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Article

Effect of 12-week physical training on fat reduction of college students

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Abstract: This paper focuses on 184 students from University A as the experimental subjects. Aiming to explore the impact of physical training on fat reduction with a biomechanical approach, a comprehensive physical training experiment scheme is designed using various methods. The students in the experimental group undergo training four times a week. Through a detailed analysis of the students' morphology, body composition, body function, and physical quality indicators from a biomechanical standpoint both before and after the experiment, in-depth insights are gained. The results indicate that before the experiment, there is no significant difference between the experimental group and the control group, demonstrating homogeneity. After the 12-week training, several biomechanically-related changes occur. In terms of morphology, the physical structure of the body is affected by the training. For instance, changes in muscle mass distribution can alter the body's center of mass and movement mechanics. Regarding body composition, significant differences emerge between the control group and the experimental group. Biomechanically, these changes can be related to the way the body adapts to the physical stress of training, such as increased muscle density and reduced fat mass, which also influence the body's mechanical properties and movement efficiency. In terms of physical fitness, some indicators of the experimental group show statistical significance from a biomechanical perspective. The improvement in physical fitness, such as enhanced strength and endurance, is related to the biomechanical adaptations of the body during training. For example, the strengthening of muscle-tendon units and the optimization of joint mobility contribute to better movement performance. In contrast, the control group shows no such differences. This study provides valuable insights into improving the fat-reduction effect of college students from a biomechanical perspective. It also offers practical guidance for promoting the construction of fat-reduction work in schools by taking into account the biomechanical principles underlying physical training.

Keywords: 12 weeks; physical training; biomechanics; college students; fat loss effect

1. Introduction

Obesity is defined as excess accumulation of body fat that is more than 20% of your ideal body weight, or a body mass index (BMI) > 28. Obesity is caused by an imbalance between the relative intake and consumption of food, and excess energy is stored as fat [1]. In recent years, people's living standards have been improved, but due to the unreasonable dietary structure of our population, the rate of overweight and obesity has been on the rise. In 2022, 2.5 billion adults aged 18 and above will be overweight, including more than 890 million who are obese. This equates to 43 percent of adults 18 and older (43 percent of men and 44 percent of women) being overweight.

With the release [2] of the Outline of the Healthy China 2030 Plan, the concept of "healthy China" has gradually gained popularity, and the public has paid great attention to the obesity problem among college students. The effect of fat reduction can be achieved through physical training and the physical health of college students can be improved. In the monograph "Sports [3] Training", Professor Tian Maijiu put forward that physical fitness refers to the basic athletic ability of the athlete's body, which is an important part of the athlete's competitive ability, and the development level of physical fitness is mainly reflected by its body form, physical function and sports quality. Based on the understanding and research of some scholars at home and abroad, Gou Bo et al. defined "physical fitness" as the human body's ability to adapt to external factors in three aspects, including body form, body function and sports quality, on the basis of combining congenital conditions such as genes, heredity and other factors and acquired conditions such as practice. Among them, body form and body function exist as the material basis of physical fitness, while athletic quality is the external expression and core of physical fitness, mainly including strength, speed, endurance, flexibility and sensitivity [4]. Therefore, this paper defines physical training as the basic athletic ability of the human body manifested by strength, speed, endurance, coordination, flexibility, agility and other athletic qualities, and is an important component of athletes' competitive ability. The level of physical fitness is closely related to the morphological characteristics and functional characteristics of the human body. The performance and function of physical fitness in different people can be divided into two levels: healthy physical fitness and competitive physical fitness. Healthy physical fitness refers to the functional ability of the organ system that is necessary for any population, and is the basis of competitive physical fitness. Competitive physical fitness is the physical function ability needed for competitive competition, which is further developed on the basis of healthy physical fitness. The physical fitness training studied in this paper is the influence of healthy physical fitness on the fat reduction effect of college students. Through the 12-week physical training experiment, the influence of physical training on the fat loss effect of college students is analyzed, Similar research by [5–7] also explored the relationship between physical training and fat loss in a student population, providing valuable insights into the potential mechanisms. This research provides certain practical and teaching basis for the school to carry out various activities about special groups, build a more harmonious and healthy campus atmosphere, promote the development of physical training, and provide theoretical reference and basic research for fat loss of obese people. Additionally, the findings of this study are in line with the broader research goals emphasized by [8], which aim to improve the overall well-being of individuals through appropriate physical activity.

2. Research methods

2.1. Literature data method

To understand the relationship between physical training and fat loss by searching databases such as CNKI, Wanfang and VIP, and to understand the training content and experimental process related to fat loss of obese college students through physical training programs and guidance literature, and to summarize and sort out on this basis.

To provide theoretical reference and guidance for the future research on the direction of fat reduction movement.

2.2. Experimental method

2.2.1. Experimental subjects

In this paper, 184 students from A University were selected as the experimental subjects. The BMI of male students was greater than 30, and the BMI of female students was greater than 29. The basic requirements of disease-free subjects were met by excluding whether the subjects suffered from heart disease, asthma, chronic diseases and were taking drugs, as well as those who could not normally complete physical training and those who had experience in fat reduction training, etc., to ensure that all participants voluntarily followed the investigation of the experiment and questionnaire activities. Taking into account the overall situation of obese college students, reasonable and safe training programs and training intensity were adopted.

2.2.2. Experimental instruments

Use the height measuring instrument and human body composition analyzer in the laboratory of A University for index testing.

2.2.3. Experiment contents and steps

Training contents of experimental group:

Warm-up stage (5–10 min):

Dynamic stretching: including high leg lift, back kick, side kick, etc., each action is carried out for 15–20 s to move the whole body joints and raise the body temperature.

