CARDIOVASCULAR RESPONSE IN MID AND LONG-DISTANCE RUNNERS UNDER TRAINING

RESPOSTA CARDIOVASCULAR EM CORREDORES DE MÉDIA E LONGA DISTÂNCIA SOB TREINAMENTO

RESPUESTA CARDIOVASCULAR EN CORREDORES DE MEDIA Y LARGA DISTANCIA EN ENTRENAMIENTO

Original Article
Artigo Original
Artículo Original

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ABSTRACT

Introduction: Research on the effects of exercise on the cardiovascular system has a long history that has recently been expanded with echocardiography. Research using Doppler echocardiography has been increasing because of the safe and non-invasive method of examination to study cardiac morphology and function. However, few studies on functional cardiac changes in mid and long-distance runners under training are still few. Objective: Study the monitoring of cardiovascular response in middle and long-distance runners during training. Methods: The CFOCS-I cardiovascular function detector was used to observe 24 indices of cardiac pump function, vascular function, and microcirculation in 12 female middle-distance runners. Results: According to the test results, diastolic force, systolic force, systolic function, left ventricular ejection fraction increased during the proposed loading exercise. The mean systolic and mean pulse pressures increased significantly with exercise load (P<0.01). Conclusion: Mid and long-distance runners demonstrated significant cardiac changes in ventricular shape, size, and systolic function, accompanied by significant changes in diastolic function when subjected to intense exercise. ***Evidence Level II; Therapeutic Studies - Investigating the result.***

Keywords: Athletic Performance; Cardiovascular Physiological Phenomena; Cardiorespiratory Fitness; Cardiovascular System.

RESUMO

Introdução: A pesquisa dos efeitos do exercício sobre o sistema cardiovascular tem uma longa história que recentemente foi expandida com o uso da ecocardiografia. Pesquisas utilizando a ecocardiografia por doppler têm crescido devido ao método de exame apresentar-se seguro e não-invasivo para estudo de morfologia e função cardíaca. Porém ainda há poucos estudos sobre as alterações cardíacas funcionais em corredores de média e longa distância sob treinamento. Objetivo: Estudar o monitoramento da resposta cardiovascular nos corredores de média e longa distância durante o treinamento. Métodos: O detector de função cardiovascular CFOCS-I foi usado para observar 24 índices de função da bomba cardíaca, função vascular, e microcirculação em 12 corredoras de média distância do sexo feminino. Resultados: De acordo com os resultados dos testes, a força diastólica, a força sistólica, a função sistólica, a fração de ejeção do ventrículo esquerdo aumentaram durante o exercício de carga proposto. A pressão sistólica média e a pressão de pulso média aumentaram significativamente com a carga de exercício (P<0,01). Conclusão: Os corredores de média e longa distância demonstraram alterações cardíacas significativas no formato, tamanho e função sistólica dos ventrículos, acompanhado por mudanças significativas na função diastólica quando submetidos ao exercício intenso. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Desempenho Atlético; Fenômenos Fisiológicos Cardiovasculares; Aptidão Cardiorrespiratória; Sistema Cardiovascular.*

RESUMEN

Introducción: La investigación sobre los efectos del ejercicio en el sistema cardiovascular tiene una larga historia que se ha ampliado recientemente con el uso de la ecocardiografía. La investigación con ecocardiografía Doppler ha ido en aumento debido a que es un método de examen seguro y no invasivo para estudiar la morfología y la función cardíacas. Sin embargo, todavía hay pocos estudios sobre los cambios funcionales cardíacos en corredores de media y larga distancia bajo entrenamiento. Objetivo: Estudiar el seguimiento de la respuesta cardiovascular en corredores de media y larga distancia durante el entrenamiento. Métodos: Se utilizó el detector de función cardiovascular CFOCS-I para observar 24 índices de la función de la bomba cardíaca, la función vascular y la microcirculación en 12 corredoras de media distancia. Resultados: Según los resultados de la prueba, la fuerza diastólica, la fuerza sistólica, la función sistólica y la fracción de eyección del ventrículo izquierdo aumentaron durante el ejercicio de carga propuesto. La presión sistólica media y la presión de pulso media aumentaron significativamente con la carga de ejercicio (P<0,01). Conclusión: Los corredores de media y larga distancia mostraron cambios cardíacos significativos en la forma, el tamaño y la función sistólica del ventrículo, acompañados de cambios significativos en la función diastólica cuando se sometieron a un ejercicio intenso. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Rendimiento Atlético; Fenómenos Fisiológicos Cardiovasculares; Capacidad Cardiovascular; Sistema Cardiovascular.*

