

ANALYSIS OF JOGGING ON MUSCLE FATIGUE AND BODY BALANCE

ANÁLISE DA CORRIDA MODERADA SOBRE A FADIGA MUSCULAR E O EQUILÍBRIO CORPORAL

ANÁLISIS DEL TROTE SOBRE LA FATIGA MUSCULAR Y EL EQUILIBRIO CORPORAL



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ABSTRACT

Introduction: The changes in muscle condition during jogging are studied according to their characteristics to formulate a correct fitness plan. With a medium effort intensity, studies on jogging have shown positive effects on mental de-stress and motor coordination. **Objective:** Study the effect of running training on muscle fatigue and body balance. **Methods:** A total of 60 sedentary freshmen from a university were selected, including 30 male and 30 female students. The volunteers were randomly divided into experimental and control groups. While the control performed routine sports activities according to the teaching plan during physical education class, the students in the experimental group performed a jogging training protocol. Data were collected before and after the intervention for comparison and statistical analysis. **Results:** The vestibular step test changed from 20.56 to 13.87, evidencing that jogging training significantly improved body balance ability in addition to providing body flexibility. **Conclusion:** Combined with curriculum standards and the level of physical training required, jogging can be integrated into physical education classes to promote student health. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Jogging; Muscle Fatigue; Postural Balance.

RESUMO

Introdução: As alterações da condição muscular na corrida moderada são estudadas segundo suas características próprias no intuito de formular um plano de aptidão física correta. Com uma intensidade de esforço média, estudos sobre a corrida vem demonstrando efeitos positivos sobre o desestresse mental e a coordenação motora. **Objetivo:** Estudar o efeito do treino de corrida moderada sobre a fadiga muscular e o equilíbrio corporal. **Métodos:** Um total de 60 calouros sedentários de uma universidade foram selecionados, incluindo 30 estudantes do sexo masculino e 30 do sexo feminino. Os voluntários foram divididos aleatoriamente em grupo experimental e grupo de controle. Enquanto o controle realizou atividades esportivas rotineiras, de acordo com o plano de ensino durante a aula de educação física, os alunos do grupo experimental realizaram um protocolo de treinamento de corrida. Os dados foram coletados antes e após a intervenção para comparação e análise estatística. **Resultados:** O teste de passo vestibular alterou-se de 20,56 para 13,87, evidenciando que o treinamento em corrida melhorou significativamente a capacidade de equilíbrio corporal além de propiciar a flexibilidade corporal. **Conclusão:** Combinado às normas curriculares e ao nível de aptidão física exigida dos estudantes, o treinamento em corrida moderada pode ser integrado às aulas de educação física para fomentar a saúde dos estudantes. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Corrida Moderada; Fadiga Muscular; Equilíbrio Postural.

RESUMEN

Introducción: Los cambios en el estado muscular durante el trote se estudian en función de sus características propias con el fin de formular un correcto plan de acondicionamiento físico. Con una intensidad de esfuerzo media, los estudios sobre el trote han demostrado efectos positivos sobre el desestresamiento mental y la coordinación motora. **Objetivo:** Estudiar el efecto del entrenamiento de carrera sobre la fatiga muscular y el equilibrio corporal. **Métodos:** Se seleccionó a un total de 60 estudiantes sedentarios de primer año de una universidad, de los cuales 30 eran hombres y 30 mujeres. Los voluntarios se dividieron aleatoriamente en grupo experimental y grupo de control. Mientras que el grupo de control realizó actividades deportivas rutinarias según el plan de enseñanza durante la clase de educación física, los estudiantes del grupo experimental llevaron a cabo un protocolo de entrenamiento de trote. Se recogieron datos antes y después de la intervención para su comparación y análisis estadístico. **Resultados:** La prueba de paso vestibular cambió de 20,56 a 13,87, lo que evidencia que el entrenamiento de trote mejoró significativamente la capacidad de equilibrio corporal además de proporcionar flexibilidad corporal. **Conclusión:** Combinado con las normas curriculares y el nivel de condición física exigido a los alumnos, el entrenamiento de trote puede integrarse en las clases de educación física para promover la salud de los estudiantes. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptor: Trote; Fatiga Muscular; Equilibrio Postural.



