RESULTS OF PLIOMETRY ON LOWER LIMB MOTOR FUNCTION IN SOCCER PLAYERS

RESULTADOS DA PLIOMETRIA SOBRE A FUNÇÃO MOTORA NOS MEMBROS INFERIORES DE FUTEBOLISTAS

RESULTADOS DE LA PLIOMETRÍA EN LA FUNCIÓN MOTORA DE LOS MIEMBROS INFERIORES EN JUGADORES DE FÚTBOL

Original Article
Artigo Original
Artículo Original

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ABSTRACT

Introduction: Soccer is watched by hundreds of millions of fans worldwide, in more than 1.5 million teams and 300,000 clubs worldwide, by men and women, children and adults of all levels of expertise. Demanding high performance from its practitioners, achieved only with the strong scientific basis of its technicians by constantly updated research. Objective: Study the results of extensor strength training with plyometrics exercises on the motor function of soccer players' lower limbs. Methods: An experiment with 30 soccer players as research volunteers was performed by randomly dividing them into high load plyometric training group (PHL, 20% of body weight), low load plyometric training group (PLL, 10% of body weight), and control group (CON) for various physiological tests before and after training. Results: Lower limb muscle mass in the PHL group increased significantly; creatine kinase (CK) changes were not statistically significant; regarding isokinetic muscle strength performance, the PHL group showed a significant improvement in peak torque at 60°/s and 180°/s, while the PLL group obtained only a significant improvement at 180°/s. Conclusion: Plyometric exercise promoted a significant improvement in isokinetic muscle strength of the lower extremity of soccer players; its training with different weights did not cause muscle damage. A progressive training load is recommended for athletes with low muscle strength during the initial training phase. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Lower Extremity; Physical Functional Performance; Plyometric Exercise; Soccer.

RESUMO

Introdução: O futebol é assistido por centenas de milhões de torcedores mundialmente, em mais de 1,5 milhões de times e 300.000 clubes em todo o mundo, tanto por homens e mulheres, crianças e adultos de todos os níveis de especialização. Exigindo alta performance de seus praticantes, conseguida apenas com forte embasamento científico de seus técnicos por pesquisas constantemente atualizadas. Objetivo: Estudar os resultados do treinamento de fortalecimento dos extensores com exercícios de pliometria sobre a função motora dos membros inferiores dos jogadores de futebol. Métodos: Um experimento com 30 jogadores de futebol como voluntários de pesquisa foi executado dividindo-os aleatoriamente em grupo de treinamento pliométrico de alta carga (PHL, 20% do peso corporal), grupo de treinamento pliométrico de baixa carga (PLL, 10% do peso corporal) e grupo de controle (CON) para vários testes fisiológicos antes e depois do treinamento. Resultados: A massa muscular dos membros inferiores no grupo PHL aumentou significativamente; as alterações de creatina quinase (CK) não foram estatisticamente significativas; em relação ao desempenho da força muscular isocinética, o grupo PHL apresentou uma melhora significativa no torque de pico a 60°/s e 180°/s, enquanto o grupo PLL obteve apenas uma melhora significativa a 180°/s. Conclusão: A pliometria promoveu uma melhora significativa na força muscular isocinética dos membros inferiores dos jogadores de futebol, seu treinamento com distintos pesos não ocasionou danos musculares. Recomenda-se a utilização de carga de treinamento progressiva aos esportistas com pouca força muscular durante a fase inicial de treinamento. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Extremidade Inferior; Desempenho Físico Funcional; Exercício Pliométrico; Futebol.*

