ADAPTATION OF CARDIORESPIRATORY ENDURANCE IN OBESE PEOPLE BY AEROBIC EXERCISE

ADAPTAÇÃO DA RESISTÊNCIA CARDIORRESPIRATÓRIA DE PESSOAS OBESAS POR EXERCÍCIO AERÓBICO

ADAPTACIÓN DE LA RESISTENCIA CARDIORRESPIRATORIA PERSONAS OBESAS MEDIANTE EJERCICIO AERÓBICO

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ABSTRACT

Introduction: Obesity is a critical pathogenic factor of hypertension and hyperlipidemia in metabolic syndrome and an independent risk factor of cardiovascular disease leading to low cardiorespiratory endurance. Objective: Explore the changes in cardiorespiratory endurance adaptation on obese subjects caused by aerobic exercise. Methods: A cardiorespiratory exercise model was proposed for obese people under different optimizations based on critical variables and cluster analysis. This model analyzes the relationship between exercise and cardiorespiratory endurance in obese people, extracts the cardiorespiratory endurance index characteristics of obese people under different exercise levels, and clusters their different index characteristics. Results: The difference between the heart rate of the proposed model and the actual heart rate is 0.11, the difference between the heart rate of the model and the actual heart rate is 4.28, and the difference between the heart rate of the model and the actual heart rate is 2.84, and the accuracy of the proposed model is the highest. Conclusion: The model proposed in this paper can accurately analyze the effects of different aerobic exercise frequencies on cardiorespiratory endurance. ***Evidence Level II; Therapeutic Studies - Investigating the result.***

Keywords: Exercise; Obesity; Endurance Training.

RESUMO

Introdução: A obesidade não é apenas um fator patogênico chave da hipertensão e da hiperlipidemia na síndrome metabólica, mas também um fator de risco independente de doença cardiovascular que leva a baixa resistência cardiorrespiratória. Objetivo: Explorar as alterações na adaptação da resistência cardiorrespiratória em obesos causadas pelo exercício aeróbico. Métodos: Foi proposto um modelo de exercício cardiorrespiratório para pessoas obesas sob diferentes otimizações com base em variáveis-chave e análise de agrupamento. O modelo analisa a relação entre o exercício e a resistência cardiorrespiratória de pessoas obesas, extrai as características do índice de resistência cardiorrespiratória de pessoas obesas sob diferentes níveis de exercício e agrupa suas diferentes características de índice. Resultados: A diferença entre a frequência cardíaca do modelo proposto e a frequência cardíaca real é de 0,11, a diferença entre a frequência cardíaca do modelo e a frequência cardíaca real é de 4,28, e a diferença entre a frequência cardíaca do modelo e a frequência cardíaca real é de 2,84, e a precisão do modelo proposto é a mais alta. Conclusão: O modelo proposto neste trabalho pode analisar com precisão os efeitos de diferentes frequências de exercícios aeróbicos sobre a resistência cardiorrespiratória. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Exercício Físico; Obesidade; Treino Aeróbico.*

RESUMEN

Introducción: La obesidad no sólo es un factor patogénico clave de la hipertensión y la hiperlipidemia en el síndrome metabólico, sino también un factor de riesgo independiente de enfermedad cardiovascular que conduce a una baja resistencia cardiorrespiratoria. Objetivo: Explorar los cambios en la adaptación de la resistencia cardiorrespiratoria en sujetos obesos provocados por el ejercicio aeróbico. Métodos: Se propuso un modelo de ejercicio cardiorrespiratorio para personas obesas bajo diferentes optimizaciones basadas en variables-clave y en el análisis de grupos. El modelo analiza la relación entre el ejercicio y la resistencia cardiorrespiratoria en las personas obesas, extrae las características del índice de resistencia cardiorrespiratoria de las personas obesas bajo diferentes niveles de ejercicio y agrupa sus diferentes características del índice. Resultados: La diferencia entre la frecuencia cardíaca del modelo propuesto y la frecuencia cardíaca real es de 0,11, la diferencia entre la frecuencia cardíaca del modelo y la frecuencia cardíaca real es de 4,28, y la diferencia entre la frecuencia cardíaca del modelo y la frecuencia cardíaca real es de 2,84, y la precisión del modelo propuesto es la más alta. Conclusión: El modelo propuesto en este trabajo puede analizar con precisión los efectos de diferentes frecuencias de ejercicio aeróbico en la resistencia cardiorrespiratoria. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Ejercicio Físico; Obesidad; Entrenamiento Aeróbico.*

