

Factors Affecting the Physical Fitness of College Students and Improvement Strategies

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Abstract—The nation has set the goal of building a strong sports country, but the physical fitness of college students remains subpar, with a low pass rate in physical fitness tests. Therefore, it becomes crucial to study the factors influencing the physical fitness test levels of college students and the impact of individual physical conditions. This study utilizes group measurements and variance analysis methods to examine the influence of factors such as gender, college, and physical condition on the physical fitness test scores of college students. The research findings contribute to proposing recommendations for improving the physical fitness of college students, including dietary enhancements, the cultivation of healthy lifestyle habits, the promotion of psychological well-being, and the optimization of curriculum design.

Keywords-College students; Analysis of variance; Mathematical statistics

1. Introduction

China places a strong emphasis on cultivating the physical fitness of college students, recognizing them as the future pillars of the nation^[1]. Currently, the improvement of physical fitness among college students is progressing at a gradual pace^[2]. The prevalence of overweight and obesity among this demographic continues to rise. The college years represent a pivotal period for physical development and the establishment of lifelong habits^[3-4]. Moreover, higher education not only prioritizes the imparting of academic knowledge but also underscores the comprehensive development of students^[5]. Physical well-being constitutes a crucial component of a student's overall quality^[6].

In order to effectively enhance the physical health of college students, the nation has implemented relevant regulations and standards to promote their fitness levels^[7]. This paper assesses the physical fitness of college students in accordance with the "National Student Physical Fitness Standards" and compiles statistical data regarding their test results^[8]. Through various methodologies, it investigates and comprehends the physical health status of college students,

identifying any existing health concerns^[9]. This enables targeted interventions and improvements, thereby effectively elevating the overall physical fitness level of college students^[10].

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2. Materials and Methods

2.1 Research Subjects

The research focuses on the physical fitness test data of the 2022 cohort of a specific university.

2.2 Research Methods

1) Literature Review Method:

Through comprehensive searches of literature related to physical fitness testing, we will gather relevant information concerning the physical health of university students. This literature will be integrated with the current research status and the challenges we are facing to conduct an in-depth analysis and study.

2) Measurement Method:

We will conduct group testing on university students from the 2022 cohort at a specific university, dividing the testing into two parts: self-physical measurements and physical fitness testing. Students from different colleges and genders will be grouped for staggered testing. One group will undergo self-physical measurements, and the other will undergo physical fitness testing, after which the test results will be exchanged. Self-physical measurements will include assessing parameters such as height, weight, and lung capacity. Physical fitness testing will encompass measurements like height, weight, lung capacity, a 50-meter sprint, standing long jump, sit-and-reach, 800-meter run (for females), 1000-meter run (for males), one-minute sit-ups (for females), and pull-ups (for males), among other items. We will record the test results along with personal information.

3) Statistical Analysis Method:

Through data preprocessing of the collected data, we will evaluate and grade the data in accordance with the "Student Physical Health Standards (Trial)" and the statistical standards for physical fitness data. Subsequently, we will employ Python for variance analysis to compare the degree of correlation between physical fitness scores and different test items, gender, and colleges, among other factors. This will aid in conducting in-depth analysis and research on the relationship between physical fitness scores and various test items, gender, and colleges. Finally, based on the more highly correlated sets of test items identified through variance analysis, we will perform

detailed statistical analysis and comparisons, and draw conclusions based on the detailed information.

3.Results and Discussion

3.1 Results

Figure 1 shows the distribution of fitness test data grades for all students, Figure 2 represents the grade distribution of fitness test data for male students, and Figure 3 displays the grade distribution of fitness test data for female students.