DOI: http://dx.doi.org/10.1590/1517-8692202228052022_0064 Article received on 01/28/2022 accepted on 02/11/2022

INTRODUCTION

Sports training plays a good role in the improvement of human functional ability, and various adaptive changes caused by sports training are one of the important physiological functions of human body.[1] In the middle and long distance running training, the cardiovascular system of athletes is far more than the normal and speed and strength of the athletes. Therefore, the cardiovascular system of middle and long distance runners must undergo corresponding adaptive changes. Evaluation of cardiovascular function has always been an important part of the attention of coaches and athletes' physiology and medical scholars.[2] From the point of view of sports medicine, in a sense, it is more important to observe the synchronous state of cardiac pump function and peripheral circulation. Cardiovascular function and blood circulation are the fundamental factors that determine human metabolism and organ function, and are closely related to the life of the body. Therefore, not only for patients, And for all sorts of solid movement may or we use CFDCS won a national science and technology award for 91 - detector subtype of cardiovascular function and bicycle power meter of middle-distance race athletes in incremental load changes before and after the intermittent movement of cardiovascular function test, trying to provide coaches with the circulation of the blood dynamics of quantitative indicators, Thus, it provides a certain basis for coaches to develop scientific training programs.[3] Studies have shown that Sosnovskyi V V believes that exercise in a hot and humid environment can increase skin blood microcirculation, blood flow of skeletal muscles, blood vessel dilation and cardiac output. Such changes can be realized by increasing heart rate in the early stage of exercise. At the same time, returning blood volume may decrease, leading to a decrease in the filling pressure of the left ventricle, which may lead to a drop in blood pressure.[4] Tokita M argued that hyperthermia induced by continuous full-body exercise, heat stress, or dehydration significantly increases the cardiovascular burden, leading to reduced cardiac output, stroke output, arterial pressure, and blood flow in the brain, skin, and skeletal muscles before exhaustion occurs.[5-6]

METHOD

Research Objects

The subjects were 44 healthy female adolescents, divided into experimental group (group A) and control group (group B). The experimental group consisted of 22 female middle-distance runners from Shaanxi Provincial Sports team and provincial sports school. Their average age was 16.18 (±L.87) years old, their average height was 164.51 (±4.84) cm, their average weight was 53.82 (±3.50) kg, and their average sports years were more than 5 years. The control group consisted of 22 female students in grade one of Xi 'an Yucai Middle School, healthy and without any professional training, with an average age of 16.23 (±0.16) years old, average height of 161.68 (±3.98) cm, and average weight of 53.32(±2.83) kg. All subjects were informed of the method and process of the experiment in advance and agreed to participate voluntarily. (Table 1)

Main experimental instruments

1. Mercury sphygmomanometer and heart sound sensor.
2. Mobility bicycle: used to adjust load and control load. The speed is 60 RPM.

Table 1. General physical conditions of subjects.

Groups	age	height	weight
A	16.18±l.87	164.51±4.84	53.82±3.50
B	16.23+0.16	161.68±3.98	53.32±2.83

Experimental Procedure

The subjects sat on the power bicycle, tied the pulse pressure band for blood pressure measurement to the left arm of the subjects, and asked them to be quiet for 5 minutes. After that, the arterial blood pressure and heart rate of the subjects were measured, and then the load activity began. The load form is incremental load, each load is 20W, 40W, 60W in turn. 80W, 100W and 120W, the load duration of each stage is 5 minutes. Arterial blood pressure and heart rate were measured immediately after the end of each load, and this value represented the value of this load.[7] After the values are taken, the lower loads are carried out.

