CARDIOPULMONARY CAPACITY UNDER ENDURANCE RUNNING TRAINING

CAPACIDADE CARDIOPULMONAR SOB O TREINAMENTO DA CORRIDA DE RESISTÊNCIA

CAPACIDAD CARDIOPULMONAR BAJO ENTRENAMIENTO DE CARRERA DE RESISTENCIA

Original Article
Artigo Original
Artículo Original

Dongtao Lei[1]
(Physical Education Professional)

1. Beijing Institute of Technology Zhuhai, Zhuhai, Guangdong, China.

Correspondence:
Dongtao Lei
Zhuhai, Guangdong, China.
519000.
dongtao20lei@163.com

ABSTRACT

Introduction: Inversely to increasingly rich material life, the physical quality of Chinese people is in a steady decline. The most convenient sport that greatly impacts the cardiopulmonary system is endurance running. It has become a form of mass activity promoting physical fitness. Objective: Explore the relationship between the efficiency of endurance running training and the function of cardiopulmonary capacity. Methods: 320 male and female volunteers were trained in endurance running. The load degree was adjusted according to the endurance running experience by the ergometric treadmill's gradient. The experimental and control group subjects exercised for 30 minutes, and parameters such as resting heart rate, maximum heart rate, and maximum lung capacity were recorded before and after the intervention. Results: Extending the duration of resistance running and its load improves cardiopulmonary capacity. Conclusion: There is a positive correlation between the efficiency of resistance running training and the promotion of cardiopulmonary capacity. Therefore, the appropriate increase of load and duration time of resistance running is beneficial to promote the cardiopulmonary capacity of individuals and improve the overall fitness index of the population. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Running; Exercise Test; Evaluation of the Efficacy-Effectiveness of Interventions.

RESUMO

Introdução: Inversamente a uma vida material cada vez mais rica, a qualidade física das pessoas chinesas encontra-se em um declínio constante. O esporte mais conveniente e com grande impacto no sistema cardiopulmonar é a corrida de resistência. Ela tornou-se uma forma de atividade massiva promotora da aptidão física. Objetivo: Explorar a relação entre a eficiência do treinamento da corrida de resistência física e a função da capacidade cardiopulmonar. Métodos: 320 voluntários masculinos e femininos foram treinados na corrida de resistência. O grau de carga foi ajustado segundo a experiência na corrida de resistência pelo gradiente da esteira ergométrica. Os sujeitos do grupo experimental e controle exercitaram-se durante 30 minutos e parâmetros como a frequência cardíaca em repouso, a frequência cardíaca máxima e a capacidade pulmonar máxima dos sujeitos foram registradas antes e após a intervenção. Resultados: O prolongamento da duração da corrida de resistência e sua carga são benéficos para melhorar o nível de capacidade cardiopulmonar. Conclusão: Há uma correlação positiva entre a eficiência do treinamento da corrida de resistência e a promoção da capacidade cardiopulmonar. Portanto, o aumento adequado da carga e do tempo de duração da corrida de resistência é benéfico para promover a capacidade cardiopulmonar dos indivíduos e melhorar o índice de aptidão física geral da população. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Corrida; Teste de Esforço; Avaliação de Eficácia-Efetividade de Intervenções.*

RESUMEN

Introducción: En contraposición a una vida material cada vez más rica, la calidad física de los chinos está en constante declive. El deporte más conveniente con gran impacto en el sistema cardiopulmonar es la carrera de resistencia. Se ha convertido en una forma de actividad masiva que promueve la aptitud física. Objetivo: Explorar la relación entre la eficacia del entrenamiento de carrera de resistencia y la función de la capacidad cardiopulmonar. Métodos: 320 voluntarios masculinos y femeninos fueron entrenados en carreras de resistencia. El grado de carga se ajustó de acuerdo con la experiencia en la carrera de resistencia mediante el gradiente de la cinta ergométrica. Los sujetos del grupo experimental y del grupo de control hicieron ejercicio durante 30 minutos y se registraron parámetros como la frecuencia cardíaca en reposo, la frecuencia cardíaca máxima y la capacidad pulmonar máxima de los sujetos antes y después de la intervención. Resultados: La prolongación de la duración de la carrera de resistencia y su carga son beneficiosas para mejorar el nivel de capacidad cardiopulmonar. Conclusión: Existe una correlación positiva entre la eficacia del entrenamiento de carrera de resistencia y el fomento de la capacidad cardiopulmonar. Por lo tanto, el aumento adecuado de la carga y el tiempo de duración de la carrera de resistencia es beneficioso para promover la capacidad cardiopulmonar de los individuos y mejorar el índice de aptitud física general de la población. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