RESUMEN

Introducción: El fútbol es visto por cientos de millones de aficionados en todo el mundo, en más de 1,5 millones de equipos y 300.000 clubes en todo el mundo, por hombres y mujeres, niños y adultos de todos los niveles de especialización. Exigir un alto rendimiento a sus practicantes, sólo se consigue con una fuerte base científica de sus técnicos mediante una investigación constantemente actualizada. Objetivo: Estudiar los resultados del entrenamiento de la fuerza extensora con ejercicios pliométricos sobre la función motora de los miembros

inferiores de los futbolistas. Métodos: Se realizó un experimento con 30 jugadores de fútbol como voluntarios de investigación, dividiéndolos aleatoriamente en el grupo de entrenamiento pliométrico de alta carga (PHL, 20% del peso corporal), el grupo de entrenamiento pliométrico de baja carga (PLL, 10% del peso corporal) y el grupo de control (CON) para realizar diversas pruebas fisiológicas antes y después del entrenamiento. Resultados: La masa muscular de las extremidades inferiores en el grupo PHL aumentó significativamente; los cambios en la creatina quinasa (CK) no fueron estadísticamente significativos; en cuanto al rendimiento de la fuerza muscular isocinética, el grupo PHL mostró una mejora significativa en el par máximo a 60°/s y 180°/s, mientras que el grupo PLL sólo obtuvo una mejora significativa a 180°/s. Conclusión: La pliometría promovió una mejora significativa en la fuerza muscular isocinética de los miembros inferiores de los futbolistas, su entrenamiento con diferentes pesos no causó daño muscular. Se recomienda una carga de entrenamiento progresiva para los atletas con poca fuerza muscular durante la fase de entrenamiento inicial. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Extremidad Inferior; Rendimiento Físico Funcional; Ejercicio Pliométrico; Fútbol.*

DOI: http://dx.doi.org/10.1590/1517-8692202329012022_0675 Article received on 02/11/2022 accepted on 11/11/2022

INTRODUCTION

As the world's largest sport, football has its unique charm. FIFA (2013) mentioned harnessing the power of football as a tool to make greater contributions to society and human development. Football is driven by hundreds of millions of fans worldwide, in more than 1.5 million groups and 300,000 clubs worldwide, as well as men and women, children and adults of all levels of expertise worldwide.[1] With the promulgation of the "Overall Plan for China's Football Reform and Development" in 2015, football reform is in full swing. Now football has become one of the favorite activities of many people.[2] The widely used method of lower extremity explosive training is high-strength and plyometric exercises, but the research on functional training methods is not so in-depth, and the overall structure of lower extremity explosive training has not been studied in detail, which needs further discussion in the future. Therefore, the authors use extensor plyometric training as the main training method and use different load qualities, that is, extensor plyometric training combined with higher-quality high-load plyometric training and plyometric training combined with lower-quality low-load plyometric training. In order to explore the benefits of different weight-bearing plyometric training, and to detect the influence of muscle mass, blood CK, and lower extremity isokinetic muscle strength of the non-dominant leg before and after training.[3,4]

METHOD

Research object

The author took 30 athletes who participated in college football games as the research object, they were randomly assigned to a high-load plyometric training group (PHL, N=10), a low-load plyometric training group (PLL, N=11), and a control group (CON, N=8), all the research subjects were not able to train due to injury, the basic data of the research subjects are shown in Table 1, and there was no statistical difference in the basic data of the research subjects in each group.

Research methods

Experimental Design

(1) The research subjects participated in this experiment voluntarily. After explaining the relevant content, process, risks and training benefits of the research, the subjects were asked to fill in the subject consent form and health status questionnaire; One week before the pre-test, explain the research content and demonstration to the research subjects, so that they can better understand the research content and training actions.[5] All test items were completed within 1 week before the start of training, the pre-test items included body composition (left leg muscle mass), isokinetic muscle strength test (60°/s and 180°/s), jumping ability (situation pendulum) arm vertical jump, step-swing arm vertical jump and landing vertical jump) and blood CK, after the pre-test, the subjects were randomly divided into a high-load plyometric training group (PHL, 20% of body weight), a low-load plyometric training group (PLL, 10% of body weight) and a control group (CON); The plyometric training group used weight-bearing vests to increase its load for 8 weeks of training, the training frequency was 3 times a week, 40-60 minutes each time, and the training items and times of the two groups of plyometric training groups were the same, while the control group did not, get involved in any athletic training. During the training period of this study, the research subjects try to maintain their original life and exercise status, and avoid participating in resistance training from 1 month before the start of the study to the end of the study to reduce the impact on the study results. Except for blood CK, which was tested on the next day after the training, the rest of the items were tested every other week after the training.[6]

(2) Training plan

The weight-bearing intensity of the high-load plyometric training group was 20% of the subject's body mass, and the low-load plyometric training group's load was 10% of the subject's body mass.

