources of psychological stress among college students. In terms of demographic variables, psychological stress levels generally increase with age. There is no significant difference in the impact of major on psychological stress among college students ($p > 0.05$). Gender has a significant impact on psychological stress, with a highly significant difference ($p < 0.01$), and overall, male students experience higher levels of psychological stress than female students. Additionally, the mean score for physical education class performance among the sample college students is 4.01, which is at a moderately high level, and there are significant differences in performance based on age, gender, and major ($p < 0.05$).

Through correlation analysis and regression analysis, it was found that psychological stress is negatively correlated with physical education class performance. Among these, competitive stress, time pressure, future uncertainty stress, and interpersonal conflict stress have a significant impact on physical education class performance, all of which exhibit a negative influence. Therefore, when conducting physical education classroom teaching, teachers can design their teaching approaches based on these psychological stress factors to enhance students' physical education class performance levels.

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