Measurement of arterial blood pressure

1. Systolic blood pressure (Ps);
2. Diastolic pressure (Pd);
3. Pulse pressure difference (PD);
4. Mean arterial pressure (Pa);

Statistical processing of data

Ibm-pc microcomputer was used for routine statistical processing of all data obtained, and the mean value (X) and standard deviation (S) of statistical indicators were obtained. Then, statistical T-test was performed on relevant statistical indicators between the two groups to determine whether there was a cyanine difference, which was used as a reference for quantitative analysis.[8]

RESULTS

Exercise can cause significant changes in cardiovascular function status. This paper involves four aspects and 20 indicators, which are classified as follows:

Changes in blood pressure

The increase of average systolic blood pressure caused by exercise, with the increase of exercise load, the average systolic blood pressure also rose synchronously, and the difference is very significant before exercise (Figure1), and diastolic blood pressure is gradually decreased, the main exercise load increased to 175W, more than the basic level, the change of average pulse pressure is basically a rising trend.

Changes in cardiac output

Exercise led to a gradual acceleration of heart rate and a significant increase in cardiac output. (Figure 2) Cardiac output began to increase with the increase of load. However, when the load increased to a certain level, cardiac output did not increase, and even decreased, indicating that after exercise to a certain level, the heart mainly increases cardiac output by increasing the heart rate. On the whole, with the elimination of the influence of body weight and height, the cardiac index of athletes increased significantly after exercise, which was consistent with the experimental results of Zhang Juwei et al.[9]

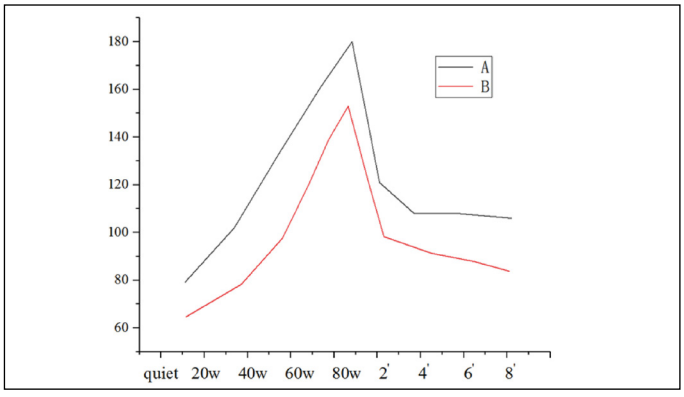

Figure 1. Schematic diagram of blood pressure before and after exercise.

Changes in circulating blood volume

Exercise results in significant changes in circulating blood volume, which is reflected in the major circulation and microcirculation. (Figure 3) With the increase of exercise load, the blood volume of the major circulation gradually decreased from 4160.9ml to 1028.76m1, with a very significant difference (P<0.01). At this time, the decrease of blood volume can be considered as the decrease of total peripheral resistance and the decrease of the average pressure gradient, which leads to the opening of microcirculation. This speeds up the flow of blood to the microcirculation, providing more blood to the tissues.

In the recovery period, the recovery speed of the athletes' pulse pressure difference was obviously faster. At the second minute, the pulse pressure difference of the two groups was close. At the sixth minute, the pulse pressure difference of the two groups formed a third crossover, and the experimental group was lower than the control group. From the 8th minute to the 10th minute, with the recovery of diastolic blood pressure, the pulse pressure difference of the experimental group decreased slowly, while the systolic blood pressure of the control group decreased further due to heart fatigue, thus forming the fourth crossover.

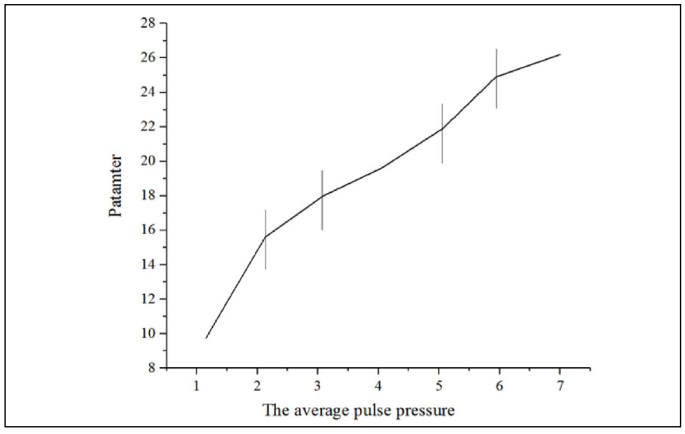

Figure 2. The average pulse pressure.

