

Original Paper

Correlation between Body Mass Index and Physical Function and Fitness in College Students

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Abstract

Using a test method and mathematical analysis, the correlation between BMI and physical function and fitness of college students was analyzed, as a basis for maintaining appropriate weight and improving physical function and fitness among college students. The results: (1) BMI of college students generally had a normal distribution with a left-hand peak and a right-hand slow tail. There was no significant difference in the proportion of males and females in the normal BMI level. (2) A highly significant positive correlation was found between BMI grade distribution and physical function ($P < 0.01$), and gender differences were minimal. (3) Standing long jump performance was strongly correlated with BMI ($P < 0.01$). The best scores were all at normal weight. (4) The correlation between body mass index and sitting and reaching performance was not significant ($P > 0.05$). (5) In boys, there was a highly significant negative correlation between pull-up performance and body mass index ($P < 0.01$), and the best performance was found in the normal weight range. Among girls, there was a negative correlation between 1 minute sit-up performance and body mass index ($0.01 < P \leq 0.05$), with the lowest weight group showing the best performance. (6) In the 50m running test, BMI was significantly correlated with body mass index of college students ($P < 0.05$), and the normal grade test score was the highest. (7) Boys' BMI and 1000m running test scores showed a highly significant positive correlation ($P < 0.01$), with the best performance occurring at low body weights. Results were found There was a significant positive correlation between BMI and 800m running test scores of girls ($0.01 < P \leq 0.05$), and the best in the range of normal body weight. Normal-weight people had the best physical function and fitness, while obese people had the worst.

Keywords

College students, Body mass index (BMI), Physical functioning, Physical fitness, Relevance

1. Research Background

In 2019, the Ministry of Education and the State General Administration of Sport deployed and carried out the Eighth National Student Physique and Health Survey Work, there was a 0.2% increase in excellent and good physical fitness and health status among students aged 19-22 years compared to 2014. There was a small increase in the rate of excellent and good physical fitness and health among college students. Students aged 19 to 22 gained 2.86kg and 1.67kg, respectively, in weight. Moreover, the survey found that some problems need to be solved urgently, such as the rise of overweight and obesity rates among college students and the decline of physical fitness.

BMI, or body mass index, measures the degree of obesity in the human body and is closely related to body composition. In order to measure body fat and thinness and evaluate nutritional status and body mass, it is an ideal index (Branscum & Sharma, 2012). According to the calculation method, BMI is equal to the weight (kg) divided by the height (m²). The Guidelines for Preventing and Controlling Overweight and Obesity in Chinese Adults, BMI is assessed as follows: low weight BMI < 18.5, normal weight $18.5 \leq \text{BMI} \leq 23.9$, overweight $24 \leq \text{BMI} < 27.9$, obese BMI ≥ 28 (Zhu, Cui, Gao, Rampersad, You, Sheng et al., 2017). The effects of different BMI levels on college students' physical fitness are different. College students with low or high BMI will have a negative impact on their physical health, increasing their risk factors for disease (Haslam & James, 2005; Boeira, Nalon de Queiroz, Zandonadi, Rower, Nakano, & Feoli, 2023). A person's BMI is closely related to his or her body constitution, which has an impact on changes in body function and physical quality (Staub, Henneberg, Galassi, Eppenberger, Haeusler, Morozova, et al., 2018). Therefore, based on the data obtained from college students' physical fitness test, this paper analyzes the relationship between different BMI grade distribution characteristics and physical function and physical quality indicators of college students, and further explores the influence of BMI grade distribution on college students' physical health.

2. Research Objectives

This study examined the distribution characteristics of BMI index based on the physical fitness test index data from Southwest University's college students, investigated the correlation between BMI distribution characteristics and various indicators of physical function and fitness among college students, college students' physical health was examined in relation to abnormal BMI grades. Students' enthusiasm for physical exercise is stimulated, and a foundation is provided for college students to maintain an appropriate weight is provided, improve physical function and physical quality.

