ANALYSIS OF THE EFFECTS OF HIGH-INTENSITY STRENGTH TRAINING ON MUSCULATURE AND METABOLISM IN COLLEGE STUDENTS

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ANÁLISE DOS EFEITOS DO TREINAMENTO DE FORÇA DE ALTA INTENSIDADE SOBRE A MUSCULATURA E O METABOLISMO DE ESTUDANTES UNIVERSITÁRIOS

ANÁLISIS DE LOS EFECTOS DEL ENTRENAMIENTO DE FUERZA DE ALTA INTENSIDAD SOBRE LA MUSCULATURA Y EL METABOLISMO EN ESTUDIANTES UNIVERSITARIOS

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ABSTRACT

Introduction: Recent studies shows that college students have decreased physical fitness and increased obesity rates, and the rate of obesity will continue to increase over time. Objective: Study the effect of high-intensity strength training on college students' muscle optimization and metabolic recovery. Methods: This paper adopts the experimental control method. An experimental group performed high-intensity strength training and completed the training with the help of the existing equipment in our school's gym. The control group used normal aerobic training to complete the running training and other movements in athletics. The experimental and control groups were trained three times a week for one hour at a time. Results: In the experimental group, left arm elbow joint extension was optimized to (18.405 ± 2.8878) kg after the experiment, P<0.05; right leg knee joint extension was optimized to (38.754 ± 6.6556) kg after the experiment, P<0.01; serum total cholesterol was optimized to (3.682 ± 0.2643) mmol/L after the experiment, P<0.01. Conclusion: High-intensity strength training, when compared with ordinary aerobic training, has a better optimizing effect on college students' indicators and higher exercise efficiency. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Resistance Training; Muscles; Energy Metabolism.

RESUMO

Introdução: Segundo consta nas pesquisas recentes, os estudantes universitários têm diminuído a aptidão física e aumentado a taxa de obesidade, e o índice de obesidade permanecerá aumentando com o tempo. Objetivo: Estudar o efeito do treinamento de força de alta intensidade sobre a otimização muscular e a recuperação metabólica dos estudantes universitários. Métodos: Este trabalho adota o método experimental de controle. Um grupo experimental realizou o treinamento de força de alta intensidade e completou o processo de treinamento com a ajuda do equipamento existente na academia da nossa escola. O grupo de controle usou o treinamento aeróbico normal para completar o treino de corrida e outros movimentos no atletismo. O grupo experimental e o grupo de controle foram treinados três vezes por semana durante uma hora de cada vez. Resultados: No grupo experimental, a extensão da articulação do cotovelo do braço esquerdo foi otimizada para (18,405 ± 2,8878) kg após o experimento, P<0,05; a extensão da articulação do joelho da perna direita foi otimizada para (38,754 ± 6,6556) kg após o experimento, P<0,01; o colesterol total sérico foi otimizado para (3,682 ± 0,2643) mmol/L após o experimento, P<0,01. Conclusão: O treinamento de força de alta intensidade, quando comparado com o treinamento aeróbico comum, tem um melhor efeito de otimização nos indicadores dos estudantes universitários e uma maior eficiência no exercício. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Treinamento de Força; Músculos; Metabolismo Energético.*

RESUMEN

Introducción: Según las investigaciones recientes, los estudiantes universitarios presentan una disminución de la forma física y un aumento de la tasa de obesidad, y la tasa de obesidad seguirá aumentando con el tiempo. Objetivo: Estudiar el efecto del entrenamiento de fuerza de alta intensidad sobre la optimización muscular y la recuperación metabólica en estudiantes universitarios. Métodos: Este trabajo adopta el método de control experimental. Un grupo experimental realizó el entrenamiento de fuerza de alta intensidad y completó el proceso de entrenamiento con la ayuda del equipamiento existente en el gimnasio de nuestro colegio. El grupo de control utilizó el entrenamiento aeróbico normal para completar el entrenamiento de carrera y otros movimientos en atletismo. El grupo experimental y el grupo de control se entrenaron tres veces por semana durante una hora cada vez. Resultados: En el grupo experimental, la extensión de la articulación del codo del brazo izquierdo se optimizó a (18,405 ± 2,8878) kg después del experimento, P<0,05; la extensión de la articulación de la rodilla de la pierna derecha se optimizó a (38,754 ± 6,6556) kg después del experimento, P<0,01; el colesterol total sérico se optimizó

a (3,682 ± 0,2643) mmol/L después del experimento, P<0,01. Conclusión: El entrenamiento de fuerza de alta intensidad, en comparación con el entrenamiento aeróbico ordinario, tiene un mejor efecto optimizador sobre los indicadores de los estudiantes universitarios y una mayor eficacia del ejercicio. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Entrenamiento de Fuerza; Músculos; Metabolismo Energético.*

