EXPLOSIVE STRENGTH TRAINING UNDER LOWER LIMBS IN SOCCER

TREINAMENTO DE FORÇA EXPLOSIVA SOB MEMBROS INFERIORES NO FUTEBOL

ENTRENAMIENTO DE FUERZA EXPLOSIVA EN LOS MIEMBROS INFERIORES EN EL FÚTBOL

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ABSTRACT

Introduction: Technical movements that mainly include running and jumping are soccer's main sport selection processes. These technical movements demand high requirements of lower limb endurance and explosive strength by athletes. Objective: Study the methods of strength and explosive force training in the lower limbs of soccer players. Methods: The experiment with 40 volunteers lasted 12 weeks and was conducted as a control experiment. The experimental group performed extensive lower limb strength training represented by weight resistance strength training on Monday and Wednesday. In contrast, the control group performed traditional modes of strength training such as half squats and deep squats. Diet was controlled, targeting to minimize the interference of unrelated variables. Results: The scores of the experimental group and the control group were improved and statistically more favorable in the experimental group. Conclusion: The strength training system with weight bearing on the lower limbs used in this study may promote better muscular development of the athletes, improve the explosive power of their lower limbs, and allow better performance on the field, and may be replicated. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Soccer; Strength Training; Lower Extremity; Athletes.

RESUMO

Introdução: Os movimentos técnicos que incluem principalmente a corrida e o salto são os principais processos de seleção esportiva no futebol. Estes movimentos técnicos exigem altos requisitos de resistência dos membros inferiores e força explosiva pelos atletas. Objetivo: Estudar os métodos de treinamento da força e da força explosiva nos membros inferiores dos jogadores de futebol. Métodos: O experimento com 40 voluntários durou 12 semanas, sendo conduzido na forma de um experimento de controle. O grupo experimental realizou um amplo treinamento da força nos membros inferiores representado pelo treinamento da força de resistência ao peso na segunda e quarta-feira, enquanto o grupo de controle realizou os modos tradicionais de treinamento da força, como meio agachamento e agachamento profundo. A dieta foi controlada visando minimizar a interferência de variáveis não relacionadas. Resultados: As pontuações do grupo experimental e do grupo de controle foram aprimoradas, estatisticamente mais favorável no grupo experimental. Conclusão: O sistema de treinamento de força com sustentação de peso nos membros inferiores utilizado neste trabalho pode promover melhor o desenvolvimento muscular dos atletas, melhorar o poder explosivo de seus membros inferiores e permitir um melhor desempenho no campo, podendo ser replicado. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Futebol; Treinamento de Força; Extremidade Inferior; Atletas.*

RESUMEN

Introducción: Los movimientos técnicos que incluyen principalmente la carrera y el salto son los principales procesos de selección deportiva en el fútbol. Estos movimientos técnicos exigen grandes requisitos de resistencia de los miembros inferiores y fuerza explosiva por parte de los atletas. Objetivo: Estudiar los métodos de entrenamiento de la fuerza y la fuerza explosiva en las extremidades inferiores de los futbolistas. Métodos: El experimento con 40 voluntarios duró 12 semanas, realizándose en forma de experimento de control. El grupo experimental realizó un extenso entrenamiento de fuerza de las extremidades inferiores representado por el entrenamiento de fuerza de resistencia con pesas los lunes y miércoles, mientras que el grupo de control realizó modos tradicionales de entrenamiento de fuerza como la media sentadilla y la sentadilla profunda. La dieta se controló con el objetivo de minimizar la interferencia de variables no relacionadas. Resultados: Las puntuaciones del grupo experimental y del grupo de control mejoraron, siendo estadísticamente más favorables en el grupo experimental. Conclusión: El sistema de entrenamiento de fuerza con carga de peso en los miembros inferiores utilizado en este estudio puede promover un mejor desarrollo muscular de los atletas, mejorar la potencia explosiva de sus miembros inferiores y permitir un mejor rendimiento en el campo, y puede ser replicado. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Fútbol; Entrenamiento de Fuerza; Extremidad Inferior; Atletas.*

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INTRODUCTION

In the process of football sports, the main technical movements are running and jumping. And in the regular competition time, the athletes have to go through a long running distance.[1] There are some explosive sprints. Or a powerful shot in the process of physical confrontation. These technical movements have high requirements on the lower limb strength and explosive force of athletes. Therefore, we should deeply study how to strengthen the training of athletes' lower limb strength and explosive force during the training process.[2,3] The improvement of lower limb strength and explosive force can effectively improve the competitive level in the competitive environment. It is in line with the development concept of modern sports to improve the physical quality of athletes to affect the trend of competition and the outcome of the competition. It can achieve faster and stronger movement goals.[4] Therefore, the research direction of this paper focuses on the training of athletes' lower limb strength and explosive force, hoping to improve the physical function of football players' lower limbs and enhance their competitive ability, so that they can gain more initiative in the sports arena and achieve better results.[5]

METHOD

As shown in Table 1, a sophomore football major student athlete of a university was selected as the research object. The study and all the participants were reviewed and approved by Ethics Committee of Tongji University(NO.TJU2019-ST049). There were 20 players in the experimental group and 20 players in the control group. There was little difference between their age, height, weight and training years, which would not interfere with the experimental results.

