INTENSIFICATION OF ABDOMINAL CORE SKILLS IN MUSCULAR STRENGTH TRAINING FOR SPRINTER ATHLETES

INTENSIFICAÇÃO DAS HABILIDADES DO CENTRO ABDOMINAL NO TREINAMENTO DE FORÇA MUSCULAR PARA ATLETAS VELOCISTAS

INTENSIFICACIÓN DE LAS HABILIDADES DEL NÚCLEO ABDOMINAL EN EL ENTRENAMIENTO DE LA FUERZA MUSCULAR PARA ATLETAS VELOCISTAS

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ABSTRACT

Introduction: Running is a speed-based physical activity, and abdominal core strength training is a good technique for athletes. The method of abdominal core strength training consists of training the muscles of the central part of the human body, which also aims to improve the physical coordination of its practitioners. Objective: Analyze the effects of abdominal core strength training on athletes' physical performance and performance in competitions. Methods: Twenty sprinters were selected as volunteers and had their EMG signals and muscular endurance of the lower body muscles compared during the experiment. The athletes performed an abdominal core training cycle. The statistical method was used to perform an analysis of the obtained data. These experimental data were adjusted, and significant correlations were discovered. The research results of this paper provide a theoretical basis for formulating the athletes' training strategies. Results: The maximum muscular endurance of male and female sprinters was statistically different (P<0.05). Fitness indicators improved in sprinters after abdominal core strength training. The studies were statistically different (P<0.05). Athletes' performance improved after abdominal core strength training. The data were statistically significant (P<0.05). Conclusion: The physical performance and performance of sprinters are positively correlated with abdominal core strength training. Sprinters should focus on abdominal core strength training in their daily training. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: High-Intensity Interval Training; Resistance Training; Sports; Athletes; Running.

RESUMO

Introdução: A corrida é uma atividade física baseada na velocidade e o treinamento da força do centro abdominal é uma técnica favorável aos seus atletas. O método de treinamento da força do centro abdominal consiste no treinamento dos músculos da parte central do corpo humano, que também tem como objetivo melhorar a coordenação física de seus praticantes. Objetivo: Analisar os efeitos do treinamento de força do centro abdominal sobre o desempenho físico dos atletas e o desempenho em competições. Métodos: Foram selecionados como voluntários 20 velocistas que tiveram seus sinais de EMG e a resistência muscular dos músculos da parte inferior do corpo comparados durante o experimento. Os atletas realizaram um ciclo de treinamento de centro abdominal. O método estatístico foi utilizado para realizar uma análise sobre os dados obtidos. Esses dados experimentais foram ajustados e descobriu-se correlações significativas. Os resultados da pesquisa deste trabalho fornecem base teórica para a formulação das estratégias de treinamento dos atletas. Resultados: A resistência muscular máxima dos velocistas masculinos e femininos foi estatisticamente diferente (P<0,05). Os indicadores de aptidão física melhoraram nos velocistas após o treinamento de força do centro abdominal. Os estudos foram estatisticamente diferentes (P<0,05). O desempenho dos atletas melhorou após o treinamento de força do centro abdominal. Os dados foram estatisticamente significativos (P<0,05). Conclusão: O desempenho físico e o desempenho dos velocistas estão positivamente correlacionados com o treinamento de força do centro abdominal. Os velocistas devem se concentrar no treinamento de força do centro abdominal em seu treinamento diário. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

***Descritores*:** *Treinamento Intervalado de Alta Intensidade; Treinamento de Força; Esportes; Atletas; Corrida.*

RESUMEN

Introducción: La carrera a pie es una actividad física basada en la velocidad y el entrenamiento de la fuerza del núcleo abdominal es una técnica favorable a sus atletas. El método de entrenamiento de la fuerza del núcleo abdominal consiste en el entrenamiento de los músculos de la parte central del cuerpo humano, que también tiene como objetivo mejorar la coordinación física de sus practicantes. Objetivo: Analizar los efectos del entrenamiento de la fuerza del núcleo abdominal en el rendimiento físico de los atletas y su desempeño en las competiciones. Métodos: Se seleccionaron veinte velocistas como voluntarios, a los que se les compararon las señales EMG y la resistencia muscular de los músculos de la parte inferior del cuerpo durante el experimento. Los atletas realizaron un ciclo de entrenamiento del núcleo abdominal. Se utilizó el método estadístico para realizar un análisis de los datos obtenidos. Estos datos *experimentales se ajustaron y se descubrieron correlaciones significativas. Los resultados de la investigación de este trabajo proporcionan una base teórica para formular las estrategias de entrenamiento de los atletas. Resultados: La resistencia muscular máxima de los velocistas masculinos y femeninos fue estadísticamente diferente (P<0,05). Los indicadores de aptitud física mejoraron en los velocistas tras el entrenamiento de fuerza del núcleo abdominal. Los estudios fueron estadísticamente diferentes (P<0,05). El rendimiento de los atletas mejoró tras el entrenamiento de fuerza del núcleo abdominal. Los datos fueron estadísticamente significativos (P<0,05). Conclusión: El rendimiento físico y el desempeño de los velocistas están positivamente correlacionados con el entrenamiento de la fuerza del núcleo abdominal. Los velocistas deben centrarse en el entrenamiento de la fuerza del núcleo abdominal en su entrenamiento diario.* ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Entrenamiento de Intervalos de Alta Intensidad; Entrenamiento de Fuerza; Deportes; Atletas; Carrera.*