(3) Test items and methods

In order to evaluate the training effect of different weight-bearing plyometric training intensities for 8 weeks, all subjects were evaluated

Table 1. Basic information of research objects.

Group	Number of people/person	Age/cm	Height/cm	Body mass/kg	Load/kg
PHL	10	20.6 ± 1.2	173.9 ± 4.4	68.2 ± 7.2	14.4 ± 2.0
PLL	10	20.2 ± 1.4	170.0 ± 7.4	65.1 ± 7.6	6.6 ± 0.7
CON	10	19.4 ± 1.7	171.1 ± 7.4	67.2 ± 10.9	0

for the following physiological indicators before and after the training in this study.

(4) Data Statistics and Analysis

The experimental data were analyzed by SPSS FOR WINDOWs20.0 Chinese version statistical software package. A mixed design two-way analysis of variance was used to compare the differences of each variable among the three groups with different weight-bearing plyometric training interventions. When the interaction reached statistical significance, the independent sample simple main effect test and the dependent sample simple main effect test were performed respectively, the differences between the groups and the differences between the pre- and post-tests within each group after cutting the files were compared, and the LSD method was used for post-hoc comparisons.[7] The significant level is α=0.05.

ETHICAL COMPLIANCE

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Guizhou Normal University, Southwest University and East China Normal University-Xuhui Postdoctoral Workstation following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

RESULTS

The effect of plyometric training on the muscle mass of the left leg

Figure 1 shows: Before 8 weeks of training, all subjects in the study measured the muscle mass of the left leg with a body composition analyzer, the results showed that the interaction of the muscle mass of the left leg was not statistically significant (P>0.05), after 8 weeks, the main effect of the time factor in the PHL group was significantly different, the muscle mass of the left leg in the PHL group after training was significantly higher than that before training (P=0.019), while the difference between the PLL group and the CON group was not statistically significant.

The effect of plyometric training on blood CK

As shown in Table 2, the interaction of CK in each group before and after 8-week training was not statistically significant (P>0.05), and there was no significant difference in the main effect of time factor and group factor (P>0.05).

Influence of plyometric training on lower extremity isokinetic muscle strength

Table 3 shows that in the results of isokinetic muscle strength test of left knee extensor before and after 8 weeks of training, the interaction between peak torque and the time to reach peak torque at 60°/s and 180°/s was not statistically significant (P>0.05), after cutting the files, it was found that the main effect of the time factor was significantly different between the PHL and PLL groups. When the angular velocity was 60°/s, the PHL group had a significant improvement in the torque peak value and the time to reach the torque peak value (torque peak value: P=0.019; Time to reach peak torque: P=0.009); In addition, in the performance of angular velocity of 180°/s, the difference in peak torque between PHL group and PLL group was statistically significant (PHL: P=0.005; PLL: P=0.026). In addition, the difference in the main effect test of the group factor was statistically significant, after comparison, it was found that the PHL group and the PLL group had peak torque at angular velocity of 60°/s (PHL: P=0.002; PLL: P=0.049) and 180°/s (PHL: P=0.001; PLL: P=0.039). were significantly better than the CON group.[8,9]

