CARDIOPULMONARY RESISTANCE IN OBESE INDIVIDUALS DURING DIFFERENT AEROBIC EXERCISES

RESISTÊNCIA CARDIOPULMONAR DE OBESOS EM EXERCÍCIOS AERÓBICOS DIFERENTES

RESISTENCIA CARDIOPULMONAR EN INDIVIDUOS OBESOS DURANTE DIFERENTES EJERCICIOS AERÓBICOS

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ABSTRACT

Introduction: Obesity is a major cause of chronic diseases such as cardiovascular and cerebrovascular diseases, cancer, and diabetes. Recent studies have reported that combined aerobic and anaerobic exercise effects are more effective for fat reduction. However, aerobic and anaerobic exercise have different fat reduction mechanisms. Comparing the intervention effects of different combinations of these exercises could provide an experimental basis for establishing an optimal protocol for weight loss. Objective: To study the effect of different aerobic exercise intensities on cardiorespiratory endurance in obese patients and its impact on fat loss. Methods: 18 obese female college students (BMI≥25) were randomly divided into two groups with different proportions of aerobic and anaerobic exercise. Bioimpedance data and BMI were collected for analysis. SPSS 25.0 software was used for statistics, with mean and standard deviation expressed for each index. Significance level at $p<0.05$ and highly significant set at $P<0.01$. Results: The weight, BMI, waist-to-hip ratio, and body fat content of the two exercise methods were positively changed before and after the experiment. This change had a very significant difference. Conclusion: There was no statistical difference in the interventions for the six weeks. Aerobic exercise can effectively improve cardiopulmonary function, and the benefits are directly proportional to the period practiced. ***Evidence Level II; Therapeutic Studies – Investigating the results.***

Keywords: Aerobic Exercise Sports; Obesity; Cardiorespiratory Fitness.

RESUMO

Introdução: A obesidade é uma causa importante de doenças crônicas como doenças cardiovasculares e cerebrovasculares, câncer e diabetes. Estudos recentes relataram que os efeitos do exercício aeróbico e anaeróbico combinados são mais eficazes para a redução de gordura. O exercício aeróbico e o exercício anaeróbico têm diferentes mecanismos de redução de gordura e a comparação dos efeitos da intervenção de diferentes combinações desses exercícios poderia fornecer uma base experimental para o estabelecimento de um protocolo ideal para perda de peso. Objetivo: Estudar o efeito de diferentes intensidades de exercícios aeróbicos sobre a resistência cardiorrespiratória de pacientes obesos e seu impacto sobre a perda de gordura. Métodos: 18 estudantes universitárias obesas (IMC≥25) foram divididas aleatoriamente em dois grupos com proporções distintas de exercícios aeróbicos e anaeróbicos. Assim como o IMC, dados coletados via bioimpedância foram mensurados antes e depois do experimento para análise. Foi utilizado o Software SPSS 25.0 para a estatística, com média e desvio padrão expressos para cada índice. Nível de significância em $p<0,05$ e muito significativo fixado em $P<0,01$. Resultados: O peso, IMC, relação cintura/quadril, e conteúdo de gordura corporal dos dois métodos de exercício foram positivamente alterados antes e depois do experimento. Essa alteração teve uma diferença muito significativa. Conclusão: Não houve diferença estatística nas intervenções pelo período de seis semanas. O exercício aeróbico pode efetivamente melhorar a função cardiopulmonar e os benefícios são diretamente proporcionais ao período praticado. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Exercício Aeróbico; Esportes; Obesidade; Aptidão cardiorrespiratória.*

RESUMEN

Introducción: La obesidad es una de las principales causas de enfermedades crónicas como las cardiovasculares y cerebrovasculares, el cáncer y la diabetes. Estudios recientes han informado que los efectos combinados de los ejercicios aeróbicos y anaeróbicos son más eficaces para la reducción de la grasa. Sin embargo, el ejercicio aeróbico y el anaeróbico tienen diferentes mecanismos de reducción de la grasa. La comparación de los efectos de intervención de diferentes combinaciones de estos ejercicios podría proporcionar una base experimental para establecer un protocolo óptimo para la pérdida de peso. Objetivo: Estudiar el efecto de diferentes intensidades de ejercicio aeróbico sobre la resistencia cardiorrespiratoria en pacientes obesas y su impacto en la pérdida de grasa. Métodos: 18 estudiantes universitarias obesas (BMI≥25) fueron divididas aleatoriamente en dos grupos con diferentes proporciones de ejercicio aeróbico y anaeróbico. Se recogieron los datos de bioimpedancia y el IMC para su análisis. Se utilizó el software SPSS 25.0 para las estadísticas, con el promedio y la desviación estándar expresadas para cada índice. El nivel de significancia se fijó en $p<0,05$ y el nivel muy significativo en $P<0,01$. Resultados: El peso, el IMC, la relación cintura-cadera y el contenido de grasa corporal de los dos métodos de ejercicio cambiaron positivamente

antes y después del experimento. Este cambio tuvo una diferencia muy significativa. Conclusión: No hubo diferencias estadísticas en las intervenciones durante las seis semanas. El ejercicio aeróbico puede mejorar eficazmente la función cardiopulmonar, y los beneficios son directamente proporcionales al periodo practicado. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Ejercicio Aeróbico; Deportes; Obesidad; Capacidad Cardiovascular.*

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INTRODUCTION

Obesity is an important cause of chronic diseases such as cardiovascular and cerebrovascular diseases, cancer, diabetes, etc. At the same time, it will cause certain harm to people's mental health.[1] Therefore, obesity is listed by the World Health Organization as one of the top ten diseases threatening human health.