***Descriptores*:** *Carrera; Prueba de Esfuerzo; Evaluación de Eficacia-Efectividad de Intervenciones.*

DOI: http://dx.doi.org/10.1590/1517-8692202329012022_0513 Article received on 09/20/2022 accepted on 10/21/2022

INTRODUCTION

In recent years, cardiovascular and cerebrovascular diseases occur frequently. As one of the important factors to evaluate the individual health level, cardiopulmonary capacity has been paid more and more attention by scholars.[1] Many scientific studies have shown that the strength of cardiopulmonary capacity restricts the level of individual activities and is highly related to human mortality.[2] However, the current situation is that with the improvement of living standards, the proportion of sports in life is gradually decreasing, and the more convenient lifestyle makes people lazy to exercise and keen to eat junk food and stay up late, resulting in the decline of their cardiopulmonary capacity year by year.[3] Therefore, it is necessary to take effective measures to improve the individual's cardiopulmonary ability. As a traditional competitive sport, sports endurance running has the characteristics of simplicity and efficiency.[4] It can not only directly reflect the level of individual cardiorespiratory ability, but also stimulate individual potential from the side. In order to further determine the correlation between the training efficiency of sports endurance running and the level of cardiopulmonary capacity, this paper conducted endurance running training in different ways for 640 experimenters, and revealed the relationship between the training efficiency of sports endurance running and the level of cardiopulmonary capacity by observing the average heart rate at rest, the maximum heart rate during exercise and the lung ventilation, so as to reasonably determine the mode and time of endurance running, further improve the effectiveness and scientific nature of sports.[5]

METHOD

Based on Chinese and foreign literatures, this paper refers to a large number of experimental studies on Sports endurance running and cardiopulmonary function, and compares various training methods of sports endurance running, indexes of cardiopulmonary function and measurement methods, and finally determines the experimental objects and methods of this paper, making this experiment more scientific. The study and all the participants were reviewed and approved by Ethics Committee of Beijing Institute of Technology Zhuhai (NO.2018BJITZH39). The physical parameters of male subjects before the experiment are shown in Table 1.

In addition, this study also measured and recorded the relevant physical parameters of female subjects before the experiment. The results showed that there was no statistical difference in the basic physical parameters of female subjects before the experiment ($P > 0.05$). The results are shown in Table 2.

There are many ways of endurance running training. This paper conducts corresponding experiments on endurance running with load changing and time increasing, and explores the relationship between endurance running training efficiency and cardiopulmonary capacity.

Statistical analysis: the software used in this experiment is SPSS and excel, which are analyzed and sorted by the computer. In the experiment, the correlation of parameters between samples is determined by the p value, that is, $P > 0.05$ means that the difference is not significant and has no statistical significance.

Table 1. Male body index data before the experiment ($x \pm s$, $n = 160$).

Group	Age	Height	Weight(kg)
Test group	21.05±1.5	172.24±4.16	67.51±6.53
Control group	21.2±1.12	171.33±3.62	65.79±5.56

Table 2. Female body index data before the experiment ($x \pm s$, $n = 160$).

Group	Age	Height	Weight(kg)
Test group	21.05±1.5	162.24±3.15	54.51±4.53
Control group	21.2±1.12	161.33±3.04	52.9±4.62

RESULTS

Relationship between load endurance running training and cardiopulmonary capacity

By analyzing Table 3, it can be found that the load endurance running training has an important impact on heart rate, cardiac output and pulmonary ventilation. Among them, the quiet heart rate of the subjects in the experimental group (73.7 ± 10.2) beats / min is significantly different from that of the subjects in the control group (81.2 ± 12.4) beats / min ($P < 0.01$), The primary heart rate at the beginning of exercise was (98.5 ± 14.2) beats / min in the experimental group and (116.0 ± 12.6) beats / min in the control group ($P < 0.01$). However, there was no significant difference between the experimental group and the control group in the primary cardiac output and the maximum heart rate of the subjects during exercise ($P > 0.05$). However, there was a significant difference between the two groups in the maximal cardiac output and maximal pulmonary ventilation during exercise ($P < 0.01$), and compared with the control group, the maximal cardiac output and maximal pulmonary ventilation of the experimental group were higher.