Reaction ball game: The coach throws a soft reaction ball to the student, and the student reacts quickly to catch the ball, improving reaction speed and hand-eye coordination.

Main body training phase (20–30 min):

Aerobic exercise: includes jogging, swimming, aerobics and other items. In the initial stage (the first 4 weeks), each aerobic exercise time can be set to 30–40 min, the intensity is moderate, such as heart rate control at the maximum heart rate (Max heart rate = 220-age) 60%–70%; With the advancement of training, gradually increase the aerobic exercise time to 40–60 min in the middle (weeks 5–8) and late (weeks 9–12), and the intensity can also be appropriately increased to 70%–80% of the maximum heart rate.

Strength training: mainly for the whole body major muscle group training, such as squats, bench press, hard pull, push up, dumbbell shoulder push and other movements. Perform 3 to 4 sets of 8 to 12 repetitions per exercise. Strength training Schedule 20–30 min in each strength training session, and include strength training content at least 2 times a week. As the training time goes on, the training load can be increased appropriately (such as increasing the weight, number of sets or reps).

Agility training: the main rope ladder training, flag bucket training, reaction training and other actions, each action for 2–3 groups, each group of 3–4 repetitions. Agility training is arranged for 20–30 min in each physical training course, and at least 2 times a week will include agility training content, as the training time goes by, the training load can be appropriately increased (such as increasing weight, number of sets

or times). (Interval training between strength training and agility training)

Flexibility training: Schedule 10–15 min of flexibility training before the end of each training session, including static stretching and dynamic stretching movements throughout the body, such as leg stretching, waist stretching, shoulder stretching, etc., to help relax muscles, reduce sports injuries, and promote physical recovery.

Cool down session (5–10 min):

Static stretching: Stretch the major muscle groups involved in agility training, such as the front and back of the thighs, calves, hips, waist, etc., and hold each stretch for 20–30 s to help relax muscles and reduce muscle soreness.

Control group training content:

Warm-up phase (5–10 min)

Walk slowly or in place: Gradually warm up your body, move your joints, and raise your heart rate.

Simple joint exercises: such as turning the head, swinging the arms, moving the waist, rotating the ankles, etc.

Body training phase (20–25 min)

Light cardio activities:

Brisk walking: Do light brisk walking in school or on the playground at a moderate pace and at an intensity that allows you to have a normal conversation to avoid excessive fatigue.

Campus bike riding: If you can, you can ride a bike on campus and ride at a relatively easy speed for some time.

Simple power activities:

Quiet squats against a wall: With your back against a wall and your feet shoulder-width apart, squat slowly until your thighs are parallel to the floor for a certain amount of time for 2–3 sets of 30–60 s each.

Pushups (boys)/kneeling position pushups (girls): Perform a small number of pushups exercises, 5 to 8 in each set, for 2 to 3 sets, the main purpose is to maintain a certain degree of muscle motion.

Cool down phase (5–10 min)

Slow walk for relaxation: Gradually reduce the intensity of the exercise to allow the heart rate to return to normal.

Full body static stretching: Stretch the muscle groups that are mainly involved in the activity, such as the quads and hamstrings in the legs, and the biceps and triceps in the upper limbs, holding each stretch for 20–30 s.

2. Implementation of the experiment procedure

Experimental procedure

Before the experiment began, the students were tested for the first time, the test results were recorded, and the students' physical health data before the experiment were mastered. To ensure that the experimental group and the control group of the data are not significantly different, with homogeneity.

According to the experimental plan, the experimental group began to perform physical training experiments for 12 weeks, each time lasting 45 min, including 10 min of flexibility training and 35 min of strength or endurance, speed and agility training. During the experiment, I kept communication and communication with the

instructor and monitored the class to ensure that the experiment requirements were met. The above experiment plan lasted for 12 weeks, and the indicators before and after the experiment were measured. The experimental plan of the control group was 45 min of continuous aerobic exercise and moderate intensity jogging. The experiment frequency of the experimental group and the control group was every Monday, Tuesday, Wednesday, Friday and Saturday, with rest scheduled on Thursday and Sunday.

2.3. Mathematical statistics

The body composition index data of the experimental objects were sorted through Excel, and the single factor repeated measurement variance analysis was carried out on the data by SPSSAU statistical software.

3. Research results and analysis

3.1. Comparison of basic situation

This study mainly conducted data statistics on the body composition index and body shape index of ordinary male college students before and after the experiment, and then conducted data analysis through SPSS26.0 software. Based on the data obtained in this experiment, the basic comparison is shown in **Tables 1** and **2**:

Table 1. Comparison of physical indexes of male students before training.

Indicators	**Control group (*n* = 53)**	**Experimental group (*n* = 53)**	***F***	***P***
Age (years)	19.37 ± 1.09	19.63 ± 1.12	2.393	0.0123
Height (cm)	178.36 ± 4.51	178.34 ± 4.53	404.132	0.000 * *
Weight (kg)	82.82 ± 8.61	81.60 ± 8.68	162.730	0.000 * *
BMI	29.98 ± 1.86	29.60 ± 1.96	29.108	0.000 * *
Body fat percentage	29.11 ± 4.84	29.64 ± 5.01	17.671	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

Table 2. Comparison of female body indicators.

