STRENGTH TRAINING OF LONG JUMP ATHLETES

TREINAMENTO DA FORÇA DOS ATLETAS DE SALTO LONGO

ENTRENAMIENTO DE FUERZA DE LOS ATLETAS DE SALTO DE LONGITUD

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Peiying Zong[1]
(Physical Education Professional)

1. Department of Physical and Mental Health, Pingdingshan Polytechnic College, Pingdingshan, Henan, China.

Correspondence:
Peiying Zong
Henan, 467000, China.
azong2009@163.com

ABSTRACT

Introduction: Lower limb strength training is one of the daily exercises of jumpers. Heavy squats are a standard method of lower body strength training. The squat is the only compound movement that directly trains "hip strength." Objective: This study aimed to analyze the effect of weighted squats on lower body strength training in long jumpers. Methods: 20 jumpers were selected and randomly divided into a general training group and a weighted squat group. Then, the changes in standing triple jump, lateral jump, and Y-axis swing were analyzed before and after training under an experimental protocol. Results: The performance of the weighted squat group was better than that of the general training group about the explosive power of the lower body of long jumpers. The data were statistically divergent (P<0.05). There was no significant difference between the two groups in the Y-balance test related to the lower limbs (P>0.05). Conclusion: Squatting exercises with weight can improve the explosive power of lower limbs in jumpers. Long jumpers use a variety of jumping exercises to develop the rapid strength needed for their specialties, and this protocol can be added to training for a better athletic outcome. ***Level of evidence II; Therapeutic studies - investigating treatment outcomes.***

Keywords: Resistance Training; Sports; Athletes; Weight-Bearing.

RESUMO

Introdução: O treinamento de força nos membros inferiores é um dos exercícios diários dos saltadores. Os agachamentos pesados são um método padrão de treinamento da força inferior do corpo. O agachamento é o único movimento composto que treina diretamente a "força do quadril". Objetivo: Este estudo teve como objetivo analisar o efeito dos agachamentos ponderados no treinamento da força inferior do corpo em saltadores de salto em distância. Métodos: 20 saltadores foram selecionados e aleatoriamente divididos em um grupo de treinamento geral e um grupo de agachamento ponderado. Em seguida, as mudanças no salto triplo em pé, salto lateral e balanço no eixo Y foram analisados antes e depois do treinamento sob um protocolo experimental. Resultados: O desempenho do grupo de agachamento com peso foi melhor que o do grupo de treinamento geral no que se refere ao poder explosivo da parte inferior do corpo dos saltadores de salto em distância. Os dados foram estatisticamente divergentes (P<0,05). Não houve diferença significativa entre os dois grupos no teste de balanço em Y relacionados aos membros inferiores (P>0,05). Conclusão: Os exercícios de agachamento com peso podem melhorar o poder explosivo dos membros inferiores nos saltadores. Os saltadores de salto longo utilizam uma variedade de exercícios de salto para desenvolver a força rápida necessária para suas especialidades e esse protocolo pode ser adicionado ao treino para um melhor resultado atlético. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Treinamento de força; Esportes; Atletas; Suporte de Carga.*

RESUMEN

Introducción: El entrenamiento de la fuerza de los miembros inferiores es uno de los ejercicios diarios de los saltadores. Las sentadillas pesadas son un método estándar de entrenamiento de la fuerza de la parte inferior del cuerpo. La sentadilla es el único movimiento compuesto que entrena directamente la "fuerza de la cadera". Objetivo: Este estudio tiene como objetivo analizar el efecto de las sentadillas con peso en el entrenamiento de la fuerza del tren inferior en saltadores de longitud. Métodos: Se seleccionaron 20 saltadores y se dividieron aleatoriamente en un grupo de entrenamiento general y un grupo de sentadillas con peso. A continuación, se analizaron los cambios en el triple salto de pie, el salto lateral y el equilibrio en el eje Y antes y después del entrenamiento con un protocolo experimental. Resultados: El rendimiento del grupo de sentadillas con peso fue mejor que el del grupo de entrenamiento general en lo que respecta a la potencia explosiva de la parte inferior del cuerpo de los saltadores de longitud. Los datos fueron estadísticamente divergentes (P<0,05). No hubo diferencias significativas entre los dos grupos en la prueba de equilibrio en Y relacionada con las extremidades inferiores (P>0,05). Conclusión: Los ejercicios de sentadilla con peso pueden mejorar la potencia explosiva de los miembros inferiores en los saltadores. Los saltadores de longitud utilizan una variedad de ejercicios de salto para desarrollar la fuerza rápida requerida para sus especialidades y este protocolo puede añadirse al entrenamiento para un mejor resultado atlético. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