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INTRODUCTION

Physical education is an important link in quality education, and strengthening students' physique has always been the teaching goal.[1] However, the current survey shows that there are many reasons for the decline of college students' physical fitness and the increase of obesity rate. The literature investigates the physical quality of current college students, and the research results show that the overweight phenomenon of current college students is very obvious, and the obesity rate will continue to increase with time.[2] In the analysis of its causes, the literature points out that the development of living standards is the main reason for the obesity rate of college students. The current popularity of elevators, cars and other means of transportation has deprived college students of many training opportunities, while online games and takeout snacks have made college students sit for a long time, resulting in physical obesity.[3] Obesity has brought many adverse effects on the quality of life and physical health of college students. At present, cardiovascular and cerebrovascular diseases are becoming younger and younger, and the major cause of cardiovascular diseases among college students is the problem of obesity among college students.[4] Many college students have symptoms of "three highs" at a young age, which will bring many adverse effects in the long run, even lead to sudden death. The decline of college students' physical quality will also lead to the decline of China's overall physique, which is not conducive to the sustainable development of China in the future.[5] Therefore, in order to strengthen college students' physique, optimize and improve their physical quality, and reduce the impact of obesity and disease on college students, we need to take certain ways to optimize college students' body composition, improve their physical quality, and improve their metabolic level.[6]

METHOD

Selection of research objects

This article has carried out a weight loss training camp in a university. The study and all the participants were reviewed and approved by Ethics Committee of China Jiliang University (NO.2019CJLUT-P019). The applicants should meet the following characteristics: First, they are full-time undergraduate students of the university and have enough time to participate in each training; second, the applicants are in good health, free from heart and lung diseases, sports injuries and other conditions, and will not have adverse conditions due to sports; third, the BMI value of the subjects belongs to overweight and obesity indicators, which is necessary to lose weight; forth, the subjects had good compliance throughout the experiment, listened to the arrangement of the researchers, and reasonably designed training and diet plans; fifth, during the whole research process, the subjects were able to keep full attendance and participate in each training. After screening, 60 subjects were selected and randomly divided into experimental group and control group. The basic information is shown in Table 1.

Experimental design

In order to explore the influence of high-intensity strength training on college students' body muscles and metabolism, this paper adopts the method of control experiment. The experimental group conducts high-intensity strength training, and completes the training process with the help of the existing equipment in the gym of our school. The control group uses ordinary aerobic training to complete jogging and other movements on the track and field. The experimental group and the control group were trained three times a week for one hour each time. Under the guidance of the researchers, the experimental group and the control group made full preparations for warm-up before each training, and carried out stretching and relaxation activities after training to prevent sports injuries caused by excessive exercise. The whole experiment lasted for 8 weeks. In addition to different training methods, the experimental group and the control group consciously kept their diet and rest basically the same according to the plan listed by the researchers, so as to minimize the interference of unrelated variables on the experimental results.

Table 1. Information of the two groups of subjects before the experiment.

Index	Experience group	Control group	T	P
Weight (kg)	78.865±12.3294	84.491±9.7672	-1.3753	>0.05
Body fat percentage (%)	31.596±5.2223	29.176±3.0168	0.9859	>0.05
BMI(kg/m^2)	27.818±2.5916	28.727±2.0335	-0.7970	>0.05
Muscle mass (kg)	29.991±5.5926	34.197±4.3903	-1.6265	>0.05
Fat free weight (kg)	54.568±9.5152	60.148±7.6332	-1.6318	>0.05

RESULTS

Optimization effect of high-intensity strength training on college students' body composition

The goal of students participating in the training camp is to improve body composition, enhance muscle strength, and achieve the training purpose of weight loss. Therefore, the first judgment indicator in this paper is the optimization of body composition. (Table 2)

The body weight of the experimental group was optimized from (78.865 ± 12.3294) kg before the experiment to (70.622 ± 12.8366) kg after the experiment, P<0.01; The weight of the control group was optimized from (85.848 ± 9.6326) kg before the experiment to (80.279 ± 9.4571) kg after the experiment, P<0.01.

In the experimental group, the body fat ratio was optimized from (31.096 ± 5.2744)% before the experiment to (23.445 ± 5.5896)% after the experiment, P<0.01; The body fat rate of the control group was improved from (29.058 ± 2.9985)% before the experiment to (29.338 ± 3.7689)% after the experiment, P>0.05. The BMI index of the experimental group was improved from (28.377 ± 2.5507) kg/m2 before the experiment to (25.521 ± 2.7941) kg/m^2 after the experiment, P<0.01; The BMI index of the control group was improved from (28.269 ± 2.1039) kg/m2 before the experiment to (26.917 ± 2.0849) kg/m^2 after the experiment, P<0.01.

