EFFECT OF SPORTS MEDICINE ON REDUCING BODY FAT PERCENTAGE AND LEAN BODY MASS

O EFEITO DA MEDICINA DO ESPORTE NA REDUÇÃO DA PORCENTAGEM DE GORDURA CORPORAL E DA MASSA MAGRA CORPORAL

EL EFECTO DE LA MEDICINA DEL DEPORTE EN LA REDUCCIÓN DEL PORCENTAJE DE GRASA CORPORAL Y MASA MAGRA CORPORAL

ORIGINAL ARTICLE
ARTIGO ORIGINAL
ARTÍCULO ORIGINAL

Chunyan Fan[1]
(Physical Education Professional)

1. Taiyuan University of Technology, Shanxi, China.

Correspondence
Chunyan Fan
Shanxi, China, 030000.
fanchunyan0283@126.com

ABSTRACT

Introduction: Aerobic exercise has begun to be widely recognized as a reasonable means of preventing fat and losing weight. Scholars have confirmed that sports can help the human body lose weight and lose fat. Objective: This article measures the exercise performance indicators of subjects in different body fat percentage groups and studies the relationship between body fat percentage and exercise performance indicators. Methods: The study uses experimental methods to determine the percentage of body fat of the subjects. After physical exercise and aerobic exercise, the volunteers were tested for aerobic capacity indicators. Results: The body fat percentage of physically inactive persons was negatively correlated with aerobic and anaerobic exercise capacity indexes. Conclusion: The mechanism of aerobic exercise in weight loss treatment has the effect of promoting lipolysis and regulating blood lipid metabolism. At the same time, it has a significant influence on the number and activity of fat cells. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Sports; Obesity; Fat body; High-intensity interval training.

RESUMO

Introdução: O exercício aeróbico tem sido amplamente reconhecido como uma maneira racional de prevenir a gordura e perder peso. Pesquisadores confirmam que o esporte pode ajudar o corpo humano a perder peso e gordura. Objetivo: Este artigo mede indicadores de desempenho em exercícios praticados por indivíduos em grupos de porcentagem de gordura corporal diferentes e estuda a relação entre a porcentagem de gordura corporal e indicadores de desempenho em exercícios. Métodos: O estudo usa métodos experimentais para determinar a porcentagem de gordura corporal dos indivíduos. Após o exercício físico e aeróbico, os voluntários foram testados para indicadores de capacidade aeróbica. Resultados: A porcentagem de gordura corporal de pessoas fisicamente inativas está negativamente correlacionada aos índices de capacidade de exercícios aeróbico e anaeróbico. Conclusão: O mecanismo de exercícios aeróbicos no tratamento de perda de peso promove a lipólise e regula o metabolismo lipídico sanguíneo. Concomitantemente, influencia significativamente o número e a atividade de células gordurosas. ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

Descritores: *Esporte; obesidade; gordura corporal; treinamento de intervalo de alta intensidade.*

RESUMEN

Introducción: El ejercicio aeróbico ha sido ampliamente reconocido como una manera racional de prevenir la grasa y perder peso. Investigadores confirman que el deporte puede ayudar el cuerpo humano a perder peso y grasa. Objetivo: Este artículo mide indicadores de rendimiento en ejercicios practicados por individuos en grupos de porcentaje de grasa corporal e indicadores de rendimiento en ejercicios. Métodos: El estudio usa métodos experimentales para determinar el porcentaje de grasa corporal de los individuos. Tras el ejercicio físico y aeróbico, se testó los voluntarios para indicadores de capacidad aeróbica. Resultados: El porcentaje de grasa corporal de personas físicamente inactivas está negativamente correlacionado a los índices de capacidad de ejercicios aeróbico y anaeróbico. Conclusión: El mecanismo de ejercicios aeróbicos en el tratamiento de pérdida de peso promueve la lipolisis y regula el metabolismo lipídico sanguíneo. Simultáneamente, influencia significativamente el número y la actividad de células grasas. ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: *Deporte; Obesidad; Grasa corporal; Entrenamiento en intervalos de alta intensidad.*