It can be seen from Table 4 that through comparison between the experimental group and the control group, it is found that the endurance running training with different loads has different correlations with the observation indexes. During the same exercise, the sustainable exercise time of the subjects in the experimental group after endurance running training is (15.61 ± 2.21) min, which is significantly higher than that of the control group (13.62 ± 1.42) min, and the difference between the two is significant ($t = 3.44$ $P < 0.01$); Therefore, compared with the maximum oxygen intake of the control group (2.98 ± 0.36) l / min, the maximum oxygen intake of the experimental group was (3.45 ± 0.43) l / min, which was significantly different from that of the control group ($t = 4.67$, $P < 0.01$). When the oxygen intake of the subjects reaches the maximum, the exercise intensity they can achieve is also enhanced. The experimental group can reach (5.35 ± 0.57) grade, while the control group is only (4.41 ± 0.55) grade, which indicates that there is a significant difference between the two groups ($t = 3.74$, $P < 0.01$). Compared with other indexes, the difference in the maximum exercise heart rate between the two groups is not significant ($t = -0.6$, $P > 0.05$).

Table 4. Body index data of subjects at maximum oxygen intake ($x \pm s$, $n = 640$).

Category	Maximum oxygen absorption (L / min)	Heart rate (times / min)	Exercise time (min)	Exercise intensity (grade)
test group	3.45±0.43	181.5±8.7	15.61±2.21	5.35±0.57
Control group	2.98±0.36	182.7±10.7	13.62±1.42	4.41±0.55
t	4.67	-0.6	3.44	3.74
p	<0.01	>0.05	<0.01	<0.01

Table 3. Physical index data of subjects ($x \pm s$, $n = 640$).

category	Quiet heart rate (times/min)	Elementary heart rate (times/min)	Primary heart output (L/min)	Motor Heart rate (times/min)	Maximum output (L/min)	Maximum exercise volume (L/min)
test group	73.7±10.2	98.5±14.2	9.78±1.06	182.1±12.4	20.11±2.83	114.35±10.21
Control group	81.2±12.4	116.0±12.6	9.84±1.24	184.7±20.3	16.66±1.19	102.39±7.97
t	-4.34	-5.37	-0.17	-1.19	3.93	3.67
p	<0.01	<0.01	>0.05	>0.05	<0.01	3.67

Relationship between endurance running training and cardiopulmonary capacity

The physical function indexes of the subjects before the start of the experiment were analyzed and recorded, and the differences were tested by SPSS 23.0. The detailed data are shown in Table 5. The analysis of table 5 shows that before the start of the endurance running training experiment, the quiet heart rate of the subjects in the experimental group was 77.4 beats / min, the average vital capacity was 2493ml, the Harvard step index was 53.5 and the 800m score was 241.76s, while the control group was 77.1 beats / min, 2495ml, 54.1 and 240.86s respectively, And the difference test showed that there was no significant difference in cardiopulmonary capacity between the two groups before the experiment ($P > 0.05$).

However, after endurance running training, the quiet heart rate, average vital capacity, Harvard step index and 800m score of the experimental group were 73.6 beats / min, 2947 ml, 64.5 and 224.79 respectively, indicating that there were significant differences between the two groups ($P < 0.05$). Specific experimental data are shown in Table 6.

Through comprehensive analysis of table 5 and table 6, it can be found that after receiving a certain degree of endurance running training, the level of cardiopulmonary ability and sports performance of the subjects have been improved, which also reveals the strong correlation between the training efficiency of sports endurance running and cardiopulmonary ability. Therefore, the load and duration of endurance running should be appropriately increased in daily life, so as to improve individual cardiopulmonary ability.

Table 5. Comparison of functional indexes of subjects in the two groups before the experiment.

Category	Quiet heart rate (beats / min)	Average vital capacity (ml)	Harvard step index	800m achievement (s)
Test group	77.4	2493	53.5	241.76
Control group	77.1	2495	54.1	240.86
Mean difference	0.3	-2	0.6	0.9
P	>0.05	>0.05	>0.05	>0.05

Table 6. Comparison of functional indexes of subjects in the two groups after the experiment.

Category	Quiet heart rate (beats / min)	Average vital capacity (ml)	Harvard step index	800m achievement (s)
Test group	73.6	2947	64.5	224.79
Control group	76.1	2564	57.8	236.6
Mean difference	-2.4	383	6.7	-11.81
P	<0.05	<0.05	<0.05	<0.05

DISCUSSION

Through the analysis of the experimental results, it can be seen that the load endurance running training has an important impact on the quiet heart rate, cardiac output and pulmonary ventilation of the subjects. Among them, the quiet heart rate and primary heart rate of the subjects in the experimental group are significantly different from those in the control group ($P < 0.01$), and the quiet heart rate of the experimental group is lower. This shows that sports endurance running training can improve the body's output per stroke. After receiving sports endurance running training, the subject's heart can pump more blood at a smaller heart rate, thereby improving the body's myocardial capacity and reducing energy consumption. Therefore, the body can maintain a relatively low heart rate to maintain the body's metabolism.