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INTRODUCTION

To model the cardiorespiratory endurance of obese people under different exercise optimizations, the best exercise form to improve the cardiorespiratory endurance of obese people can be chosen. When modeling cardiopulmonary endurance, it is necessary to analyze the correlation between cardiopulmonary endurance, physical activity, and obesity under different exercise optimization conditions, and use the analysis results to extract the characteristics of the impact of exercise on the cardiopulmonary endurance of obese people.[1] The traditional method uses least squares support vector machine to perform translation processing on the cardiopulmonary endurance feature type, and uses the attribute specification principle of rough set to establish the cardiopulmonary endurance model of obese people. It is impossible to obtain the characteristics of the influence of exercise on the cardiopulmonary endurance of obese people and cannot be optimized for different sports. Under the influence of obese people's cardiopulmonary endurance to model, there is a problem of large modeling errors. A cardiopulmonary endurance model for obese people under different exercise optimization with supervised feature selection is proposed.[2] The above model firstly counts the current obesity status and physical fitness differences of obese people, gives the obese people's adjustable cardiopulmonary risk factors, and calculates the correlation between cardiopulmonary endurance, physical activity, and obesity. Integrating with the supervised feature selection theory, exercise is divided into different stages, given that different exercise stages can improve the cardiopulmonary endurance characteristics of obese people, obtain possible mechanisms for exercise to improve cardiopulmonary endurance, calculate the cardiopulmonary endurance response characteristics of obese people at different stages of exercise, and establish a cardiopulmonary endurance model for obese people under different exercise optimization.[3] The simulation results prove that the improved model can effectively calculate the cardiopulmonary endurance response of obese people under different exercise levels.

METHOD

With the rapid development of medical technology, there are currently many indicators that can accurately reflect a person's cardiorespiratory capacity, but the most common one is using human body's maximum oxygen uptake as an important indicator for evaluating cardiorespiratory endurance. Under normal conditions, the maximum oxygen uptake is expressed in absolute and relative values. The two are called absolute maximum oxygen uptake and relative maximum oxygen uptake. The units are L/min and ml/kg/min. Because people are different from person to person, there will be a relatively large difference between the height and weight of each individual. In order to prove the effectiveness of the proposed model of obesity and population cardiopulmonary endurance under different exercise optimization based on supervised feature selection, an experiment is needed.[4] In the Matlab environment, a simulation platform for modeling the cardiopulmonary endurance of obese people under different exercise optimizations was built. The age range is 18 to 48 years old, and the exercise training and testing of different stages for nearly 3 months are carried out. Through centralized resident training and unified management, the participants' cardiopulmonary endurance response of obese people under the exercise level at different exercise levels every day experiment. Relative maximum oxygen uptake can effectively eliminate the influence of body weight, and can more accurately reflect a person's maximum oxygen uptake when comparing individuals. Using a cardiopulmonary tester to collect data from the subjects, the subjects' stable heart rate 15 minutes before exercise, the instantaneous heart rate before exercise, and the heart rate 5 minutes after the end of exercise were collected. Modeling is based on the collected results, namely:

$$K = \frac{d}{n} \qquad \text{Formula (1)}$$

In formula (1), d represents the subject's normal heart rate, and n represents the vital capacity index. Assuming that y represents the blood pressure during normal activities, r represents the blood pressure of the subject during the recovery period per unit exercise frequency, and the relationship between the two is given by the following formula:

$$1 = y_i - y_j \qquad \text{Formula (2)}$$

According to the cardiorespiratory endurance of different subjects, the following is the exercise frequency corresponding to the irregular exercise:

$$N = \frac{y_i - y_j}{b} \qquad \text{Formula (3)}$$

1. Long-term exercise can effectively improve myocardial blood supply and myocardial function.
2. Aerobic exercise can effectively transport and use human cells to grapes.
3. Long-term exercise can promote the decomposition of adrenaline and fat.
4. Long-term exercise can effectively reduce blood pressure, improve heart function, and thereby improve kidney function. The blood vessels in the human body are very elastic. In order to promote the smooth flow of blood, the inner walls of the blood vessels are very soft. However, with the increase of age, the lipids in the human body will continue to erode the blood vessels, causing the elasticity of the arteries to become worse and worse, even die. Participating in appropriate physical exercise can effectively improve liver cirrhosis. The relationship between exercise frequency and lipids is expressed as:

$$g = \frac{u}{b} \qquad \text{Formula (4)}$$

In formula (4), u represents the subject's body's ability to absorb fat and exercise to lower blood pressure. The mechanism can be effectively applied to the cerebral cortex and the subcortical vascular motor center to improve the state of higher blood pressure, namely:

$$g^n = \frac{u(1 - S_i)}{h} \qquad \text{Formula (5)}$$

In summary, the cardiopulmonary endurance response modeling under different frequencies of aerobic exercise has been completed. Analysis of the above data shows that long-term aerobic exercise can effectively improve people's physical fitness and can effectively help patients with different diseases. In order to verify the comprehensive validity of the cardiopulmonary endurance response model of different frequencies of aerobic exercise based on Mate analysis, experiments are needed. Among them, aerobic exercise (running) is mainly used as the main training method, and the training is set for 1 hour per day. Since the heart rate recovery rate and vital capacity index play a decisive role in the cardiorespiratory health of the subjects, in the experiment, the heart rate recovery rate and vital capacity index are used as independent variables, and the maximum oxygen uptake is used as the dependent variable. Before the experiment, the average heart rate recovery rate of all students was 42%, and the range of vital capacity was [40.6mL/kg, 60.5mL/kg]. After the experiment started, the heart rate at different frequencies and the actual change result of vital capacity index in Figure 1 and Figure 2 was used. Analyzing Figure 1 and Figure 2, it can be seen that the average heart rate range of subjects at different frequencies is [141beat/min, 157.beat/min], and the average vital capacity index range is [45mL/kg, 69mL/kg].

Analysis of Figure 3 shows that the heart rate changes of the proposed model are basically consistent with the actual results. The other two models fluctuate greatly from the actual results. When the experimental days are 4 days, the heart rate of the proposed model is 154 beat/min,

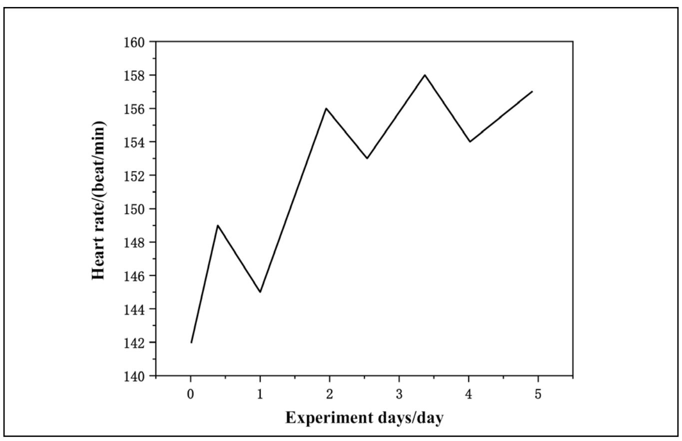

Figure 1. Heart rate curve at different frequencies.

