ANALYSIS OF THE CARDIOPULMONARY ENDURANCE RESPONSE OF WOMEN TO AEROBIC EXERCISE

ANÁLISE DA RESPOSTA DE RESISTÊNCIA CARDIOPULMONAR DE MULHERES AO EXERCÍCIO AERÓBICO

ANÁLISIS DE LA RESPUESTA DE RESISTENCIA CARDIOPULMONAR DE LAS MUJERES AL EJERCICIO AERÓBICO

Original Article
Artigo Original
Artículo Original

Hua Tian[1]
(Physical Education Professional)

1. Hebi Polytechnic, Hebi, China.

Correspence:
Hua Tian Hebi, China, 458030.
HuaTian376@163.com

ABSTRACT

Introduction: The main purpose of aerobic exercise is to enhance cardiopulmonary endurance, so it is necessary to build cardiopulmonary endurance response models based on different frequencies of aerobic exercise. Objective: To study the cardiopulmonary endurance response of women to different frequencies of aerobic exercise. Methods: Twenty young female desk workers (female teachers and civil servants) who worked out at a fitness club were randomly divided into two groups. Cardiopulmonary function, both before and after 16 weeks of aerobic exercise at different exercise loads, was studied and analyzed. Results: After 16 weeks of aerobic exercise at different exercise loads, all the young women had significantly improved their vital capacity (VC), and their maximum oxygen uptake ability was improved to a certain extent. Compared with the 45-minute aerobic exercise group, the vital capacity (VC) of 90-minute aerobic exercise group was significantly increased (P>0.05). Conclusions: When performed at a consistent frequency level, aerobic exercise with a relatively high exercise load can better develop the body's respiratory system function. This may be due to deep stimulation of the respiratory system from high-load aerobic exercise, and ultimately to the intensive exercising of lung function. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Exercise; Cardiopulmonary bypass; Analyses.

RESUMO

Introdução: O principal objetivo do exercício aeróbico é aumentar a resistência cardiopulmonar, por isso é necessário construir modelos de resposta de resistência cardiopulmonar baseados em diferentes frequências de exercício aeróbico. Objetivo: Estudar a resposta de resistência cardiopulmonar de mulheres em diferentes frequências de exercício aeróbio. Métodos: Vinte jovens profissionais de escritório (professoras e funcionárias públicas) que frequentavam uma academia foram divididas randomicamente em dois grupos. A função cardiopulmonar foi estudada e analisada antes e depois de 16 semanas de exercício aeróbico com diferentes cargas de exercício. Resultados: Depois de 16 semanas de exercícios aeróbicos com diferentes cargas, todas as jovens tiveram melhora significativa da capacidade vital (CV), sendo que a capacidade máxima de captação de oxigênio melhorou até certo ponto. Comparada com o grupo de exercícios aeróbicos de 45 minutos, a capacidade vital (CV) do grupo de exercícios aeróbicos de 90 minutos foi significativamente maior (P > 0,05). Conclusões: Quando praticado com frequência regular, o exercício aeróbico com carga relativamente alta pode melhorar o desenvolvimento da função respiratória. Isso pode dever-se à estimulação profunda do sistema respiratório a partir de exercícios aeróbicos de alta carga e, em última instância, é devido ao exercício intensivo da função pulmonar. ***Nível de Evidência II; Estudos terapêuticos - Investigação dos resultados do tratamento.***