DOI: http://dx.doi.org/10.1590/1517-8692202127072021_0337 Article received on 07/29/2021 accepted on 08/18/2021

INTRODUCTION

Among the many ways to lose weight, aerobic exercise is a reasonable way to lose weight. Exercise is the key to ensuring effective and safe weight loss, which is determined by exercise intensity and exercise duration. Exercise intensity is the main factor that determines the degree of fat oxidation and decomposition during exercise and guarantees that the weight loss person may bear it under health conditions. However, many weight loss failures in many exercise weight loss practices are related to improper control of weight loss exercise intensity or exercise duration.[1] Because aerobic exercise below the anaerobic threshold intensity is an effective way to lose weight through exercise, different individuals have different anaerobic thresholds. The individual differences in weight loss tolerance to exercise intensity make exercise weight loss programs vary from person to person. This article studies the relationship between body fat percentage and exercise performance index by measuring the exercise performance index of subjects in different body fat percentage groups.[2] We hope that this research can provide the experimental basis for exploring scientific exercise weight-loss theory and formulating a scientific exercise weight-loss plan.

METHOD

Research object

We selected 51 adult girls aged 19-22 as the subjects of this study. After measuring the subjects' height, weight, body fat percentage, and other indicators, the samples were divided into the low group (body fat percentage <19%), middle group (20% <body fat percentage <25%), and the high group (Body fat percentage> 25%). There are 17 people in each group. The subjects are all healthy people without metabolic and cardiovascular diseases. They have not received professional sports training. (Table 1)

Research methods

Test indicators and methods of the body's aerobic metabolism

The test indicators of the body's gas metabolism level include relative maximum oxygen uptake (S.VO2max), carbon dioxide production (VCO2), oxygen consumption (VO2), and respiratory quotient (RQ).

Anaerobic threshold-related indicators include lactate anaerobic threshold speed (Km/h), lactate anaerobic threshold heart rate (HRAT), lactate anaerobic threshold maximum oxygen uptake utilization rate (%VO2max).

We use a treadmill to perform an incremental load exercise experiment and use the MAX-II gas metabolism analyzer to collect breathing gas during exercise. At the same time, we collected fingertip blood dry heparin anticoagulation capillary immediately after each level of load exercise to take 50-100ul of whole blood and measure blood lactic acid.[3] We use the interpolation formula to find the relevant indicators of the corresponding lactate threshold: lactate anaerobic threshold speed (Km/h), lactate anaerobic threshold heart rate (HRAT), lactate anaerobic threshold maximum oxygen uptake utilization rate (%VO2max).

Test indicators and methods of the body's anaerobic metabolism

We use the classic 30s test method. The subjects did full pedaling on the Monark 834 power bicycle after preparation activities and recorded the riding speed and heart rate every 5 seconds.[4] The resistance is 75% of the subject's body weight, and the test indicators include maximum anaerobic power (PP) and average anaerobic power (AP).

Table 1. The basic situation of the experimental subjects.

Group	Low group	Middle group	High group
Number of cases	17	17	17
age)	19.9±0.9	19.5±0.8	19.7±0.8
Height (cm)	160.0±6.6	160.9±5.2	161.3±5.1
Weight (kg)	49.8±4.9	54.3±7.9	61.7±14.4
Resting heart rate (times/min)	80.5±10.1	77.3±8.9	79.5±10.3
Systolic blood pressure (mmHg)	93.9±6.2	93.3±9.6	101.8±14.3
Diastolic blood pressure (mmHg)	63.8±6.8	61.1±5.5	66.7±8.6
Waist circumference (cm)	69.0±4.5	73.2±5.9	80.4±11.3
Hip circumference (cm)	86.7±3.5	91.1±5.8	95.5±6.8
Body fat percentage	16.2±1.3	22.7±1.1	31.4±6.9

Test methods for the primary conditions of subjects

We use established methods to determine the percentage of body fat. We use the skinfold forceps method to take the sum of the skinfold thickness at the midpoint of the outer upper arm and the subscapular corner to calculate the body density and body fat percentage.

