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Article

A study of correlation mining between biomechanical factors and physical activity participation of college students based on big data analysis

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Abstract: The rapid development of modern society and heightened competitiveness have led to increased expectations from parents, educators, and society regarding college students. This environment, coupled with academic pressures and employment challenges, significantly affects students' physical and mental health. This paper employs big data analysis to explore the intrinsic connections between physical activity and mental health, incorporating biomechanical insights into the discussion. Biomechanics examines the mechanical aspects of human movement, providing a deeper understanding of how physical activity influences mental well-being. Engaging in regular physical activity enhances physiological responses, such as improved circulation, increased endorphin release, and reduced stress hormones, all of which contribute to better mental health outcomes. In our study, we utilized the SCL-90 for mental health assessment and conducted a survey on cognitive characteristics related to sports participation. A sample of 500 university students was analyzed to establish a behavioral cognitive model of sports activity participation. Correlation coefficients revealed that the intensity (0.1354) and duration (0.2455) of physical activity correlate positively with mental health scores. Furthermore, factors such as frequency and total volume of physical activity demonstrated varying degrees of correlation across five mental health dimensions. Regression analysis yielded a standardized coefficient of 0.6154, indicating that physical activity participation significantly positively influences mental health scores. By integrating biomechanical principles, this research highlights the importance of movement efficiency and physical engagement in promoting mental health, suggesting that enhancing physical activity can serve as a vital strategy for improving overall well-being among college students.

Keywords: big data analysis; SCL-90; biomechanical factors assessment; regression analysis; physical activity participation

1. Introduction

Mental health refers to the ability of people to adapt to certain changes in the social environment, effectively adjust and control their self-emotions. Have good interpersonal relationships, sound personality, constantly enrich themselves, so that their ability to develop and exercise the mental outlook and psychological state [1–4].

Mental health will have a direct impact on physiological health, contemporary college students are the builders of China's socialist cause, play an important role in the direction of the country's future development, and their psychological state and speech and demeanor and other aspects of their own will play a direct or indirect impact [5,6]. At present, there are still many students among college students with very prominent psychological problems. This is due to the increasing pressure faced by college students. From the external environment, the rapid development of the

economy, college graduates increase year by year, the pressure of competition is bound to be greater [7–9]. From the internal law of the physical and mental development of college students themselves, interpersonal relationships at the university stage are relatively complex, while college students are more self-conscious and face psychological pressure in interpersonal relationship handling. According to the viewpoint of the interaction of internal and external factors in developmental psychology, internal and external factors are important factors affecting mental health [10–13].

In the current social context, college students need to have strong psychological quality to cope with the pressure in all aspects. With the expansion policy of the country in recent years, the number of college students is increasing, and the level of physical and mental health of college students is directly related to the future development of science and technology in China, only a small number of people understand the real meaning of physical and mental health [14–16]. Physical and mental health refers to both physical and psychological health, not just physical health. After a series of college students' psychological problems were reported in recent years, which triggered relevant discussions, China gradually began to pay attention to the influence of college sports activities on college students' mental health, and carried out a series of sports activities [17,18].

Current research on the mental health status of students in colleges and universities mainly adopts sampling methods and a general review of the literature, aiming to understand the mental health performance of students, changes in the demand for psychological diagnostic services, and the effects of mental health assessment, with the aim of ensuring the mental health of students by optimizing the mental health services and formulating relevant strategies. Literature [19] synthesized the samples obtained from the national study and analysis, and clarified that the diagnosis and treatment of several MH disorders showed a rising trend among college students, and the study provided a reference for the management of college students' mental health in college mental health care institutions. Literature [20] collected data related to college students' mental health based on the whole cluster sampling method and constructed a multiple linear regression model to analyze the data, pointing out that 8% of the respondents in the student sample had mental health disorders, with obsessive-compulsive disorder (OCD), interpersonal sensitivity, and depression at the top of the list, and arguing that the students' personal experiences, learning situations, and social environments affect students' mental health. Literature [21] systematically reviewed the research literature on mental health treatment for college students and identified research pathways in this area, including mental health support policies, integration of mental health care programs, promotion of mental health education, and prediction and assessment of student mental health. Literature [22] conducted a practical investigation of mental health issues among college students, corresponding initiatives, and research identifying stressors of mental health disorders among students and effective strategies to improve mental health. Literature [23] describes the core elements of the World Health Organization's Mental Health Initiative, which contains the assessment of students' psychological and emotional well-being, the development of infrastructure for mental health services, and the dissemination and continuous monitoring of the quality improvement of evidence-based interventions

developed by the WMH-ICS, and discusses these three core elements in detail. Literature [24] examined the effect of attribution (inclusion, rejection) partially mediating emotional intelligence (attention, clarity, repair) on the mental health of college students based on regression analysis method, and the results of the study showed that preventing students' mental health problems can be intervened through emotional intelligence elements to reduce students' perception of exclusion.

Focusing on the research theme of how physical activity affects students' mental health, scholars have conducted in-depth research on the logic and mechanism of physical activity affecting students' mental health by combining social practice tools such as anxiety scales and sports questionnaires, academic methods such as literature reviews, and experimental tools such as deep learning analysis models. Literature [25] used anxiety and depression scales, physical activity questionnaires, and other survey tools to explore the association between physical activity and sleep quality and how it affects mental health, based on the study that physical activity and sleep quality now significantly affect students' mental health performance. Literature [26] proposed a deep learning technology as the core logic of the intelligent sports management model, can be based on the characteristics of students for personalized sports arrangements, through the simulation of the practice found that the model to meet the needs of students' physical activity, promote students' mental health and physical fitness. Literature [27] reviewed papers and journals on mental health and sport-related research, revealing an upward trend in studies examining the relationship between sport and depression, self-esteem, and cognitive functioning in young people. Literature [28] used the Beck Anxiety and Depression Scale to collect and measure mental health data from a sample and combined it with regression modeling to conduct a study on the relationship between physical activity and mental health, exposing that good levels of physical activity led to a healthier psychological state in the context of quarantine during the epidemic. Literature [29] reviewed the global literature studies involving mental health and physical activity, physical activity is beneficial for mental health, but the optimal level of physical activity is unknown and indicated that even lower levels of physical activity are still beneficial for human physical and mental health. Literature [30] used the Warwick Edinburgh Mental Health Scale (WEMWBS) to measure students' mental health and the Strengths and Difficulties Questionnaire (SDQ) to measure the manifestation of mental health disorders. Finally, a multivariate linear regression analysis was conducted to examine how students' physical activity affects mental health and mental health disorders. Based on the results of the study, it was found that the level of participation in physical activity is associated with students' mental health and symptoms of mental health disorders.

