

ANALYSIS OF CARDIOPULMONARY RESISTANCE UNDER DIFFERENT LOADS IN AEROBIC EXERCISES




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ANÁLISE DA RESISTÊNCIA CARDIOPULMONAR SOB DIFERENTES CARGAS EM EXERCÍCIOS AERÓBICOS

ANÁLISIS DE LA RESISTENCIA CARDIOPULMONAR BAJO DIFERENTES CARGAS EN EJERCICIOS AERÓBICOS

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ABSTRACT

Introduction: The key objective of aerobic exercise is enhancing cardiorespiratory endurance. On the national gymnastics plan implementation, the idea of lifelong sports was gradually accepted by the masses, and the aerobic gymnastics concept was sweeping the world. **Objective:** Analyze the cardiorespiratory endurance responses in female college students under different frequencies in aerobic exercise. **Methods:** 20 female professors and civilian women were randomly selected and divided into two groups. The experimental group performed 45 and 90 minutes of aerobic exercise to analyze changes in cardiopulmonary function before and after each exercise. **Results:** After 16 weeks of aerobic exercise with different loads, all young women who had participated in the program training showed a significant increase in vital capacity and maximal oxygen uptake capacity. The vital capacity of the 90-min aerobic exercise group was significantly higher than that of the 45-min aerobic exercise group ($P < 0.05$). **Conclusion:** The establishment of a cardiorespiratory endurance response model can accurately analyze the effects of different aerobic exercise frequencies on cardiorespiratory endurance. **Evidence Level II; Therapeutic Studies – Investigating the results.**

Keywords: Aerobic Exercise; Exercise Test, Cardiopulmonary; Physical Endurance.

RESUMO

Introdução: O principal objetivo do exercício aeróbico é melhorar a resistência cardiorrespiratória. Com a implementação do plano nacional de ginástica, a ideia de esportes para toda a vida é gradualmente aceita pelas massas e o conceito de ginástica aeróbica está popularizando-se. **Objetivo:** Analisar as respostas de resistência cardiorrespiratória em estudantes universitárias sob distintas frequências no exercício aeróbico. **Métodos:** 20 jovens professoras e mulheres civis foram aleatoriamente selecionadas e divididas em dois grupos. O grupo experimental executou exercícios aeróbicos de 45 e 90 minutos, sob análise das alterações na função cardiopulmonar antes e depois de cada exercício. **Resultados:** Após 16 semanas de exercício aeróbico com diferentes cargas, todas as mulheres jovens que participaram do treinamento mostraram um aumento significativo na capacidade vital e na capacidade máxima de absorção de oxigênio. A capacidade vital do grupo de exercícios aeróbicos de 90 minutos foi significativamente maior do que a do grupo de exercícios aeróbicos de 45 minutos ($P < 0,05$). **Conclusão:** O estabelecimento de um modelo de resposta de resistência cardiorrespiratória pode analisar com precisão os efeitos de diferentes frequências de exercício aeróbico sobre a resistência cardiorrespiratória. **Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.**

Descritores: Exercício Aeróbico; Teste Cardiopulmonar de Exercício; Resistência Física.

RESUMEN

Introducción: El objetivo principal del ejercicio aeróbico es mejorar la resistencia cardiorrespiratoria. Con la puesta en marcha del plan nacional de gimnasia, la idea de los deportes de por vida es gradualmente aceptada por las masas y el concepto de la gimnasia aeróbica está popularizándose en todo el mundo. **Objetivo:** Analizar las respuestas de resistencia cardiorrespiratoria en estudiantes universitarias bajo diferentes frecuencias en el ejercicio aeróbico. **Métodos:** Se seleccionaron al azar 20 profesoras jóvenes y mujeres civiles y se dividieron en dos grupos. El grupo experimental realizó ejercicios aeróbicos de 45 y 90 minutos, bajo el análisis de los cambios en la función cardiopulmonar antes y después de cada ejercicio. **Resultados:** Tras 16 semanas de ejercicio aeróbico con diferentes cargas, todas las mujeres jóvenes que participaron en el entrenamiento mostraron un aumento significativo de la capacidad vital y de la capacidad máxima de captación de oxígeno. La capacidad vital del grupo de ejercicio aeróbico de 90 minutos fue significativamente mayor que la del grupo de ejercicio aeróbico de 45 minutos ($P < 0,05$). **Conclusión:** El establecimiento de un modelo de respuesta a la resistencia cardiorrespiratoria puede analizar con precisión los efectos de diferentes frecuencias de ejercicio aeróbico sobre la resistencia cardiorrespiratoria. **Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.**