INTRODUCTION

Jogging, as one of the most easily carried out daily fitness and exercise methods, has the effect of relaxing mental pressure and exercising muscle and body coordination.¹ The exercise intensity of jogging belongs to medium intensity, which only requires a set of sports clothes and a pair of running shoes, and does not require specific sports equipment, sports venues and sports time.² Although the form of jogging is simpler than other forms of exercise, it does not mean that jogging does not require scientific and systematic exercise methods and exercise plans.³ Compared with the walking state, the jogging muscle activity is more intense than the walking muscle activity, and the body muscle cell consumption is greater.⁴ According to the existing research, based on the influence of different fitness methods on muscle state in sports, there are few studies on synchronous dynamic analysis of muscle related indicators.⁵ This paper measures the law and relationship between the changes of muscle oxygen content and EMG signal during jogging training by integrating the numerical changes of EMG value, and then evaluates the level of body flexibility, stability, balance ability and core strength, analyzes the muscle fatigue and body balance ability during jogging, so as to adjust and train the muscles under different conditions. In order to reduce the probability of injury during sports.⁶

METHOD

Research object

Based on the research objective, this experiment selected 60 non sports major freshmen in a university, including 30 male and 30 female students. The study and all the participants were reviewed and approved by Ethics Committee of Early Warning Academy(NO.ELWA20PZ075). The selected students will be randomly divided into two groups: the experimental group and the control group. Each group has 30 students, including 15 boys and 15 girls. First, the students were tested before the experiment. The basic information of the subjects is shown in Table 1. The test results exclude the relevant influence caused by various objective factors and meet the requirements of this experiment. In addition, all subjects are trained in an informed and voluntary manner. Before training, ensure that all subjects are free of diseases such as cardiorespiratory function, which can ensure the normal conduct of basic sports activities and jogging training.

Research methods

Before the experiment, 60 students were divided into the experimental group and the control group. The students in the control group carried out routine and simple sports activities, mainly jogging, during the physical education class according to the teaching plan. The students in the experimental group carried out jogging training at the same time. At the same time, complete data were recorded at the beginning of the experiment and during the process of the experiment, mainly by means of comparison between groups.

The data collection methods during the experiment mainly include:

When testing the muscle quality of the students, we mainly used the TSAH-100 near-infrared tissue blood oxygen parameter nondestructive detector to select the large and relatively developed left leg lateral thigh muscle to test the muscle oxygen content, including the absolute amount of blood oxygen saturation (TOI), with the statistical unit of%.

Table 1. Basic information of the experimental group and the control group.

Group	Age (age)	Height (cm)	Weight (kg)	Body mass index (BMI)
Experience group	19.17±0.78	171.71±8.32	63.86±14.28	22.08±1.17
Control group	20.07±0.81	172.35±8.23	63.66±15.02	22.12±1.08

The relatively developed biceps femoris, lateral femoris, lateral gastrocnemius and other parts were selected for IEMG value analysis. The Mega surface electromyography tester was selected as the instrument to obtain the required surface electromyography data. After the experiment, the collected integral electromyography was processed and analyzed.

During the analysis of balance ability, the observation method was used to record the static and dynamic balance indicators of the subjects. The static balance indexes mainly include standing with eyes closed on one foot, lifting heels with eyes closed and standing upright. Dynamic balance indexes mainly include vestibular step test, balance beam walking and blind spot walking.

RESULTS

Effect of jogging training on muscle fatigue

Muscle oxygen content can reflect the oxygen saturation of local tissues of skeletal muscle, which is of great significance for judging the degree of muscle fatigue. Figure 1 shows the muscle oxygen content of the left lateral thigh muscle of the test group and control group students after 40 minutes of exercise in the second week of the experiment.

On the whole, there was a very significant difference between the two groups in muscle oxygen content during 40 minutes of exercise ($P<0.01$). It can be seen from the changes of the curve in Figure 1 that, in the same time, the overall trend of muscle oxygen content in general sports activities and jogging is relatively consistent, showing a trend of first falling and then rising.

At the same time, IEMG values of lower limb muscles measured during 40 minutes of exercise were tested to diagnose the degree of muscle fatigue of the subjects. The changes of IEMG of each muscle are shown in Figure 2.

It can be seen from Figure 2 that the IEMG values of the three muscles of lower limbs in the control group and the total IEMG values are smaller than those in the experimental group. The difference between biceps femoris was small ($P>0.05$). The difference of IEMG value between lateral thigh muscle and lateral gastrocnemius muscle was significant ($P<0.05$). The total IEMG value was significantly different ($P<0.01$). At the same time, the IEMG value of the lateral gastrocnemius in the control group was the highest, followed by the biceps femoris, and the lateral femoris was smaller. In the experimental group, the IEMG value of the lateral gastrocnemius was the highest, followed by the biceps femoris, and the lateral femoris was smaller.

Summarizing the values in Figure 1 and Figure 2, it can be concluded that compared with jogging, jogging training has a higher degree of muscle fatigue, but generally speaking, the two maintain a small difference in the test values of some muscles, indicating that jogging is not easy to produce fatigue compared with simple sports activities such as jogging, and it is suitable for most people to participate.