Difference equation model of weight change

Usually, when the energy conservation in the body is broken, it will cause a change in body weight. People gain weight by absorbing calories through diet and converting them into fats. In addition, calories consumed by metabolism and exercise cause weight loss.[5] The daily weight loss is not easy to exceed 0.2kg. The calorie absorbed per day should not be less than 1500kcal. Record the bodyweight on an nth day as $w(n)$ kg, and the calorie absorbed on an nth day as $c(n)$ kcal. Then the weight gain caused by the absorbed heat is $ac(n)$ kg. The weight loss caused by normal metabolism is $\beta w(n)$kg. The weight loss caused by exercise is $\gamma w(n)$kg. We get the differential equation model of weight change as:

$$w(n-1) = w(n) + ac(n+1) - (\beta + \gamma)w(n) \quad (1)$$

The heat conversion coefficient $a = 1/800$ is a constant. The metabolic coefficient β varies from person to person. The exercise consumption coefficient γ is related to exercise form and exercise time. This method is suitable for people who have no time to participate in sports. To achieve weight loss, diet control reduces the number of calories absorbed to achieve the effect of weight loss. Then (1) $\gamma = 0$ in the formula.[6] The weight loss model is:

$$w(n+1) = w(n) + ac(n-1) - \beta w(n) \quad (2)$$

First, in the first stage, a diet method is adopted to reduce the number of calories absorbed every day to the safe lower limit $c_{mic} = 1500kcal$. So that the weight is reduced to 60kg. Then (2) can be simplified as:

$$w(n+1) = (1-\beta)w(n) + ac_{mic} \quad (3)$$

Where $c_{mic} = 1500kcal$ is a constant. Suppose the weight can be reduced to 60kg after n days. According to (3) formula:

$$\begin{aligned} w(n) &= (1-\beta)^n w(0) + ac_{mic}[1 + (1-\beta) + \cdots - (1-\beta)^{n-1}] \\ &= (1-\beta)^n [w(0) - ac_{mic}/\beta] + ac_{mic}/\beta \end{aligned} \quad (4)$$

Then substitute $w(D) = 80, w(n) = 60, a = \frac{1}{8000}, \beta = \frac{25}{6400}, c_{mic} = 1500$ into:

$$\begin{aligned} 60 &= (1 - \frac{25}{6400})^n [80 - \frac{1}{8000} \times 1500 \times \frac{6400}{25}] + \frac{1}{8000} \times 1500 \times \frac{6400}{25} \\ 60 &= (1 - \frac{25}{6400})^n [80 - 48] + 48 \end{aligned} \quad (5)$$

Since the number of weight loss days n is an integer, $n = 251$ can be obtained by solving equation (4). The lady's weight can be reduced to 60kg after 251 days when the lower limit $c_{mic} = 1500kcal$ of calories absorbed per day is kept safe.

Mathematical Statistics

We use the SPSS11.5 statistical software package and Microsoft Excel 2010 software to analyze the obtained data. The results are expressed as mean ± standard deviation. P<0.05 indicates a significant difference, and P<0.01 indicates a very significant difference.

RESULTS

Correlation between aerobic and anaerobic indicators and body fat percentage (Table 2)

It can be seen from Table 2 that there is a significant negative correlation between the anaerobic capacity index selected in the experiment and the percentage of body fat. The correlation coefficients were -0.445 and -0.621, respectively, P<0.01. This suggests a close correlation between anaerobic power and body fat percentage, and high body fat components have constituted a non-negligible reason for the reduction of anaerobic power.[7] As the degree of obesity increases, both aerobic exercise capacity and anaerobic exercise capacity will gradually decline. High body fat composition is the limiting factor of the body's exercise capacity.