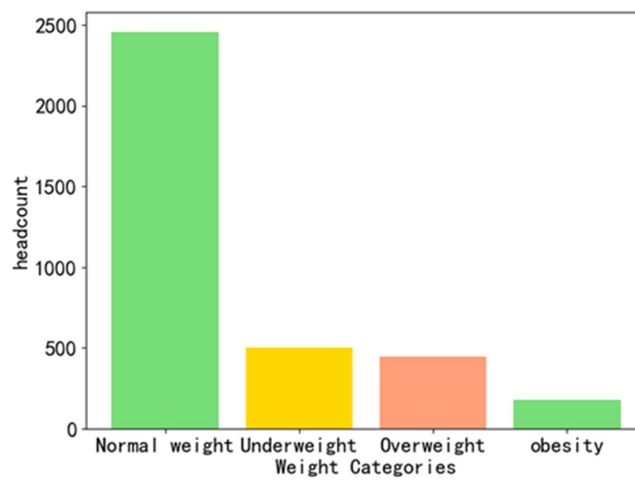


Figure 1 Physical Fitness Grade Distribution

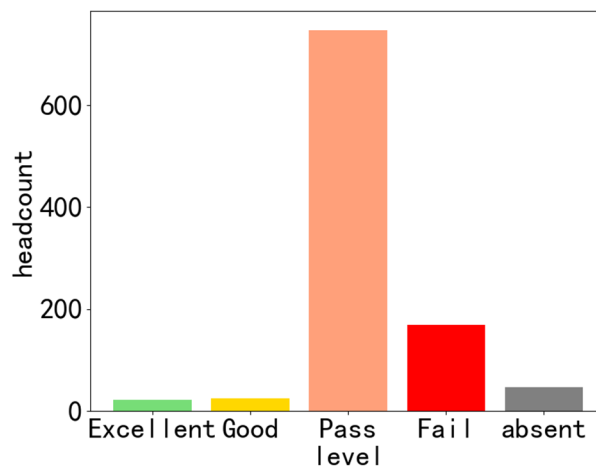


Figure 2 Male Fitness Grade Distribution

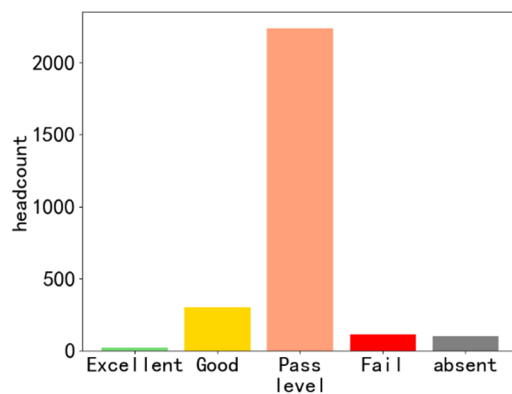


Figure 3 Female Fitness Grade Distribution

Table 1 Number and Percentage of College Students in Different Fitness Test Performance Levels by Gender

Subject	Percentage of excellence	Percentage of satisfactory	Percentage of pass	Percentage of fail	Total proportion
Female	22/2.18%	25/2.48%	748/74.06%	169/16.73%	1010/26.71%
Male	21/0.76%	301/10.86%	2239/80.77%	112/4.04%	2772/73.29%
Total students	43/1.14%	326/8.62%	2987/78.98%	281/7.43%	3782

Table 2 Distribution of University Students BMI Values by Gender and Level, Including Number of Individuals and Percentages

Object	Normal weight	Underweight	Overweight	Obesity	Total population
Male	581/57.52%	178/17.62%	101/10.00%	91/9.01%	951/26.54%
Female	1876/67.68%	409/14.75%	266/9.60%	80/2.89%	2631/73.46%
Total student	2457/64.97%	500/13.22%	444/11.74%	181/4.79%	3582

