EFFECTS OF RUNNING COMBINED WITH MUSCULAR TRAINING OF THE ABDOMINAL CORE

EFEITOS DA CORRIDA ALIADA AO TREINAMENTO MUSCULAR DO CENTRO ABDOMINAL

EFECTOS DE LA CARRERA COMBINADA CON EL ENTRENAMIENTO MUSCULAR DEL NÚCLEO ABDOMINAL

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ABSTRACT

Introduction: Running has specific effects on different areas of the human body, and the sagittal angular variation of the hip, knee, and ankle joints is widely explored. In addition to accelerating body metabolism, it can also improve body shape. Recent studies have revealed that running can also improve athletes' muscular strength of the abdominal core. Objective: Explore the effects of running combined with muscle training on the abdominal center strength of athletes. Methods: It investigated the effects of 3 different running intensities on athletes' abdominal core muscle strength. Computerized kinematic motion capture technology was used to measure the impacts of running on 18 young volunteers. The sagittal planes of the hip, knee, and ankle joints were evaluated. Abdominal center muscle strength was assessed during running. Results: Running particularly affected the combined contraction rate of the tibial, gluteal, and soleus muscles. The correlation between speed, muscle activation, and joint angle was also analyzed. Conclusion: Athletes tend to adjust the angle and frequency of joint movements to reduce fatigue. It was noted can have the ability to control muscle strength in different regions of the abdominal core. The research results establish a theoretical basis for the effectiveness of abdominal core muscle strength performance in athletes. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Track and Field; Jogging; Abdominal Core; Resistance Training.

RESUMO

Introdução: A corrida tem efeitos específicos em distintas áreas do corpo humano e a variação angular sagital das articulações do quadril, joelho e tornozelo são amplamente exploradas. Além de acelerar o metabolismo corporal, também pode melhorar a forma corporal e alguns estudos recentes revelaram que a corrida também pode melhorar a força muscular do centro abdominal dos atletas. Objetivo: Explorar os efeitos da corrida aliada ao treinamento muscular sobre a força do centro abdominal dos atletas. Métodos: Investigou-se os efeitos de 3 diferentes intensidades de corrida sobre a força muscular do centro abdominal dos atletas. Foi utilizada a tecnologia de captura de movimento cinemática computadorizada para medir os impactos da corrida sobre 18 jovens voluntários. Os planos sagitais das articulações do quadril, joelho e tornozelo foram avaliados. A força muscular do centro abdominal foi avaliada durante a corrida. Resultados: A corrida afetou particularmente o índice combinado de contração dos músculos tibial, glúteo e sóleo. A correlação entre velocidade, ativação muscular e ângulo articular também foi analisada. Conclusão: Os atletas tendem a ajustar o ângulo e a frequência de movimentos articulares para reduzir a fadiga. Notou-se que os atletas também tem a capacidade de controlar a força muscular em diferentes regiões do centro abdominal. Os resultados da pesquisa estabelecem uma base teórica para a eficácia do desempenho de força muscular do centro abdominal nos atletas. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Atletismo; Corrida Moderada; Centro Abdominal; Treinamento de Força.*

RESUMEN

Introducción: Correr tiene efectos específicos en diferentes áreas del cuerpo humano y la variación angular sagital de las articulaciones de la cadera, la rodilla y el tobillo son ampliamente exploradas. Además de acelerar el metabolismo, también puede mejorar la forma del cuerpo y algunos estudios recientes revelaron que correr también puede mejorar la fuerza muscular del núcleo abdominal en los atletas. Objetivo: Explorar los efectos de la carrera combinada con el entrenamiento muscular en la fuerza del núcleo abdominal de los atletas. Métodos: Investigamos los efectos de 3 intensidades de carrera diferentes en la fuerza muscular del centro abdominal de los atletas. Se utilizó la tecnología de captura del movimiento cinemático por ordenador para medir los impactos de la carrera en 18 jóvenes voluntarios. Se evaluaron los planos sagitales de las articulaciones de la cadera, la rodilla y el tobillo. Se evaluó la fuerza muscular del núcleo abdominal durante la carrera. Resultados: Correr afectó especialmente a la tasa de contracción combinada de los músculos tibiales, glúteos y sóleo. También se analizó la correlación entre la velocidad, la activación muscular y el ángulo articular. Conclusión: Los deportistas tienden a ajustar el ángulo y la frecuencia de los movimientos articulares para reducir la fatiga. Se observó que los atletas

también tienen la capacidad de controlar la fuerza muscular en diferentes regiones del núcleo abdominal. Los resultados de la investigación establecen una base teórica para la eficacia del rendimiento de la fuerza muscular del núcleo abdominal en los atletas. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Atletismo; Trote; Núcleo Abdominal; Entrenamiento de Fuerza.*

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INTRODUCTION

Jogging is a good and typical way to improve physical fitness. In the development and enrichment of materials, human beings are constantly seeking and exploring ways to improve the health of the body. Jogging is an aerobic exercise that boosts both the body and mind. The way it moves is easy and dangerous. Any environment does not limit it. At the same time, the sport will not be restricted by age, gender, environment, etc. Athletes can improve their fitness by jogging.[1] Due to the different physical qualities, the movement control of the body will also change accordingly during jogging. The influence of nerves and muscles on movement is critical in multi-limb jogging. This article analyzes the body movements and muscle tissue changes of joggers.