Descriptor: Ejercicio Aeróbico; Prueba de Esfuerzo Cardiopulmonar; Resistencia Física.



INTRODUCTION

Aerobic exercise has become a fashionable fitness exercise. Therefore, it is of positive significance to explore the impact of aerobic exercise on body shape, composition and cardiopulmonary function. A large number of studies show that aerobic exercise can effectively improve various functions of the body. However, with the implementation of the national fitness plan, the idea of lifelong sports is gradually accepted by the masses, and the concept of aerobic fitness is sweeping the world. Aerobic exercise is the physical exercise carried out by the human body under the condition of sufficient oxygen.¹ In the process of exercise, the oxygen inhaled by the human body and the oxygen required by the human body are required to be balanced, and the aerobic exercise time is longer, about more than 30 minutes, the exercise intensity is large, and the maximum heart rate value is between 60% and 80%.² In order to comprehensively and systematically study the effects of aerobic exercise on body shape, body composition and cardiopulmonary function of female college students, this paper measured and studied the body shape, body composition and cardiopulmonary function of female college students who participated in aerobic exercise. The purpose is to understand the influence of aerobic exercise on body shape, composition and cardiopulmonary function of female college students, and to elaborate the role of aerobic exercise in shaping body-building, so as to provide effective theoretical and practical basis for scientific aerobic fitness training.^{3,4}

METHOD

Research object

20 young female teachers and civilian women in a fitness club, aged 22 ~ 26 years, with a weight controlled at (50 ± 5) kg, who had no formal exercise history before participating in this experiment, were randomly divided into two groups. They participated in aerobic aerobics training for 45 min and 90 min each time, and did not participate in any other physical exercise in the experimental room. The basic information of the two subjects is shown in Table 1. Before the experiment, the basic physical conditions (age, height and weight) of the two groups of subjects were highly similar, and statistical analysis showed no significant difference ($P < 0.05$), indicating that this study was carried out on the basis of the same conditions, so this study has high reliability and validity.⁵

Research methods

Exercise plan the aerobic exercise time of the two groups is as follows:

- 90 min fitness group: warm-up for 15 min, body building for 25 min, aerobic exercise for 35 min, finishing for 15 min
- 45 min fitness group: warm up 7 5 min 12 5 min aerobic exercise 17 5 min finishing 7 5 min

The two fitness groups exercise three times a week, and the exercise intensity is strictly controlled between with heart rate.

Test index quiet heart rate (HR); Vital capacity (VC); Blanche heart work index (BI)

1. Quiet heart rate (HR): let the subject sit still (or stay in bed) for more than 10 minutes before measurement to maintain emotional stability and quiet surrounding environment. The tester sits in front of the subject, places the stethoscope in the subject's precordial area or apex for auscultation, and calculates the number of heart beats in 1 min.⁶

Table 1. List of basic conditions of subjects.

group	number of people	age	height	weight
45 min Fitness Exercise Group	10	23.93±1.05	50.46±1.90	161.42±2.14
90 min Fitness Exercise Group	10	23.93±1.08	50.73±2.03	161.16±2.29

2. Vital capacity (VC): it is the total amount of air that the human body inhales deeply and exhales as much as possible. During the measurement, the subject stood facing the vital capacity (VC) meter. First take one or two deep breaths, then take a breath, and then exhale as much as possible until you can't exhale again. Measure 3 times and take the maximum value. Keep your body upright when exhaling. Don't bend down and breathe. The blowing nozzle for measuring vital capacity (VC) shall be disinfected, and only one person is allowed to use one blowing nozzle.