***Descriptores*:** *Entrenamiento de Fuerza; Deportes; Atletas; Soporte de Peso.*

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INTRODUCTION

The long-jump is a flexible sport that combines periodic and aperiodic. The combination of good physical fitness and professional sports skills guarantees long jumpers achieve excellent results. The explosive power of the muscles plays a crucial role in the movement. The development of explosive power training is the top priority of our long jumpers. The "weight-bearing squat" is the most complicated exercise in bodybuilding and a prescribed movement with many exercise parts.[1] The "weight-bearing squat" strongly stimulates the entire lower body and trunk. It can exercise the quadriceps femoris (rectus femoris, vastus medius, vastus lateralis, vastus medialis), gluteus maximus, biceps femoris, Semitendinosus, semimembranosus. At the same time, it also has a strong effect on the erector spine, piriformis, adductor Magnus, gluteus medius, gluteus minimus, and calf muscles. Therefore, practicing "weight-bearing squats" can be compulsory for professional athletes and amateur bodybuilders. This article intends to discuss the physiological basis of developing explosive power in the long jump from the perspective of weight-bearing squat training.

METHOD

Training method

This paper divided the experimental subjects into parallel groups according to grades, gender, years of training, height, and weight. Athletes follow traditional training methods as an everyday training group. Athletes use vest weights for weighted squat sets. The experimental period lasted 12 weeks, three times a week. Long jumpers perform vest weights every time they perform their regular training movements.[2] The weight-bearing weight starts at 10% to 13% of body weight. Athletes must ensure the correctness of their movements when training with weights. The general training group and the weight-bearing squat group strive to be the same in training methods, the number of exercises, the number of times, and the interval between sets. We collect the raw data of the two groups before the experiment. We collect post-experimental data after 12 weeks of training.

Design of simulation device for long jumper's leg muscle force

In this paper, the inertia parameters are adjusted according to the output torque of the knee joint, and the OpenSim technology is used to realize the control of the athlete's leg and hip joint.[3] In this way, we get the relationship between the explosive force inertia parameters m_{L3} and m_{R3} of the long jumper's leg muscles:

$$N_f = P_f \pi D L \frac{m_{L3}}{m_{R3}} \tag{1}$$

Because the long jumper is affected by the forward speed and the driving parameters of the long jumper's leg motion, the knee joint moment expression of the long jumper's leg is:

$$F_{el} = ((P - P_e)D_0 - N_f)\frac{\sin\theta}{I_i} + 2Et_k \tag{2}$$

In formula (2) I_i is the moment of inertia of the long jumper's leg. This paper constructs a knee joint torque fusion model by actively adjusting the knee joint torque when the leg unit touches the ground.[4] At this time, the torque coefficient adjustment output is obtained in this paper:

$$\frac{dP}{dt} = -\frac{kTF_{el}}{V} - \frac{kP}{V}\frac{dx}{dt}\overline{A} \tag{3}$$

In formula (3) k represents the moment of inertia. V represents the working volume of the muscle chamber. T represents muscle temperature. This paper realizes the reliability simulation of the long jumper's leg muscle force by analyzing the force balance parameter. At this point, we get the active torque of the knee joint:

$$x' = 1 - \left(\frac{L_0 - x}{L_0}\right)^2 \cos^2\theta \tag{4}$$

In formula (4), x represents the muscle contraction displacement. The potential kinetic energy of the equivalent stiffness of the athlete's leg is denoted as E_{es}. This paper uses a linear spring in the mechanism.[5] The velocity kinetic energy expression of the mechanical explosive mechanism is:

$$E_v = \frac{\pi {E_{es}}^2 (L_0 - x)}{4\sin^2\theta} \tag{5}$$

In this paper, the Lagrange dynamic equation is substituted to realize the simulation of the long jumper's leg muscle force.

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

RESULTS

Enhancement of absolute power

The long jump is to jump the maximum distance through the movement of the human body to overcome its body weight. It is not enough for an athlete to have a sizeable absolute force in a brief period.[6] However, studies have demonstrated a significant correlation between absolute strength and relative explosive power. (Table 1) So, we increase absolute strength to help improve relative explosive power.

Weighted squat jump exercise

Weighted squat jumping exercises are the best way to develop rapid strength in your leg muscles. The long-jump is a speed-strength sport. Athletes need to adhere to the special weighted squat jumping exercises 3-4 times a week in their usual training.[7] The purpose is to improve the rapid force that directly affects the exceptional performance based on the continuous development of the maximum force. Because athletes have undergone a lot of weight-bearing squat exercises in the long jump training, the long jump performance has also been greatly improved. (Table 2)

The comparison P-value for the long jump event after 12 weeks of training was 0.02. The results showed differences.[8] After the test, the weight-bearing squat group performed significantly better than the general training group. This shows that the vest weighted squat training effect is significant. It outperforms traditional training methods. Weighted squat training can effectively improve long jump performance.

Table 1. Correlation between absolute strength and relative explosive power.