3. Research Object and Method

3.1 Subjects

Students from Southwest University's public classes in 2021 and 2022 were selected for this study, and 360 students who participated in the national physical fitness test in 2023 and had comprehensive and valid data were selected as the samples, including 180 males and 180 females. The basic information of

the test objects is shown in Table 1.

Table 1. Basic Information of Test Subjects

	height (cm)	weight (kg)
man (n=180)	171.65±5.821	67.75±14.101
woman (n=180)	160.92±5.487	55.60±10.477

3.2 Research Method

3.2.1 Research Method

Search terms used for this study included “BMI”, “body function”, “physical fitness” and others, to lay the theoretical foundation for this paper, relevant books such as “School Physical Education” and “Sports Statistics” were searched and read in the library. To conclude, the relevant literature and data were sorted and summarized, and relevant background information was understood to establish ideas and theoretical frameworks.

3.2.2 Cut-and-try Method

Vital capacity and body mass index are included in the body function indexes. Physical fitness indicators include standing long jump, sitting forward bend, pull-up (men) /1 minute sit-up (women), 50 meters, 800 meters (women) /1000 meters (men).

3.2.3 Mathematical Statistics

To calculate the index value (BMI, vital capacity/body mass index), the initial index data of height, weight and vital capacity were used, along with related calculation formulas. The obtained data were graded and categorized using SPSS26.0. Standardized tests were conducted for each indicator, and the obtained data indicated that all indicators fit the normal distribution. The correlation between BMI grade and physical function and physical quality of college students was analyzed after the results were obtained.

4. Research Results and Analysis

4.1 BMI Distribution Characteristics of College Students

Table 2. Distribution Characteristics of BMI(kg/m²) of College Students

	N	M±SD	min	max	lowweight		normalweight		overweight		obesity	
					n	%	n	%	n	%	n	%
man	180	22.96±4.42	15.83	39.21	19	10.6	108	60	32	17.8	21	11.7
woman	180	21.44±3.72	15.34	40.44	34	18.9	113	62.8	23	12.8	10	5.6

According to Table 2, both male and female college students have normal BMIs. Normal weight is the norm for most college students, male and female. The normal weight of male college students accounted for 60%, and the normal weight of female college students accounted for 62.8%. Male and female college students have relatively similar BMIs, which are generally in the normal range. However, it is common for both boys and girls to be underweight, overweight, or obese. The BMI histogram of college students (see Figures 1 and 2) shows an uneven distribution of male and female college students on either side of “normal weight.” Underweight people were more prevalent on the left than overweight or obese people on the right, especially for girls. In boys, the number of “overweight or obese” people on the right was higher than the number of “underweight” people on the left.

Male and female college students have different mean BMIs, as well as their distribution. Male college students' average BMI was 22.96, higher than female college students' (21.44). The proportion of underweight students (10.6%) was lower than that of female students (18.9%), while the proportion of overweight or obesity students (29.5%) was higher than that of female students (18.4%). This is consistent with the results of previous studies (Wong, Chen, Chan, Wang, & Yamamoto, 1999; Wong & Huang, 1999). This difference may be explained by boys' preference for fitness, while girls' preference for thinness.