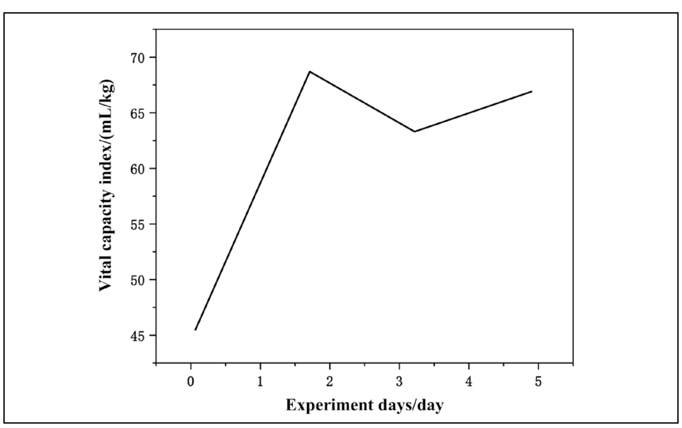

Figure 2. Vital capacity index change curve at different frequencies.

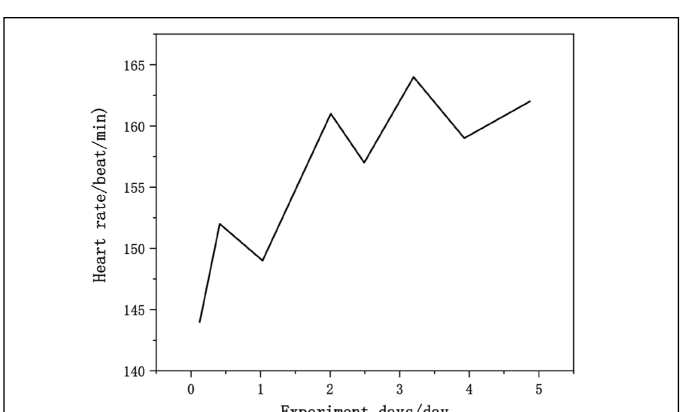

Figure 3. Comparison of the results of heart rate changes in different methods.

the heart rate of the model is 164 beat/min, the heart rate of the model is 164 beat/min, and the actual heart rate is 153 beat/min. Through comparison, it can be seen that the error between the heart rate of the proposed model and the actual result is the smallest, which fully proves the high accuracy of the proposed model.[5,6]

RESULTS

The cardiopulmonary endurance response experiments under different frequencies of aerobic exercise were performed using the proposed models. The average heart rate of the three models was compared with the actual results. The comparison results are shown in Table 1. In Table 1, AS stands for different models, A stands for the proposed model, and DS stands for data difference.

Analysis of Table 1 shows that the heart rate of the proposed model differs from the actual heart rate by 0.11, the model's heart rate differs from the actual heart rate by 4.27, and the model's heart rate differs from the actual heart rate by 2.83. The proposed model has the highest accuracy.[7] The proposed model is used for different frequencies. In the cardiorespiratory endurance reaction experiment under aerobic exercise, the average vital capacity index of the three models was compared with the actual results. The comparison results are shown in Table 2.

Table 1. Comparison of differences between different variables.

AS	DS
A	0.11
B	4.27
C	2.83

Table 2. Comparison results of average vital capacity index of different methods.

QA/t	XS/(mL/kg)	A	B	C
1	52.4	52	50	48
2	65.3	65.3	60	57
3	61.6	61.3	58.5	58
4	62.7	62.4	58.3	55.6

DISCUSSION

It can be seen from Table 2 that the vital capacity index of the proposed model is close to the actual results, and the other two models have large deviations from the actual results. It can be seen that the accuracy of the proposed model is higher. In summary, 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.[8] The current cardiopulmonary endurance response model cannot accurately calculate the vital capacity index and heart rate recovery rate of subjects. For this reason, a cardiopulmonary endurance response model of different frequencies of aerobic exercise based on Mate analysis is proposed. Experimental results show that the proposed model can accurately analyze the effects of different frequencies of aerobic exercise on cardiorespiratory endurance.[9-10]

CONCLUSION

A cardiopulmonary endurance model for obese people under different exercise optimization based on principal component and cluster analysis is proposed. The model first analyzes the relationship between exercise and the cardiopulmonary endurance of obese people, extracts the cardiopulmonary endurance index characteristics of obese people at different exercise levels, and clusters their different index characteristics. Based on this analysis theory, a cardiopulmonary endurance model for obese people under different exercise optimizations was established.