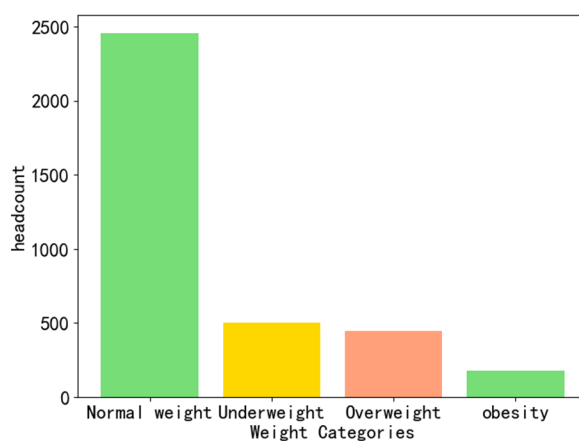


Figure 4 Distribution of Weight Categories Among All Students

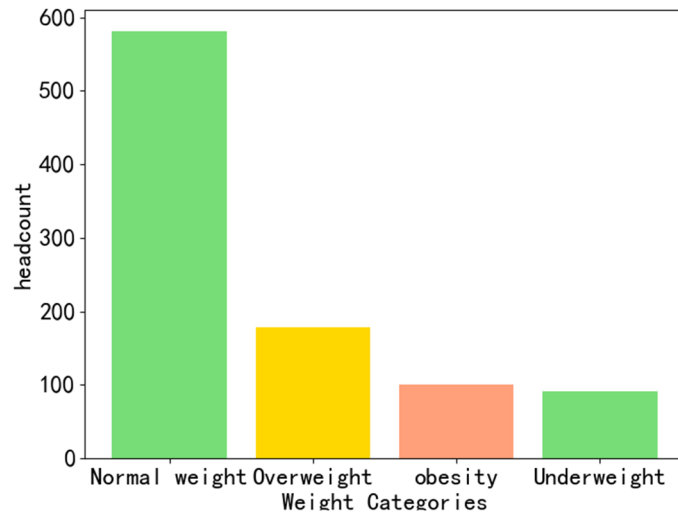


Figure 5 Distribution of Weight Categories Among Male Students

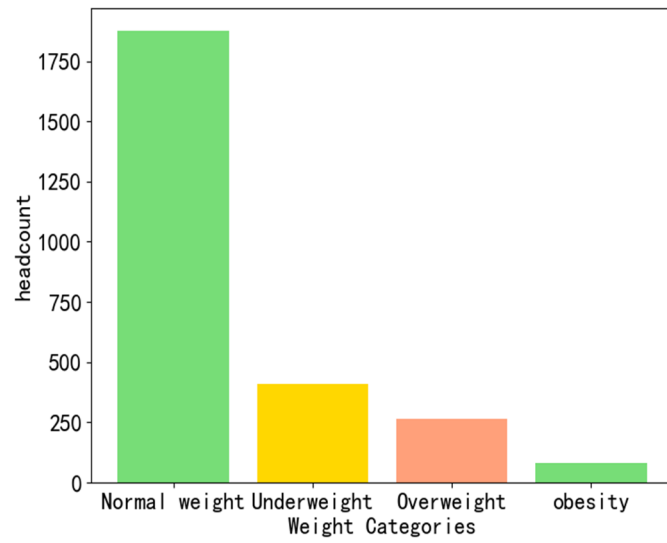


Figure 6 Distribution of Weight Categories Among Female Students

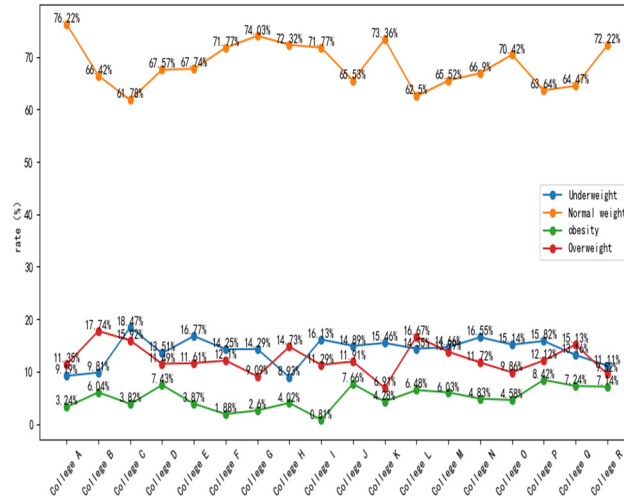


Figure 7 Proportional Distribution of BMI Values in different Categories by Various Colleges

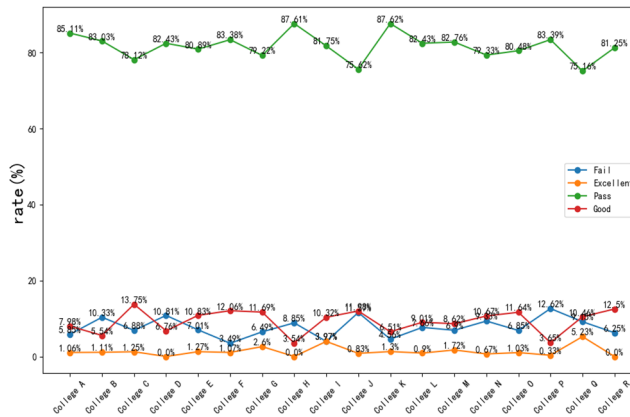


Figure 8 Proportional Distribution of Number of Individuals in Different Physical Fitness Levels Across Various Colleges