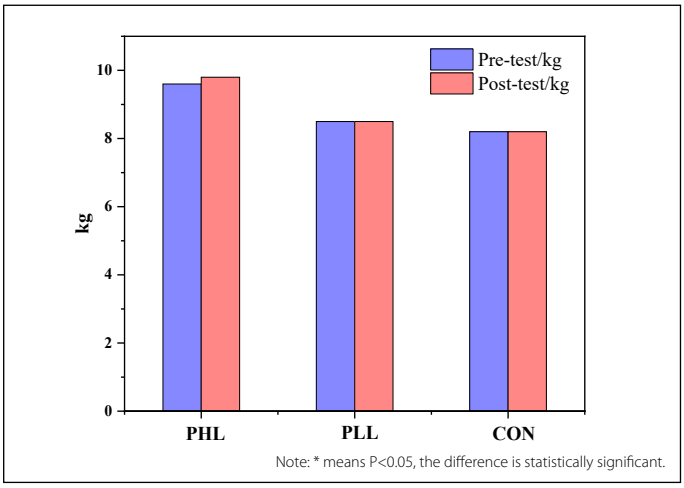

Figure 1. The effect of different weight-bearing plyometric training on the muscle mass of the left leg.

Table 1. Comparison of left and proper trials of YBT-LQ.

Group	Pre-test/kg	Post-test/kg
PHL	209.4 ± 116.9	176.0 ± 57.8
PLL	195.2 ± 82.7	211.2 ± 103.1
CON	226.8 ± 162.7	231.9 ± 76.3

DISCUSSION

The results of this study indicated that after 8 weeks of plyometric training, the muscle mass of the left leg increased significantly in the PHL

Table 3. Effects of different weight-bearing plyometric training subjects on the performance of left knee knee extensor muscle strength.

Project		Group	Pre-test/kg	Post-test/kg
Angular velocity 60°/s	Torque peak/nm	PHL	191.7 ± 26.5	213.8 ± 35.4
		PLL	178.7 ± 31.1	189.5 ± 27.0
		CON	156.0 ± 28.6	147.1 ± 23.0
	Time to reach torque peak/ms	PHL	385.0 ± 81.7	316.0 ± 65.2
		PLL	311.8 ± 94.9	291.8 ± 97.0
		CON	356.3 ± 127.9	363.7 ± 82.2
Angular velocity 180°/s	Torque peak/nm	PHL	124.3 ± 24.6	141.8 ± 26.7
		PLL	97.5 ± 35.7	122.9 ± 22.5
		CON	87.5 ± 13.7	84.1 ± 17.5
	Time to reach torque peak/ms	PHL	175.0 ± 36.3	153.0 ± 28.7
		PLL	147.3 ± 31.0	143.6 ± 21.1
		CON	177.5 ± 38.1	156.7 ± 23.4

group, while there was no significant change in the PLL and CON groups. Since the main benefit of general plyometric training is the improvement of muscle strength, explosive power and jumping ability, the improvement of muscle mass is less discussed, however, additional benefits may arise when plyometric training is combined with external stimuli; In the performance of plyometric training on isokinetic muscle strength, the PHL group in this study showed significant improvement in both 60°/s and 180/s peak torque performance, while the PLL group only had significant improvement at 180°/s, in addition, the time to reach the peak torque representing explosive force was only significantly improved in the PHL group at 60°/s; In the comparison of differences between groups, after 8 weeks of training, the PHL group was significantly better than the CON group in the peak torque at an angular velocity of 60°/s, and in terms of the time to reach the peak torque at an angular velocity of 180°/s, both the PHL group and the PLL group were significantly better than the CON group. The training results of this study are similar to those of sHaNKar et al, in the PHL group that received higher stimulation, the improvement of various muscle performance was better, therefore, according to the results of this study, intervention with higher stimulation had a better promoting effect on muscle performance.[10]

CONCLUSION

The PHL group with 20% body weight in the leg muscle mass improved significantly, and at the same time, the lower limb muscle strength also increased significantly; After 8 weeks of different weight-bearing plyometric training, the changes of blood CK in each group were not statistically significant, that is, plyometric training with different weights does not cause serious muscle damage. The author used 20% of body weight and 10% of body weight combined with plyometric training to provide a reference for general boys to improve leg muscle mass, sprint time, lower limb muscle strength and jumping performance, in order to improve the performance of ordinary sports participation, but for those with poor lower limb muscle strength, it is recommended to use a progressive training load in the early stage of training.

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. Bo Cao: writing; Xiaojin Zeng: data analysis; Lin Luo: intellectual concept of the article.

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