	Control group (*n* = 39)	**Experimental group (*n* = 39)**	***F***	***P***
Age (years)	19.47 ± 1.12	19.79 ± 1.07	2.125	0.014
Height (cm)	165.89 ± 3.64	165.86 ± 3.67	399.847	0.000 * *
Weight (kg)	66.52 ± 8.55	65.57 ± 8.51	156.431	0.000 * *
BMI (kg/m^2)	32.14 ± 2.77	32.80 ± 2.76	27.009	0.000 * *
Body fat percentage (%)	31.09 ± 4.62	31.49 ± 4.79	15.141	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

Tables 1 and **2** respectively reflect the physical indicators between the experimental group and the control group of male and female students before the start of the comparison experiment. As can be seen from the data in the table, there was no significant difference in the significance level of age, height, weight, BMI, body fat percentage and other body indicators between the control group and the experimental group in the same sex ($P > 0.05$), indicating that the body indicators of the

experimental group and the control group in the same sex were similar, and there was a basis for comparative experiments. At the same time, it can be seen from the test data that the BMI, waist-hip ratio and body fat percentage of girls in the control group and the experimental group were about 29 kg/m^2 and 29%, while the BMI and body fat percentage of boys in the control group and the experimental group were about 32 kg/m^2 and 31%, all exceeding the normal range of boys and girls, reaching the standard of obesity and meeting the needs of the experiment.

3.2. Comparison of morphological index differences

The 185 students in the fat reduction and shape shaping class underwent the 12-week experiment. The comparison between the test results before the experiment and those in the 12th week is shown in **Tables 3–5**.

Table 3. Changes of routine morphological indexes of male subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
Weight (kg)	82.82 ± 8.61	82.76 ± 7.61	7.311	0.241
BMI (kg/m^2)	29.98 ± 1.86	29.65 ± 1.74	7.156	0.658
Body fat percentage (%)	29.11 ± 4.84	29.01 ± 5.04	4.861	0.462
WHR	0.84 ± 0.07	0.83 ± 0.06	1.809	0.072
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
Weight (kg)	81.60 ± 8.68	79.63 ± 1.12	6.231	0.005
BMI (kg/m^2)	29.60 ± 1.96	27.72 ± 1.65	4.74	0.001
Body fat percentage (%)	29.64 ± 5.01	27.56 ± 4.15	2.65	0.000
WHR	0.83 ± 0.07	0.79 ± 0.06	1.19	0.001

* $p < 0.05$, ** $p < 0.01$.

According to **Table 3**, there were no statistical differences in the four indexes of body weight, BMI, WHR and body fat percentage of male students in the control group ($P > 0.05$). After physical training, the body weight, BMI, WHR and body fat percentage of the male experimental group showed statistical changes compared with the control group ($P < 0.05$). WHR decreased from 0.83 ± 0.07 to 0.79 ± 0.06, body weight decreased from 81.60 ± 8.68 kg to 79.63 ± 1.12 kg, BMI decreased from 29.60 ± 1.96 kg/m^2 to 27.72 ± 1.65 kg/m^2. Body fat percentage decreased from 29.64% ± 5.01% to 27.56% ± 4.15%.

According to **Table 4**, there were no statistically significant differences among the four conventional morphological indexes of female students in the control group: body weight, BMI, WHR and body fat percentage ($P > 0.05$). After physical training, the body weight, BMI, WHR and body fat percentage of the female experimental group showed statistical changes compared with the control group ($P < 0.05$). WHR decreased from 0.95 ± 0.05 to 0.89 ± 0.05, body weight decreased from 65.57 ± 8.51 kg to 62.63 ± 2.10 kg, BMI decreased from 32.80 ± 2.76 kg/m^2 to 28.72 ± 1.72 kg/m^2. Body fat percentage decreased from 31.49% ± 4.79% to 27.56% ± 4.01%. There were no significant differences in body weight, BMI, WHR and body fat percentage of

female control group before and after the experiment ($P > 0.05$).

Table 4. Changes of routine morphological indexes of female subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
Weight (kg)	66.52 ± 8.55	66.52 ± 8.55	5.186	0.143
BMI (kg/m^2)	32.14 ± 2.77	32.14 ± 2.77	5.132	0.538
Body fat percentage (%)	31.09 ± 4.62	31.09 ± 4.62	4.653	0.172
WHR	0.94 ± 0.07	0.92 ± 0.06	1.503	0.271
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
Weight (kg)	65.57 ± 8.51	62.63 ± 2.10	4.261	0.000 * *
BMI (kg/m^2)	32.80 ± 2.76	28.72 ± 1.72	4.215	0.000 * *
Body fat percentage (%)	31.49 ± 4.79	27.56 ± 4.01	3.354	0.000 * *
WHR	0.95 ± 0.05	0.89 ± 0.05	1.19	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

Table 5. Changes of routine morphological indexes between the control group and the experimental group after the experiment.

Name	**Boys (mean ± SD)**		**Difference**	***P***
	Control group	**Experimental group**		
Weight (kg)	82.76 ± 7.61	79.63 ± 1.12	3.13	0.000 * *
BMI (kg/m^2)	29.65 ± 1.74	27.72 ± 1.65	1.93	0.000 * *
Body fat percentage (%)	29.01 ± 5.04	27.56 ± 4.15	1.45	0.000 * *
WHR	0.83 ± 0.06	0.79 ± 0.06	0.04	0.000 * *
Name	Girls (mean ± SD)		Difference	*P*
	Control group	Experimental group		
Body weight (kg)	66.52 ± 8.55	62.63 ± 2.10	3.89	0.000 * *
BMI (kg/m^2)	32.14 ± 2.77	28.72 ± 1.72	3.42	0.000 * *
Body fat percentage (%)	31.09 ± 4.62	27.56 ± 4.01	3.53	0.000 * *
WHR	0.92 ± 0.06	0.89 ± 0.05	0.03	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

According to the analysis of changes in routine morphological indexes of male students after the experiment in **Table 5**, the differences between the experimental group and the control group in body weight (kg), BMI (kg/m^2), body fat percentage (%) and WHR were 3.13, 1.93, 1.45 and 0.04, and the *P* value was less than 0.05, indicating significant differences. It indicates that physical training has significant changes in male students' morphological indexes compared with conventional training. In the analysis of the changes of the conventional morphological indexes of female students after the experiment, the difference values of body weight (kg), BMI (kg/m^2), body fat percentage (%) and WHR between the experimental group and the control group were 3.89, 3.42, 3.53 and 0.03, and the *P* value was less than 0.05, indicating that physical training had obvious changes on the morphological indexes of female students than the conventional training.