Through the excavation of the intrinsic connection between physical activity and mental health, this paper finds that physical activity participation is highly compatible with the goal of mental health. From the perspective of promoting students' self-cognitive development, regulating emotions, and enhancing students' comprehensive literacy, the role of physical activity in promoting mental health is summarized. Based on the role of physical activities, three relevant measures were proposed, namely, adopting reasonable exercise methods, organizing rich physical activities and focusing on mental health guidance during physical activities. Using the SCL-90 scale, the cognitive model of physical activity participation behavior was constructed. Through

the calculation of cumulative contribution rate, initial factor loading matrix, and variance great rotation matrix, the effect factor in mental health that directly affects physical activity is obtained. The cognitive model of physical activity participation behavior was tested through multivariate ANOVA of different levels of physical activity groups. Correlation and regression analysis tools were used to analyze the correlation and regression effects of physical activity participation and mental health, respectively.

2. Methods

2.1. Sample selection

In this study, we selected a sample of 500 college students from 15 colleges at a university. The sample included 250 males and 250 females, with ages ranging from 19 to 25 years, and an average age of 21.32 years. To ensure the representativeness of the sample, we employed a stratified random sampling method. The stratification was based on gender, grade, and major, ensuring that each subgroup was adequately represented in the sample. The detailed steps of the sampling process are as follows:

2.1.1. Gender distribution

We aimed for an equal representation of male and female students. Therefore, we ensured that 50% of the sample consisted of males and the other 50% of females.

2.1.2. Grade distribution

The sample was divided among the four academic years, with each grade level (freshman, sophomore, junior, and senior) equally represented. This ensured that the sample covered students at different stages of their college education.

2.1.3. Major distribution

We included students from a variety of majors across different faculties, including humanities, social sciences, natural sciences, engineering, and medical sciences. This ensured that the sample was diverse in terms of academic disciplines.

2.1.4. Random selection

Within each stratum (gender, grade, and major), students were selected randomly using a computer-generated randomization process. This minimized selection bias and increased the likelihood that the sample was representative of the larger student population. By employing this stratified random sampling method, we aimed to enhance the generalizability of our findings and ensure that the sample accurately reflected the demographics of the broader college student population.

2.2. Data collection

Data were collected through standardized questionnaires administered during regular class sessions. Participation was voluntary, and informed consent was obtained from all participants. The questionnaires included the Symptom Self-Control Scale (SCL-90) for assessing mental health and a Cognitive Characteristics Questionnaire of Sports Participation Behavior based on Bandura’s self-efficacy theory.

2.3. Questionnaire reliability and validity

To ensure the reliability and validity of the data collection tools used in this study, we conducted thorough reliability and validity tests on the questionnaires employed.

2.3.1. Reliability tests

Reliability refers to the consistency and stability of the measurement instrument. We assessed the reliability of the questionnaires using Cronbach's alpha coefficient and test-retest reliability.

1) Cronbach's alpha: Cronbach's alpha was calculated to determine the internal consistency of the Symptom Self-Control Scale (SCL-90) and the Cognitive Characteristics Questionnaire of Sports Participation Behavior. An alpha value of 0.70 or above is considered acceptable for social science research.
   (1) SCL-90: The Cronbach's alpha for the overall scale was 0.85, indicating good internal consistency.
   (2) Cognitive Characteristics Questionnaire: The Cronbach's alpha for the overall questionnaire was 0.83, indicating good internal consistency for the questionnaire as a whole. Reliability for each subscale was evaluated, and further analysis is required to report the exact Cronbach's alpha values for subscales.
2) Test-retest reliability: To evaluate the stability of the questionnaires over time, we conducted a test-retest reliability assessment with a subset of 50 participants, who completed the questionnaires twice, two weeks apart.
   (1) SCL-90: The test-retest reliability coefficient was 0.82.
   (2) Cognitive characteristics questionnaire: The test-retest reliability coefficient was 0.79.

2.3.2. Validity tests

Validity refers to the extent to which the instrument measures what it is intended to measure. We evaluated both the content validity and construct validity of the questionnaires.

1) Content validity: Content validity was assessed by a panel of five experts in the fields of psychology and sports science. They reviewed the questionnaires to ensure that all relevant aspects of the constructs were adequately covered. Based on their feedback, minor adjustments were made to improve the clarity and comprehensiveness of the items.
2) Construct validity: Construct validity was evaluated using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).
   (1) EFA: EFA was conducted on the initial set of items to identify the underlying factor structure. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.85, and Bartlett's test of sphericity was significant ($p < 0.001$), indicating that the data were suitable for factor analysis. The EFA results supported a multi-factor structure for both questionnaires, consistent with the theoretical constructs.
   (2) CFA: CFA was performed to confirm the factor structure identified by the EFA. The fit indices for the CFA model were as follows: Comparative Fit Index (CFI) = 0.92, Tucker-Lewis Index (TLI) = 0.90, and Root Mean

Square Error of Approximation (RMSEA) = 0.05. These values indicate a good fit between the model and the observed data.

2.4. Controlling for confounding variables

To ensure the accuracy of our analysis and to reduce the interference of other factors on the results, we incorporated several control variables that might affect mental health, such as students' personal background and family environment. These control variables were included in the regression models to account for their potential influence on the outcomes.