BMI Among College Students

Table 3 One-Way ANOVA Results for BMI by Gender and Department

	df	sum_sq	mean_sq	F	PR(>F)
C(sex)	1.0	2480.230302	2480.230302	173.671259	9.200785e-39
Residual(sex)	3580.0	51126.619985	14.281179	null	null
C(department)	17.0	596.097200	35.064541	2.357447	0.001321
Residual(department)	3564.0	53010.753087	14.873949	null	null

Physical Fitness Test Results for College Students

Table 4 One-Way ANOVA Results for Physical Fitness Test Scores of College Students by Gender and Department

	sum_sq	Df	F	PR(>F)
C(sex)	34331.009858	1.0	447.17456	1.262026e-93
Residual	274847.959276	3580.0	null	null
C(department)	8049.636784	17.0	5.604179	1.036085e-12
Residual	301129.332351	3564.0	null	null

Table 5 Multifactorial Analysis of Variance Results for the Effects of Height, Weight, and Lung Capacity on College Students' Physical Fitness Test Scores

	sum_sq	Df	F	PR(>F)
C(height)	23444.379784	223.0	2.112181	2.168655e-14
C(weight)	86844.149844	586.0	2.977421	1.555402e-48
C(lung capacity)	155740.139885	2061.0	1.518168	7.787314e-13
Residual	43253.620942	869.0	null	null

Table 6 One-Way ANOVA Results for Different Physical Fitness Test Components on College Students' Physical Fitness Test Scores

	sum_sq	Df	F	PR(>F)
Broad Jump	11093.934882	1.0	133.238111	2.738033e-30
Residual(Broad Jump)	298085.034253	3580.0	null	null
Sitand Reach	25312.021919	1.0	319.223634	1.848418e-68
Residual(Sitand Reach)	283866.947215	3580.0	null	null
One-Minute Sit-Up	61320.855993	1.0	885.70296	4.203378e-174
Residual(One-Minute Sit-Up)	247858.113141	3580.0	null	null
Pull-Up	3369.199861	1.0	39.441956	3.784878e-10
Residual(Pull-Up)	305809.769273	3580.0	null	null
50-Meter Dash	12223.677434	1.0	147.364827	2.915996e-33
Residual(50-Meter Dash)	296955.291701	3580.0	null	null
800-Meter Run	128416.651885	145.0	16.834437	2.323251e-299
Residual(800-Meter Run)	180762.317250	3436.0	null	null
1000-Meter Run	88579.924186	159.0	8.642006	1.519143e-155
Residual(1000-Meter Run)	220599.044948	3422.0	null	null

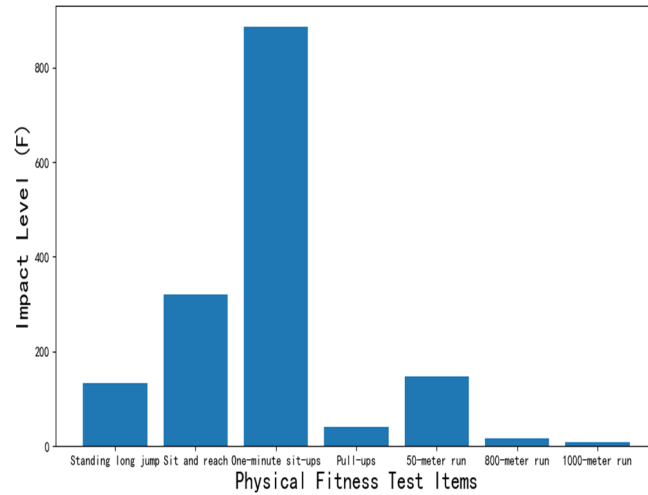


Figure 9 Impact of Different Physical Fitness Test Components on College Students' Physical Fitness Test Scores