3.3. Changes of body composition index

As shown in **Tables 6** and **7**, before the experiment, there were no statistical differences in body composition indexes of different parts, including waist circumference, hip circumference and hip ratio, between the male and female experimental groups and the control group ($P > 0.05$). After the experiment, the indexes of body composition in different parts of the experimental group showed statistical changes ($P < 0.05$).

Table 6. Changes of waist circumference, hip circumference and hip ratio indexes of male subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**post-experiment**		
Waist circumference (cm)	87.53 ± 5.85	85.90 ± 6.25	8.877	0.024 * *
Hip circumference (cm)	118.64 ± 4.31	112.88 ± 4.92	8.827	0.011 * *
Hip ratio	1.21 ± 0.03	1.01 ± 0.04	0.709	0.000
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
Waist circumference (cm)	87.31 ± 7.92	81.52 ± 8.02	8.456	0.000 * *
Hip circumference (cm)	115.75 ± 5.18	106.67 ± 4.39	9.662	0.000 * *
Hip ratio	1.20 ± 0.04	0.92 ± 0.04	0.268	0.000 *

* $p < 0.05$, ** $p < 0.01$.

According to **Table 6**, after the experiment, waist circumference, hip circumference, hip ratio and other indicators of the male experimental group were found to have statistical significance ($P < 0.05$), among which, waist circumference (before the experiment: 87.31 ± 7.92; After the experiment: 81.52 ± 8.02 cm), hip circumference (before the experiment: 115.75 ± 5.18 cm; After the experiment: 107.67 ± 4.29 cm), hip ratio (before the experiment: 1.20 ± 0.04 cm; After the experiment: 0.92 ± 0.04 cm) were significantly decreased ($P < 0.05$). There were significant differences in waist circumference, hip circumference and hip ratio of male control group before and after the experiment ($P < 0.05$).

Table 7. Changes in waist circumference, hip circumference and hip ratio indexes of female subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
Waist circumference (cm)	75.40 ± 8.12	73.43 ± 8.34	9.403	0.027 * *
Hip circumference (cm)	96.81 ± 5.05	94.90 ± 5.31	11.369	0.005 * *
Hip ratio	1.01 ± 0.05	0.91 ± 0.06	2.022	0.162 *
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
Waist circumference (cm)	75.31 ± 7.92	70.52 ± 8.02	8.973	0.000 * *
Hip circumference (cm)	96.75 ± 5.18	91.67 ± 3.49	10.662	0.000 * *
Hip ratio	1.02 ± 0.04	0.82 ± 0.04	3.147	0.000 *

* $p < 0.05$, ** $p < 0.01$.

According to **Table 7**, the girth of the female experimental group (before the experiment: 75.31 ± 7.92 cm; After the experiment: 70.52 ± 8.02 cm), hip circumference (before the experiment: 96.75 ± 5.18 cm; After the experiment: 91.67 ± 3.49 cm), hip ratio (before the experiment: 1.20 ± 0.04 cm; After the experiment: 0.92 ± 0.04 cm) were significantly decreased ($P < 0.05$). All were significantly decreased ($P < 0.05$). The girth and hip circumference of female control group were significantly different before and after the experiment ($P < 0.05$). There was no significant difference in hip ratio index ($P > 0.05$).

According to the analysis of changes in body composition indexes between the experimental group and the control group after the experiment in **Table 8**, the differences in waist circumference, hip circumference and hip circumference ratio between the experimental group and the control group were 4.38, 6.21 and 0.09, and the *P* value was less than 0.05, indicating that physical training had obvious changes in body composition indexes of male students than conventional training. In the analysis of the changes of body composition indexes of female students after the experiment, the difference values of body weight (kg), BMI (kg/m^2), body fat percentage (%) and WHR between the experimental group and the control group were 2.91, 3.23 and 0.09, and the *P* value was less than 0.05, indicating that physical training had obvious changes in body composition indexes of female students compared with conventional training.

Table 8. Changes of waist circumference, hip circumference and hip ratio between control group and experimental group after the experiment.

Name	**Boys (mean ± SD)**		**Difference**	***P***
	Control group	**Experimental group**		
Waist circumference (cm)	85.90 ± 6.25	81.52 ± 8.02	4.38	0.000 * *
Hip circumference (cm)	112.88 ± 4.92	106.67 ± 4.39	6.21	0.000 * *
Hip ratio	1.01 ± 0.04	0.92 ± 0.04	0.09	0.000 * *
Name	Girls (mean ± SD)		Difference	*P*
	Control group	Experimental group		
Waist circumference (cm)	73.43 ± 8.34	70.52 ± 8.02	2.91	0.000 * *
Hip circumference (cm)	94.90 ± 5.31	91.67 ± 3.49	3.23	0.000 * *
Hip ratio	0.91 ± 0.06	0.82 ± 0.04	0.09	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

3.4. Comparison of body function indicators

Before the experiment, there were no statistical differences in SBP, DBP, VO2max, vital capacity and resting heart rate between the male and female experimental groups and the control group ($P > 0.05$). After the experiment, compared with the control group, VO2max, vital capacity and resting heart rate of the experimental group showed significant statistical changes ($P < 0.05$).