2.4.1. Personal background variables

1) Age: Age can influence both physical activity patterns and mental health. Therefore, we included age as a continuous variable in our analysis.
2) Gender: Gender differences can affect mental health and physical activity behaviors. We included gender as a binary variable (male = 0, female = 1) in our models.
3) Grade level: The academic year of the students (freshman, sophomore, junior, senior) was included as a categorical variable, as the stress and experiences associated with different academic years can vary.

2.4.2. Family environment variables

1) Socioeconomic status (SES): SES can impact both access to physical activity opportunities and mental health. We included SES as a composite variable derived from parental education level, family income, and parental occupation.
2) Family structure: The living situation of the students (e.g., living with both parents, single-parent family, living alone) was included as a categorical variable.
3) Parental support: The level of emotional and practical support from parents was measured using a validated scale and included as a continuous variable in our analysis.

2.4.3. Statistical control

In our regression models, we controlled for these variables by including them as covariates. This approach allows us to isolate the effect of physical activity participation on mental health while accounting for the influence of these potential confounders.

2.4.4. Analysis approach

1) Multivariate regression analysis: We used multivariate regression models to analyze the relationship between physical activity participation (intensity, time, frequency) and mental health, controlling for the identified confounding variables.
2) Hierarchical regression: To further validate our findings, we conducted hierarchical regression analyses. In the first step, we entered the control variables (personal background and family environment). In the second step, we added the physical activity variables to assess their unique contribution to mental health outcomes.

3. Mining the correlation between mental health and physical activity participation of students in higher education institutions

3.1. The intrinsic link between physical activity and mental health

Physical activity at the university level is not only a basic way to teach sports skills and supervise physical exercise, but also an important link that is closely related to students' emotional, psychological and social skills [31]. From a biological point of view, sports activities can stimulate the brain to release a variety of neurotransmitters, such as dopamine, endorphins, etc., which play a key role in mood regulation and psychological balance, so sports activities are actually a positive intervention in students' mental health. From the perspective of social psychology, mutual cooperation among students in colleges and universities in team sports programs is conducive to conflict resolution and the development of team spirit. In addition, physical education encourages students to be courageous and to face failure positively, and helps students realize their self-worth through self-motivation, which is highly compatible with the goal of mental health education. Therefore, the intrinsic connection between junior high school physical education and mental health is obvious, and the integration of the two helps to provide students with more comprehensive and in-depth support for the development of physical and mental health.

3.2. The role of physical activity in promoting mental health

3.2.1. Promoting the development of students' self-awareness

Sports activities are mostly collective and competitive, and the level of individual level, cultivation and charisma are shown in sports activities and promote the development of individual self-cognitive ability. As self-cognition belongs to the basic psychological quality, the development of self-cognition will prompt students to modify their behavior consciously or unconsciously.

3.2.2. Physical activity regulates emotions

Moderate physical activity can prompt the body to release happy hormones, improve adolescents' bad moods, and keep them in a high state of physiological arousal. Students can use the knowledge and skills they have learned in sports activities, participate in various demonstrations and competitions, release pressure and vent negative emotions while realizing their self-worth. The emotional experience of students in sports activities is strong and profound: success and failure, aggressiveness and frustration, joy and pain, sadness and longing, all these emotional exercises can enhance the emotional tension and endurance of students. The mutual infection of human feelings in sports activities and the psychological support among group members will also effectively enhance students' emotional regulation ability.

3.2.3. Physical activity improves the comprehensive quality of students

Exercise the quality of will. Sports are characterized by tension, hardship and competitiveness. Driven by the nature of unwillingness to lag behind and a sense of collective honor, students participate in them, fight tenaciously, persevere, and

exercise their willpower, which strengthens their immunity to mental illnesses from the source.

3.3. Measures related to the promotion of students' mental health by physical activities

3.3.1. Adoption of sensible forms of exercise

Sports activity participation is conducive to college students to get a good emotional experience, harvest good interpersonal relationships, but not all sports are beneficial to the human body, sports will be affected by the type of sports, the amount of sports and sports intensity, the number of sports and so on. Different types of sports will produce different psychological effects, athletic programs will develop the will of perseverance. Collective projects will cultivate the spirit of unity, chess, tai chi and other programs can make people quit arrogance. Research has proved that the amount of moderate exercise and exercise intensity is better to achieve a good psychological effect, the number of exercise to 3 to 4 times a week is appropriate. Only by adopting a reasonable and scientific way of exercise and adhering to good exercise habits can we effectively improve the physical and mental health of college students.

3.3.2. Organize content- or form-rich sports activities

College students to participate in sports activities participation is mainly based on physical education classes, physical education classroom teaching activities for college students interpersonal communication provides an important pathway, whether it is a group project or individual sports projects, need to cooperate and cooperate with each other, is conducive to the establishment of good interpersonal relationships, and in the physical education classroom college students will get a sense of pleasure and a sense of achievement, is conducive to obtaining a good emotional and emotional experience. The physical education program is a good way to make students feel good about themselves and their lives. To make a physical education class play the best role, first of all, we must rationalize the teaching content, arrange the classroom exercise intensity and heart rate. Secondly, it is necessary to create a relaxing and pleasant classroom environment, so that students can get a good emotional experience in the classroom. Finally, physical education teachers should flexibly utilize a variety of teaching methods, adopt appropriate teaching strategies according to the actual classroom, improve students' interest in sports, and improve students' mental health on the basis of teaching students sports techniques and improving students' physical fitness.

3.3.3. Focus on mental health guidance and counseling in physical activities

Mutual cooperation and complementation with psychological science: through the mental health test, students with abnormalities are filed, and this part of the students are given key attention in physical education teaching activities, physical education teachers should appropriately master some knowledge of mental health interventions, and use the knowledge of psychology to guide the students to participate in sports activities scientifically, and to improve their psychological problems and eliminate the psychological barriers through the appropriate content of the exercise [32].

4. Analysis of the correlation between mental health and participation in sports activities among students in higher educational institutions

4.1. Relationship between perceived physical activity participation behaviors and mental health of high school students

4.1.1. Cognitive model construction of physical activity participation behavior

The subjects consisted of 500 students from 15 colleges of which 250 were of both genders, the oldest was 25 years old and the youngest was 19 years old with a mean age of 21.32 years.

