A STUDY ON THE EFFECTIVENESS OF MUSCLE STRENGTH GAIN TRAINING IN RUNNING ATHLETES

UM ESTUDO SOBRE A EFICÁCIA DO TREINAMENTO DE GANHO DE FORÇA MUSCULAR EM ATLETAS DE CORRIDA

UN ESTUDIO SOBRE LA EFICACIA DEL ENTRENAMIENTO DE GANANCIA DE FUERZA MUSCULAR EN ATLETAS QUE CORREN

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Hongyu Wang[1]
(Physical Education Professional)

1. Baotou Teachers College, Baotou, China.

Correspondence:
Hongyu Wang, Baotou, China, 014030.
xuerongrong0310@163.com

ABSTRACT

Introduction: Muscle strength training can increase the strength of the phasic muscles, aiding in balance and body stability. Running is a physical-dominant speed sport where strength-speed is two crucial quality in the athletic training of its practitioners. It is believed that training muscle strength at high-intensity intervals can increase athletic speed performance. However, there is no determinant point to determine the peak of this relationship. Objective: The purpose of this study is to examine the effect of high-intensity interval muscular strength training on the physical conditioning of athletes. This paper also examines the relationship between muscular strength training and performance training in sprinters. Methods: Twenty sprinter volunteers were randomly selected as research subjects, divided without discrepancies into control and experimental groups, with ten people each. Mathematical statistics were used to analyze the physiological indicators of the subjects before and after muscle strength training. At the same time, the statistical correlation method was applied to analyze the performance changes of athletes before and after the exercise cycle. Results: After muscle strength training, the athletes in the experimental group were better than those before the training. The data were statistically significant (P<0.05). Conclusion: Muscle strength training can promote the physical conditioning of sprinters. At the same time, the training mode can also improve the athlete's performance. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

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

RESUMO

Introdução: O treinamento de força muscular pode aumentar a força dos músculos fásicos, auxiliando no equilíbrio e na estabilidade corporal. Correr é um esporte de velocidade físico-dominante onde força e velocidade são duas qualidades cruciais na capacitação atlética dos seus profissionais. Acredita-se que o treino da força muscular em intervalos de alta intensidade possa aumentar o desempenho da velocidade atlética, porém não há um ponto determinante onde determinar o pico dessa relação. Objetivo: O objetivo deste estudo é analisar o efeito do treinamento de força muscular intervalado de alta intensidade no condicionamento físico dos atletas. Este artigo também examina a relação entre treinamento de força muscular e treinamento de desempenho em velocistas. Métodos: Selecionou-se aleatoriamente 20 voluntários velocistas como sujeitos de pesquisa, divididos sem discrepâncias em grupos controle e experimental, com dez pessoas cada. Utilizou-se estatísticas matemáticas para analisar os indicadores fisiológicos dos indivíduos antes e depois do treinamento de força muscular. Ao mesmo tempo, aplicou-se o método de correlação estatística para analisar as mudanças de desempenho dos atletas antes e depois do ciclo de exercícios. Resultados: Após o treinamento de força muscular, os atletas do grupo experimental foram melhores do que os anteriores ao treino. Os dados foram estatisticamente significativos (P<0,05). Conclusão: O treinamento de força muscular pode promover o condicionamento físico dos velocistas. Ao mesmo tempo, o modo de treinamento também pode melhorar o desempenho do atleta. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

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

RESUMEN

Introducción: El entrenamiento de la fuerza muscular puede aumentar la fuerza de los músculos fásicos, ayudando en el equilibrio y en la estabilidad corporal. Correr es un deporte de velocidad con predominio físico en el que la fuerza-velocidad son dos cualidades cruciales en la formación atlética de sus practicantes. Se cree que el entrenamiento de la fuerza muscular en intervalos de alta intensidad puede aumentar el rendimiento de la velocidad atlética, sin embargo, no existe un punto determinante donde determinar el pico de esta relación. Propósito: El propósito de este estudio es examinar el efecto del entrenamiento de fuerza muscular por intervalos de alta intensidad en el acondicionamiento físico de los atletas. Este documento también examina la relación entre el entrenamiento de la fuerza muscular y el entrenamiento del rendimiento en los velocistas. Métodos: Se seleccionaron aleatoriamente veinte voluntarios velocistas como sujetos de investigación, divididos sin discrepancias en grupos de control y experimental,