According to **Table 9**, after the experiment, it was found that VO2max (mL/kg/min), vital capacity (mL), resting heart rate (min/time) and other indicators in the male experimental group had statistical significance ($P < 0.05$). Among them, VO2max (before the experiment: 36.04 ± 10.98 mL/kg/min; After the experiment:

39.53 ± 5.32 mL/kg/min), vital capacity (before the experiment: 2882.45 ± 179.93 mL; After the experiment: 3001.47 ± 356.22 mL), resting heart rate (before the experiment: 75.95 ± 11.67 min/time; After the experiment: 70.36 ± 9.45 min/time) were significantly decreased ($P < 0.05$). There were no significant differences in SBP (mmHg), DBP (mmHg) and other indexes in the male experimental group before and after the experiment ($P > 0.05$). There were no significant differences in SBP (mmHg), DBP (mmHg), VO2max (mL/kg/min), vital capacity (mL) and resting heart rate (min/time) before and after the control group ($P > 0.05$).

Table 9. Changes of physical function indexes of male subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
SBP (mmHg)	116.43 ± 6.52	115.68 ± 7.14	35.854	0.512
DBP (mmHg)	68.62 ± 5.75	66.34 ± 5.32	14.237	0.342
VO2max (mL/kg/min)	43.05 ± 10.65	43.15 ± 4.57	11.365	0.542
Lung capacity (mL)	2894.67 ± 199.78	2938.57 ± 486.12	134.76	0.362
Resting heart rate (min/beats)	75.66 ± 11.68	72.16 ± 9.63	21.33	0.562
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
SBP (mmHg)	117.12 ± 7.24	116.24 ± 5.45	32.725	0.496
DBP (mmHg)	67.35 ± 5.27	65.14 ± 5.42	11.532	0.296
VO2max (mL/kg/min)	36.04 ± 10.98	39.53 ± 5.32	11.137	0.000 *
Lung capacity (mL)	2882.45 ± 179.93	3001.47 ± 356.22	102.46	0.000 * *
Quiet heart rate (min/beats)	75.95 ± 11.67	70.36 ± 9.45	17.82	0.000 *

* $p < 0.05$, ** $p < 0.01$

Table 10. Changes of physical function indexes of female subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
SBP (mmHg)	117.33 ± 8.72	114.48 ± 8.05	41.501	0.727
DBP (mmHg)	67.58 ± 5.75	65.57 ± 6.31	12.246	0.612
VO2max (mL/kg/min)	36.05 ± 11.75	38.08 ± 3.26	13.202	0.542
Lung capacity (mL)	2394.67 ± 199.78	2338.57 ± 486.12	134.76	0.362
Resting heart rate (min/beats)	77.86 ± 12.95	87.06 ± 9.75	21.33	0.562
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
SBP (mmHg)	117.52 ± 8.31	115.53 ± 7.55	42.256	0.657
DBP (mmHg)	67.63 ± 5.35	66.07 ± 5.52	10.662	0.519
VO2max (mL/kg/min)	36.01 ± 10.98	39.93 ± 3.12	11.137	0.000 *
Lung capacity (mL)	2381.67 ± 195.93	2598.57 ± 466.12	102.46	0.000 * *
Resting heart rate (min/time)	77.95 ± 11.67	72.16 ± 10.55	17.82	0.000 *

* $p < 0.05$, ** $p < 0.01$.

According to **Table 10**, after the experiment, it was found that VO2max (mL/kg/min), vital capacity (mL), resting heart rate (min/time) and other indicators in

the female experimental group had statistical significance ($P < 0.05$). Among them, VO2max (before the experiment: 36.01 ± 10.98 mL/kg/min; After the experiment: 39.93 ± 3.12 mL/kg/min), vital capacity (before the experiment: 2381.67 ± 195.93 mL; After the experiment: 2598.57 ± 466.12 mL), resting heart rate (before the experiment: 77.95 ± 11.67min/time; After the experiment: 72.16 ± 10.55min/time) were significantly decreased ($P < 0.05$). There were no significant differences in SBP (mmHg), DBP (mmHg) and other indexes in the male experimental group before and after the experiment ($P > 0.05$). There were no significant differences in SBP (mmHg), DBP (mmHg), VO2max (mL/kg/min), vital capacity (mL) and resting heart rate (min/time) before and after the control group ($P > 0.05$).

According to the analysis of the changes of body composition indexes of boys and girls after the experiment in **Table 11**, the difference between the experimental group and the control group in SBP and DBP was small, and there was no obvious change. VO2max, vital capacity and resting heart rate all had great changes after physical training for boys and girls.

Table 11. Changes of physical function indexes between the control group and the experimental group after the experiment.

Name	**Boys (mean ± SD)**		**Difference**	***P***
	Control group	**Experimental group**		
SBP (mmHg)	115.68 ± 7.14	116.24 ± 5.45	−0.56	0.503
DBP (mmHg)	66.34 ± 5.32	65.14 ± 5.42	1.2	0.323
VO2max (mL/kg/min)	43.15 ± 4.57	39.53 ± 5.32	3.62	0.000 * *
Lung capacity (mL)	2938.57 ± 486.12	3001.47 ± 356.22	-62.9	0.000 * *
Quiet heart rate (min/beats)	72.16 ± 9.63	70.36 ± 9.45	1.8	0.000 * *
Name	Girls (mean ± SD)		Difference	*P*
	Control group	Experimental group		
SBP (mmHg)	114.48 ± 8.05	115.53 ± 7.55	−1.05	0.612
DBP (mmHg)	65.57 ± 6.31	66.07 ± 5.52	−0.5	0.541
VO2max (mL/kg/min)	38.08 ± 3.26	39.93 ± 3.12	−1.85	0.000 * *
Vital capacity (mL)	2338.57 ± 486.12	2598.57 ± 466.12	−260	0.000 * *
Quiet heart rate (min/beats)	87.06 ± 9.75	89.16 ± 10.55	−2.1	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