The experiment lasted for 12 weeks, and was conducted in the form of a control experiment. The experimental group carried out a comprehensive lower limb strength training system represented by weight bearing resistance strength training on Monday and Wednesday, while the control group used traditional lower limb strength training modes such as half squatting and deep squatting, instead of weight bearing and resistance. In addition to different lower limb strength training twice a week and one hour each time, other training plans and diet arrangements of the experimental group and the control group are almost the same, so as to minimize the interference of unrelated variables and improve the rigor of this experiment.

Before the experiment, the athletes' lower limb circumference, peak torque of knee joint and lower limb muscle explosive force was measured and archived as data before the experiment. After the 12-week experiment, measure the above data again, calculate the average value before and after the experiment, in the form of X ± SD, and calculate the change rate of relevant indicators during the experiment to facilitate research and comparison.

RESULTS

Changes of lower limb muscles of football players

The changes of athletes' lower limb muscles are visually displayed in the changes of lower limb circumference. Muscles are developed during exercise, their cross-sectional area increases, and the strength they can provide also increases. When they are displayed on the lower limbs, they show an increase in leg circumference. Therefore, by measuring the circumference of the lower limbs on the left, right, left and right sides of the thigh, we can intuitively feel the development of the athletes' lower limb muscles.

As shown in Table 2, after the experimental training, the cross sectional area of the lower limb muscles of football players in both the experimental group and the control group increased, but the extent of increase was different for different groups and parts. The left thigh circumference of the experimental group increased from (55.050 ± 0.646) cm to (57.095 ± 0.676) cm, which was optimized by 4.050%, higher than 0.997% of the control group; The circumference of the right thigh in the experimental group increased from 56.184 ± 0.672 cm to (57.432 ± 0.668) cm, which was optimized by 4.070%, higher than 1.983% in the control group; The left circumference of the lower leg in the experimental group was increased from 37.410 ± 0.686 cm to (37.405 ± 0.718) cm, which was optimized by 1.987%, higher than 2.025% in the control group; The circumference of the right leg in the experimental group was increased from 36.820 ± 0.712 cm to (38.099 ± 0.718) cm, which was optimized by 2.990%, higher than 0.997% in the control group.

Changes in muscle strength of football player

In addition to measuring the cross-sectional area of the muscle, in order to have a more intuitive understanding of the changes in muscle strength, it is also necessary to measure the peak torque of the joint. The selected position is the knee joint, and the peak torque of the joint when bending and extending the knee is measured. The specific results are shown in Table 3.

Table 3 shows the changes of peak knee moment of football players before and after experimental training. It can be seen from the table that the peak knee bending moment of the left knee in the experimental group has increased from (115.004 ± 27.129) nm to (119.654 ± 22.767) nm, which is 4.627% higher than the control group's 2.512%; The peak

Table 1. Basic information of research objects.

Group	Experimental group	Control group
Age (year)	19.369±0.526	19.551±0.669
Height (cm)	175.361±3.832	176.668±6.237
Weight (kg)	69.690±5.457	70.691±7.096
Training years (years)	6.676±0.839	6.792±0.784

Table 2. Changes of lower limb muscles of football players before and after experimental training (cm).

Lower limb circumference	Group	Before	After	Change rate
Left thigh	Experimental group	55.050±0.646	57.095±0.676	4.050%
	Control group	57.095±0.688	59.089±0.600	0.997%
Right thigh	Experimental group	56.184±0.672	57.432±0.668	4.070%
	Control group	57.432±0.668	59.556±0.578	1.983%
Left calf	Experimental group	37.410±0.686	37.405±0.718	1.987%
	Control group	37.365±0.731	38.195±0.696	2.025%
Right calf	Experimental group	36.820±0.712	38.099±0.718	2.990%
	Control group	37.319±0.718	37.673±0.641	0.997%

Table 3. Peak torque change of football players' knee joints before and after experimental training (nm).

Knee area	Group	Before	After	Change rate
Left knee bend	Experimental group	115.004±27.129	119.654±22.767	4.627%
	Control group	106.275±30.374	111.558±32.304	2.512%
Right knee bend	Experimental group	127.182±23.228	128.082±33.482	2.849%
	Control group	106.004±43.971	113.761±35.554	5.296%
Left knee extension	Experimental group	218.943±38.975	220.194±37.996	2.445%
	Control group	186.605±80.850	187.916±72.146	0.405%
Right knee extension	Experimental group	232.591±28.255	228.703±28.796	-3.090%
	Control group	205.430±58.997	197.189±73.257	-4.186%

moment of right knee flexion in the experimental group was increased from (127.182 ± 23.2289) nm to (128.082 ± 33.482) nm, which was optimized by 2.849%, lower than 5.296% in the control group; The peak moment of knee extension of the left knee in the experimental group was increased from (218.943 ± 38.9759) nm to (220.194 ± 37.996) nm, which was optimized by 2.445%, higher than 0.405% in the control group; The peak moment of right knee extension in the experimental group decreased from (232.591 ± 28.2559) nm to (228.703 ± 28.796) nm, which was -3.090% higher than that in the control group (-4.186%).