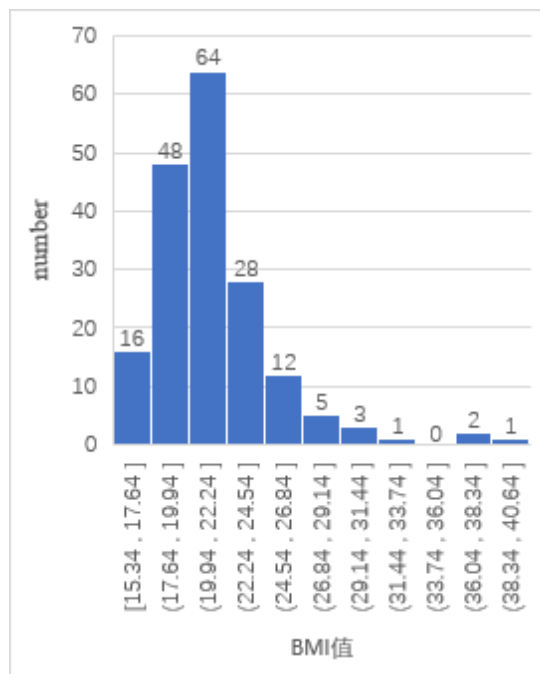


Figure 1. BMI Histogram of Female

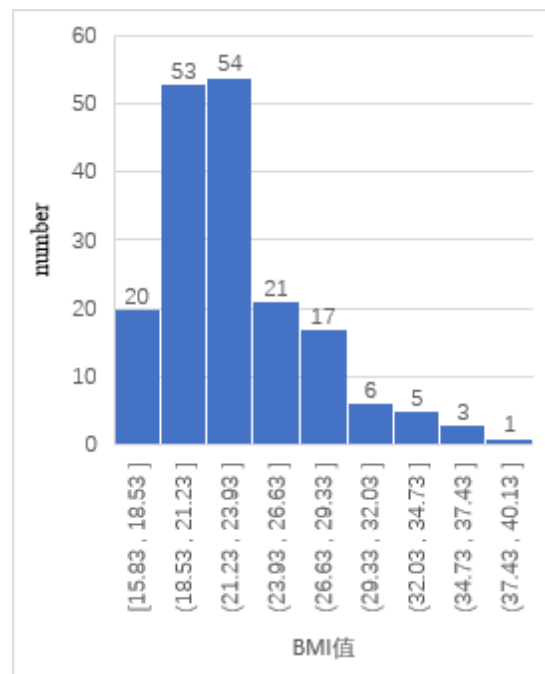


Figure 2. BMI Histogram of Male

4.2 Correlation Analysis of BMI and Body Function Index of College Students

Table 3. Correlation Analysis between BMI and the Mean Value of Vital Capacity (ml) and Vital Capacity/Body Mass Index (ml/kg) of College Students

sex	test indicator	underweight	normal	overweight	obesity	r	P
man	vital capacity	3105.47	3591.15	3973.06	3866.86	.395**	.000
	vital capacity index	59.6153	57.9589	51.1423	41.0736	-.674**	.000
woman	vital capacity	2313.12	2517.04	2708.30	2947.60	0.425**	.000
	vital capacity index	50.1088	46.9220	41.2204	35.0130	-0.540**	.000

Note. r is pears on simple correlation coefficient, p is the significance of the two-tail test p value, $P \leq 0.01$ indicates “highly significant correlation”, represented by “***”; $0.01 < P \leq 0.05$ indicates “significant correlation”, represented by “**”; $P > 0.05$ indicated “no significant correlation”.

4.2.1 Correlation Analysis of BMI Index and Vital Capacity

Table 3 shows that vital capacity and body mass index of all college students show a highly significant positive correlation ($P < 0.01$). Boys and girls in overweight and obesity grades have the largest mean value of vital capacity of the four grades, low weight grade men and women have the shortest mean life expectancy. Therefore, lung capacity increases with BMI, but the grade from overweight to obesity decreases in boys.

4.2.2 Correlation Analysis of BMI and Index Vital Capacity/Body Mass Index

As can be seen from Table 3, the lung capacity/body mass index of male and female students was the highest in the underweight class and the lowest in the obesity class, both of which showed a highly significant negative correlation with body mass index ($P < 0.01$). It can be seen that overweight and obesity have a great adverse effect on the respiratory function of college students. Both types of students had significantly lower respiratory function than those who were underweight or normal.