METHOD

Experimental subjects

This article uses motion capture technology to measure the jogging rate of 18 young volunteers. In this paper, volunteers are divided into two categories.[2] The number of experimental groups (athletes) was 9, and the number of the control group (healthy people) was 9. Subject-specific data are shown in Table 1.

Test steps

Subjects can perform a 5-minute warm-up on the jogging machine at the fastest rate. This paper sets this rate as the optimal movement rate. The subjects then exercised for about 5 minutes at three different running speeds. This article collects data on various sports.[3] The rotational speed on the jogging machine was adjusted according to the tester's request. Participants performed 5 minutes of brisk exercise on a jogging machine. Participants must decide on the optimal comfort level after the warm-up exercise. Increase or decrease the speed of the jogger as required by the subject until a comfortable jogging rate is reached. In this paper, the averages are calculated respectively under three different rotational speeds. In this paper, the average number is set to 3 kinds of rotation speeds: 1) Self-selected speed. 2) 20% faster than the optional speed. 3) 20% slower than the optional speed.

3D analysis method of human morphological features

The human body movement pattern implicit movement injury data and the human body reasonable movement data both contain the essential physical condition of the human body.[4] The data includes both the motion characteristics of bones and the motion characteristics of muscles. On this basis, this paper analyzes the physical condition of the human body by using the three-dimensional image analysis method. $U = \{\mu_1, \mu_2, \cdots, \mu_i\}$ represents the collection of bone movement properties in human activity data. $V = \{v_1, v_2, \cdots, v_j\}$ represents the set of action characteristics of the muscle. i, j refers to the number of bones and muscles in the human body. g is a function of complete physical condition.

$$g = \lambda Q \sum (\mu_i + v_i) / \sqrt{r^2 + 1} \quad (1)$$

r refers to the moment of exercise. Q refers to the scope of activity. λ is the physical condition of human beings. Through the calculation of formula (1), the human body tissue is divided into h parts, and the physical condition characteristics of each part are represented by the set $C = \{c_1, c_2, \cdots, c_h\}$. Through formula (2), this paper compares the physical condition characteristics c_i arranged in the order in the set C with formula (1) to obtain the similarity α of the two:

$$\alpha = \sqrt{c_i^2 + g^2} / c_i \quad (2)$$

The article gives the critical point v_i of a person's physical state parameters. If it is $\alpha > v_i$, then it can be determined that the physical condition of the person in the 3D image is legal.[5] Then, the corresponding human action information in α is entered into the rationality judgment simulation of the action.

Data processing

This paper used a combination of independent t-tests and descriptive statistical analysis to analyze the demographic differences between groups.[6] This paper compared the combined contraction degree of tibialis anterior/peroneus longus, tibialis anterior/gluteal minor, and tibialis anterior/soleus. ($P<0.05$) means that the difference is statistically significant.

Ethical Compliance

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Luoyang Institute of Science and Technology following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

Table 1. Summary list of objects.

Group	Age	Height (m)	Weight (kg)
Test Group	22.6±0.63	1.85±4.38	71.67±5.83
Control group	21.35±0.83	1.82±5.73	69.38±4.38

RESULTS

Combined contraction index of tibialis anterior/peroneus longus, tibialis anterior/gluteus minimus, and tibialis anterior/soleus at custom comfort speed

Self-selected comfort refers to increasing or decreasing the speed of the jogger at a rate of 0.1 km/h, as suggested by the participants. It can be seen from Table 2 that the total contraction strength of the tibialis anterior/peroneus longus at average jogging speed is between 100 and 200 ms, and the data are significantly different ($P<0.05$). No significant differences were found in the remaining periods.[7] Tibialis anterior/gluteus minimus.

Real contraction significantly differed between stages I and IV ($P<0.01$). Compared with the standard group, the joint contraction index of the tibialis anterior muscle/soleus muscle was significantly different in each period ($P<0.01$). There were no significant differences in the remaining periods.

Table 2. Tibialis anterior/peroneus longus, A/gluteus minimus, and tibialis anterior/soleus combined at custom comfort speeds.

Stage	Group	Tibialis anterior/ peroneus longus	Tibialis anterior/ gluteus minimus	Tibialis anterior/soleus
I	Athlete group	66.88±43.54	66.04±68.65	66.98±63.85
	Control group	67.92±28.96	78.65±11.88	72.29±38.75
II	Athlete group	70±52.08	74.38±54.58	64.69±55.52
	Control group	70.21±29.9	76.56±28.13	76.15±36.35
III	Athlete group	67.19±44.06	71.46±54.9	53.85±51.04
	Control group	67.08±43.54	71.56±49.38	43.44±53.85
IV	Athlete group	73.65±49.38	61.35±63.02	40.73±50.83
	Control group	56.67±31.04	49.06±24.27	43.13±33.02

Table 3. Combined contraction of tibialis anterior/peroneus longus, tibialis anterior/ gluteus minimus, and tibialis anterior/soleus during rapid movement.

