IMPACT OF CORE STRENGTH TRAINING ON YOUNG DARTS THROWERS

IMPACTO DO TREINO DE FORÇA NO CORE EM JOVENS PRATICANTES DE ARREMESSO DE DARDOS

IMPACTO DEL ENTRENAMIENTO DE FUERZA EN JÓVENES PRACTICANTES DE LANZAMIENTO DE DARDOS

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ABSTRACT

Introduction: Recent research on core strength training of young athletes is vague and inconclusive. The lack of complete understanding about the relevance of core training programs still keeps some coaches wary in their training practice. Objective: Explore the impact of core strength training on young athletes' physical fitness and sports ability. Methods: Young athletes on the javelin throwing team underwent a bi-weekly core strengthening protocol for 16 weeks. Biomechanical changes were acquired by biomechanical kinematic analysis, and index data were worked out statistically. Results: Core strength training developed the latissimus dorsi, external oblique muscles, erector spine, and hip extensor muscles of athletes and improved stability in spine motion (P<0.05). Conclusion: Core strength training significantly affects developing specific skills in darts-throwing athletes. The training has been shown to increase athletes' interest in the sport. ***Evidence level II; Therapeutic Studies – Investigating the results.***

Keywords: Strength training; Track and field; Sports; Athletes.

RESUMO

Introdução: Pesquisas recentes sobre o treino de força no core de jovens atletas são vagas e inconclusivas. A ausência da total compreensão sobre a relevância dos programas de treinamento no core ainda mantém alguns treinadores receosos na prática de seu treino. Objetivo: Explorar o impacto do treino de força no core sobre a aptidão física e a capacidade esportiva de jovens atletas. Métodos: Jovens atletas da equipe de arremesso de dardos passaram por um protocolo de fortalecimento do core, bissemanal por 16 semanas. As alterações biomecânicas foram adquiridas por análise cinemática biomecânica e os dados indexadores foram trabalhados estatisticamente. Resultados: O treinamento da força central desenvolveu o latíssimo do dorso, os músculos oblíquos externos, os espinhais eretos e os músculos extensores do quadril dos atletas, além de aprimorar a estabilidade no movimento da coluna vertebral (P<0,05). Conclusão: O treino de força do core tem um efeito significativo sobre o desenvolvimento de habilidades específicas nos atletas de arremesso de dardos. O treino demonstrou aumentar o interesse dos atletas pela prática esportiva. ***Nível de evidência II; Estudos terapêuticos - Investigação de resultados.***

Descritores: *Treinamento de Força; Atletismo; Esportes; Atletas.*

RESUMEN

Introducción: Las investigaciones recientes sobre el entrenamiento de la fuerza en el core de los jóvenes atletas son vagas y no concluyentes. La falta de comprensión total sobre la relevancia de los programas de entrenamiento básico todavía mantiene a algunos entrenadores recelosos en su práctica de entrenamiento. Objetivo: Explorar el impacto del entrenamiento de la fuerza del core en la aptitud física y la capacidad deportiva de jóvenes atletas. Métodos: Los jóvenes atletas del equipo de lanzamiento de dardos se sometieron a un protocolo quincenal de fortalecimiento del core durante 16 semanas. Los cambios biomecánicos se adquirieron mediante un análisis cinemático biomecánico y los datos del índice se elaboraron estadísticamente. Resultados: El entrenamiento de la fuerza del core desarrolló el dorsal ancho, los músculos oblicuos externos, los erectores de la columna y los músculos extensores de la cadera de los atletas, y también mejoró la estabilidad en el movimiento de la columna (P<0,05). Conclusión: El entrenamiento de la fuerza del core tiene un efecto significativo en el desarrollo de habilidades específicas en los atletas que lanzan dardos. Se ha demostrado que el entrenamiento aumenta el interés de los atletas por la práctica deportiva. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Entrenamiento de Fuerza; Atletismo; Deportes; Atletas.*

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INTRODUCTION

Traditional strength training gives athletes a strong muscle group, which plays an important role in increasing athletes' movement speed and performance. But in fact, the strong muscles of many athletes have not completely transformed into specific strength. Nowadays, the research on core strength training in the training field is more on the vague and theoretical level. Not fully aware of the pertinence of core strength training programs.[1] It is very common for some coaches to grasp the eyebrows and beards during the core strength exercises during the training process. In particular, the design of training methods and means related to sports events needs to be further studied. Therefore, this research focuses on the research of core strength training in the

training of javelin throwers. Strive to summarize and refine special training methods for high-level male javelin athletes' core strength training. The article hopes to provide a reference for continuously improving the scientific level of China's high jump training.