3. Blanche cardiac work index (BI): let the subject sit quietly for 15min, and measure the heart rate and blood pressure for 1min.

The calculation formula is as follows:

• Evaluation criteria: Blanche cardiac work index (BI) in the range of 110-160 is normal cardiovascular function (mean value is 140) 1.2.3 data processing adopts SPSS11.0 statistical analysis software, paired t-test analysis of independent samples within and between groups before and after the experiment was carried out for three kinds of indexes: quiet heart rate (HR), vital capacity (VC) and Blanche cardiac function index (BI). $P < 0.05$ was the significant difference, and $P < 0.01$ was the very significant difference.⁷

RESULTS

Comparison of cardiopulmonary function indexes before and after the experiment in the 45 min aerobic exercise group

The results showed that before and after 16 weeks of aerobic exercise, the quiet heart rate (HR) and Blanche heart function index (BI) of 45 min aerobic exercise group decreased to a certain extent, but there was no significant difference ($P > 0.05$). The vital capacity (VC) after the experiment was significantly higher than that before the experiment ($P < 0.05$). (Table 2)

Comparison of cardiopulmonary function indexes before and after 90 min aerobic exercise group

The experimental results showed that the quiet heart rate (HR) and Blanche heart function index (BI) of the 90 min aerobic exercise group decreased to a certain extent after the experiment compared with those before the experiment, but there was no significant difference ($P > 0.05$), and the vital capacity (VC) increased significantly compared with those before the experiment ($P < 0.05$).^{8,9} (Table 3)

Comparison of cardiopulmonary function indexes between 45 min aerobic exercise group and 90 min aerobic exercise group after the experiment

After the experiment, the comparison of cardiopulmonary function indexes between 45 min aerobics group and 90 min aerobics

Table 2. Comparison of indexes before and after the experiment in the 45 min aerobics group.

Indicator classification	name of index	45 min Aerobic Fitness Group	
		Prior to the experiment	After the experiment
Heart and lung indicators	Quiet HR	80.20±2.39	76.20±2.62
	vital capacity	3 018.90±107.81	3 149.20±164.96
	Heart power index	142.07±6.43	138.52±6.57

Table 3. Comparison of indexes before and after the experiment in the 45 min aerobics group.

Indicator classification	name of index	90 min Aerobic Fitness Group	
		Prior to the experiment	After the experiment
Heart and lung indicators	Quiet HR	81.00±3.46	75.40±3.40
	vital capacity	2995.30±149.38	3183.60±158.71
	Heart power index	148.30±7.56	139.49±5.59

group showed that the decrease of quiet heart rate (HR) and Blanche heart function index (BI) in 45 min aerobics group was lower than that in 90 min aerobics group, and the increase of vital capacity (VC) in 45 min aerobics group was also lower than that in 90 min aerobics group, but there was no significant difference ($P > 0.05$). This study showed that after 16 weeks of aerobic exercise with different exercise loads, the quiet heart rate of young female desk workers showed a downward trend. The quiet heart rate (HR) of the 90 min fitness group was lower than that of the 45 min fitness group, and the decline was also higher than that of the 45 Min fitness group, but there was no significant difference ($P > 0.05$), It is speculated that the heart function may be enhanced to a certain extent after 90 minutes of aerobic exercise, indicating that its potential is increased and the heart reserve capacity has been improved to a certain extent. (Table 4)

Table 4. Comparison of cardiopulmonary function indexes between 45 min aerobic exercise group and 90 min aerobic exercise group after the experiment.