con diez personas cada uno. Se utilizaron estadísticas matemáticas para analizar los indicadores fisiológicos de los individuos antes y después del entrenamiento de la fuerza muscular. Al mismo tiempo, se aplicó el método de correlación estadística para analizar los cambios en el rendimiento de los atletas antes y después del ciclo de ejercicios. Resultados: Tras el entrenamiento de la fuerza muscular, los atletas del grupo experimental fueron mejores que los anteriores al entrenamiento. Los datos fueron estadísticamente significativos (P<0,05). Conclusión: El entrenamiento de la fuerza muscular puede favorecer la condición física de los velocistas. Al mismo tiempo, el modo de entrenamiento también puede mejorar el rendimiento del atleta. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

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

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INTRODUCTION

Core strength training is a training method introduced from rehabilitation to sports in our country. Especially in recent years, theoretical research on sports training has advanced by leaps and bounds, and core strength training has been rapidly applied to various sports. Researchers have found that almost all sports are based on the core muscle group in the center of the human trunk as the human body's kinematic chain. The human body stabilizes posture through the action of core strength.[1] At the same time, core strength training can improve motor skills and special skills. Only in this way can exercise create good sports performance. When we compare the characteristics of physical fitness training of modern and traditional printers, we can find that the traditional sprint training process attaches great importance to the training of limb muscle groups. But athletes often ignore or don't train core muscles. This results in a prolonged improvement in the performance of the athlete. We found that sprinting requires exceptionally high core muscle groups from sports training. Athletes need core muscles to control body posture, movement posture and maintain the stability of specific techniques. This will get better results.

Modern core strength training complements traditional sprinting fitness training. It is also the primary trending method for training now and in the future. In this study, the core strength training theory was introduced into the special strength training of sprinting for middle school students according to the characteristics of sprinting.[2] This study aims to explore a systematic core practice method suitable for sprinters. This can help middle school sprinters fully understand core strength and make reasonable use of core strength. Athletes can use the most direct and effective training methods to improve the ability to synergize force. This way, the athlete's strength, and technical potential can be fully utilized.

METHOD

Research objects

In this paper, 30 male sprinters in the youth palace were selected as the test subjects of this study.[3] The above athletes all have a history of lumbar, spine, hip, and knee injuries. The mean age of the tested sprinters was 14.2±1.4 years. The average time spent in special training was 1.3±0.5 years. We randomly divided the test subjects into a control group and an experimental group, with ten people in each group. Statistical analysis of the two groups of volunteers before the experiment found no significant difference in their strength. (Table 1)

Table 1. The speed index change table of the experimental group and the control group before the experiment (unit: s) n=30.

Test content	Test group	Control group	T	P
30m timed run/s	4.44±0.14	4.43±0.11	0.184	>0.05
60m timed run/s	7.3±0.13	7.13±0.04	0.196	>0.05
100m timed run/s	13.37±0.03	13.04±0.09	0.363	>0.05

Research methods

Documentation method

This article examines theoretical and practical material on sprinting, core strength training, and research related to teaching and training published over nearly ten years. We understand related theories' research status and development trends.[4] These data provide specific materials and basis for this study to determine the research direction, formulate the research plan design, and the overall structure of the thesis.

Experimental method

The athlete uses only the mat for the first phase of core strength training. This exercise stage aims to let the athlete experience the feeling of muscle force during core strength training.[5] Athletes learn and master the technical essentials of core strength training. At the same time, it improves the functional state of athletes' core muscles, ligaments, joints, and tendons.

Exercise load: 5 or more training methods are arranged in each session.[6] We arrange each exercise for 30~60s according to the difference in the difficulty of the movements. The ratio of practice time to rest time is 1:2. The rest between groups is 2 to 3 times the rest between groups.