Stage	Group	Tibialis anterior/ peroneus longus	Tibialis anterior/ gluteus minimus	Tibialis anterior/ soleus
I	Athlete group	69.06±34.79	73.85±42.81	71.46±50.42
	Control group	67.19±30.73	82.81±33.44	73.54±40
II	Athlete group	71.56±34.38	82.08±30.83	73.13±45.31
	Control group	71.67±39.9	85.63±18.85	77.6±34.27
III	Athlete group	68.85±30	90±57.4	60.1±50.42
	Control group	66.88±45.42	92.71±46.77	60.1±48.85
IV	Athlete group	65.94±45.42	64.79±63.23	40.1±49.27
	Control group	52.19±27.08	54.79±24.17	48.44±26.67

Comprehensive contraction index of tibialis anterior/ peroneus longus, tibialis anterior/gluteus minimus, and tibialis anterior/soleus during fast jogging

Fast jogging was based on a 20% increase in each participant's comfort rate. Table 3 shows that the two muscles of the tibialis anterior/ soleus did not differ in each landing phase during jogging (P>0.05). Compared with the standard group, the combined contraction of the anterior tibialis and gluteus minimus muscle was P<0.01. The total contraction index of the tibialis anterior muscle/peroneus longus muscle was significantly different (P<0.05), and there was no significant difference in other stages.

Comparison of joint contraction indexes of tibialis anterior/ peroneus longus, tibialis anterior/gluteus minimus, and tibialis anterior/soleus at lower jogging speed

The slower running speed is based on a 20% reduction in each subject's comfortable running speed.[8] Table 4 shows that the tibialis anterior/peroneus longus did not differ in each drop phase during jogging (P>0.05). The total contraction of tibialis anterior/gluteus minimus significantly differed from the standard group (P<0.05). There was a significant difference in the total contraction index of the tibialis anterior muscle/soleus muscle (P<0.05), and there was no significant difference in other parts.

Table 4. Low Jogging Speed Tibialis Anterior/Peroneus Longus, Tibialis Anterior/ Gluteus Minimus, and Tibialis Anterior/Soleus Combined Contraction Indicators.

Stage	Group	Tibialis anterior/ peroneus longus	Tibialis anterior/ gluteus minimus	Tibialis anterior/ soleus
I	Athlete group	71.04±26.25	76.46±39.17	66.04±40.83
	Control group	72.08±19.17	79.48±20.21	71.15±35.63
II	Athlete group	70±29.58	70.21±43.13	64.69±29.38
	Control group	70.21±22.71	72.29±24.27	68.85±47.6
III	Athlete group	67.19±42.92	58.96±52.19	37.92±39.06
	Control group	67.08±36.67	66.98±32.6	43.54±48.65
IV	Athlete group	57.4±39.58	40.52±26.56	46.25±13.23
	Control group	55.1±39.27	64.48±36.25	53.02±39.58

DISCUSSION

The brain is less active when the body is relatively relaxed and calm. Before exercising, the body will have a series of movements. These movements cause the muscles to contract.[9] The body then sends these signals to the brain, making the nerves in the cerebral cortex more active. This allows for the coordination between the various parts and systems of the brain to allow the body to perform better movements. If you don't prepare before exercising, it will hurt your body. A jog before a workout can give your body a good stretch to stretch your bones and muscles. Whether a 5-minute trot or a 10-minute trot, the gastrocnemius changes in contraction time, reaction time, relaxation time, sustained contraction time, and radial displacement. 5 and 10 minutes of exercise had the same effect on biceps femoris excitability. There was a significant change in quadriceps excitation before jogging.

The power of the hips in the swing stage of jogging is mainly based on the movement and interaction torque.[10] The muscles around the buttocks are always in the opposite direction of the interaction torque during movement. The ankle is less torqued than the hip and knee joints. The reason is that the knee joint's flexion and extension range is relatively narrow due to the foot's lightweight. The range of motion of each joint during jogging will not cause significant damage to the ankle. In this process, the mechanical relationship between hip, knee, and ankle is similar to the mechanical law of upper limb fast swing. Due to the ground surface's reaction, the torques' mutual relationship is intricate. Its main controlling factors have also changed. The contact moment on the lateral side has the most significant impact on the lower extremity. It has the most significant effect on the moment and gravitational distance of the hip.

In practice, pay special attention to jogging and jogging with variable speed. Body muscle contractions also become weaker during short-distance jogging. Over time, this exercise strengthens muscle contractions that increase the athlete's speed and strength. Building muscle core strength requires grasping the sensitive points of strength training. Athletes should be careful to select those muscles that significantly impact athletic performance for strength training.

CONCLUSION

This experiment verified that different jogging speeds are different for increased muscle strength. The research results of this paper provide a theoretical basis for quantitative analysis of muscle co-contraction and core strength training in athletes during exercise. The research results of this paper aim to provide better guidance and training for PE teachers and coaches.

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

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