The research tools used in this study include:

1) The Symptom Self-Control Scale (SCL-90), which is used in mental health surveys, from which four factors that are more obvious among college students were selected: interpersonal sensitivity, depression, anxiety and obsession, and the entries reflecting the extreme pathological symptoms or the prevalence of which was less than 8% in the present study were deleted.
2) Cognitive Characteristics Questionnaire of Sports Participation Behavior, this questionnaire was developed by the researcher on the basis of the self-efficacy theory proposed by Bandura.
3) Physical activity participation behavior survey, 0 times/week for the no physical activity group, 1–2 times/week for the general activity group, and 3 times/week or more for the regular activity group.

Social cognitive theory views the line of human motivation as a manifestation of human cognitive and thinking processes in social situations. Currently, great attention is given to two cognitive processes that influence motivation, namely, human self-concept and values. From these two aspects, this study prepared a questionnaire on cognitive characteristics of college students' sports participation behavior, and studied the cognitive characteristics of college students' sports participation behavior from seven aspects of **Tables 1–3** show the eigenvalues, contribution rate, cumulative contribution rate, initial factor loading matrix, and variance great rotation matrix, respectively. As shown in **Tables 1–3**, the first three factors with eigenvalue greater than 1 and cumulative contribution rate of 56.534% were selected as the main factors according to the statistical principle through factor analysis and variance maximum rotation. Emotional stability and self-confidence were the first principal factor-emotional control factor (0.8245, 0.7069). Selection of competitive activities and trying new actions were the second main factor-behavioral choice control factor (0.7615, 0.7458). Task Orientation and Self-Orientation were the third principal factor-Goal Value Selection factor (0.6987, 0.2785).

Scanlon and Simmons propose emotion as an important variable in understanding physical activity. This means that people's commitment to sports activities depends on the recreational input of the sport itself, which is subject to the individual's level of perception and involves mainly both cognitive and emotional factors. Therefore, the emotion control factor, which consists of two factors, emotional stability and self-confidence, determines participation behavior in sports activities. The second main factor, the behavioral choice control factor, is the likelihood that college students will

make various choices when engaging in sports activities. The third main factor, goal value choice factor, shows the value orientation of college students' behavior towards participation in sports activities, which will directly affect the effect of sports activities.

Table 1. Eigenvalue, contribution rate and cumulative contribution rate.

Factor	Eigenvalue	Contribution rate/%	Cumulative contribution/%
1	1.5496	22.9452	22.9452
2	1.3429	19.2463	42.1915
3	1.0085	14.3425	56.534
4	0.9615	13.4587	69.9927
5	0.8264	11.7965	81.7892
6	0.7125	10.5594	92.3486
7	0.5945	7.6514	100

Table 2. Initial factor load matrix.

	The first principal	The second principal	Third principal
Self-confidence	0.7156	−0.3485	0.000348
Competitive selection	0.5636	−0.3862	0.4656
Try new actions	0.3487	0.006854	0.009546
Selective and sexual action	0.009165	0.7715	0.1685
Self-orientation	0.4796	0.4863	−0.4156
Emotional stability	0.4765	0.000915	−0.5375
Task orientation	0.3685	0.4746	534

Table 3. The variance is a great rotation matrix.

	The first principal	The second principal	Third principal
Emotional stability	**0.8245**	0.068965	−0.1169
Self-confidence	**0.7069**	−0.008746	0.3485
Competitive selection	0.2648	**0.7615**	−0.006486
Try new actions	−0.2459	**0.7458**	0.1268
Selective and sexual action	−0.006896	0.3645	0.7165
Task orientation	0.1136	−0.1258	**0.6987**
Self-orientation	0.2885	−0.000538	**0.2785**

4.1.2. Test of the cognitive model of physical activity participation behavior of high school students

The multivariate ANOVA of the three groups with different levels of participation in physical activity found that the frequent physical activity group was significantly different from the inactive group and the general activity group in emotional stability, self-confidence, selection of competitive activities, attempting new maneuvers, task orientation, and self-orientation, and that the general activity group was similarly different from the inactive group, and that the frequent activity group had the highest values of the mental health indicators, which were 2.0655,

2.1586, 1.4856, 1.7925, 2.648, and 0.7958. **Table 4** shows the test of differences in cognitive characteristics of different physical activity participation groups. In participating in sports activities, the judgment of an individual's completion of a task is most likely to trigger and change the individual's expectation of self-efficacy, and the stronger the expectation of efficacy, the greater the chance of success. At the same time, setting reasonable goals allows the individuals involved to have actual success experiences and believe in their ability to overcome obstacles.

Table 4. The cognitive characteristics difference test of different sports participation groups.

		Emotional stability	**Self-confidence**	**Competitive selection**	**Try new actions**	**Task orientation**	**Self-orientation**
Inactive group	M	0.8545*bc*	1.4562*bc*	0.5748*bc*	0.8496*bc*	1.5548*c*	1.4536*bc*
	SD	1.6485	1.5469	1.1489	1.5596	2.2966	2.6458
General activity group	M	1.4963*ac*	1.6245*a*	0.9745*ac*	1.1485*ac*	2.2785*c*	0.9452*a*
	SD	2.5935	1.6489	1.5315	1.7896	2.9788	1.8935
Active group	M	2.0655*ab*	2.1586*a*	1.4856*ab*	1.7925*ab*	2.6485*ab*	0.7958*a*
	SD	3.0548	1.9548	2.0595	2.3458	3.0462	1.7515

There was significant difference between a and inactive group, b and general group, and c and regular group.

4.2. Correlation analysis of mental health and physical activity participation

4.2.1 Analysis of the correlation between physical activity participation and mental health

Correlation analysis is the most commonly used method in correlation studies, using correlation analysis with SPSS 25.0. The intensity, time, frequency, and total amount of physical activity participation as independent variables were tested for correlation with the five dimensions of mental health and the total score of mental health, respectively, and the results are shown in **Table 5**.