Changes of lower limb explosive force of football players

The ultimate goal of improving the strength of lower limbs in football is to improve the competitive level of football players. Therefore, when judging the explosive force of lower limb muscles, we have selected indicators such as 20m sprint time, vertical jump height and standing long jump distance for analysis. These indicators can not only be used as the criteria for judging the explosive force of lower limbs, but also be used as some basic actions on the football field to improve the speed and agility of athletes, Specific data are shown in Table 4.

It can be seen from Table 4 that when analyzing the duration of the 20m sprint, the duration of the experimental group before the experiment was (3.210 ± 0.139) seconds, which was reduced to (3.210 ± 0.139) seconds after the experiment, with an optimization of 8.170%; The time of the control group before the experiment was (3.064 ± 0.101) seconds, which was reduced to (2.925 ± 0.092) seconds after the experiment, with an optimization of 6.778%. When analyzing the vertical jump height, the height of the experimental group before the experiment was (38.765 ± 5.922) cm, which was improved to (43.558 ± 7.067) cm after the experiment, with an optimization of 14.957%; The height of the control group before the experiment was (37.079 ± 4.181) cm, which was increased to (42.141 ± 2.871) cm after the experiment, with an optimization of 11.465%. When analyzing the distance of standing long jump, the distance of the experimental group before the experiment was (74.476 ± 6.360) cm, which was improved to (278.348 ± 9.270) cm after the experiment, with an optimization of 3.299%; The distance of the control group before the experiment was (273.976 ± 11.241) cm, which was increased to (279.786 ± 10.564) cm after the experiment, with an optimization of 1.833%. Through the comparative analysis of the data of the experimental group and the control group, it can be seen that the control group can also optimize the relevant indicators of the athletes' lower limb explosive force, which shows that the traditional lower limb strength training method is also effective, but the weight bearing resistance lower limb training system proposed in this paper optimizes the relevant indicators much more than the control group, This shows that the weight bearing resistance lower limb training system proposed in this paper is an optimization of the traditional lower limb strength training system, which can improve the training level and training efficiency of athletes.

Table 4. Changes of related indexes of football players' lower limb muscle explosiveness before and after experimental training.

Knee area	Group	Before	After	Change rate
Time for 20m sprint (s)	Experimental group	3.210±0.139	2.936±0.149	-8.170%
	Control group	3.064±0.101	2.925±0.092	-6.778%
Vertical jump height (cm)	Experimental group	38.765±5.922	43.558±7.067	14.957%
	Control group	37.079±4.181	42.141±2.871	11.465%
Distance of standing long jump (cm)	Experimental group	274.476±6.360	278.348±9.270	3.299%
	Control group	273.976±11.241	279.786±10.564	1.833%

DISCUSSION

In the process of football, long-distance attacks and regular sprints are common in the game, so high requirements are put forward for the lower limb strength of athletes. And when shooting, the explosive force of calf muscles is required to be excellent. Therefore, in the daily training link, athletes should pay enough attention to the training of lower limb strength. The training links for lower limb strength can be divided into the following aspects. The first is the necessary warm-up link. The warm-up link can make the body reach the best exercise state through sports equipment or simple exercise methods. At the end of the warm-up activity, the body should be stretched in time to make the joints, ligaments and other soft tissues of the whole body flexible and flexible. The second is for thigh muscles and hip muscles. In the training of thigh and hip muscles, barbell squatting exercises can be carried out with the help of auxiliary equipment. Barbell squat exercise is a more traditional lower limb strength training method. This method is simple and efficient, and the training intensity can be controlled by the weight bearing intensity. It helps athletes break through their own physical limits. You can also use the Smith machine for squatting exercises. Under the protection of equipment, the training can be carried out in a safe environment. The strength of biceps femoris can be improved through the training method of straight leg hard pulling.

CONCLUSION

The optimization of football players' lower limb strength training can not only promote the growth and development of the athletes' leg muscles, improve the athletes' muscle strength, and increase their sports explosive force, but also can be applied to the field to improve the athletes' running speed and body coordination in the field, so that they can gain more initiative in the field of competition, improve the competitive level, and obtain greater achievements. This paper studies the training effect of the compound weight bearing resistance lower limb strength training system, and analyzes the difference between it and the traditional lower limb strength training mode. The research results show that the compound weight bearing resistance lower limb strength training system used in this paper can better promote the development of athletes' leg muscles, improve the explosive force of athletes' lower limbs, and enable athletes to achieve better performance in the field, so it is worth promoting.

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

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