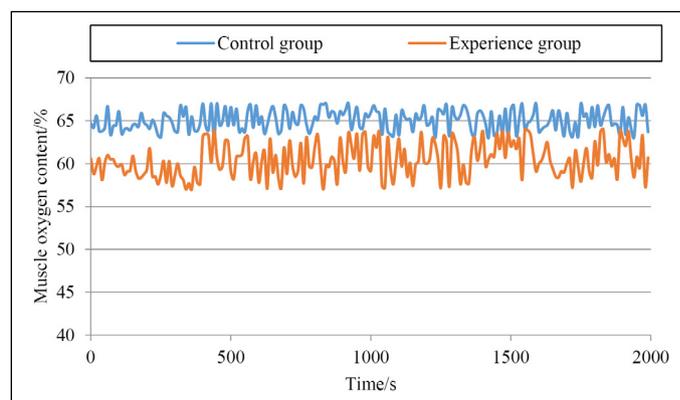


Figure 1. Changes of muscle oxygen content of subjects after 40 minutes of exercise.

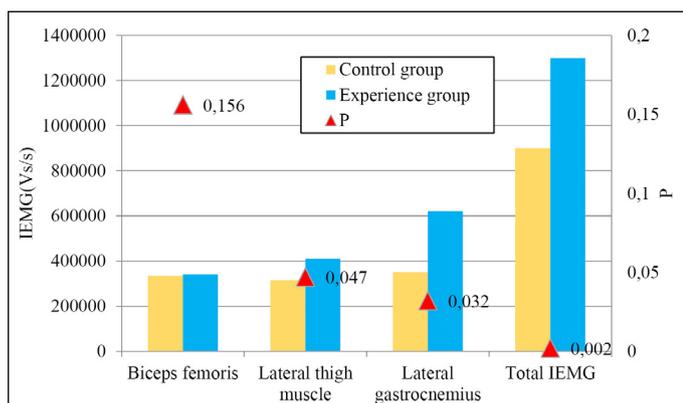


Figure 2. Changes of IEMG of lower limb muscles during exercise.

Impact of jogging on students' balance ability

The human body needs the coordination of the trunk and muscles of various parts to maintain body balance in the process of movement. At the same time, it also includes the functions of sensory system, visual system and other body systems. The impact test of jogging training on body balance ability is mainly reflected by static and dynamic indicators. The test results of balance ability indicators are shown in Table 2.

It can be seen from Table 2 related indexes of static balance ability that the indexes of standing with eyes closed and one foot, lifting heels with eyes closed and standing upright in the experimental group have changed significantly before and after jogging training, $P < 0.01$. Among them, the standing with eyes closed on one foot increased from 29.56 ± 7.01 to 58.68 ± 6.89 , the heel lifting with eyes closed increased from 21.36 ± 5.88 to 42.56 ± 7.04 , and the standing with crane's stand increased from 8.89 ± 4.12 to 20.58 ± 4.01 , which showed that jogging had the highest impact on crane's stand.

It can be seen from the relevant indexes of dynamic balance ability in Table 2 that the vestibule step test and blind standing step indexes of the experimental group have changed significantly before and after jogging training, $P < 0.05$. The vestibular step test changed significantly from 20.56 ± 5.01 to 13.87 ± 4.29 , and the blind step test increased from 9.77 ± 2.14 to 16.25 ± 1.34 . The walking index of balance beam changed from 8.87 ± 1.24 to 6.05 ± 1.02 , $P > 0.05$, there was no significant difference, indicating that jogging had no significant effect on improving students' balance beam index. In the control group, the vestibular step test, balance beam walking and blind spot walking had no significant change ($P > 0.05$), but the vestibular step test and balance beam walking had decreased to varying degrees, and blind spot walking had slightly increased, indicating that sports activities had a certain improvement effect on dynamic balance indicators, and jogging had a significant impact.

Impact of jogging on students' body composition

Physical exercise can cause changes in body composition, such as the reduction of body fat and the increase of muscle content, while changes in body composition can greatly affect the degree of muscle fatigue and balance ability of the human body. Therefore, this paper analyzes the influence of jogging on body composition. The changes of body composition indexes are shown in Table 3.

Physical flexibility is one of the important indicators that affect physical fitness, and it also has a certain impact on the improvement of body balance ability and the increase of muscle elasticity. Stretching after sports training is one of the factors that affect the flexibility of the body. This paper makes statistics on the flexibility indicators of the students before and after training, and the specific data are shown in Table 4.

As shown in Table 5, the score of physical flexibility before and after jogging training has been significantly improved, $P < 0.05$ has statistical

Table 2. Changes of subjects' balance ability indexes before and after training.