Indicator classification	name of index	45minGroup (n=10)	90minGroup (n=10)
Heart and lung indicators	Quiet HR	76.20±2.62	75.40±3.40
	vital capacity	3149.20±164.96	3183.60±158.71
	Heart power index	138.52±6.57	139.49±5.59

DISCUSSION

Modeling index analysis

Aerobic exercise has many effects on human body. Aerobic exercise is one of the main ways of fitness at present. Long term aerobic exercise can effectively improve cardiovascular function.¹⁰ Specific analysis is carried out as follows:

Aerobic exercise is also called metabolic exercise, mainly through the inhalation and exhalation of oxygen. The metabolic level function of human body is given by using the following formula:

$$\omega_i = \frac{1 - S_i}{\sum_{i=1}^m (1 - S_i)} \quad (1)$$

Where S_i represents the exercise cycle, i represents the i -th subject, and m represents the respiratory rate.

It can be seen from the above formula that with the increase of human metabolic level, the human body's demand for blood and oxygen will gradually increase. At this time, the human heart will also accelerate. The relationship between blood and oxygen supply in the human body is expressed as follows:

$$N(k) = \frac{\omega_i \cdot X_i(KD)}{n} \quad (2)$$

Where, X_i represents tissue energy consumption, (KD) represents the highest value of oxygen consumption, and n represents vital capacity index.

Modeling of cardiopulmonary endurance response under different frequency aerobic exercise

The cardiopulmonary tester is used to collect the data of the subjects. The stable heart rate 15 minutes before exercise, the instantaneous heart rate before exercise and the heart rate 5 minutes after exercise

are collected respectively. The model is established according to the collection results, namely:

$$K = \frac{d}{n} \quad (3)$$

Where, d represents the normal heart rate of the subject and n represents the vital capacity index.

Assuming that y_i represents the blood pressure during normal activity and y_j represents the blood pressure during recovery under unit exercise frequency, the relationship between the two is given by using the following formula:

$$1 = y_i - \hat{y}_j \quad (4)$$

According to the blood pressure during exercise and the blood pressure in recovery cycle, the increase range of blood pressure is calculated as follows:

$$S = \sum_{j=1}^i (y_i - \hat{y}_j)^2 \quad (5)$$

The change range of blood pressure before and after exercise is calculated by the following formula:

$$F = \frac{(y_i - \hat{y}_j)}{S/(m' - n' - 1)} \quad (6)$$

Where, m' represents the blood pressure 10 min after exercise, and n' represents the peak blood pressure.

In conclusion, the modeling of cardiopulmonary endurance response under aerobic exercise with different frequencies is completed. By analyzing the above data, it can be seen that long-term aerobic exercise can effectively improve people's physical quality and effectively help patients with different diseases, as shown in Figure 1.

CONCLUSION

The calculation results of the proposed model are basically consistent with the actual results, and the difference between the two results is small, which fully proves the effectiveness and practicability of the proposed model, and the accuracy of the proposed model is high. The current cardiopulmonary endurance response model can not accurately

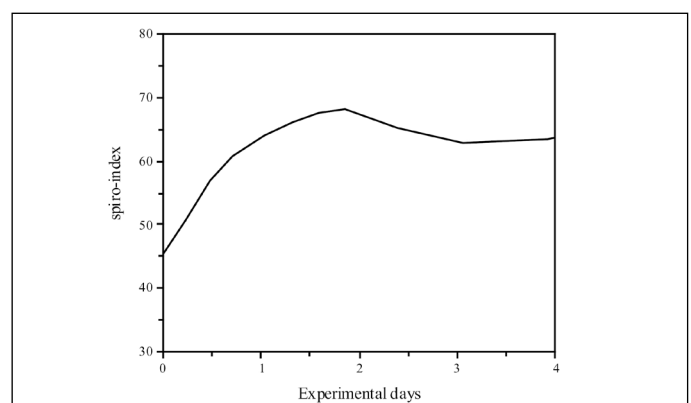


Figure 1. Change curve of vital capacity index under different frequencies.

calculate the subject's vital capacity index and heart rate recovery rate. Therefore, a cardiopulmonary endurance response model of aerobic exercise at different frequencies based on meta-analysis is proposed. The experimental results show that the proposed model can accurately

analyze the effects of different frequencies of aerobic exercise on cardiopulmonary endurance.

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