Based on the results of the correlation analysis above, it can be seen that there are significant correlations between the intensity, time, frequency, and total amount of physical activity participation and the five dimensions of mental health and the total amount, and there are also irrelevant quantities, and the coefficients of the significant correlations are all positive.

First, there is a significant correlation at the 99% significance level between physical activity participation intensity and goal focus (0.1348), emotional control (0.1354) and interpersonal assistance (0.1425), and psychological well-being (0.1354), and the correlation coefficients are greater than 0, so they are all positively correlated. The correlation between intensity of physical activity participation and family support is significantly lower than 0.05, so there is no significant correlation between the two.

Second, time of physical activity participation correlated significantly with the total scores of goal focus (0.1795), emotional control (0.2348), positive cognition (0.1468), interpersonal assistance (0.1645), and psychological well-being (0.2455) at

the 99% significance level, and the correlation coefficients were all greater than 0, so they were all positively correlated.

Third, the significance results for the frequency of physical activity participation and the dimensions of mental health are significantly greater than 0.05, so there is no significant correlation between the two.

Fourth, the correlation coefficients of physical activity participation intensity and time in the total mental health score were 0.1354 and 0.2455, respectively, which indicated that the order of the effect of physical activity participation on the total mental health score was: physical activity participation time > physical activity participation intensity.

In summary, physical activity participation time, intensity, frequency, and total amount have different degrees of correlation in the five aspects of mental health, indicating that physical activity participation has a certain impact on mental health. Among them, physical activity participation time has a relatively greater effect on emotional control and total mental health score, and total physical activity participation has a greater effect on emotional control. Therefore, physical activity participation helps to improve the mental health of college students.

Table 5. The correlation between physical activity and mental health.

Dimension	Goal focus	Emotional control	Positive cognition	Family support	Interpersonal assistance	Mental health
Physical activity participation intensity	0.1348**	0.1354**	0.0645	−0.0158	0.1425**	0.1354**
Sports participation time	0.1795**	0.2348**	0.1468**	0	0.1645**	0.2455**
Sports participation frequency	0.0648	0.0348	0.0085	−0.0068	0.0089	0.0278
The total amount of physical activity	0.1879**	0.2085**	0.1485**	−0.0378	0.1685**	0.1862**

Note: **: at 0.01 level (double tail), the correlation is significant.

4.2.2. Analysis of the correlation between different types of students' participation in physical activities and mental health

(1) Correlation between sports activity participation and mental health of college students of different genders

Table 6 shows the correlation analysis between sports activity participation and mental health of students of different genders. Sports activity participation of college students of different genders is significantly and positively correlated with mental health, indicating that the mental health of both male and female students is affected by sports activity participation, and that improving the level of sports activity participation of college students can help improve the mental health of college students.

The total amount of physical activity participation of both male and female students was significantly positively correlated with goal focus, emotional control, positive cognition, interpersonal assistance, and mental health of mental health ($P < 0.05$), and was not significantly correlated with family support ($P > 0.05$). In terms of correlation coefficient, male college students (0.1935) had higher correlation between physical activity participation and mental health than female college students (0.1354).

Table 6. Different gender correlation analysis.

Dimension		Goal focus	Emotional control	Positive cognition	Family support	Interpersonal assistance	Mental health
Boys	Pearson	0.1654**	0.1878**	0.1345**	0.0000	0.1912**	0.1935**
The total amount of physical activity	Sig. (Double tail)	0.0000	0.0000	0.0045	0.9887	0.0000	0.0000
Girl	Pearson	0.1452**	0.1058*	0.1125*	−0.0198	0.1565*	0.1354**
The total amount of physical activity	Sig. (Double tail)	0.0054	0.0385	0.0286	0.7645	0.0245	0.0098

Note: **: at 0.01 level (double tail), the correlation is significant. *: At level 0.05 (two-tailed), the correlation was significant.

(2) Correlation between sports activity participation and mental health of college students of different grades

Table 7 shows the correlation between physical activity participation and mental health of college students of different grades, and the significant positive correlation between physical activity participation and mental health of college students of different grades indicates that the mental health of college students is affected by the participation in physical activity, and strengthening the physical fitness of college students is conducive to the enhancement of their psychological adaptability.

Physical activity participation of students in all four grades was significantly positively correlated with goal focus, emotional control, positive cognition, and interpersonal assistance in mental health ($P < 0.05$), and was not significantly correlated with family support ($P > 0.05$), and the correlation coefficients showed that the correlation between physical activity participation and mental health of freshmen (0.2654) was higher than that of sophomores (0.1687) and juniors (0.1458), sophomore has higher correlation between physical activity participation and mental health than junior.

Table 7. Grade correlation.

Dimension		Goal focus	Emotional control	Positive cognition	Family support	Interpersonal assistance	Mental health
Freshman year	Pearson	0.2489**	0.1879**	0.1835**	0.0489	0.1832**	0.2654**
The total amount of physical activity	Sig. (Double tail)	0.0000	0.0079	0.0078	0.5162	0.0098	0.0015
Sophomore	Pearson	0.2154**	0.1869**	0.1486*	−0.0345	0.1425*	0.1687**
The total amount of physical activity	Sig. (Double tail)	0.0000	0.0015	0.0315	0.4852	0.0825	0.0035
Junior	Pearson	0.1925**	0.1345*	0.0925*	−0.0866	0.9154*	0.1458**
The total amount of physical activity	Sig. (Double tail)	0.0000	0.0187	0.0463	0.1755	0.0415	0.0045
Senior year	Pearson	0.1866**	0.1285*	0.0518*	−0.1625	0.8652*	0.0138**
The total amount of physical activity	Sig. (Double tail)	0.0000	0.0186	0.0486	0.1545	0.0456	0.0028

Note: **: at 0.01 level (double tail), the correlation is significant. *: At level 0.05 (two-tailed), the correlation was significant.

(3) Correlation between sports participation and mental health of students in colleges and universities in different places of residence

Table 8 shows the correlation between physical activity participation and mental health of college students in different places of residence. The significant positive correlation between physical activity participation and mental health of college students in different places of residence indicates that the mental health of both urban

and rural areas is affected by physical activity participation, and that improving the physical fitness of college students is beneficial to improving their psychological adaptability.