Descritores: *Exercício; Ponte cardiopulmonar; Análises.*

RESUMEN

Introducción: El principal objetivo del ejercicio aeróbico es aumentar la resistencia cardiopulmonar, por lo que es necesario desarrollar modelos de respuesta de resistencia cardiopulmonar basados en diferentes frecuencias de ejercicio aeróbico. Objetivo: Estudiar la respuesta de resistencia cardiopulmonar de mujeres a diferentes frecuencias de ejercicio aeróbico. Métodos: Veinte jóvenes profesionales de oficina (profesoras y funcionarias públicas) que asistían a un gimnasio fueron divididas aleatoriamente en dos grupos. Se estudió y analizó la función cardiopulmonar antes y después de 16 semanas de ejercicio aeróbico con diferentes cargas de ejercicio. Resultados: Después de 16 semanas de ejercicio aeróbico con diferentes cargas, todas las mujeres jóvenes presentaron una mejora significativa de la capacidad vital (CV), siendo que la capacidad máxima de captación de oxígeno mejoró en cierta medida. En comparación con el grupo de ejercicio aeróbico de 45 minutos, la capacidad vital (CV) del grupo de ejercicio aeróbico de 90 minutos fue significativamente mayor (P > 0,05). Conclusiones: Cuando se practica con una frecuencia regular, el ejercicio aeróbico con una carga relativamente alta puede mejorar el desarrollo de la función respiratoria. Ello puede deberse a la profunda estimulación del sistema respiratorio por el ejercicio aeróbico de alta carga y, en última instancia, al ejercicio intensivo de la función pulmonar. ***Nivel de Evidencia II; Estudios terapéuticos - Investigación de los resultados del tratamiento.***

Descriptores: *Ejercicio; Puente cardiopulmonar. Análisis.*

DOI: http://dx.doi.org/10.1590/1517-8692202228012021_0447 Article received on 11/03/2021 accepted on 11/09/2021

INTRODUCTION

With the progress and development of society, the way of production and life in modern society, while bringing great benefits to human beings, has also brought some negative factors and adverse effects to human health and development, modern civilization disease and sports deficiency have become common social phenomena.[1] However, with the implementation of the national fitness plan, the idea of physical education is gradually accepted by the masses, and the idea of aerobic fitness is sweeping the world.[2] The physical exercise carried out by the human body under the condition of sufficient oxygen is aerobic exercise. In the process of exercise, the oxygen inhaled by the body is required to be balanced with the oxygen needed by the body, and the duration of aerobic exercise is longer, for more than 30 minutes, the exercise intensity is high, and the maximum heart rate is between 60% and 80% . Aerobic exercise has the following characteristics: (1) Exercise intensity is low; (3) It has a certain rhythm[3] (3) Longer duration; (4) Effectively eliminate fat in the body; (5) Enhance the cardiopulmonary function of human body; (6) Can effectively adjust people's mental state and state of mind, is an important way of current fitness.[4] Through regular aerobic exercise, the human body can effectively enhance the function of the heart, and the oxygen supply capacity of the human body will be correspondingly enhanced.[5] People with better cardiopulmonary function can participate in longer aerobic exercise and exercise recovery is faster, aerobic aerobics is an effective form of aerobic exercise based on fitness, organic combination of body posture in the rhythm of music accompaniment, integration of physical training, dance, music as one of the body exercises. It can cultivate women's aesthetic ability, edify their sentiment and regulate their mental health, which is also the purpose of the implementation of the national fitness program.[6]

METHOD

Research Objects

Twenty young female teachers and civil servants in a health club participated in aerobic aerobics exercise, aged from 22 to 26 years old, with the weight controlled at (50±5) kg, they had no formal exercise history before participating in this experiment, and were randomly divided into two groups, which participated in aerobic aerobics training for 45 min and 90 min respectively, and did not participate in any other physical exercise during the experiment. The basic information of the two subjects is shown in Table 1. Before the experiment, the basic physical conditions (age, height and weight) of subjects in the two groups were highly similar, and statistical analysis showed no significant difference (P <0.05), it indicates that this study is carried out on the basis of the same conditions, so this study has high reliability and validity.[7]

Research Methods

1. Exercise Program The aerobic exercise schedule of the two groups is as follows:

90 min fitness group: warm up for 15 min, exercise for 25 min, aerobics for 35 min and trim for 15 min

45 min fitness group: warm up 7. 5 min physique 12. 5 min aerobic exercise 17

Table 1. Basic conditions of experimental 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

The two fitness groups exercised three times a week, with the intensity of exercise strictly controlled between (220 - age) x 60% ~ 80% and heart rate.