Table 7 Statistical Table of Pass Rates for Lung Capacity and Physical Fitness Test Component Scores

	Lung capacity	50-Meter Dash	Broad Jump	Sit and Reach	One-Minute Sit-Up	Pull-Up	800-Meter Run	1000-Meter Run
Male	98.20%	95.79%	64.06%	95.91%	Null	26.32%	Null	97.37%
Female	99.58%	89.50%	81.42%	97.92%	74.24%	Null	91.21%	Null

3.2 Discussion

1) Preliminary Analysis of Physical Fitness Data

This physical fitness assessment collected a total of 3782 data points, and in accordance with the revised National Student Physical Fitness and Health Standards (2014), these data to some extent reflect the physical fitness status of college students. Therefore, we conducted a standardized scoring and grading for each college student's physical fitness data.

First, let's delve into an in-depth analysis of the basic physical fitness information of college students. From the data presented in Table 1 and Figures 1-3, it can be observed that the proportion of female college students excelling in the categories of excellence, goodness, and pass is higher than that of male students. Conversely, the proportion of females in the category of failure is lower than that of males. This suggests that, overall, female students demonstrate relatively better performance in terms of physical fitness assessment results.

2) Analysis of Variance (ANOVA)

We conduct a variance analysis to systematically examine the factors that may influence the total score and BMI-related physical fitness. This helps us identify the key factors affecting the

physical fitness and fitness scores of college students. By doing so, we can pinpoint the areas that require improvement and formulate specific plans to enhance the physical fitness of college students. For a detailed research plan, please refer to Figure 10.

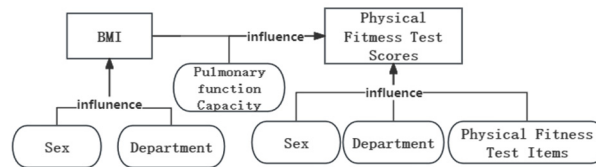


Figure 10 Factors that may influence college students' physical fitness scores and physical stature

The research analysis primarily focuses on two aspects of study:

Regarding the BMI (Body Mass Index) of university students:

1. Whether there are differences in BMI among students of different genders, and how significant these differences are. (Considering only health levels and not taking into account gender-related physiological differences.)
2. Whether there are differences in BMI among students from different academic faculties, and how significant these differences are.

Concerning the physical fitness test scores of university students:

1. Whether there are differences in physical fitness test scores among students of different genders, and how significant these differences are. (Considering only health levels and not taking into account gender-related physiological differences.)
2. Whether there are differences in physical fitness test scores among students from different academic faculties, and how significant these differences are.
3. Whether different types of physical fitness test scores have varying impacts on overall fitness scores among university students. Specifically, determining which physical fitness test component has the most significant impact on the overall fitness score.
4. Whether there are differences in physical fitness test scores among university students with different BMI values and lung capacities (considering varying body types), and how significant these differences are.

To analyze these differences, the study employs analysis of variance (ANOVA) methodology. The relationships between different genders, academic faculties, and BMI are analyzed through single-factor ANOVA, as presented in Table 3. The impact of different types of physical fitness test scores on overall fitness scores among students of different genders and academic faculties is examined using single-factor ANOVA, as illustrated in Tables 4 and 6. Additionally, the relationship between students' height, weight, lung capacity (considering diverse body types), and overall physical fitness test scores is analyzed using multifactor ANOVA, as demonstrated in Table 5. Based on these analyses, the following conclusions were drawn.

3.2.1 BMI-based Physical Fitness of University Students

When analyzing the BMI data of university students, a gender variance analysis was conducted. The results, as shown in Table 3, indicate that gender has a significant impact on BMI values. Subsequently, we continued to calculate and analyze the health proportions of BMI for different genders.

Based on Table 2 and Figures 4-6, the distribution of BMI among university students reveals that a higher proportion of female students have a normal weight, while a relatively higher proportion of male students are obese. The proportion of underweight individuals is also higher among female students.