Appropriate aerobic exercise helps to promote the breakdown of fat and achieve the effect of weight loss. In recent years, studies have reported that aerobic and anaerobic exercise's effects on fat reduction are greater than that of various single exercises.[2] Aerobic exercise and anaerobic exercise have different mechanisms of reducing fat. This study intends to compare the intervention effects of different combinations of aerobic exercise and anaerobic exercise time through exercise intervention for obese people. This provides an experimental basis for establishing the optimal aerobic and anaerobic combined exercise to reduce fat.

METHOD

Research object

This study recruited 17 overweight or obese female college students (BMI≥25) who volunteered to participate in the weight-loss exercise experiment.[3] In the experiment, the subjects were randomly divided into aerobic + 4 anaerobic groups (N=7), aerobic + 6 anaerobic groups (N=10). By comparing the changes in body composition and physiological function indexes of overweight or obese female college students, we summarized and analyzed the weight loss effect of aerobic exercise and anaerobic exercise on different time ratios of obese college students.

Adipocyte endothelial growth factor model

The release of vascular endothelial growth factors from fat cells can induce the growth of new blood vessels. The following reaction-diffusion equation can describe this process:

$$\frac{\partial V}{\partial t} = D_V \Delta V + \chi_{tum}(t,x) S_v - \chi_{vex}(t,x) q_V V - \delta_V V \quad (1)$$

Assume that the endothelial cells at the top of the capillary sprout control the movement of the entire blood vessel.[4]

$$P_k \infty \left(\frac{\alpha k_V}{k_V + V} \nabla V + \lambda \nabla F \right) l_k, k = 1,2,3,4 \quad (2)$$

α is the chemotaxis coefficient. k_V is the weight that controls the concentration of vascular endothelial growth factor in chemotaxis sensitivity. $\lambda \nabla F$ describes the chemotaxis of endothelial cells to fibronectin.[5] Where λ is the tactical coefficient.

Statistical methods

This study uses spss 25.0 software for statistical analysis. The mean ± standard deviation expresses the measured value of each index. The significance level is set to p<0.05, and the very significant level is set to P<0.01.

RESULTS

Before the experimental intervention, there were no significant differences in body weight, fat weight, lean body weight, protein, mineral content, and skeletal muscle mass between the two groups of subjects.[6] After the experiment, the same group of indicators before and after the experiment found that all the body classification indicators of the two groups were not significantly different before and after the experiment (P>0.05). The comparison between groups found no significant difference in each index before and after the experiment. (Table 1)

Before the experimental intervention, there were no significant differences in heart rate, respiratory efficiency, respiratory rate, ventilation volume, maximum oxygen uptake, basal metabolic rate, and% carbohydrates between the two groups of subjects.[7] After the experiment, the same group of indicators before and after the experiment found significant differences in the resting heart rate, ventilation volume, and basal metabolic rate between the two groups before and after the experiment (p<0.05). But there was no significant difference between the two groups (p>0.05). (Table 2)

Before the experiment, there was a significant difference in the exhaustion time between the two groups (p<0.05). There was no significant difference in exhaustion time between the two groups after the end of the experiment. (Table 3)

DISCUSSION

Body composition

Bodyweight is the basic index to evaluate the degree of obesity of a person. It is mainly composed of the quality of various tissues and organs of the human body. Bodyweight includes lean body mass and fat mass. Lean body mass mainly includes the weight of bones and muscles. Changes in fat and muscle content mainly cause changes in body weight in adulthood. So, there are two reasons for being overweight. Excessive first energy intake causes increased body fat synthesis, and fat accumulation causes overweight.[8] The increase in the second muscle content causes weight gain. Body fat percentage and fat weight are indicators to evaluate the degree of obesity and health risk. Body fat percentage

Table 1. Body composition changes.

		Aerobic exercise + 4 groups of anaerobic exercise	Aerobic exercise + 6 groups of anaerobic exercise
Weight (kg)	Before	71.88±14.33	66.25±7.14
	After	72.21±15.30	65.15±6.16
Fat (kg)	Before	25.44±7.12	23.60±4.63
	After	25.88±8.09	22.38±3.40
Lean body weight (kg)	Before	46.44±8.55	42.65±4.19
	After	46.34±8.02	42.77±4.34
Protein (kg)	Before	9.11±1.65	8.35±0.84
	After	9.13±1.62	8.40±0.87
Mineral content (kg)	Before	3.41±0.610	3.11±0.31
	After	3.41±0.56	3.13±0.32
Skeletal muscle mass (kg)	Before	43.58±8.06	40.05±3.93
	After	43.49±7.56	40.15±4.08

Table 2. Measured values of physiological function indexes in the peaceful state before and after the experiment.