2. Test indicators quiet heart rate (HR); Lung capacity (VC); Blanche cardiac work index (BI)

Quiet heart rate (HR) : Subjects should sit still (or lie in bed) for more than 10 minutes before measurement, keep their mood stable and the surrounding environment quiet. The tester sat in front of the subject, placed the stethoscope in the precardiac region or apex of the heart of the subject for auscultation, and counted the number of heart beats in 1 min.

RESULTS

The test results showed that before the experiment, there was no significant difference in cardiopulmonary function indexes between the two groups (P>0.05), and all cardiopulmonary function indexes were at the same level, indicating that the two groups were basically the same on the basis of different exercise loads of aerobic aerobics exercise.[8-10] This provides a good platform for the comparison and analysis of the data before and after the experiment and the comparison and evaluation of the exercise effect between the two aerobic aerobics groups.

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

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

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

The results showed that the resting heart rate (HR) and Branch cardiac work index (BI) of the 90 min aerobics group decreased to a certain extent after the experiment compared with before, however, there was no significant difference (P>0.05), and the vital capacity (VC) was significantly increased compared with before experiment (P<0.05). (Table 3)

Comparison of cardiac and pulmonary function indexes between 45 min aerobics group and 90 min aerobics group after experiment

The data showed that the cardiowork index of the 45 min fitness group was lower than that of the 90 min fitness group, however, this does not mean that the meaning of the blanche cardio work index rating indicates a range between 110 and 160(normal), with a low score indicating better

Table 2. Comparison of indicators before and after 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 indicators before and after 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

cardiovascular function. The improvement of cardiovascular function in the 90 min aerobic exercise group was better than that in the 45 min aerobic exercise group, because the cardiowork index was not at the same level in the early stage of the experiment, blanche cardiac function index decreased significantly in the 90 min aerobics group than that in the 45 min aerobics group, indicating that aerobics with relatively high exercise load can improve the level of cardiovascular function more significantly. (Table 4)

Table 4. Comparison of cardiac and pulmonary function indexes between 45 min aerobics group and 90 min aerobics group after the experiment.

Indicator classification	name of index	45 min Group (n=10)	90 min Group (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 is also known as metabolic exercise, which mainly aims at inhaling and exhaling oxygen, the metabolic level function of human body is given by the following formula:

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

Where, S_i represents the period of motion, i is subject i, and m is respiration rate.

As can be seen from the above formula, with the increase of human metabolism, the demand for blood and oxygen will gradually increase, and the human heart rate will also accelerate, so the relationship between blood and oxygen supply in human body can be expressed as follows:

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

Where, X_i represents energy consumption of the organization, (KD) is maximum oxygen, n is vital capacity index.

Cardiopulmonary endurance response modeling at different frequencies of aerobic exercise

The cardiopulmonary tester was used to collect data of the subjects, the subjects' steady heart rate 15 minutes before exercise, instantaneous heart rate before exercise and heart rate 5 minutes after exercise were collected respectively, and modeling was conducted according to the collection results, namely

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

Where, d represents the subjects' normal heart rate and n represents vital capacity index.

Suppose, y_i represents the blood pressure during normal activity, and $\hat{y}_{ij}$ represents the blood pressure during recovery of subjects at unit exercise frequency. The relationship between the two is given by the following formula:

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

Based on blood pressure during exercise and blood pressure during recovery cycle, the increase of blood pressure was calculated as follows:

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

The variation range of blood pressure before and after exercise was calculated by the following formula:

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

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

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

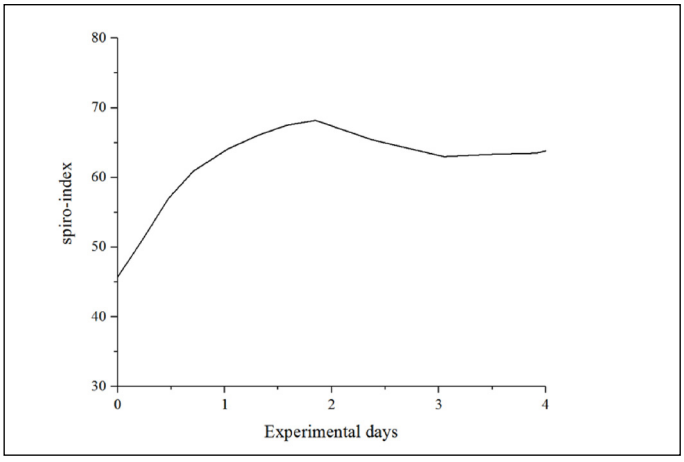

Figure 1. The change of FEVI% in the experimental group before and after exercise intervention.

CONCLUSION

Current cardiopulmonary endurance response model cannot accurately calculate the vital capacity index and heart rate recovery rate of subjects. Therefore, a cardiopulmonary endurance response model based on Mate analysis was proposed for aerobic exercise at different frequencies. The experimental results show that the proposed model can accurately analyze the effect of different frequencies of aerobic exercise on cardiopulmonary endurance.

ACKNOWLEDGMENT

Key research and development and promotion special project (soft science research) of Henan Province in 2021, Project No.: 212400410246.

AUTHORS' CONTRIBUTIONS: The author made significant contributions to this manuscript. Hua Tian: writing and performing surgeries; data analysis and performing surgeries; article review and intellectual concept of the article.

REFERENCES

1. Armstrong HF, Bartels MN, Paslavski O, Cain D, Shoval HA, Ballon JS, et al. The impact of aerobic exercise training on cardiopulmonary functioning in individuals with schizophrenia. Schizophrenia Research. 2016; 173(1-2): 116-17.
2. Bourdon A, Grandy SA, Keats M R. Aerobic exercise and cardiopulmonary fitness in childhood cancer survivors treated with a cardiotoxic agent: a meta-analysis. Supportive Care in Cancer.2018; 26(7):2113-23.
3. Dereppe H, Forton K, Pauwen NY, Faoro V. Impact of bariatric surgery on women aerobic exercise capacity. Obesity Surgery.2019; 29(7):1-8.
4. Kabiri S, Halabchi F, Angoorani H, Yekaninejad S. P-29comparison of three modes of aerobic exercise combined with resistance training on the pain and function of patients with knee osteoarthritis: a randomised controlled trial. British Journal of Sports Medicine. 2018; 50(Suppl 1): A47.1-A47.
5. Gaspard D, Kass J, Akers S, Hunter K, Pratter M. Patient-reported dyspnea correlates poorly with aerobic exercise capacity measured during cardiopulmonary exercise testing. Lung. 2017; 195(5):613-17.
6. Bucci R, Koutris M, Lobbezoo F, Michelotti A. Occlusal sensitivity in individuals with different frequencies of oral parafunction. The Journal of Prosthetic Dentistry. 2019; 122(2): 119-22.
7. Yu C, H Xu, Liu C, Wang Q, Zhang X. Modeling and analysis of common-mode resonance in multi--parallel pv string inverters. IEEE Transactions on Energy Conversion.2019; 34(1):446-54.
8. Yang M, Guo S, Y Chen, Dai Q, Li H, Yang J. Chimera states with coherent domains owning different frequencies in a ring of nonlocally coupled brusselators. Nonlinear Dynamics. 2021;104(3):2843-52.
9. Garcia R, Carrasco JA, Espí JM, Dede EJ, Castelló J. Modeling and simulation of non linear magnetic coresat high frequencies using pspice. Epe Journal;2015: 11(2), 13-22.
10. Ghisu T, Puddu P, Cambuli F. Numerical analysis of a wells turbine at different non-dimensional piston frequencies. Journal of Thermal Science. 2015; 06(v.24):35-43.