On the other hand, we also conducted a variance analysis between BMI and academic departments. The results, as presented in Table 3, demonstrate that academic departments also significantly affect BMI values, with notable differences in BMI between different departments. Examining the proportion of weight categories across various academic departments in Figure 7, we can analyze the differences between departments:

1. Disparities in underweight proportion: There are significant differences in the proportion of underweight individuals among different departments. For instance, C College and D College have a higher proportion of underweight individuals, whereas B College and F College have a lower proportion.

2. Differences in the proportion of normal weight individuals: Regarding the proportion of individuals with a normal weight, most departments have a relatively high proportion, exceeding 60% in many cases. However, H College and R Department have a lower proportion of normal-weight individuals.

3. Discrepancies in the proportion of obese individuals: The proportion of obese individuals varies among different departments. For example, C College and P College have a higher proportion of obese individuals, while E College and I Department have a lower proportion.

4. Variances in the proportion of overweight individuals: In terms of the proportion of overweight individuals, A College, B College, and L College have a higher proportion, whereas I Department and M College have a lower proportion.

In summary, when looking at the overall BMI status of university students, a significant proportion falls into the normal weight category, accounting for 64.97%. However, there is still a notable percentage of individuals who are either underweight, overweight, or obese.

3.2.2 In terms of physical fitness assessment scores for college students:

According to the results of the analysis of variance (ANOVA) in Table 4, it is evident that gender significantly influences the physical fitness assessment scores, and this finding has already been verified in the preliminary analysis discussed above. In terms of different academic departments, the ANOVA results indicate significant variations in the physical fitness scores among various departments. Further data analysis, as depicted in Figure 8, reveals that:

First, in the "fail" category, the proportion of students from P College and D College is relatively high, while I Department and F College have a lower proportion. This suggests that students from I Department and F College perform better in the physical fitness scores in the "fail" category.

Continuing the analysis in different categories, in the "excellent" category, Q College and I Department have a higher proportion, whereas D College and H College have zero representation, indicating that no students achieved the "excellent" level in these departments. In the "pass" category, H College and K College have a higher proportion, while J College and Q College have a lower proportion. In the "good" category, C College and R Department have a higher proportion, while H College and P College have a lower proportion.

The results of the ANOVA presented in Table 6 demonstrate that different physical fitness assessments significantly impact the overall physical fitness scores of college students. To analyze the extent of influence of these assessments, a visual representation is provided in Figure 9, showing that the sit-and-reach test, one-minute sit-up test, 800-meter run, and 1000-meter run have a relatively higher impact on students' physical fitness scores, while the standing long jump, pull-up test, and 50-meter run have a comparatively smaller impact.

Table 7 displays the pass rates for each physical fitness assessment, and an evaluation was conducted on the pass rates for male and female students in various categories. Notable differences were observed in pass rates between male and female students in different assessments. For instance, male students had a higher pass rate in the 50-meter run compared to female students, while female students had a higher pass rate in the standing long jump compared to male students. The differences in performance between male and female students were not very significant in the sit-and-reach test.

Female students had a lower pass rate in the one-minute sit-up test, while male students had a lower pass rate in the pull-up test. Additionally, female students had a lower pass rate in the 800-meter run compared to male students in the 1000-meter run. In summary, male and female students generally had lower pass rates in assessments such as the standing long jump, one-minute sit-up test, and pull-up test.

To analyze the impact of different lung capacity and BMI (body composition) on the physical fitness scores of college students, an analysis of the relationship between height, weight, and lung capacity was conducted. The degree of influence of these factors on physical fitness scores is presented in Table 5, indicating that one's physical condition has a relatively low impact, approximately between 1 and 3. The influence of height and weight on physical fitness scores has already been analyzed in the context of BMI analysis. Therefore, a separate analysis was conducted on lung capacity using the data in Table 7. In the lung capacity test, male students had a pass rate of 98.20%, while female students had a pass rate of 99.58%, demonstrating that female students excelled in lung capacity compared to their male counterparts. Subsequently, an analysis was performed on the pass rate in the lung capacity test and BMI pass rate. As previously mentioned, the pass rates in the third point of testing indicated that male students generally had lower lung capacity and BMI scores compared to female students.

4. Conclusion and Improvement Strategies

4.1 Conclusion

4.1.1 Regarding the BMI and Physical Fitness of College Students.

1) The differences between different genders are as follows:

Female college students pay more attention to their 'figure' and are more inclined towards 'beauty' than male students.