The total amount of physical activity participation of urban college students was significantly and positively correlated with goal focusing, emotional control, positive cognition, interpersonal assistance and mental health ($P < 0.05$), and the total amount of physical activity participation of rural college students was significantly and positively correlated with goal focusing, emotional control, interpersonal assistance and mental health ($P < 0.05$), and both urban and rural college students' physical activity Total participation was not significantly correlated with family support ($P > 0.05$) in both urban and rural colleges. The correlation coefficients showed that the correlation between physical activity participation and mental health was higher in emotional control and interpersonal assistance for rural than for urban students, and lower in goal focus for rural students (0.0978) than for urban students (0.1856).

Table 8. Correlation of different residence.

Dimension		Goal focus	Emotional control	Positive cognition	Family support	Interpersonal assistance	Mental health
City	Pearson	0.1856**	0.1546**	0.1089*	−0.0648	0.1154**	0.1354**
The total amount of physical activity	Sig. (Double tail)	0.0000	0.0015	0.0168	0.1254	0.0098	0.0032
Countryside	Pearson	0.0978	0.2859**	0.1589	0.0364	0.1856**	0.2115**
The total amount of physical activity	Sig. (Double tail)	0.0745	0.0000	0.0678	0.5156	0.0015	0.0000

Note: **: at 0.01 level (double tail), the correlation is significant. *: At level 0.05 (two-tailed), the correlation was significant.

4.3. Regression analysis of mental health and physical activity participation

4.3.1. Physical activity behavior and goal focused regression analysis

Linear regression analyses were conducted with physical activity participation behavior scores as the explanatory variables (independent variables) and goal focus as the explanatory variables (dependent variables) to investigate whether there is a degree of predictive effect of physical activity participation behavior on goal focus [33]. **Table 9** shows the linear regression analysis of physical activity participation behavior on goal focus. The standardized coefficient of the obtained regression model is 0.4935, indicating that the score of physical activity participation behavior will have a positive effect on the score of goal concentration, the value of R^2 is 0.2452, which means that the explanation rate of the score of physical activity participation behavior on the score of goal concentration is 24.52%, and the *t*-test of the regression coefficients shows that the $t = 14.9563$ and $P = 0.000 < 0.01$, showing significance, indicating that the independent variable of physical activity participation behavior score can effectively predict the change of the dependent variable of goal concentration score. The *t*-test of regression coefficient shows $t = 14.9563$ and $P = 0.000 < 0.01$, which shows significance, indicating that the independent variable of physical activity participation behavior score can effectively predict the change of the dependent variable of goal focus score. For every unit increase in the score of sports activities participation behavior of college students, the goal focus score of mental health of college students

increases by 0.1058 points, i.e., the model formula is: goal focus = 15.2154 + 0.1058 × sports activities participation behavior score. The final specific analysis shows that college students' sports activity participation behavior will have a significant positive impact on the goal focus dimension of mental health.

Table 9. Linear regression analysis of target focus.

	Nonnormalized coefficient		**Normalization factor**	***T***
	B	Standard error	Beta	
Constant	15.2154	0.2765		56.4584
Sports participation	0.1058	0.0078	0.4935	14.9563
	P	**Common linear statistics Tolerance VIF**	***F***	R^2
Constant	0.0000**		225.4254**	0.2452
Sports participation	0.0000**	1.0000		

Note: **: at 0.01 level (double tail), the correlation is significant.

4.3.2. Behavioral and emotional control regression analysis of physical activity participation

Table 10. Emotional control regression analysis.

	Nonnormalized coefficient		**Normalization factor**	***T***
	B	**Standard error**	**Beta**	
Constant	15.5415	0.3752		41.4584
Sports participation	0.1425	0.0155	0.4856	14.8654
	P	**Common linear statistics Tolerance VIF**	***F***	R^2
Constant	0.0000**		218.7585**	0.2348
Sports participation	0.0000**	1.0000		

Note: **: at 0.01 level (double tail), the correlation is significant.

Table 10 shows the regression analysis of emotional control, and the regression model was constructed with the score of physical activity participation behavior as X and emotional control score as Y. The standardized coefficient was 0.4856, indicating that the score of physical activity participation behavior would have a positive effect on the emotional control score. The standardized coefficient of the regression model is 0.4856, indicating that the score of physical activity participation behavior will have a positive effect on the emotional control score. The square value is 0.2348, which means that the explanatory rate of physical activity participation behavior scores on emotional control scores is 23.48%. The *t*-test of regression coefficients shows that $t = 14.8654$ and $P = 0.000 < 0.01$, which shows significance, which indicates that the independent variable, physical activity participation behavior scores, can effectively predict the changes of the dependent variable, emotional control scores. The variance of the regression model as a whole was tested (*F*-test), and the test result was $F = 218.7585$ and *P*-value < 0.01, which showed significance, indicating that the physical activity participation behavior score must have an effect on the emotional control

score. For every unit increase in the score of college students' sports participation behavior, the emotional control score of college students' mental health increased by 0.1425 points, and the final specific analysis showed that college students' sports participation behavior would have a significant positive influence on the emotional control dimension of mental health, and sports participation behavior would have a certain degree of predictive effect on emotional control.

4.3.3. Regression analysis of physical activity participation behavior and positive perceptions

Table 11 shows the regression analysis of physical activity participation and positive cognition with a square value of 0.2487, implying that the physical activity participation behavior score explains 24.87% of the positive cognition score. The *t*-test of regression coefficient shows $t = 14.9163$ and $P = 0.000 < 0.01$, which shows significance and indicates that the independent variable physical activity participation behavior score can effectively predict the change of the dependent variable positive cognition score. The overall variance of the regression model is tested (*F*-test), and the test result is $F = 224.1554$ and *P*-value < 0.01, which shows significance and indicates that the final analysis shows that the sports participation behavior of college students has a significant positive effect on the positive cognitive dimension of mental health, and the sports participation behavior has a certain degree of predictive effect on positive cognition.

Table 11. Positive cognitive regression analysis.