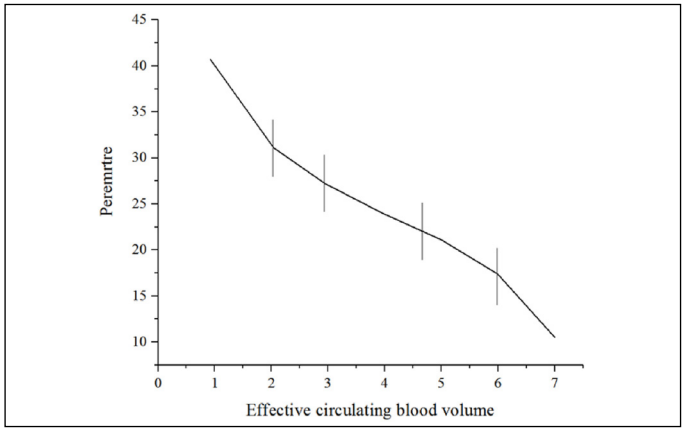

Figure 3. Cardiac index.

DISCUSSION

Although there were negative myocardial hypertrophy and myocardial weight increase during middle and long distance running, the diastolic velocity integral systolic velocity was normal and higher than that in the control group (P<0.05). This indicates that the compliance of ventricular muscle is not affected, and the left ventricle is well filled, which is similar to the results of foreign scholars. In the study of atrial morphology, it was found that the enlargement of left and right atrium was more obvious in the athletes group, which were P<0.05 and P< 0.01 respectively compared with the control group. The results also showed that the incidence of tricuspid and pulmonary valve regurgitation in the athletes group was significantly higher than that in the control group, which may be related to the enlargement of right atrial ventricle and valve ring. In addition, the subendocardial myocardium is more sensitive to hypoxia stimulation during exercise training, especially the subendocardial myocardium of the right ventricle, due to the vascular structure characteristics of the subendocardial myocardium and the work characteristics of myocardial fibers. Long-term hypoxia may cause tricuspid papillary muscle dysfunction, which may lead to tricuspid regurgitation, but the results are similar to those of other studies on exercise hearts, which need to be confirmed by further studies [10]. This study also found that the heart rate of middle and long distance runners at quiet time was significantly lower than that of normal people (P<0.01). Sinus bradycardia is the result of increased vagal tone after training, which is different from sick sinus syndrome because the heart rate can increase rapidly after exercise.

Cardiovascular system is a whole, the effects of all aspects are mutual influence, exercise makes the body in a state of stress, cause the sympathetic adrenal system of excitement and a large amount of phenol amine release. Therefore, the heart rate of athletes increased from 65 beats/min at rest to 135.11 beats/min at 175W load, the average systolic blood pressure increased by 31.3mmHg, the myocardial systolic rate increased by more than three times, the left ventricular end diastolic volume increased and the systolic end space decreased. The cardiac output was 3.4 times higher than the basal level, and the total vascular impedance decreased 2.26 times. The mean pressure gradient was reduced from 9.14 to 4.4, allowing a large amount of blood to flow into the microcirculation. Therefore, the circulating blood volume decreased from 4160.9ml to 1028.76m1, and the blood flow velocity of microcirculation increased nearly ten times. Optimally adjusted blood flow efficiency allows the body to take in more oxygen and nutrients and take away the products of metabolism. In this experiment, the change of "index" was used, excluding the influence of height and weight. This also shows that the training of the subjects is effective to the function of the cardiovascular system, and the cardiovascular system is one of the important physiological basis of the special middle and long distance runners

CONCLUSION

The adaptability of athletes' arterial blood pressure and heart rate to exercise mainly shows the following characteristics: Mean systolic pressure and mean pulse pressure increased significantly with the increase of exercise load (P<0.01). Through the test results of several indicators of cardiac pump, it is shown that the systolic force and cardiac empelling function of stroke power index increase in the experimental load exercise. With the increase of exercise load, heart rate and cardiac output increased successively, and stroke output gradually decreased after 125W, indicating that when exercise load increased to a certain level, the increase of heart rate was mainly dependent on the increase of heart rate. After the increase of exercise load, the decrease of total peripheral resistance and average pressure gradient leads to the opening of microcirculation, which leads to the gradual reduction of the major circulation, which has a very significant difference compared with before exercise.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. YZ: writing and performing surgeries; XH: data analysis and performing surgeries, CX: article review and intellectual concept of the article.

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