METHOD

Research object

The subjects were five male javelin throwers on the track team. They are in the same training group and are guided by the same coach.[2] Core strength training is conducted every Tuesday and Thursday. Before and after the experiment, the videos of the best test jump scores of 5 subjects were taken for analysis.

Research methods

The experiment divides core strength training into five units. Each unit is scheduled for core strength training on Tuesdays and Thursdays, and each unit is scheduled for 4 weeks. The duration is 16 weeks.

The first unit arranges static movements in a stable state.[3] This allows athletes to deeply appreciate the strength of the core muscles and improve the ability to control the stability of the center of gravity. At the same time, this exercise training improves the functional status of the core muscles, ligaments, joints, and tendons.

The second unit arranges static movements in an unstable state; forward lunges with the front foot on the Swiss ball, sitting on the ball, raising the waist, kneeling on the ball, standing on the ball, standing on the balance board, and leaning on the bridge, Folding bridge with fixed feet, etc. This level of training can more directly mobilize the involvement of deep muscles and nerves to improve the stability of the core.

The third unit arranges exercises that overcome one's resistance in an unstable state. Such as double-foot support ball left-right rotation hip pull ball, double-arm pull back on the Swiss ball, single-leg support ball, swing suspension training, etc.

Sports biomechanics video measurement method

Video shooting method the training venue uses two SONY-120X cameras to shoot the male javelin athletes at fixed points. Machine A is located on the side close to the athlete's throwing arm, which is 20m perpendicular to the centerline of the runway. Machine B is located 10m after the approach to the top of the arc. The main optical axis is parallel to the auxiliary runway.[4] The entire shooting process is always fixed-point and fixed-focus, and the shooting range starts from the post-run-up stage to the whole process of the javelin shot.

Mathematical Statistics

The average difference and standard deviation of each index are calculated by computer processing on the obtained indexes. The correlation coefficient between the indicators and the significance of the correlation degree is tested.

Athletics high-density crowd simulation algorithm

Assuming that the distance between individuals is as small as a certain value, they will not get close again. Then the distance is the minimum distance between people, denoted by $d_{\min}$. Based on this, the upper limit of the population density ρ_M can be given, which we call the UIC restriction rule:

$$\rho \le \rho_M = 2\alpha / (\sqrt{3} d_{\min}^2) \quad (1)$$

ρ_M indicates the maximum density allowed. The parameter $\alpha \le 1$ represents the degree of closeness between individuals.[5] According to the continuity of the crowd model, the density ρ and the speed v satisfy the continuity equation:

$$\frac{\partial \rho}{\partial t} + \nabla \times (\rho v) = 0 \quad (2)$$

Assuming that the crowds try their best to move in their desired direction at the maximum speed while avoiding collisions, the selection of the correction speed v aims to maximize the integral $\int \rho v \times \tilde{v}$. Meet the limitation of maximum movement speed $\|v\| \le v_{\max}$. According to the above conditions, the best form of correction speed v can be obtained:

$$v = \upsilon_{\max} \frac{\tilde{v} - \nabla p}{\|\tilde{v} - \nabla p\|} \quad (3)$$

"Pressure" p satisfies the following conditions:

$$\rho < \rho_{\max} \Rightarrow p = 0 \quad (4)$$

$$p > 0 \Rightarrow \nabla \times v = 0 \quad (5)$$

In formulas (4) and (5), p indicates that there is a non-negative pressure item in the crowd flow. It is used to prevent crowds from gathering to cause the density to be higher than the maximum value ρ_M. Under the influence of pressure p, the individual will strengthen the speed correction to obtain the maximum allowable speed $v_{\max}$. The formula (4) can also be expressed as the formula (6):

$$p > 0 \Rightarrow \rho = \rho_{\max} \quad (6)$$

RESULTS

The effect on the rear trunk angle of the fourth step of the approach

A moderate torso tilt angle is conducive to the formation of a "full bow" state, is the prerequisite and guarantee for the force of the whiplash, and "is conducive to the final force of the trunk and chest strap arm and the speed of the shot." Before the experiment, the torso angle $X = 17.65^{\circ}$ of the male javelin thrower in the fourth step was far behind the elite athlete $(X = 20.25)$. This causes the athlete to fail to effectively maintain the overtaking equipment formed in the cross step in the fourth step before the final exertion and reduce the extent of the overtaking equipment to form stable support on the left side.[6] This results in the loss of overtaking in the final exertion. And shortens the effective working distance that has been obtained. During the training, the athlete's ability to control the hip and waist muscles was improved. The athlete's torso backward inclination in the fourth step of the approach run is 19.46° $(T = 0.391, P < 0.05)$. (Table 1)

Table 1. The backward angle of the athlete's trunk was analyzed in the fourth step before and after the experiment.