Comparison of aerobic capacity indicators between groups with different body fat percentages

Table 3 shows that the oxygen threshold is related to body fat composition. There are significant differences in the corresponding %VO2max, HRAT, and lactate threshold velocity among the three experimental subjects. The decreasing trend as the body fat percentage value increases indicates decreased aerobic capacity.[8] This suggests that the higher the body fat percentage, the lower the lactic acid anaerobic threshold and the lower the lactic acid anaerobic threshold intensity.

Comparison of anaerobic capacity indexes between different body fat percentage groups

It can be seen from Table 4 that the average anaerobic power has a significant difference between the high body fat percentage group and the low body fat group, while the difference in the maximum anaerobic power index among the three groups is not significant. However, in the average anaerobic power index with a significant difference, the average value of the low group is only slightly larger than the average value of the high group.[9] Considering that under the premise that the subjects' overall exercise ability is at a low level, the low body fat percentage group has relatively more vital anaerobic exercise ability.

Table 2. Correlation between the subjects' exercise ability index and body fat percentage.

	Body fat%	
Index	r	P
PP (W/kg)	-0.445	0.001
AP (W/kg)	-0.621	0.001
%VO2max	-0.322	0.026
HRAT (times/min)	-0.44	0.001
Lactic acid threshold speed (km/h)	-0.411	0.003
S.VO2max (ml/kg/min)	-0.101	0.497

Table 3. Comparison of aerobic capacity indicators between different body fat percentage groups.

Group	n	%VO2max	HRAT	Lactate threshold velocity	S.VO2max
Low group	17	66.13±11.33	160.82±15.16	6.68±1.10	34.88±4.70
Middle group	17	55.88±14.11	150.53±17.11	5.87±1.47	32.88±4.44
High group	17	50.91±12.26	141.76±18.15	5.41±1.16	34.02±3.68

Table 4. Comparison of anaerobic capacity indexes between different body fat percentage groups.

Group	Number of cases	Maximum anaerobic power (PP)	Average anaerobic power (AP)
Low group	17	6.80±0.83	5.66±0.58
Middle group	17	6.62±0.95	5.19±0.62
High group	17	6.20±0.83	4.83±0.82*

Changes in respiratory quotient in different body fat percentage groups during incremental exercise

As a reminder indicator of the oxidation of the three major energy-supplying substances during exercise, the respiratory quotient is of great significance.[10] When the respiratory quotient is 1.0, it indicates that 100% of the energy comes from carbohydrates. A respiratory quotient of 0.7 indicates that 100% of energy comes from fat burning. A respiratory quotient of 0.85 indicates that the energy supply is derived from carbohydrates and fats. It can be seen from Table 5 that the respiratory quotient change trend of the three groups in the incremental exercise load gradually increased.

Table 5. Respiratory Quotient Statistics of Different Body Fat Percentage Groups in Increasing Load Exercise.

Group	Exercise load				
	Before exercise	Load 1	Second load	3rd load	Load 4
Low group	0.80±0.05	0.88±0.07	0.92±0.07	0.96±0.07	0.98±0.07
Middle group	0.77±0.06	0.84±0.05	0.89±0.06	0.94±0.07	0.97±0.08
High group	0.79±0.06	0.86±0.08	0.93±0.09	0.97±0.09	0.97±0.09

DISCUSSION

Exercise intensity is usually expressed in maximum oxygen uptake utilization rate or maximum heart rate utilization rate. Increased blood lactic acid levels after strenuous exercise inhibit lipolysis.[11] The rate of release of fatty acids into the blood and the oxidation rate is the highest during exercise at this intensity. During moderate-intensity exercise (65% VO2max), fat oxidation accounts for the highest energy supply ratio. When the exercise intensity reached 85% VO2max, the total fat oxidation decreased, and the rate of fatty acid entering the blood also decreased significantly. The utilization of intramuscular triglycerides did not increase. In this case, the breakdown of muscle glycogen and the increase of lactic acid inhibit the breakdown of fat in the body. Based on the above discussion, the proportion of fatty acid oxidation energy in total energy consumption is relatively high when exercising at rest or low. With the increase of exercise intensity, the oxidation rate of fatty acid is restricted when the VO2max exceeds 70% to 80%, and the energy supply material mainly changes from fat to sugar. Only moderate and low-intensity exercise can be accepted and persisted by obese people.