Absolute power	Standing long jump	Relatively explosive back and forth	50 yards run	Softball throw
Squat	0.32	0.53	0.39	0.55
Deadlift	0.53	0.63	0.53	0.54
Curl	0.45	0.55	0.38	-
Sit-ups	0.36	0.43	0.38	0.53
Bench press	0.39	0.37	0.51	0.52

Table 2. Comparison of athletic performance of long jumpers before and after training.

NO.	Standing long jump / m		Standing triple jump/m		Long jump score/m	
	Before training	After training	Before training	After training	Before training	After training
A	2.85	3.25	8.8	9.5	6.83	7.62
B	2.9	3.28	8.9	9.5	6.85	7.66
C	2.86	3.25	8.74	9.3	6.91	7.36
D	2.7	3.15	8.6	9.05	6.55	7.06
E	2.65	3.18	8.24	8.9	5.85	6.9

DISCUSSION

The effect of weight-bearing squat

"Loading" is an essential factor leading to changes in the tested muscles' level of recruitment and excitation. Under the condition of 30% RM weight-bearing subjects, trunk and lower extremity agonists all showed increased contractility. This is most likely related to the "weight" and "unsteady" conditions. The motor units of the muscles are sequentially recruited with increasing exercise intensity. When the weight-bearing degree reaches the maximum, the body will mobilize some new muscles (groups) that did not work in the stable state to participate in the movement to overcome the unstable state.[9] This type of training builds strength in muscles that are not mobilized or poorly mobilized at a steady state. Long-term training can lead to a decline in significant muscles strength. During training, coaches need to attach great importance to the influence of stable and unstable factors on weight-bearing strength training. Clarify the different roles of "unsteady" and "weight-bearing" in training. Athletes cannot simply view "unsteady" as a training tool to improve strength. Nor should the "weight-bearing" effect of unstable conditions be viewed as a one-way increase or decrease in muscle strength. Coaches need to distinguish between "freehand" and "weight-bearing" under unstable conditions and the different effects on moderate, low, and maximum loads of muscle strength.

Other training methods

Ankle strength exercises

During the long jump, the three joint muscles of the lower limbs, hip, knee, and ankle, should be exerted simultaneously. If the muscle strength of these three joints is insufficient when stepping, the cushioning of the distal joint and the elongation of the muscles will be weakened. This results in a greatly diminished utilization of muscle elasticity.[10] According to some data, 60% of the total force pushing the human body forward to run and jump comes from the ankle joint. Therefore, in the high-speed take-off, pay attention to strengthening the tension of the hip, knee, and ankle joints. Athletes should pay special attention to the training of ankle muscle strength. General athletes can use sand trap vertical jump, continuous hurdle jump, weight-bearing continuous vertical jump, weight-bearing standing heel raise, and other means to improve the strength of the ankle joint, Achilles tendon, and gastrocnemius muscle. The magnitude and load of the exercises vary from person to person. Athletes need to focus on ankle strength exercises. This is an integral part of improving the explosiveness of the long jump and reducing ankle injuries. During the long jump, the three major joints of the lower limbs must maintain a certain degree of tension.

Strength exercises for key muscle groups

While barbell exercises and squat weight-bearing exercises improve leg extensor strength and power, long jump hip flexibility and mobility have a lot to do with hip extension. In training, athletes still need to arrange some exercises to develop key muscle groups.11 The general athlete can use the support wood to swing the legs, lie down on the jumping box and raise the legs and pull the pimps to swing the legs. Our athletes can do exercises such as lying on their backs on the gymnastics mat, raising their hips, and bending forward with weights to strengthen their strength. The muscle's absolute strength, speed of movement, synchronous regulation of the movement center, development of the type II muscle fiber, and energy supply of the phosphagen system are the physiological basis for determining the explosive power of the long jumper. Long-term, systematic, and reasonable training can help improve these abilities. Barbell strength exercises are an essential and effective training method for developing rapid strength. The training intensity is generally once a week. The load should be controlled within 70%-90% of the maximum load. Move as fast as possible. In particular, the trainer should emphasize the transition speed of the muscle from eccentric contraction to concentric contraction. This will be more in line with the force requirements of a particular practice.

The above exercises must be practiced consistently throughout the year. At the same time, athletes need to choose the exercise method combined with the characteristics of muscle contraction in the unique technique of the long jump to maximize muscle strength. Only through the above methods can athletes achieve the purpose of developing explosive power.

CONCLUSION

Long jumpers use a variety of squat weight-bearing exercises to develop the rapid strength required for their specialties. These exercises are closer to the specific requirements regarding movement structure and force characteristics. And the weight of the squat is more about the speed of force. The weighted squat exercise is super isometric. The athlete uses the tension change produced by the elastic muscle body and the principle of muscle stretch reflex to change the falling height to control the load intensity. Its power value is dozens of times higher than that of the human body. This is a very effective means of developing explosiveness in the long jump. Athletes need to master the general squat weight training method in this training. While developing the maximum strength and explosive power of significant muscle groups, athletes should also arrange strength training for their opposing muscle groups and some small muscle groups. Only in this way can the development of power be balanced.

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