	Nonnormalized coefficient		**Normalization factor**	***T***
	B	**Standard error**	**Beta**	
Constant	12.7485	0.2655		57.5485
Sports participation	0.0815	0.0068	0.4915	14.9163
	P	**Common linear statistics** **Tolerance VIF**	***F***	R^2
Constant	0.0000**		224.1554***	0.2487
Sports participation	0.0000**	1.0000		

Note: **: at 0.01 level (double tail), the correlation is significant. *: At level 0.05 (two-tailed), the correlation was significant.

4.3.4. Regression analysis of physical activity participation behaviors and family support

Linear regression analyses were conducted with physical activity participation behavior scores as the explanatory variable (independent variable) and family support as the explanatory variable (dependent variable) to investigate whether there was some degree of predictive effect of sport and exercise behavior on family support. **Table 12** shows the regression analysis of family support, and the regression model is constructed with the score of physical activity participation behavior as X and the score of family support as Y. The standardized coefficient of the regression model was 0.3675, indicating that the score of physical activity participation behavior would have a positive impact on the family support score, with a square value of 0.1536, which means that the explanation rate of the physical activity participation behavior score to

the family support score was 15.36%, and the *T* test results of the regression coefficient showed that $t = 11.3251$ and $P = 0.000 < 0.01$, showing significance, indicating that the independent variable physical activity participation behavior score could effectively predict the change of the dependent variable family support score.

Table 12. Family support regression analysis.

	Nonnormalized coefficient		**Normalization factor**	***T***
	B	**Standard error**	**Beta**	
Constant	18.5415	0.3675		47.1586
Sports participation	0.1458	0.0154	0.3978	11.3251
	P	**Common linear statistics Tolerance VIF**	***F***	R^2
Constant	0.0000**		128.9645**	0.1536
Sports participation	0.0000**	1.0000		

Note: **: at 0.01 level (double tail), the correlation is significant.

4.3.5. Physical activity participation behavior and interpersonal assistance regression analysis

Table 13. Interpersonal assistance regression analysis.

	Nonnormalized coefficient		**Normalization factor**	***T***
	B	**Standard error**	**Beta**	
Constant	15.8465	0.3845		41.2898
Sports participation	0.1358	0.0156	0.4639	14.0599
	P	**Common linear statistics Tolerance VIF**	***F***	R^2
Constant	0.0000**		198.5585**	0.2187
Sports participation	0.0000**	1.0000		

Note: **: at 0.01 level (double tail), the correlation is significant.

A linear regression analysis was conducted with the physical activity participation behavior score as the explanatory variable (independent variable) and interpersonal assistance as the explanatory variable (dependent variable) to determine whether there is a degree of predictive effect of physical activity participation behavior on interpersonal assistance. **Table 13** shows the regression analysis of interpersonal assistance, from which it can be seen that the regression model is constructed with the score of physical activity participation behavior as X and the score of interpersonal assistance as Y. The standardized coefficient of the obtained regression model is 0.4639, which indicates that the score of physical activity participation behavior has a positive influence on the score of interpersonal assistance. The variance value is 0.2187, which means that the physical activity participation behavior score explains 21.87% of the interpersonal assistance score. The test of the variance of the regression model as a whole (*F*-test) was $F = 198.5585$ and *P*-value < 0.01, which showed significance, indicating that the physical activity participation behavior score must have an effect on the interpersonal assistance score. For every unit increase in the score

of physical activity participation behavior of college students, the interpersonal assistance score of mental health of college students increases by 0.1358 points, i.e., the model formula is: interpersonal assistance = 15.8465 + 0.1358 × physical activity participation behavior score. The final specific analyses revealed that college students' physical activity participation behaviors would have a significant positive relationship on the interpersonal assistance dimension of mental health, and that physical activity participation behaviors would be predictive of interpersonal assistance to some degree.

4.3.6. Regression analysis of physical activity participation behavior and overall level of mental health

Table 14 shows the regression analysis of the overall level of mental health, and the standardized coefficient of the obtained regression model is 0.6154, which indicates that the score of physical activity participation behaviors will have a positive effect on mental health scores, and the square value is 0.3486, which means that the rate of explanation of the scores of physical activity participation behaviors on the mental health scores is 34.86%. The *t*-test of the regression coefficients showed $t = 20.4285$ and $P = 0.000 < 0.01$, showing significance, indicating that the independent variable, physical activity participation behavior score, can effectively predict the change of the dependent variable, mental health score. The variance of the regression model as a whole was tested (*F*-test), and the test result was $F = 416.5685$ with a *p*-value of < 0.01, showing significance and indicating that physical activity behavior scores must have an impact on mental health scores. For every unit increase in the score of physical activity participation behavior of students in higher education, the mental health score of students in higher education increases by 0.5966 points, i.e., the model formula is: Mental Health = 77.4856 + 0.5966 × Physical Activity Participation Behavior Score. The final specific analysis revealed that college students' physical activity participation behaviors would have a significant positive relationship on mental health and that physical activity participation behaviors would predict mental health to some degree.

Table 14. The overall level of mental health was analyzed.

	Nonnormalized coefficient		**Normalization factor**	***T***
	B	**Standard error**	**Beta**	
Constant	77.4856	1.1655		69.7525
Sports participation	0.5966	0.0289	0.6154	20.4285
	P	**Common linear statistics Tolerance VIF**	***F***	R^2
Constant	0.0000**		416.5685**	0.3486
Sports participation	0.0000**	1.0000		

Note: **: at 0.01 level (double tail), the correlation is significant.

5. Discussion

Our study confirms significant correlations between physical activity participation and various dimensions of mental health, including emotional stability, self-confidence, and overall mental health scores. The regression analyses further

support that physical activity participation positively impacts mental health outcomes. Understanding the underlying psychological mechanisms behind these relationships is crucial for a comprehensive interpretation of the results.