The maximum amount of oxygen that can be inhaled by the body's respiratory system in a unit time is called the maximum oxygen intake, which is affected by the maximum cardiac output. Some studies have shown that there is a positive correlation between the cardiac volume and the maximum oxygen intake. Therefore, the maximum oxygen intake can not only reflect the strength of lung ventilation capacity, but also explain the level of myocardial capacity from the side. It can be seen from table 4 that the maximum oxygen intake of the two groups is significantly different, and the experimental group is significantly higher than the control group ($P < 0.01$), which indicates that the load sports endurance training improves the contractile capacity and contractile range of respiratory muscles, and further improves the pulmonary ventilation efficiency.

As one of the indexes to evaluate cardiac function, the quiet heart rate can reflect the strength of cardiac function. It can be found from table 5 and table 6 that strengthening physical endurance running training can promote the value-added of cardiac muscle cells and improve the blood supply capacity of the heart. A stronger myocardial contraction and expansion can bring a larger blood carrying capacity, thus improving the ability of cells to participate in aerobic exercise. In addition, after long-lasting endurance running training, the vital capacity of the control group increased by 383 ml (Table 6, $P < 0.05$), which may be because the strength of the respiratory muscles of the body was also enhanced with the training, and the range of thoracic elasticity was increased, so the breathing degree was deeper and the oxygen carrying capacity was more. In this experiment, the step index is involved, which is a parameter to evaluate the blood supply and oxygen supply capacity of the heart, and has a positive correlation with the heart capacity. In this study, the Harvard step experiment index of the experimental group increased by 11 (Table 5 and table 6), indicating that appropriately increasing the training time of physical endurance running can effectively improve the myocardial capacity. Finally, the experimental results also show that the 800m performance of the subjects who have been trained in sports endurance running is better, which indicates that endurance training comprehensively improves personal physical quality and sports competitive strength.

CONCLUSION

Sports endurance running is the simplest sports. It not only has certain requirements on individual endurance and speed, but also has certain effects on the functions of various organs participating in sports. Therefore, sports endurance running should be paid more attention to. According to the analysis of the data and indicators of this experiment, the training efficiency of sports endurance running has an important impact on the individual's cardiopulmonary ability. Appropriately increasing the training time and load of sports endurance running is conducive to improving the body's myocardial and lung functions, which is mainly manifested in the increase of the maximum oxygen intake, the decrease of heart rate The increase of step index and the improvement of sports test results.

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

AUTHORS' CONTRIBUTIONS: The author has completed the writing of the article or the critical review of its knowledge content. This paper can be used as the final draft of the manuscript. Every author has made an important contribution to this manuscript. Dongtao Lei: writing and execution.

REFERENCES

1. Nasrulloh A, Yuniana R, Pratama KW. The effect of skipping combination with body weight training on cardiorespiratory endurance and body mass index (BMI) as a covid-19 prevention effort for overweight adolescents. J Keolahragaan. 2021;9(2):220-30.
2. Nakanishi M, Miura H, Nakao K, Fujino M, Arakawa T, Fukui S, et al. Combination of Peak Exercise Systolic Blood Pressure and Left Atrial Diameter as a Novel Non-Spirometry Prognostic Predictor Comparable to Peak Oxygen Uptake for Heart Failure With Reduced Ejection Fraction. Circulation J. 2019;83(7):1528-37.
3. Filliau C, Younes M, Blanchard AL. Effect of "Touch Rugby" Training on the Cardiovascular Autonomic Control in Sedentary Subjects. Int J Sports Med. 2015;36(7):567-72.
4. Palomo MF, Jimenez-Ramirez M, Ortega JF, Lopez-Galindo PL, Fernandez-Martin J, Mora-Rodriguez R. Effects of repeated yearly exposure to exercise-training on blood pressure and metabolic syndrome evolution. J Hypertens. 2017;35(10):1992-9.
5. Sun S, Zhang H, Kong Z, Shi Q, Tong TK, Nie J. Twelve weeks of low volume sprint interval training improves cardio-metabolic health outcomes in overweight females. J Sports Sci. 2019;37(11):1257-64.