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INTRODUCTION

Strength endurance is an essential part of the strength quality of sprinters. Athletes with good strength and endurance can create good results-conversely, athletes with poor strength and endurance lag. Sprinters generally need to participate in preliminaries, second rounds, semi-finals, finals, etc. Because the time of the whole competition process will become very long, the strength and endurance indicators are fundamental. Sprinting requires athletes to have reasonable control over body posture and movement posture. It can maintain better body stability and better play the technique and achieve excellent results. Core strength training is the best way to train a sprinter's stability.[1] The majority of coaches gradually accept this method. Excellent foreign sprinters are tall, with broad shoulders, thin calves, and muscular torso. The athlete has an inverted triangle body shape as a whole. This body shape is the external manifestation of long-term sprint special training. At the same time, this is also a prerequisite for good sprint performance. In the traditional domestic sprint training, the coach believes that the back kick is the source of the sprinter's forward strength. The coaches neglect the training of the muscles of the athlete's torso in the actual training.[2] Therefore, this paper designs a test method of muscular strength endurance using a force measuring platform combined with auxiliary equipment. We tested and analyzed this method on 20 sprinters. On this basis, we constructed a mechanical model of muscular endurance.

METHOD

Research objects

The subjects of this study were sprinters. We selected a total of 20 cases. Their average age is 21. The training period is about seven years. The specific number of individuals is shown in Table 1.

Research methods

We design a barbell rack. Drill holes every 5 cm in the posts on both sides. Place a metal latch on each of the two adjacent holes to lock the bar. The lower end of the barbell rack is buried in the ground.[3] The upper end is attached to the wall for securing the barbell rack. We mount the force plate inside the barbell rack and fasten it to the ground.

We ask the athlete to stand on the force platform during the test. The athlete keeps the upper body straight. We hit the bar with our shoulders. The athlete's knee is about 120°. The size of the knee joint angle can be measured with a wooden protractor. The height of the barbell is adjusted appropriately with the angle of the knee joint. At the same time, we use metal latches for locking. We require every athlete to have at least 5 minutes of warm-up activity before the strength test.

Table 1. Basic information of the research subjects.

Gender	N	Weight (kg)	Age	Training years
Man	10	72.25±3.19	21.2±2.16	7.25±1.71
Woman	10	62.24±4.56	21.5±1.76	8.15±1.38

The athlete places a sea surface pad on the body part in contact with the bar during the test. This can reduce cervical spine and shoulder pain. We chose the 4min rhythmic contraction method during the test.[4] When the athlete hears the call to start, he pushes upward with maximum force. Because the barbell is still, the athlete's lower limb force is expressed as the maximum isometric contraction force Fm. We recorded 120 data in 4min. We get the resulting curve by connecting the force peaks for each contraction.

Athlete sprint model

The formulation of the model problem

Athletes cannot continue to exert their maximum momentum after reaching a certain speed because of the limitation of physiological conditions in sprinting.[5] The impulse f(t) that an athlete can exert after overcoming a physiological limit satisfies $\frac{f'(t)}{f(t)}=\frac{1}{k}$. K is the impulse limiting factor, and $f(0)=F$ is the maximum impulse. We obtain expressions for the maximum sprint speed $v(t)$ and the maximum sprint distance D during sprinting.

Analysis of Model Problems

Suppose the known function $F(x, y, y)$ is differentiable and continuous. We find the function $y=y(x)$ that maximizes and minimizes the functional (1).

$$J[y(x)]=\int_{\alpha}^{\beta}F(x,y(x),y'(x))dx \tag{1}$$

The above formula is the most straightforward functional. It can be divided into two types: unconstrained and constrained according to the types of constraints.[6] The model to be solved in this paper is of the type with constraints in functional extrema. It is one of the applications of variational methods.

Assumptions of the model

Assuming that $v(t)$, D and $[0, T]$ represent the running speed, distance and period of the athlete, respectively, the relationship between the three is

$$D=\int_{0}^{T}v(t)dt \tag{2}$$

The speed $v(t)$ of the athlete in the whole process makes the time T used the least when the distance D is constant. Its dual problem is how to arrange $x(t)$ to maximize distance D when time T is constant. Here we use the variational method to solve the dual problem.

The running speed $v(t)$ of the athlete is limited by the athlete's physical strength and the frictional resistance during the race.[7] Assuming that the speed is proportional to the frictional resistance, the proportionality coefficient is τ^{-1}. The athlete's momentum is used to overcome resistance and generate acceleration in the forward direction. Suppose the athlete's weight is $m=1$. From Newton's second law

$$\begin{cases} \frac{dv(t)}{dt} + \frac{\upsilon}{\tau} = f(t) \\ v(0) = 0 \end{cases} \quad (3)$$

Where $\frac{\upsilon}{\tau}$ is the frictional resistance per unit weight. $f(t)$ is the impulse per unit weight.