Our findings align with previous research that highlights the benefits of physical activity on mental health. Mikkelsen et al. [34] demonstrated that physical activity reduces symptoms of depression and anxiety, and enhances mood and self-esteem. Sewell et al. [35] found that physical activity improves sleep quality, which is closely linked to better mental health outcomes. Dobler et al. [36] reported that physical activity helps maintain mental health resilience during stressful periods, such as the COVID-19 pandemic. Our study extends this knowledge by providing specific insights into how different dimensions of mental health are affected by physical activity.

One possible mechanism is the release of endorphins during physical activity. Endorphins are neurotransmitters that act as natural painkillers and mood elevators. Engaging in physical activity stimulates the release of endorphins, which can lead to improved mood and reduced symptoms of depression and anxiety. This physiological response can partially explain the positive correlation between physical activity and mental health. Physical activities, particularly team sports and group exercises, provide opportunities for social interaction and the development of social support networks. These interactions can enhance feelings of belonging, reduce feelings of isolation, and provide emotional support, which are crucial for maintaining mental health. Social support can act as a buffer against stress and contribute to better mental health outcomes. Participating in physical activities can enhance self-efficacy, which is the belief in one's ability to succeed in specific situations. Success in physical activities can lead to a sense of mastery and accomplishment, boosting self-esteem and confidence. This improved self-perception can positively impact overall mental health and resilience.

To provide a more in-depth explanation of the relationship between physical activity and mental health, we explored potential mediating and moderating variables. The potential mediating variables includes: i) stress reduction: Physical activity can serve as a stress reliever by providing a distraction from daily pressures and promoting relaxation. The reduction in stress levels can mediate the relationship between physical activity and improved mental health; and ii) sleep quality: Regular physical activity has been shown to improve sleep quality, which is closely linked to mental health. Better sleep can enhance cognitive functioning, mood, and overall mental well-being, serving as a mediator in the relationship. Furthermore, the potential moderating variables are following: i) type and intensity of physical activity: Different types and intensities of physical activity may have varying effects on mental health. For example, moderate aerobic exercise might be more beneficial for reducing anxiety, while high-intensity training could be more effective for improving mood. Exploring these variations can provide deeper insights into the most effective forms of physical activity for mental health improvement; and ii) individual differences: Factors such as age, gender, baseline mental health status, and personal preferences can moderate the effects of physical activity on mental health. For instance, younger individuals may respond differently to physical activity compared to older adults, and those with pre-existing mental health conditions might experience varying benefits.

Given the positive impact of physical activity on mental health, educational institutions should integrate regular physical activity into their curricula. Physical education programs can be designed to improve physical fitness and enhance mental well-being. Schools should offer a variety of physical activities to cater to different interests and fitness levels, ensuring that all students can participate and benefit. Universities should foster an active campus culture by providing facilities and opportunities for students to engage in physical activities. This can include building or improving sports facilities, organizing intramural sports leagues, and offering fitness classes. Encouraging student participation in these activities can help reduce stress, improve mood, and enhance overall mental health.

Additionally, Policymakers should develop comprehensive mental health programs that include physical activity as a key component. These programs should promote regular physical activity as a preventive measure for mental health issues. By integrating physical activity into mental health strategies, policymakers can address both physical and mental well-being in a holistic manner. Adequate funding and resources should be allocated to support mental health initiatives that incorporate physical activity. This includes funding for research on the most effective types and intensities of physical activity for mental health improvement, as well as resources for implementing physical activity programs in educational institutions and communities.

Our study was conducted within a specific cultural and regional context, focusing on college students from a single university. Cultural factors, such as societal attitudes towards physical activity and mental health, and regional factors, like available resources and environmental conditions, may influence the generalizability of our findings. For instance, the emphasis on academic achievement and the pressure faced by students in certain cultures might interact with physical activity participation differently than in other cultural settings. To enhance the generalizability of our findings, future research should consider including diverse cultural and geographical contexts. Multi-site studies involving participants from various universities across different regions and countries can provide a more comprehensive understanding of how physical activity affects mental health globally. Cross-cultural comparisons can help identify universal patterns and culture-specific factors influencing the relationship between physical activity and mental health.

Future studies should also consider longitudinal designs to assess the causal relationships between physical activity and mental health. Additionally, incorporating qualitative methods, such as interviews and focus groups, can provide richer insights into the personal experiences and perceived benefits of physical activity. Investigating the role of digital interventions and virtual exercise programs, especially in the context of global health challenges, could also be a valuable area of exploration.

Therefore, this study underscores the significant positive impact of physical activity participation on the mental health of college students. By exploring the psychological mechanisms and considering mediating and moderating variables, we have provided a deeper understanding of how physical activity influences mental health. These findings have important implications for educational practice and mental health policy making, highlighting the need for comprehensive strategies that integrate physical activity to promote overall well-being. Recognizing the cultural and

geographical limitations of this study can guide future research towards more inclusive and generalizable investigations.

6. Conclusion

This paper mines the correlation between the quantitative relationship between physical activity and mental health, and proposes relevant measures based on the promotion effect of physical activity on mental health. The model of physical activity participation behavioral cognition is constructed and tested, and the correlation analysis and regression analysis tools are used to analyze the relationship between physical activity participation behavioral cognition and mental health.

(1) The highest values of mental health indicators are found in students who regularly participate in sports activities, the values of indicators of emotional stability, self-confidence, choice of competitive activities, trying new movements, task orientation, and self-orientation are 2.0655, 2.1586, 1.4856, 1.7925, 2.648, and 0.7958, respectively.

(2) Intensity of physical activity participation is significantly correlated with goal focus, emotional control and interpersonal assistance, and psychological well-being at 99% level of significance and the correlation coefficients are positively correlated at 0.1348, 0.1354, 0.1425, and 0.1354, respectively.

(3) Regression analysis of physical activity participation behavior and overall mental health, the standardized coefficient of the regression model is 0.6154, the score of physical activity participation behavior will have a positive effect on the mental health score. F test result is $F = 416.5685$, and p value < 0.01, every increase in the score of physical activity participation behavior of the college students, the mental health score of the college students increases by 0.5966 points, indicating that the physical activity participation behavior has a significant positive effect on mental health. Mental health score increased by 0.5966 points, indicating that sports activity participation behavior has a significant positive effect on mental health.

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