Index		Group	Before training	After training	t	P
Static state	Standing on one foot with eyes closed	Experience group	29.56±7.01	58.68±6.89	7.21	0.000
		Control group	30.12±6.98	38.33±5.65	6.53	0.053
	Close your eyes and lift your heels	Experience group	21.36±5.88	42.56±7.04	6.88	0.000
		Control group	22.55±6.89	30.28±6.01	5.26	0.062
	Stand erect	Experience group	8.89±4.12	20.58±4.01	7.25	0.000
		Control group	8.77±4.28	13.56±3.65	5.61	0.035
Dynamic	Vestibular step test	Experience group	20.56±5.01	13.87±4.29	-9.98	0.010
		Control group	21.05±4.56	17.52±4.43	-3.21	0.052
	Balance beam walking	Experience group	8.87±1.24	6.05±1.02	-3.69	0.068
		Control group	8.25±1.33	7.08±1.21	-1.02	0.160
	Step in situ with eyes closed	Experience group	9.77±2.14	16.25±1.34	8.63	0.040
		Control group	9.18±1.66	13.04±1.28	6.22	0.078

Table 3. Body composition changes of subjects before and after training.

Option	Group	Before training	After training	t	P
Weight (kg)	Experience group	63.86±14.28	58.12±3.38	-2.36	0.048
	Control group	63.66±15.02	63.11±2.58	-1.22	0.142
Body mass index (BMI)	Experience group	22.08±1.17	18.52±1.02	-4.58	0.021
	Control group	22.12±1.08	20.57±1.11	-3.55	0.106
Fat volume (kg)	Experience group	18.96±6.23	13.52±5.22	-5.62	0.032
	Control group	17.98±5.26	15.33±6.21	-2.38	0.125
Muscle volume (kg)	Experience group	45.32±7.89	48.21±6.22	4.35	0.061
	Control group	44.65±6.87	45.23±7.01	3.08	0.144

Table 4. Changes of subjects' physical flexibility scores before and after training.

Index	Group	Before training	After training	t	P
Stand forward	Experience group	2.58±0.77	2.89±0.42	3.56	0.066
	Control group	2.47±0.56	2.52±0.47	2.32	0.114
Body flexibility	Experience group	25.41±3.25	29.02±3.58	6.77	0.085
	Control group	25.03±4.22	26.87±3.44	4.58	0.092

difference, and the score has been increased from 25.41 ± 3.25 to 29.02 ± 3.58 . The forward bending index of standing posture improved slightly, and the score increased from 2.58 ± 0.77 to 2.89 ± 0.42 . The scores of standing posture, forward bending and body flexibility in the control group increased slightly after general sports activities, but the difference was not significant. It shows that jogging has a significant impact on the improvement of the physical flexibility of the subjects. At the same time, the improvement of physical flexibility can also increase the coordination and extension of human running movements, and further improve their running skills and physical fitness.

DISCUSSION

No matter the human body is in a static state or in a moving state, muscle cells always need a certain amount of oxygen to maintain the normal physiological function of muscles. This amount of oxygen will change with the diversity of muscle cell states and the difference in the load of cells generated by different exercise intensities. The higher

the intensity, the higher the oxygen demand of aerobic respiration of muscle cells. Compared with the oxygen demand of the human body under static or small amplitude exercise, the unit oxygen demand of the body under exercise will increase dozens or even hundreds of times. In the 40 minute training process of this experiment, at the initial stage of exercise, the change trend of muscle oxygen content of the two groups was basically the same, which was first down and then up, and the decline of jogging training was greater than that of general sports activities. On the whole, the content of muscle oxygen in jogging training changes greatly, while the content of muscle oxygen in general sports activities is basically in a relatively stable state, and the total content of muscle oxygen in general training is always higher than that in jogging training. Muscle oxygen content is inversely proportional to muscle fatigue. Therefore, compared with general sports activities, jogging training is more prone to fatigue due to relatively large amplitude of muscle vibration, but also more energy consumption. Therefore, the research on the change of body composition shows that jogging has a significant effect on the reduction of body weight and body fat content. Generally speaking, the two maintain a small difference in the test values of some muscles, indicating that jogging is easy to cause fatigue to a low degree,

suitable for most people to participate, and less dangerous in the process of reasonable exercise.

CONCLUSION

To sum up, jogging has significant advantages compared with general sports activities, which can increase the energy consumption of the human body and have a certain impact on the improvement of body balance. At the same time, jogging belongs to aerobic exercise, so it can effectively reduce weight and body fat content, which is conducive to improving the level of physical health. Moreover, jogging has low requirements for venues and techniques, and is easy to carry out. It is a sport suitable for most people. Therefore, based on the research results of this paper, according to the students' actual physical conditions and specific training goals, based on the basic principles of sports and the general laws of teaching, with the targeted teaching of jogging skills and action training, or as a warm-up and preparation activity for other training to organically combine it with other sports, students' sports ability and physical quality can be effectively improved.

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