3.5. Comparison of physical fitness indexes

Physical fitness refers to the comprehensive activity ability of the human body (speed, strength, endurance, flexibility and sensitivity shown in work, life and sports). Physical quality and athletic ability level: mainly includes speed, strength, endurance, sensitivity, coordination, as well as walking, running, jumping, throwing and other basic activities of the body. In this study, according to the "National Physical Health Standards for Students (Revised in 2021)" issued by the Ministry of Education, physical fitness test items were determined as 50 m, 800 m, standing long jump, sitting forward bend, and 1-min sit-up. Paired sample *T*-test was conducted on the physical fitness index test scores of the experimental group and the control group before and after the experiment. The results of the experimental group are shown in **Tables 3–7**.

The results of the experimental group and control group are shown in **Tables 3–8**.

According to **Table 12**, after the experiment, it was found that the indexes of 1000m, sit-up, standing long jump, seated forward bend and so on in the male experimental group had statistical significance ($P < 0.05$). Among them, 1000 m (before the experiment: 5.96 ± 1.81 min; After the experiment: 5.03 ± 0.18 min), sit-ups (before the experiment: 34.89 ± 5.43; After the experiment: 35.01 ± 5.26), standing long jump (before the experiment: 1.66 ± 2.40cm; After the experiment: 1.75 ± 1.91 cm); Sit forward bend (before the experiment: 13.73 ± 4.053 cm; After the experiment: 14.87 ± 3.716 cm). 50 m (before experiment: 9.70 ± 0.869 s; After the experiment: 9.36 ± 0.718 s) there was no significant difference ($P > 0.05$). There were no statistically significant differences in 1000 m, sit-up, standing long jump, 50 m and seated forward bend in male control group ($P > 0.05$).

Table 12. Changes of physical function indexes of male subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
1000 m (min)	5.73 ± 0.21	5.61 ± 0.15	−0.397	0.693
Sit-ups (one)	33.85 ± 5.61	34.89 ± 6.52	0.184	0.854
Standing long jump (cm)	1.64 ± 1.44	1.73 ± 1.59	0.735	0.468
50m (s)	9.96 ± 0.76	9.86 ± 0.76	0.130	0.897
Seated forward bend (cm)	13.42 ± 2.54	13.52 ± 3.61	0.137	0.891
Name	Experimental group (mean ± SD)		T	P
	pre-experiment	After the experiment		
1000 m (min)	5.96 ± 1.81	5.03 ± 0.18	2.56	0.02
Sit-ups (one)	34.89 ± 5.43	35.01 ± 5.26	3.13	0.016
Standing long jump (cm)	1.66 ± 2.40	1.75 ± 1.91	4.25	0.011 *
50 m (s)	9.70 ± 0.869	9.36 ± 0.718	2.36	0.152
Seated forward bend (cm)	13.73 ± 4.053	14.87 ± 3.716	1.82	0.024

* $p < 0.05$, ** $p < 0.01$.

According to **Table 13**, after the experiment, it was found that the indicators of 800 m, sit-ups, standing long jump, 50 m, and seated forward bend in the male experimental group were statistically significant ($P < 0.05$). Among them, 800 m (before the experiment: 5.62 ± 0.47 min; After the experiment: 5.01 ± 0.51 min), sit-ups (before the experiment: 33.51 ± 5.36; After the experiment: 36.82 ± 5.13), standing long jump (before the experiment: 1.34 ± 0.22 cm; After the experiment: 1.48 ± 0.19 cm); Sit forward flexion (before the experiment: 17.18 ± 3.41 cm; After the experiment: 17.89 ± 2.52 cm) were significantly decreased ($P < 0.05$). 50 m (before the experiment: 10.44 ± 0.69 s; After the experiment: 10.01 ± 0.61 s) there was no significant difference ($P > 0.05$). There were no significant differences in 800 m, sit-up, standing long jump, 50 m and seated forward bend in female control group ($P > 0.05$).

Table 13. Changes in physical function indexes of female subjects before and after the experiment.

Name	**Control group (mean ± SD)**		***T***	***P***
	pre-experiment	**After the experiment**		
800 m (min)	5.68 ± 0.56	5.58 ± 0.46	1.231	0.142
Sit-ups (one)	33.43 ± 5.43	33.89 ± 5.43	2.253	0.423
Standing long jump (cm)	1.36 ± 0.21	1.39 ± 0.25	3.202	0.673
50m (s)	10.46 ± 0.73	10.16 ± 0.63	31.76	0.401
Seated forward bend (cm)	17.17 ± 3.55	17.65 ± 3.37	1.353	0.452
Name	Experimental group (mean ± SD)		*T*	*P*
	pre-experiment	After the experiment		
800 m (min)	5.62 ± 0.47	5.01 ± 0.51	2.263	0.017
Sit-ups (one)	33.51 ± 5.36	36.82 ± 5.13	1.678	0.019
Standing long jump (cm)	1.34 ± 0.22	1.48 ± 0.19	1.159	0.000 *
50 m (s)	10.44 ± 0.69	10.01 ± 0.61	2.461	0.312
Seated forward bend (cm)	17.18 ± 3.41	17.89 ± 2.52	7.825	0.000 *

* $p < 0.05$, ** $p < 0.01$.

Table 14. Changes of physical function indexes between the control group and the experimental group after the experiment.