Group	N	X	S	T	P
Before the experiment	5	17.65°	1.24	0.391	<0.05
After the experiment	5	19.46°			

Influence on the maximum bending angle of the left knee joint during the final exertion

Before the experiment, the maximum bending angle of the left knee joint of the male javelin thrower X=154° during the final exertion is quite different from the average knee joint bending angle X=165° of the excellent javelin thrower during the least exertion. This causes the athlete's body to form a forward lunge position. Extend the time of the left leg support and push and disperse the momentum transmission of the left leg's braking force to the trunk, and at the same time reduce the full elongation of the full arch muscle group.[7] In this way, a strong "rigid" support is formed, and the left knee support is not firm when the final force is exerted, which affects the control and throwing effect. After the experiment, the maximum bending angle of the left knee joint X=160°, the result is close to the average bending angle of the excellent javelin athlete's knee joint X=165°. (Table 2) The significant difference before and after the experiment shows that their braking effect has been greatly improved. The training can effectively transfer the momentum gained from the approach to the weapon.

Impact on shooting speed

The pros and cons of the complete technique of throwing events mainly depend on the coordination between the muscles involved in the exercise and the ability to control the center of gravity of the body during high-speed exercise. For example, the fast approach of the weapon not only requires athletes to have good physical fitness but, more importantly, they must have the ability to control equipment.[8] The formation and improvement of this ability mainly depend on the improvement of core strength. After 16 weeks of core strength training, athletes' internal obliques, external obliques, trapezius, erector spinae, serratus anterior, and other trunk muscles have been well exercised. It can be seen from Table 3 that there is a significant difference in the athlete's shooting speed before and after the experiment.

DISCUSSION

A throwing event is a whole-body movement involving multiple joints and multiple muscle groups (muscles). In this exercise, how to integrate the movement of different joints and the contraction of multiple muscles (muscle groups) to form a muscle "kinematic chain" that conforms to the laws of specific mechanics. This creates ideal conditions for the end of the limbs to exert force, which is also a problem facing throwing events.[9] Through core strength training, athletes' thigh anterior iliopsoas muscle, rectus femoris, adductor Magnus rectus femoris, sartorius muscle, tensor platysma, adductor longus, adductor brevis, adductor Magnus, psoas major, the rectus abdominis is related to the strengthening and improvement of the contraction function of the core muscles such as the internal obliques of the throwing arm and the opposite side of the external obliques. In addition, after core strength training, the athlete's ability to move smoothly in sports and withstand loads is improved.

From the mechanic's formula that determines the distance of the throw, it is known that the initial speed of the shot, the height of the shot, and the angle of the shot are the three major factors that affect the performance of the discus throw. The initial speed of the shot is the most important factor that affects the performance of the discus throw, and the initial speed of the shot is the cumulative result of the weapon in each stage of the completion of the throwing technique. The core strength can increase the power of the end muscles through proximal fixation. This has a key supporting role for the complete technology of the throwing event. The core strength can quickly and accurately transfer the strength of the lower limbs and trunk muscles to the upper limbs and gather the whole body's power in the "whipping" action of the weapon.

Table 2. Analysis of the maximum bending angle of the left knee joint before and after the experiment.

Group	N	X	S	T	P
Before the experiment	5	154°	2.25	0.45	<0.05
After the experiment	5	160°			

Table 3. Analysis of the athletes' shooting speed before and after the experiment.

Group	N	X	S	T	P
Before the experiment	5	29.4	1.87	0.15	<0.05
After the experiment	5	32.5			

CONCLUSION

Through the training of core strength, athletes' approach technique has been greatly improved. There is a significant difference in the speed of the athletes before and after the experiment. After 16 weeks of core strength training, the athlete's angle tends to be larger than the maximum bending angle of the left knee joint at the last exertion before training, and there is a significant difference. The maximum bending angle of the left knee joint is close to (X=165°). Core strength training developed the athletes' latissimus dorsi, external oblique muscles, erector spine, and hip extensor muscles to strengthen the stability of spinal movement. This makes the athlete's technique more reasonable in the fourth step of the approach, and the torso's backward angle is increased. The experiment proves that core strength training has a more significant effect on the development of the weapon's special ability and, at the same time, can increase the athlete's interest in practicing. This can mobilize the subjective initiative of the practitioner. This increases the fatigue threshold of the practitioner, who can withstand a greater amount of exercise.

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