		Aerobic + 4 groups of anaerobic	Aerobic + 6 groups of anaerobic
Heart rate (1/min)	Before	92.50±7.84	91.30±12.58
	After	92.75±9.59	86.30±9.96
Respiratory efficiency	Before	33.14±4.39	33.44±3.19
	After	32.90±2.39	33.00±2.98
Respiratory rate (1/min)	Before	17.51±3.58	18.54±3.36
	After	19.28±2.22	19.41±4.08
Ventilation volume per serving (l/min)	Before	9.84±2.28	10.53±1.34
	After	10.08±2.42	9.99±2.69
Maximum oxygen uptake (ml/min/kg)	Before	4.00±0.54	4.70±0.68
	After	3.36±1.33	4.40±1.17
Basal metabolic rate (g/h)	Before	16.63±4.84	17.00±2.50
	After	18.00±4.57	17.40±5.52
%Carbohydrate	Before	47.13±28.11	43.10±18.13
	After	66.88±12.11	55.90±23.53

Table 3. Maximum oxygen uptake test exhaustion time.

		Aerobic + 4 groups of anaerobic	Aerobic + 6 groups of anaerobic
Exhaustion time (min)	Before	19.18±4.82	15.33±2.78
	After	20.40±2.23	20.67±2.00

is the percentage of fat weight to body mass, and fat weight is the sum of the mass of human adipose tissue. Therefore, body fat percentage is a better indicator of the degree of obesity.

Before the experimental intervention, there was no significant difference in various body composition indicators between the two groups. The first possibility is that there is no dietary intervention for the subjects. The subjects took in excessive energy according to the habit after exercise or took more energy after exercise than usual and did not reach a negative energy balance. Therefore, there is no significant difference in body composition indicators before and after the intervention.

The second possibility is that the number of weeks of exercise intervention is relatively short. Six weeks of exercise could not cause significant changes in the subjects' body composition indicators. Studies have shown that aerobic exercise can control the synthesis of fat and promote the metabolism of fat in the body as an energy source to be consumed by muscle tissue to reduce fat. However, there is still no clear conclusion about the minimum number of weeks that should be intervened to achieve the effect of reducing fat. Therefore, if the number of weeks of exercise intervention is extended, the subjects' body composition indicators may have more significant changes.

The impact of athletic performance

During the experiment, we selected the subjects' resting heart rate, basal metabolic rate, and maximum oxygen uptake exhaustion time as indicators for judging the subjects' exercise performance. Resting heart rate refers to the number of heart beats per minute in an awake, inactive, and quiet state. Changes in heart rate are affected by many factors. Obesity leads to an increase in resting heart rate, and a faster heartbeat rate increases the risk of cardiovascular disease. Studies have shown that certain exercise interventions will reduce the resting heart rate and increase the maximum heart rate during exercise.

On the one hand, long-term exercise can increase the contraction strength of the ventricle, the ventricular cavity will increase correspondingly, and the stroke volume will increase, which will cause the heart rate to slow down accordingly. On the other hand, the heartbeat frequency is regulated by the sympathetic nerve and the vague nerve. Exercise will cause the sympathetic nerve to weaken, and the vague nerve will strengthen, and the resting heart rate will drop.

The basal metabolic rate refers to the energy metabolism rate when the human body is not affected by muscle activity, environmental temperature, food, and mental stress in being awake and extremely quiet. The basal metabolic rate is affected by factors such as surface area, age, and gender. Studies had shown that the basal metabolic rate before and after exercise intervention in the two groups increased significantly. The carbohydrate energy supply percentage increased significantly ($p<0.05$), and the fat energy supply percentage did not change significantly. Because the daily dietary intake of carbohydrates is too much and cannot be completely consumed, carbohydrates are converted into fat and stored in the body. The increase in basal metabolic rate will increase the daily consumption of obese people. The basic energy supply increases the ratio of carbohydrate energy supply and cooperates with regular and appropriate exercise to help reduce fat.

The maximum oxygen uptake refers to the amount of oxygen that the body can take in when the body is unable to continue to support the next exercise when the body is doing the highest intensity exercise. Maximum oxygen uptake is the most common and effective method for evaluating aerobic capacity. Maximum oxygen uptake is affected by factors such as age, gender, and genetics. Studies have shown that the heritability of maximum oxygen uptake is 93.4%. The relative VO2 uptake difference before and after the experiment was not significant ($p>0.05$), but there was significant in the exhaustion time between the two groups before and after the experiment ($p<0.05$).

CONCLUSION

The 6-week aerobic exercise intervention in this experiment has no significant difference in the effect of fat reduction. Aerobic exercise can effectively improve cardiorespiratory endurance. The longer it is, the more effective it is for improving cardiorespiratory endurance.

The author declare no potential conflict of interest related to this article

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