The second stage is 7-12 weeks. Train 2 times a week. Each training time is about half an hour.

Exercise load: More than five training methods are arranged in each training session, and each exercise is trained in 4 groups. We arrange each exercise for 30~60s according to the difficulty of the movement.[7] The ratio of practice time to rest time is 1:2. The rest between groups is 2 to 3 times the rest between groups.

The training regimen for the control group: The control group used traditional strength training. Athletes use barbells, dumbbells, kettlebells, combination training equipment, and freehand strength training for strength training. The training schedule is divided into 3 phases. The preparation period is 1 to 4 weeks. The muscle strength and coordination training phase are 5 to 8 weeks. The muscle power and endurance training phase are 9 to 12 weeks. The strength training program should be changed every few weeks to improve performance.[8] We arrange the strength training program in reasonable stages during the ten weeks of training. The initial training should be non-specific strength training and then gradually turn to special training.

Mathematical Statistics

We perform statistical analysis on the data of the pre-experiment and post-experiment tests.[9] In this way, the influence of core strength training on the technical performance of technical cheerleading was explored.

Variational Athlete Sprint Model

It is assumed that the impulse f(t) that the athlete can exert after overcoming the physiological limitation satisfies $\frac{f'(t)}{f(t)} = \frac{1}{k}$. k is the impulse limiting factor. $f(0) = F$ is the maximum impulse.[10] We need to find

expressions for the maximum sprint speed $v(t)$ and the maximum sprint distance D during sprinting. Suppose the known function $F(x, y, y)$ is differentiable and continuous. Solving the function $y = y(x)$ maximizes or minimizes the functional (1).

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

Let $v(t), D$ and $[0,T]$ denote the running speed, distance and period of the athlete, respectively. The relationship between the three is

$$D = \int_0^T v(t)dt \quad (2)$$

The problem in sprinting is to arrange the speed $v(t)$ of the athlete in the whole process so that the time T used is the least when the distance D is constant. The dual problem is to arrange $x(t)$ to maximize the distance D when the time T is constant. Here, the variational method is used 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.[11] 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. We assume that the weight of the athlete is $m = 1$.

The first stage

This is the initial stage of the sprint. The athlete runs forward with maximum momentum. The speed must satisfy $\begin{cases} \frac{dv(t)}{dt} + \frac{v}{\tau} = F \\ v(0) = 0 \end{cases}$. The maximum sprint speed in the initial stage of the sprint competition is solved as

$$v_1(t) = F\tau(1 - e^{-\frac{t}{\tau}}) \quad (3)$$

The maximum sprint distance is

$$D_1 = \int_0^{t_1} F\tau(1 - e^{-\frac{t}{\tau}})dt \quad (4)$$

t_1 is the duration of sprinting with maximum force. Substitute (4) into (5) to get:

$$E(t) = E_0 + (\sigma - F^2\tau)t + F^2\tau^2(1 - e^{-\frac{t}{\tau}}) \quad (6)$$

If $(\sigma - F2\,\tau) > 0$, then $E(t) \to +\infty$ is impossible when $t \to +\infty$. Derive the above formula

$$\frac{dE(t)}{dt} = (\sigma - F^2\tau)t + F^2\tau e^{-\frac{t}{\tau}} \quad (7)$$

The best performance is achieved if the athlete can run with maximum effort throughout the entire process.[12] Determine the maximum speed of the athlete at time t_1 at time t_1 $(0 < t \le t_1 < T)$. The athlete runs with maximum momentum during the time $[0, t_1]$. The determination of t_1 is left to the next stage of the calculation.