4.3 Correlation Analysis of BMI and Physical Fitness Index of College Students

Table 4. Correlation Analysis between BMI and Average Physical Fitness Indicators of College Students

sex	test indicator	underweight	normal	overweight	obesity	r	P
man	standing broad jump (cm)	217.42	220.47	218.10	199.09	-.319**	.000
	Sit and Reach (cm)	12.10	13.11	11.13	13.33	-.009	.900
	pull-up (number)	8.47	8.58	5.03	2.68	-.435**	.000
	50m (s)	7.40	7.37	7.58	7.8	.309**	.000
	1000m(min)	3.89	4.00	4.18	4.73	.454**	.000
woman	standing broad jump (cm)	162.21	166.03	163.22	143.30	-.244**	.001
	Sit and Reach (cm)	15.25	18.61	18.40	12.56	-.073	.327
	1minsitup (number)	44.62	43.17	41.04	40.80	-.179*	.016

50m(s)	9.18	9.09	9.52	9.65	.266**	.000
800m(min)	3.94	3.89	4.09	4.11	.165*	.027

4.3.1 Correlation Analysis of BMI Index and Standing Long Jump Performance

Table 4 shows that BMI grade strongly influences standing long jump performance and is highly negatively correlated with it ($P < 0.001$). Boys and girls perform best at the normal weight grade level. Both boys' and girls' performance shows a gradual decline with a decrease or increase in body weight. As body weight and BMI index increased, standing long jump performance decreased for obese boys and girls.

4.3.2 Correlation Analysis of BMI Index and Sitting forward Bending Performance

The results of Table 4 show that the BMI level does not significantly affect the performance of sitting forward bending ($P > 0.05$). In male students, obesity is the best performing level, followed by normal, and in female students, normal is the best performing level, followed by overweight.

4.3.3 Correlation Analysis between Body Mass Index (BMI) and Test Scores of Pull-ups (male)/1min Sit-up (Female)

The results of Table 4 indicate that, except for the low weight grade, the boys' pull-up performance was negatively correlated with body mass index ($P < 0.01$). Normal weight resulted in the best performance. BMI grade index increased deteriorated performance. Those who needed to perform the test more did so less. 1 minute sit-up was negatively correlated with body mass index in girls ($0.01 < P \leq 0.05$). A low BMI resulted in the best performance, while an increase in BMI resulted in worse performance.

4.3.4 Correlation Analysis of BMI Index and 50m Running Test Results

Based on Table 4, boy's and girl's 50m running performance is negatively correlated with body mass index ($P < 0.05$). A higher body mass index translates into poorer performance. Both boys and girls performed well in the 50m running test of normal grades. Students with BMI indexes in the low body weight and normal range have better results in the 50m running test than those with overweight and obesity. Thus, increasing body weight will negatively affect the 50m running performance due to lower speed quality. Students with low body weight perform worse than those with normal body weight, so both low and high body weight have a negative effect on speed.

4.3.5 Correlation Analysis of BMI Index and 1000m(male)/800m(female) Running Test Scores

Figure 4 shows a highly and significantly positive correlation between 1000m running performance and body mass index ($P < 0.01$) among boys. When the body weight is low, the performance is best, and as the weight is increased, the performance deteriorates. Performance during 800 meters running was significantly correlated with body mass index ($0.01 < P \leq 0.05$) in girls. As body weight increased, performance gradually deteriorated. The best performance was seen in the normal weight range. The respiratory system function of college students is negatively affected by overweight and obesity. The respiratory system function of students with this type is far less than that of students with low weight and normal range, so it is easy to slow down because of insufficient oxygen uptake in muscles during

endurance tests such as 1000m running and 800m running. As a result, running performances for 1000m and 800m are lower with a higher body mass index.

5. Conclusion and Suggestion

The physical function and quality of college students with different BMIs differ significantly. It is important for college students to maintain a healthy weight in order to develop a healthy physical function and quality of life. Vital capacity increases with body weight, but vital capacity/body mass index decreases. Overweight and obese students had poorer respiratory function than normal weight students. In college students, a weight that is too high or too low will negatively affect their speed quality, lower limb explosive power, endurance, and upper limb strength. It is therefore recommended that college students pay attention to their weight and form a proper "health concept". Maintain a healthy BMI index through a balanced diet and scientific physical exercise, so they can effectively improve their body shape, enhance their body function, and maintain their physical health.

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