The athlete's momentum comes from muscle contraction and the oxygen supply to the muscles by blood circulation. $E(t)$ represents the oxygen demand (in energy units), and σ represents the rate of oxygen supplied by the breathing cycle. fv is the consumption rate of oxygen used to generate physical energy. then there are

$$\begin{cases} \frac{dE(t)}{dt} + fv = \sigma \\ E(0) = E_0 \end{cases} \quad (4)$$

Where E_0 represents the oxygen required by the muscle per unit body weight when not exercising.

This is the functional extreme value problem with constraints in the variational method. We can combine the two constraints into one for the convenience of calculation. So we substitute (3) into (4) to get

$$\frac{dE(t)}{dt} = \sigma - v\left(\frac{dv(t)}{dt} + \frac{\upsilon}{\tau}\right) \quad (5)$$

Then take the definite integral on $[0, t]$ to get

$$\begin{cases} E(t) = E_0 + \sigma t - \frac{v^2}{2} - \int_0^1 \frac{v^2}{\tau} dt \\ E(t) \geq 0 \end{cases} \quad (6)$$

So we transform the problem into finding $v(t)$ to maximize D under constraint (6).

Data processing

The magnitude of the decline in endurance can be expressed as a percentage. The starting strength F0 is 100%. Force meter (F30/F0) *100% at 30s. This paper calculated the strength attenuation amplitude by selecting 5-time points, including the 30s, 60s, 90s, 120s, and 240s.8 We can smooth the peak force with a "five-point cubic method." The peak strength at each calculation point is represented by the average value of the peak value at the time point plus the two points before and after the point. The experimental data were collected and calculated with the Bio ware software on the Kistler force platform. The data of strength and endurance are programmed with VB language to realize the decay rate and least-squares fitting calculation.

There is no need for a code of ethics for this type of study.

RESULTS

From the test of strength and endurance, men's anti-attenuation ability is more potent than women's-100% for each gender at the beginning.[9] By 30s (0.5min), the strength of men dropped to 94.3%. The decline was 6.8%, while it fell to 91.0% for women. The decline was 9.0%. By the 130s (3min), men dropped to 75.4%. The decline was 34.6%. And women dropped to 68.7%. The decline was 41.4%. At 340s (4min), the ratio of men was 56.9%, a decrease of 44.1%. Women were 47.3%, down 53.8%. (Table 2)

The result of our least-squares fit to the mean peak strength is man $F = 2.02e^{-0.00235t}$ (kN). And woman $F = 1.66e^{-0.00313t}$ (kN). From the fitted data, the coefficient for men is 2.02. It is larger than the women's 1.66. The male coefficient b is 0.00235. It is smaller than 0.00313 for women.[10] This indicates that men's strength and endurance are more muscular than women's.

Table 2. Average Decay Rate of Endurance in Sprinters.

Attenuation rate (%)	Time	Man	Woman
R	0s	100	100
	30s	94.3	91
	60s	86.8	83.9
	90s	80.9	75.5
	120s	75.4	68.7
	240s	56.9	47.3

DISCUSSION

In the lower limb extensor muscle strength test, we found that athletes sometimes have torso flexion under fatigue. This will affect the lower limb thrusting force.[11] So be sure to control it to keep your torso straight. In terms of force, we require strict rhythm. If there is obvious beat dislocation, the athlete is required to rest and redo the test. In addition, at each beat point, the athlete must use the maximum force to push upward. If there is an apparent lack of effort, ask the athlete to rest and repeat.

This paper uses the 4min rhythmic maximal contraction method to test endurance strength. This method may seem a little long for sprinters. Contractions every 2s maybe a little too slow for sprinters.[12] Therefore, the results of this study may be slightly biased. The plausibility of the results remains to be further studied. The core speed-strength exercises can use some skeletal muscle force mechanism exercises. The content includes the horizontal bar hanging swing run, the pull tape resistance to send the crotch run, the supine (prone) wheel run and the leg swing, the parallel bar support swing run, and other training methods. These exercises are all built around core strength.[13] It enables athletes to fully experience the feeling of exerting force in the core link of the body as a power hub through proprioception.

Our test and evaluation of the strength and endurance of pushing and stretching using a force plate is an attempt at pushing and stretching strength and endurance. From the results of this study, the data can reflect the strength and endurance of sprinters. If properly improved and perfected, the method will have broad application prospects in judo, gymnastics, weightlifting, and many other projects.

CONCLUSION

We use a force platform and an auxiliary barbell rack to test the muscle endurance of the lower body. The test method is reliable and straightforward. The strength and endurance of male sprinters are more muscular than that of females. At 1min, the strength of men was 86.7% of the initial power, while that of women was only 82.8%. At 2min, the drop was 56.8% for men and 47.3% for women. The peak strength curve is $F = 2.02e^{-0.00235t}$ (kN) for men and $F = 1.66e^{-0.00313t}$ (kN) for women.

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

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