Male students are more inclined to drink beer and smoke compared to female students, which makes male students more prone to gaining weight.

2) The differences between different colleges are as follows:

Discipline Differences: Different colleges may have various academic disciplines that can influence students' lifestyles and weight distribution. For instance, C College and P College may involve more physical activities, such as experiments and creative activities, which can lead to lower body weight. In contrast, B College and L College may require more computational and laboratory work, leading to reduced physical activity and potential weight gain.

Academic Stress: Different colleges impose varying levels of academic stress, which can impact students' eating and exercise habits. For example, A College, compared to B College, has higher academic requirements and a more stressful learning environment, making students at A College more prone to irregular eating habits and a lack of physical activity.

4.1.2 Regarding college students' physical fitness test scores.

1) The differences between different genders are as follows:

Differences in body shape and physical function between male and female college students: Males tend to excel in explosive strength and speed, while females tend to perform better in flexibility and coordination. Males typically have better endurance, while females tend to perform better in short-distance running.

2) The differences between different colleges are as follows:

Different colleges have different course offerings and varying levels of academic stress. H College places more emphasis on students' physical education and exercise, while K College has numerous extracurricular projects that require physical labor and exercise, which is why students from these two colleges tend to perform better in physical fitness tests. In contrast, J College and Q College req

uire more natural science experiments, which often involve long hours in the laboratory and provide less time for exercise.

3) The differences between different physical fitness test items are as follows:

College students receive relatively less training in upper body strength and abdominal muscle strength, and they excel in running exercises. This leads to a lower pass rate in physical fitness

tests related to upper body strength and a higher pass rate in running-related physical fitness tests, which further demonstrates that college students do not achieve an all-around development in their physical exercise.

4.2 Improvement strategies

4.2.1 Regarding curriculum design

Schools should develop and implement curriculum that reduces student stress, includes additional physical exercise programs and extracurricular activities, provides more sports facilities and sports instruction, and encourages students to engage in regular physical activity. Promoting healthy weight management and offering students a comprehensive exercise plan is essential. Students should actively participate in appropriate training and instruction to improve their physical fitness and overall health.

4.2.2 In terms of school diet and mental health

Schools should provide guidance to students in terms of their diet and mental health, helping them plan their meals sensibly and manage life stress. This can be achieved by offering appropriate dietary programs and access to psychological counseling.

4.2.3 In terms of students' lifestyle habits

Schools should establish guidelines for students' lifestyles, such as regulating their daily routines, prohibiting the use of tobacco and alcohol on school premises, and promoting a healthy and scientific campus life. Students should cultivate good exercise habits and actively participate in fitness programs and extracurricular activities.

5. Conclusions

This passage analyzes the factors influencing the physical fitness levels of college students, and the research findings indicate the following: Different genders have an impact on the physical fitness levels of college students, with a higher pass rate for female students. Different academic colleges also influence the physical fitness levels of college students, with a higher proportion of students with normal body weight in Colleges A and G.

When examining the factors affecting the scores in physical fitness tests for college students, the analysis reveals the following: Gender differences have an impact on the physical fitness test results, with female students achieving higher test scores. Different academic colleges affect the physical fitness test scores, with Colleges I and F showing better performance in fitness assessments. Different fitness test components have a significant impact on the overall physical fitness scores, with particular emphasis on the sit-ups and sit-and-reach exercises. Various body metrics (such as lung capacity, height, weight, etc.) have a relatively minor impact on college students' physical fitness test scores. Among these, the Body Mass Index (BMI) has the most significant influence.

The article also suggests certain improvement strategies, such as enhancing the curriculum to provide individual exercise guidelines^[13], promoting proper dietary habits, offering psychological counseling, and establishing healthy lifestyle guidelines^[14]. The study has some limitations, and future research could consider additional factors like the students' academic disciplines (e.g., STEM or humanities), their place of origin, and their lifestyle habits as influencing factors for analysis. In terms of physical fitness data, incorporating data from more grades and additional features, such as psychological health information and overall physical well-being, could further enhance the research. Additionally, employing various algorithms like machine learning, logistic regression, and decision trees may lead to more effective analysis^[15].

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