The muscle mass of the experimental group was improved from (30.419 ± 5.6267) kg before the experiment to (30.652 ± 5.7907) kg after the experiment, P<0.05; The muscle mass of the control group was optimized from (34.332 ± 4.3903) kg before the experiment to (34.369 ± 4.3939) kg after the experiment, P>0.05. The body weight of the experimental group was optimized from (53.816 ± 9.6680) kg before

Table 2. The optimization effect of high-intensity strength training on college students' body composition.

Index	Group	Before experiment	After experiment	T	P
Weight (kg)	Experience group	78.865±12.3294	70.622±12.8366	80.5393	<0.01
	Control group	85.848±9.6326	80.279±9.4571	12.3599	<0.01
Body fat percentage (%)	Experience group	31.096±5.2744	23.445±5.5896	15.2678	<0.01
	Control group	29.058±2.9985	29.338±3.7689	0.6559	>0.05
BMI(kg/m^2)	Experience group	28.377±2.5507	25.521±2.7941	31.3727	<0.01
	Control group	28.269±2.1039	26.917±2.0849	11.8790	<0.01
Muscle mass (kg)	Experience group	30.419±5.6267	30.652±5.7907	-0.9416	<0.05
	Control group	34.332±4.3903	34.369±4.3939	-0.1381	>0.05
Fat free weight (kg)	Experience group	53.816±9.6680	53.815±9.9908	-1.0492	<0.05
	Control group	59.911±7.4371	56.760±7.2541	4.5614	<0.01

the experiment to (53.815 ± 9.9908) kg after the experiment, P<0.05; The fat free weight of the control group was optimized from (59.911 ± 7.4371) kg before the experiment to (56.760 ± 7.2541) kg after the experiment, P<0.01.

The optimization effect of high-intensity strength training on college students' muscle strength

After determining the change of muscle content, we also need to analyze the muscle strength. In this respect, we chose the strength of upper and lower limbs to judge. In order to more comprehensively analyze the body in the limited measurement items, we chose the left arm elbow joint and the right leg knee joint as the measurement objects. (Table 3)

In the experimental group, the left arm elbow joint extension was optimized from (15.003 ± 3.4882) kg before the experiment to (18.405 ± 2.8878) kg after the experiment, P<0.05; The extension of the left arm elbow joint in the control group was improved from (15.334 ± 2.2373) kg before the experiment to (16.669 ± 2.377) kg after the experiment, P>0.05. In the experimental group, the bending force of the left arm elbow joint was optimized from (19.706 ± 3.0380) kg before the experiment to (24.681 ± 3.9292) kg after the experiment, P<0.05; The bending force of the left arm elbow joint in the control group was optimized from (20.795 ± 3.7363) kg before the experiment to (22.583 ± 3.6040) kg after the experiment, P<0.05. The knee joint extension of the right leg in the experimental group was optimized from (34.207 ± 6.3421) kg before the experiment to (38.754 ± 6.6556) kg after the experiment, P<0.01; The knee joint extension of the right leg in the control group was optimized from (34.703 ± 6.9663) kg before the experiment to (36.907 ± 7.2485) kg after the experiment, P>0.05. In the experimental group, the knee joint bending force of the right leg was optimized from (21.994 ± 4.3201) kg before the experiment to (26.139 ± 4.8722) kg after the experiment, P<0.01; In the control group, the knee joint bending force of the right leg was optimized from (20.508 ± 2.9156) kg before the experiment to (22.338 ± 2.5612) kg after the experiment, P<0.05.

Optimization effect of high-intensity strength training on college students' metabolic indicators

In the previous analysis, it was mentioned that the current adverse effects of college students' obesity include cardiovascular diseases, and many cardiovascular diseases are caused by high levels of body indicators, such as low-density lipoprotein, triglycerides, serum total cholesterol, etc. Therefore, in order to improve college students' physique and reduce the harm of poor blood indicators to college students' health, metabolism should be taken as a judgment indicator, To explore the optimization effect of experimental training on the metabolism of college students. (Table 4)

The blood glucose GLU refers to the glucose content in the blood. The content in the experimental group was optimized from (4.761 ± 0.2663) mmol/L before the experiment to (4.504 ± 0.4269) mmol/L after the experiment, P<0.05; The content of the control group was optimized from (4.991 ± 0.2506) mmol/L before the experiment to (4.557 ± 0.2183) mmol/L after the experiment, P>0.05.

HDL, also known as high-density lipoprotein, was optimized from (1.206 ± 0.4252) mmol/L before the experiment to (1.113 ± 0.3045) mmol/L after the experiment, P<0.05; The content of the control group was optimized from (1.002 ± 0.1480) mmol/L before the experiment to (1.053 ± 0.2005) mmol/L after the experiment, P<0.05.

Table 3. The optimization effect of high-intensity strength training on college students' muscle strength.