Name	**Boys (mean ± SD)**		**Difference**	***P***
	Control group	**Experimental group**		
1000 m (min)	5.61 ± 0.15	5.03 ± 0.18	0.58	0.005
Sit-ups (one)	34.89 ± 6.52	35.01 ± 5.26	−0.12	0.323
Standing long jump (cm)	1.73 ± 1.59	1.75 ± 1.91	−0.02	0.631
50m (s)	9.86 ± 0.76	9.36 ± 0.718	0.5	0.856
Seated forward bend (cm)	13.52 ± 3.61	14.87 ± 3.716	−1.35	0.000 * *
Name	Girls (mean ± SD)		Difference	*P*
	Control group	Experimental group		
800 m (min)	5.58 ± 0.46	5.01 ± 0.51	0.57	0.012
Sit-ups (one)	33.89 ± 5.43	36.82 ± 5.13	−2.93	0.338
Standing long jump (cm)	1.39 ± 0.25	1.48 ± 0.19	−0.09	0.741
50m (s)	10.16 ± 0.63	10.01 ± 0.61	0.15	0.672
Seated forward bend (cm)	17.65 ± 3.37	17.89 ± 2.52	−0.24	0.000 * *

* $p < 0.05$, ** $p < 0.01$.

According to the analysis of changes in physical function indexes of male students after the experiment in **Table 14**, the difference between the male experimental group and the control group in 1000 m, sit-up, standing long jump, 50 m and seated forward bend after the experiment was 0.58, −0.12, −0.02, 0.5 and −1.35. Among them, 1000 m and seated forward bend were statistically significant ($P < 0.05$), and there were significant differences, while sit-up, standing long jump and 50 m were not statistically significant ($P > 0.05$). After the experiment, the difference between the female experimental group and the control group in 800 m, sit-up, standing long jump, 50 m, and sitting forward bend was 0.57, −2.93, −0.09, 0.15, −0.24. The female

experimental group and the control group had statistical significance in 1000 m, sitting forward bend and other indicators ($P < 0.05$), there were significant differences. There were no statistical differences in sit-up, standing long jump and 50 m ($P > 0.05$).

4. Discussion and analysis

4.1. The influence of physical training on the body form of college students

Bad body shape, such as obesity, has become a real problem plaguing college students. According to the statistics of the Ministry of Education, the obesity rate of college students in China is becoming increasingly prominent. In 2020, the obesity rate of college students in China will be 5.5%. According to a survey of college students in a certain province, the incidence of overweight in male and female college students was 22.74% and 8.42%, respectively, and the incidence of central obesity in male and female students was 7.85% and 3.02%, which is expected to grow rapidly in the next few years. After 12 weeks of physical training, the experimental group of college students due to regular aerobic exercise, strength training and agility training, the body energy consumption increased significantly. Aerobic exercises such as jogging, aerobics and jumping rope can continue to burn fat and provide energy for the body. At the same time, strength training increases muscle mass and increases your basal metabolic rate, allowing your body to burn more calories even at rest. Agility training further increases the body's activity level and increases overall energy expenditure. These factors worked together to cause the experimental group to lose weight over time. Waist and abdomen: Aerobic exercise and strength training in physical training have a positive effect on fat burning and muscle tightening in the waist and abdomen. For example, jogging can mobilize the muscles of the whole body to participate in the exercise, especially the stabilizing effect of the abdominal core muscles, which helps to reduce the accumulation of abdominal fat. Strength training in the plank, squat and other movements can also effectively exercise the muscles of the abdomen and buttocks, so that the waist and abdomen line more tight. In this study, college students' strength, speed, endurance, coordination, flexibility, agility and other sports quality training were carried out. Under the condition of ensuring a variety of movements, the strategy of gradually increasing the movement speed and shortening the interval time was adopted to enable the subjects to achieve high-intensity exercise in the gradual adaptation. After practice, it has a very good shaping effect on the body shape of college students. After the experiment, various indicators that can reflect the body shape of college students have corresponding changes. The waist circumference of college students in the experimental group is significantly reduced, the abdominal fat is reduced, and the body shape is more beautiful. Hip circumference and thigh circumference: aerobic training and strength training in the squat, hard pull and other actions can exercise to the buttock and thigh muscles, improve muscle strength and endurance. At the same time, these exercises also help burn fat in the hips and thighs and reduce hip circumference. As the training progressed, the hip and thigh circumference of the experimental group of college students gradually decreased, the hips became more elevated, and the legs became slimmer. Upper arm circumference:

the dumbbell shoulder push and push up in strength training can exercise the muscles of the upper arm, increase muscle mass and reduce fat accumulation at the same time. After a period of training, the upper arm circumference of the experimental group of college students may be slightly reduced, but due to the growth of muscles, the arm will be more compact and powerful. Wu Haitan et al. took more than 200 students from a middle school in Shanghai as the experiment subjects, respectively using 15 min of medium-high intensity interval training and 10 min of high-intensity continuous exercise. The results showed that the BMI of the students decreased to a certain extent [5]. 12 weeks of physical training can significantly change and improve the body weight, WHR and body fat percentage of male and female college students, and the external shape is also changing, which is consistent with the results of Wuhaitan study, and it shows that physical training is a very good way to improve the body shape of college students.