The second stage

Athletes overcome physical limitations in this phase. The impulse satisfies $\frac{f'(t)}{f(t)} = \frac{1}{k}$, and the solution is $f(t) = C_0 e^k$. This is a conditional extremum problem, that is, to find the extremum of functional (1) under condition (2). Let $I(v(t), f(t)] = \int_{t1}^{T} [H - \lambda(t)\, v'(t)]dtC$, where $H = (v(t) + \lambda(t)f(t) - \frac{v(t)}{\tau})$. The problem is transformed into a system of differential equations

$$\begin{cases} \lambda'(t) = \frac{\partial H}{\partial v} \\ \frac{\partial H}{\partial f} = 0 \\ v' + \frac{v}{\tau} = f \end{cases} \quad (8)$$

Solve that the maximum sprint speed in the second stage of the sprint competition is $v_2(t) = \frac{k\tau}{k-\tau}C_0 e^{-\frac{t}{k}} + Ce^{-\frac{t}{\tau}}$.

Because sprinting is an oxygen-deficient sport, the moment when the athlete overcomes physical limitations is the critical point between the two phases. $E(t) = E_0, \frac{dE(t)}{dt} = 0$. Substitute into (4) to solve $t_1 = -\tau \ln(1 - \frac{\sigma}{F^2\tau})$. The maximum sprint distance at this time is

$$\begin{aligned} D &= \int_0^{t_1} F_\tau(1 - e^{-\frac{t}{\tau}}dt) + \int_{t_1}^{T} (\frac{k\tau}{k-\tau}C_0 e^{-\frac{t}{k}} + Ce^{-\frac{t}{\tau}})dt \\ &= [\ln(1 - \frac{\sigma}{F^2\tau})^{-F,2} - \frac{\tau\sigma}{F}] + \tau[(kF - \frac{\sigma}{F}) - (\frac{k^2}{k-\tau}C_0 e^{-\frac{T}{k}} + Ce^{-\frac{T}{\tau}})] \end{aligned} \quad (9)$$

And from $f(t_1) = F$, $v_2(t_1) = v_1(t_1)$, we can get: $C_0 = F(1 - \frac{\sigma}{F^2\tau})^{-\frac{\tau}{k}}, C = \frac{-F\tau^2}{k-\tau}(1 - \frac{\sigma}{F^2\tau})^{-1} - F\tau$. Substitute C_0, C into the above calculation formula of speed and distance to get the final result.

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

RESULTS

After 12 weeks of traditional strength training in the control group, all three indicators tested improved to some extent. And the performance of the experimental group was significantly better than that of the control group ($P < 0.05$). The experimental group where the youth palace sprint student-athletes belonged implemented core strength training. Because of core strength training, the sprinter's ability to rebuild quickly is enhanced. (Table 2)

DISCUSSION

The experimental group can effectively improve the stability of the core muscle group of middle school student sprinters under the effect of this training program. The strength of the abdominal, hip, and abdominal muscle groups and the deep small muscle group of middle school sprinters guarantees the athlete's stability. The athlete is in a constant principle state during running. An athlete's lower extremity produces a forward rotational moment while necessarily producing a rotational moment opposite. This is how to achieve balance. The experimental group of sprint student-athletes improved their physical fitness by using the unstable training method of the equipment. This has played a perfect role in promoting the power transmission effect of the dynamic movements of the sprint student-athletes.

Table 2. Changes in the speed index of the experimental group and the control group after the experiment.

Test content	Test group	Control group	T	P
30m timed run/s	4.41±0.11	4.19±0.13	0.003	<0.05
60m timed run/s	7.19±0.02	7.04±0.01	0.004	<0.05
100m timed run/s	13.24±0.03	13.01±0.05	0.013	<0.05

CONCLUSION

The experimental group can significantly improve the speed and strength of athletes through relevant core strength training. The effect of core strength training on improving the explosive force and movement speed of sprint student-athletes is better than that of power and braking force. Core strength training for middle school sprint student-athletes is not just a simple addition to traditional strength training but a complementary relationship. The exercise load intensity should not be too large when sprinters perform core stability training. We need to remind players to be more attentive to prevent injuries. At the same time, the coach should strengthen protective measures. The coach should emphasize strength quality, balance, and coordination ability in sprint strength training. Athletes need to combine core stability training with traditional waist and abdominal strength training. Coaches should continue to learn the theory and training methods of core strength training in depth. The school sports management department should study more training methods combined with the special training of sprinting for middle school students.

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