Index	Group	Before experiment	After experiment	T	P
Elbow joint extension of left arm	Experience group	15.003±3.4882	18.405±2.8878	3.3072	<0.05
	Control group	15.334±2.2373	16.669±2.3773	0.6303	>0.05
Elbow joint flexion force of left arm	Experience group	19.706±3.0380	24.681±3.9292	0.8614	<0.05
	Control group	20.795±3.7363	22.583±3.6040	0.0471	<0.05
Knee joint extension of right leg	Experience group	34.207±6.3421	38.754±6.6556	0.1073	<0.01
	Control group	34.703±6.9663	36.907±7.2485	0.0438	>0.05
Knee joint bending force of right leg	Experience group	21.994±4.3201	26.139±4.8722	0.5662	<0.01
	Control group	20.508±2.9156	22.338±2.5612	0.8527	<0.05

Table 4. The Optimization Effect of High Intensity Strength Training on Metabolic Indexes of College Students.

Index	Group	Before experiment	After experiment	T	P
GLU (mmol/L)	Experience group	4.761±0.2663	4.504±0.4269	0.3536	<0.05
	Control group	4.991±0.2506	4.557±0.2183	0.9249	>0.05
HDL (mmol/L)	Experience group	1.206±0.4252	1.113±0.3045	0.6806	<0.05
	Control group	1.002±0.1480	1.053±0.2005	0.2977	<0.05
LDL (mmol/L)	Experience group	3.090±0.3089	2.124±0.2126	6.3449	<0.05
	Control group	2.239±0.7419	1.611±0.6114	1.6400	<0.05
TG (mmol/L)	Experience group	0.996±0.3473	0.882±0.2632	0.6277	<0.01
	Control group	2.104±1.2630	1.154±0.2192	0.7989	<0.05
TC (mmol/L)	Experience group	4.651±0.5467	3.682±0.2643	2.9471	<0.01
	Control group	4.181±0.7003	3.232±0.6946	1.5245	>0.05

LDL is also called low-density lipoprotein, which is easy to cause arteriosclerosis when it is excessive. The content of the experimental group was optimized from (3.090 ± 0.3089) mmol/L before the experiment to (2.124 ± 0.2126) mmol/L after the experiment, P<0.05; The content of the control group was optimized from (2.239 ± 0.7419) mmol/L before the experiment to (1.611 ± 0.6114) mmol/L after the experiment, P<0.05.

TG, namely triglyceride, was optimized from (0.996 ± 0.3473) mmol/L before the experiment to (0.882 ± 0.2632) mmol/L after the experiment, P<0.01; The content of the control group was optimized from (2.104 ± 1.2630) mmol/L before the experiment to (1.154 ± 0.2192) mmol/L after the experiment, P<0.05.

Blood lipid TC refers to total cholesterol in serum. The content of the experimental group was optimized from (4.651 ± 0.5467) mmol/L before the experiment to (3.682 ± 0.2643) mmol/L after the experiment, P<0.01; The content of the control group was optimized from (4.181 ± 0.7003) mmol/L before the experiment to (3.232 ± 0.6946) mmol/L after the experiment, P>0.05.

DISCUSSION

Maintaining physical fitness and strengthening sports training is a key point of current college students' physical education teaching. However, through research and analysis, we can see that the current college students' physical education teaching has the following problems: First of all, college students are lack of motivation, many of them lack the knowledge of sports health, and their awareness of fitness and weight loss is relatively indifferent. Even if they have enthusiasm for sports, they can only stick to it for a short time, Therefore, they can not form good sports habits, which leads to a decline in physical fitness; Secondly, many college students have heavy academic pressure. Although they have sports requirements, they are often in a state of perfunctory response. At present, physical education teaching is still in a clocking stage, and it is impossible to really apply the results of physical education teaching to life; Third, the emergence of the COVID-19 has squeezed the original living space of many college students, closed schools or isolated at home, forcing college students who could have gone out for sports to stay in dormitories or families, lacking enough space for sports. Many college students just gave up sports, leading to the decline of their physique.

CONCLUSION

At present, Chinese college students are faced with the problem of obesity, which has brought a lot of adverse effects on college students. This paper discusses the impact of high-intensity strength training and ordinary aerobic exercise on college students' muscle development and multiple indicators of metabolic optimization from the perspective of exercise to lose weight. The research results show that high-intensity strength training has better optimization effect on college students' multiple indicators than ordinary aerobic training, More efficient exercise. Of course, there are still some shortcomings in this paper. For example, when selecting sports types, only high-intensity strength training and ordinary aerobic running are selected, therefore, only high-intensity strength training and ordinary aerobic running can be analyzed, and there is a lack of comparison with other sports types. Therefore, more sports comparisons need to be added in the subsequent research to more comprehensively analyze the advantages of high-intensity strength training.

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