4.2. Influence of physical training on body function

The study found that the physical function level of obese college students was significantly lower than that of healthy college students. The increase in the obesity rate of college students will not only affect their physical health, but also affect their physical function. As the future builders and promoters of the country, it will bring negative and negative impacts on the society [9]. Xu Wei found in his research that different obesity grades of college students are positively correlated with their physical function indicators, indicating that the level of physical function of college students is greatly affected by the degree of obesity. When there is too much fat accumulation in the body, the ability to use oxygen inside the body decreases, which affects the work efficiency of various organ systems to a certain extent, obstructs gas exchange, and increases the contractile load of respiratory muscle [10]. The resting heart rate of athletes is slightly lower than that of the general population, because the contractile force of the heart and the number of muscle fibers are strengthened and increased after the intense load training of the athletes. The thickened myocardium helps them increase the output per minute and reduce the number of heart beats. Therefore, the resting heart rate can be used as an effective indicator to evaluate the level of physical function. The indicator of vital capacity requires the subject to exhale as much air as possible after the maximum inhalation. An increase in the volume of air indicates a significant increase in the maximum inspiratory capacity of the lungs. The strengthening of pulmonary contractility and the strengthening of muscle fibers can lead to an increase in lung capacity. For blood pressure, when a person’s stroke output is high, the body does not need high blood pressure to maintain blood supply to other tissues and organs. The level of blood pressure indicates the elasticity and cushioning capacity of the blood vessels. VO2max is one of the indicators that can best reflect the human exercise ability. VO2max can effectively reflect the aerobic exercise ability of the body, which is mainly affected by the heart’s pumping ability and the muscle’s ability to use oxygen. Therefore, this study selected the above indicators to evaluate the physical function of obese female college students. There is no doubt about the positive effect of exercise on the physical function of obese women, which has been verified by many scholars. Zouhal et al. [12] included 116 studies on the impact of

aerobic and anaerobic exercise on obese people for systematic review. Through data comparison and analysis, they found that anaerobic exercise could improve the body composition and physical performance indicators of obese people, reduce the body weight, body fat percentage and BMI of subjects, and effectively raise the level of VO2max [13]. This study also found that after 12 weeks of physical training, the resting heart rate, vital capacity, SBP, DBP, VO2max and other indicators of college students were improved. Compared with traditional aerobic training, physical training can effectively improve the physical function level of obese college students, which is basically similar to the results of existing studies. In addition, although the subjects selected in this study are obese people, their average age is about 20 years old, and they are in a good state with no obvious symptoms of metabolic diseases.

4.3. Influence of physical training on physical fitness

The increasing number of college students obesity seriously affects the average physical fitness level of college students in China, and brings great negative impact on their daily life. According to Zhang Haiping et al., compared with healthy students in various physical qualities, the physical qualities of obese students are obviously backward, and the performance of various indicators is lower than that of healthy students [12]. Obesity may, to a certain extent, reduce the muscle strength in the core area of the subjects, weaken the power transmission of all parts of the muscles, weaken the pulmonary muscle contraction force, reduce the ligament stretching power, weaken the flexibility of neural activity in the cerebral cortex, and greatly decrease the physical fitness [14]. At the same time, the strength of physical fitness also represents the comprehensive performance of the functions of various organ systems of the human body under the central nervous system. When the physical fitness of obese people is low, the operation of cardiovascular and cerebrovascular functions will be blocked, and the stroke output of the heart and the volume of the heart will be reduced, which is not conducive to the circulation of blood inside the body. Yi Lingli and other scholars found in the study that 8 weeks of HIIT can significantly improve endurance, speed and strength quality, and greatly improve the physical fitness level of the explosive strength machine of the lower limb muscle group [15]. Physical fitness is the foundation of health, and both the country and society attach great importance to the physical fitness of students. The Ministry of Education requires that college students must be tested for physical fitness every academic year, and has formulated a series of documents and standards. In this study, the physical fitness of obese female college students was evaluated by five indexes, namely, endurance, speed, strength, flexibility and balance quality, using the current implementation of “Students’ physical health Standard”. After 12 weeks of physical training, this study found that the physical qualities of male and female students, including endurance, strength, speed, flexibility and agility, have been greatly improved, and the data of 800/100 meters in middle distance running and sit-ups have significantly changed under the effect of physical training. This is similar to the results of previous studies, indicating that 12-week physical training can effectively enhance the cardiopulmonary function and muscle contraction force of college students, and has a significant effect on the improvement and enhancement of physical fitness. Physical training method can

continuously stimulate various functions of the body and make it more stable adaptability in a short period of time. The burden of the body is reduced due to the increase of muscle content and the decrease of body fat percentage, which results in the continuous strengthening and improvement of physical fitness, so as to greatly improve the body function level of obese people. And it may increase the capacity of mitochondrial protein and ATPase in the sarcoplasmic reticulum to a large extent, and induce greater adaptability of mitochondrial organisms and higher ability to maintain high strength muscle contraction.

5. Study conclusions

After 12 weeks of physical training, the physical form, physical function and physical quality of college students of different genders were improved. From the experimental results, the changes of the three indexes of body form, body function and physical fitness basically meet the expectations. In terms of body form, there are significant differences in BMI index before and after the experimental group, indicating that physical training intervention has a significant impact on body form, which is consistent with the results of some previous studies. However, according to some literatures and scientific research data, This does not mean that physical training on the improvement of body shape is meaningless, but also need to be combined with diet, growth and other factors to consider comprehensively; In terms of physical function, although the experimental group has significantly improved the performance of vital capacity, but compared with the control group there is no significant difference, indicating that the physical training intervention program compared with the general physical education course on the impact of physical function is not obvious, did not achieve beyond the effect of conventional physical education course, indicating that in endurance training also need to optimize the arrangement and control of training content; In terms of physical fitness, the analysis of changes in body composition indexes of boys and girls after the experiment showed that the difference between the experimental group and the control group was small and there was no significant change. After the experiment, there were significant differences in indicators such as 1000 m and sitting forward bend, but there were no statistical differences in sit-ups, standing long jump and 50 m for boys. There were significant differences between the experimental group and the control group in 1000 m and sit-up forward bend, but no statistical differences in sit-up, standing long jump and 50 m. It shows that the training content of flexibility exercise, upper limb and back strength exercise needs to be further optimized and improved.

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