The model is relatively simple, but there is a problem of large limitations of the model. A cardiopulmonary endurance model for obese people under different exercise optimization based on support vector machine is proposed. The model first adds the translation processing of feature types based on the weighted least squares support vector machine, which solves the problem of feature sparseness and uneven sample height when the obese people's cardiopulmonary endurance response features during exercise phase. It is based on the attributes of rough sets. According to the principle of the protocol, a model of cardiopulmonary endurance for obese people under different exercise optimizations is established. The model has strong scalability. However, with the current model, it is impossible to obtain the characteristics of the influence of exercise on the cardiorespiratory endurance of obese people, and there is a problem of large modeling errors. A model of cardiopulmonary endurance for obese people under different exercise optimization based on genetic neural network is proposed. The model combines genetic theory and neural network theory, uses the input layer and hidden layer of genetic neural network to map the relationship between different exercise stages and the cardiopulmonary endurance of obese people, and builds a cardiopulmonary endurance model for obese people under different exercise optimizations. This model has high modeling accuracy, but it has the problem of cumbersome and time-consuming statistical process.

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REFERENCES

1. Aoike DT, Baria F, Kamimura MA, Ammirati A, Cuppari L. Home-based versus center-based aerobic exercise on cardiopulmonary performance, physical function, quality of life and quality of sleep of overweight patients with chronic kidney disease. Clinical and Experimental Nephrology. 2017;22(1):1-12.
2. Askari J, Saberi-Kakhki A, Taheri H, Yassini SM. The Effect of Aerobic Exercise on Different Symptoms of Depression: An Investigation of Psychological Mechanisms of Stress and Coping. Open Journal of Medical Psychology. 2017;6(2):86-102.
3. Lee CJ, Kim TW. Effects of cardiopulmonary exercise intensity on FGF-21 expression and FFA levels. Korean Journal of Sports Science. 2017;26(6):1073-80.
4. Amorim H, Rui C, Parada F, Rocha A. Progression of aerobic exercise intensity in a cardiac rehabilitation program. Revista Portuguesa de Cardiologia (English Edition). 2019;38(4):281-6.
5. Ramos AE, Claire L, Estephan LE, Tai YY, Tang Y, Zhao J et al. Specific circulating microRNAs display dose-dependent responses to variable intensity and duration of endurance exercise. Ajp Heart & Circulatory Physiology. 2018;315(2):H273-83.
6. Weyer S, Meyer T, Ohmer M, Gorecky D, Zühlke D. Future Modeling and Simulation of CPS-based Factories: an Example from the Automotive Industry. IFAC-PapersOnLine. 2016;49(31):97-102.
7. Ho JP, Alison JA, Ng LWC, Wootton SL, McKeough ZJ, Jenkins SC et al. People With COPD Who Respond to Ground-Based Walking Training Are Characterized by Lower Pre-training Exercise Capacity and Better Lung Function and Have Greater Progression in Walking Training Distance. Journal of Cardiopulmonary Rehabilitation and Prevention. 2019;39(5):338-43.
8. Berzal LF. Simulation modeling and analysis (5th ed.). Computing reviews. 2017;58(8):449-50.
9. Fakhimi M, Mustafee N, Stergioulas LK. An investigation into modeling and simulation approaches for sustainable operations management. Simulation: Journal of the Society for Computer Simulation. 2016;92(10):907-19.