CONCLUSION

The body fat percentage of physically inactive persons is negatively correlated with aerobic and anaerobic exercise capacity indexes. As the degree of obesity increases, both aerobic exercise capacity and anaerobic exercise capacity of the body will gradually decline. High body fat composition is the limiting factor of the body's exercise capacity.

ACKNOWLEDGMENT

Philosophy and Social Science Planning Project of Shanxi Province, Exploration and Practice of Sports and Medical Integration of Healthy Shanxi Philosophy and Social Science Planning Project of Shanxi Province, 2019B043.

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

AUTHORS' CONTRIBUTIONS: This paper is independently completed by the author, Chunyan Fan: data analysis and article writing.

REFERENCES

1. An KH, Han KA, Sohn TS, Park IB, Kim HJ, Moon SD, et al. Body Fat Is Related to Sedentary Behavior and Light Physical Activity but Not to Moderate-Vigorous Physical Activity in Type 2 Diabetes Mellitus. Diabetes Metab J. 2020;44(2):316-25. doi: https://doi.org/10.4093/dmj.2019.0029.
2. Wittels P, Mansfield L. Weight stigma, fat pedagogy and rediscovering the pleasures of movement: Experiencing physical activity and fatness in a public health weight management programme. Qualitative Research in Sport, Exercise and Health. 2021;13(2);342-59.
3. Bombak AE, Meadows A, Billette J. Fat acceptance 101: Midwestern American women's perspective on cultural body acceptance. Health Sociology Review. 2019;28(2);194-208.
4. Fukuoka Y, Narita T, Fujita H, Morii T, Sato T, Sassa MH, Yamada Y. Importance of physical evaluation using skeletal muscle mass index and body fat percentage to prevent sarcopenia in elderly Japanese diabetes patients. J Diabetes Investig. 2019;10(2):322-30. doi: https://doi.org/10.1111/jdi.12908.
5. Budiono I, Rahayu T, Kurnia AR. Use of "Nutriatlet" smartphone application-based personalized nutrition program to improve energy consumption, body mass index, and body fat percentage among martial arts athletes. The Journal of Physical Fitness and Sports Medicine. 2019;8(1); 29-35.
6. Norman ME, Moola FJ. The weight of (the) matter: A new material feminist account of thin and fat oppressions. Health (London). 2019;23(5):497-515. doi: https://doi.org/10.1177/1363459317724856
7. Cameron L. The "good fatty" is a dancing fatty: Fat archetypes in reality television. Fat Studies. 2019;8(3);259-78.
8. Dondzilo L, Rieger E, Jayawardena N, Bell J. Drive for thinness versus fear of fat: approach and avoidance motivation regarding thin and non-thin images in women. Cognitive Therapy and Research. 2019;43(3);585-93.
9. Hagovska M, Švihra J, Buková A, Dračková D, Horbacz A, Nagyová I. Effect of an exercise programme for reducing abdominal fat on overactive bladder symptoms in young overweight women. Int Urogynecol J. 2020;31(5);895-902.
10. Gholinejad PM, Hojjati H, Ghorbani S. The effect of aerobic exercise on body composition and muscle strength of female students at elementary schools of Ali Abad Katoul in 2018. Int J Sch Health. 2019;6(4);27-33. doi: https://doi.org/10.30476/intjsh.2019.45892.
11. Farahnak Z, Yuan Y, Vanstone CA, Weiler HA. Maternal and neonatal red blood cell n-3 polyunsaturated fatty acids inversely associate with infant whole-body fat mass assessed by dual-energy X-ray absorptiometry. Appl Physiol Nutr Metab. 2020;45(3):318-26. doi: https://doi.org/10.1139/apnm-2019-0311.