

# IMPACT OF ECCENTRIC TRAINING ON JUMPING ABILITY IN ATHLETES



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IMPACTOS DO TREINAMENTO EXCÊNTRICO SOBRE A CAPACIDADE DE SALTO EM ATLETAS

IMPACTO DEL ENTRENAMIENTO EXCÉNTRICO EN LA CAPACIDAD DE SALTO EN ATLETAS

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## ABSTRACT

**Introduction:** Strength quality can be divided into total strength, rapid strength, endurance strength, and reaction strength, among which rapid strength has been a much-discussed theme in sports industry research. **Objective:** Study the impacts of eccentric lower limb training on jumping ability in soccer athletes. **Methods:** A multifunctional centrifugal training device was used as a training tool, and the effect of eccentric training on rapid strength in soccer players was analyzed. **Results:** The average force of soccer players in the experimental group increased by about 524N, and the completion rate increased by about 76%. Both average strength and completion rate were significantly improved. Compared to the control group, the experimental group benefited more from the explosive power and kinetic indexes. There was also a significant improvement in the four indices of jumping ability, the three indices of sensitivity (except 15s step frequency), and eccentric training in the experimental group ( $P < 0.01$ ). **Conclusion:** The proposed lower limb eccentric training resulted in a beneficial effect on the jumping ability of athletes. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

**Keywords:** Resistance Training; Lower Extremity; Soccer.

## RESUMO

**Introdução:** A qualidade da força pode ser dividida em força total, força rápida, força à resistência e força de reação, entre as quais a força rápida é um tema bastante discutido nas pesquisas da indústria esportiva pelos últimos anos. **Objetivo:** Estudar os impactos do treinamento excêntrico dos membros inferiores sobre a capacidade de salto nos atletas de futebol. **Métodos:** Foi utilizado um dispositivo de treinamento centrífugo multifuncional como instrumento de treino, analisou-se o efeito do treinamento excêntrico sobre a força rápida em jogadores de futebol. **Resultados:** A força média dos jogadores de futebol do grupo experimental aumentou em cerca de 524N, e a taxa de conclusão aumentou em cerca de 76%. Tanto a força média quanto a taxa de finalização foram significativamente aprimoradas. Em comparação com o grupo controle, o grupo experimental teve um benefício maior do índice de potência explosiva e índice cinético. Também houve melhora significativa nos quatro índices de habilidade de salto, nos três índices de sensibilidade (exceto a frequência de passos de 15s), e no treinamento excêntrico do grupo experimental ( $P < 0,01$ ). **Conclusão:** O treinamento excêntrico proposto para membros inferiores resultou em um efeito benéfico sobre a capacidade de salto dos atletas. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

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

## RESUMEN

**Introducción:** La calidad de la fuerza puede dividirse en fuerza total, fuerza rápida, fuerza a la resistencia y fuerza de reacción, entre las cuales la fuerza rápida es un tema suficientemente discutido en las investigaciones de la industria del deporte durante los últimos años. **Objetivo:** Estudiar las repercusiones del entrenamiento excéntrico de los miembros inferiores en la capacidad de salto de los deportistas de fútbol. **Métodos:** Se utilizó un dispositivo de entrenamiento centrífugo multifuncional como herramienta de entrenamiento, y se analizó el efecto del entrenamiento excéntrico sobre la fuerza rápida en jugadores de fútbol. **Resultados:** La fuerza media de los futbolistas del grupo experimental aumentó en unos 524N, y la tasa de finalización aumentó en un 76%. Tanto la fuerza media como la tasa de finalización mejoraron significativamente. En comparación con el grupo de control, el grupo experimental obtuvo un mayor beneficio del índice de potencia explosiva y del índice cinético. También hubo una mejora significativa en los cuatro índices de capacidad de salto, los tres índices de sensibilidad (excepto la frecuencia de paso de 15s) y el entrenamiento excéntrico en el grupo experimental ( $P < 0,01$ ). **Conclusión:** El entrenamiento excéntrico de las extremidades inferiores propuesto tuvo un efecto beneficioso en la capacidad de salto de los atletas. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

**Descriptorios:** Entrenamiento de Fuerza; Extremidad Inferior; Fútbol.



## INTRODUCTION

Strength quality can be divided into maximum strength, rapid strength, strength endurance, and reaction strength, among which rapid strength is a hot topic in sports industry research in recent years. However, eccentric training through the multi-functional eccentric training instrument can effectively avoid the shortcomings of the above training methods, and has the advantages of high-intensity stimulation and low-fatigue electrical stimulation training.<sup>1</sup> This method has the advantages of eccentric contraction and low fatigue, strengthens muscle elastic tissue and stretch firing, and promotes the periodic transformation of muscle “shortening-lengthening”, thereby improving the rapid training of the body. Eccentric training is currently relatively understudied and has not achieved relatively large breakthroughs, and there is little data on eccentric training to improve rapid strength in athletes.<sup>2</sup>

Theoretical research on eccentric training generally believes that eccentric exercise has a repetitive effect or a protective mechanism, that is, when the same muscle performs repeated eccentric exercise within a certain period of time after the initial eccentric exercise, the muscle damage and muscle strength decline will be significantly reduced, and the recovery process will speed up.<sup>3</sup> This repetitive effect of centrifugal motion has been supported by numerous experiments. Jheng-Yi found through animal experiments and eccentric training experiments of adult female college students: 2 days and 4 days after the initial eccentric exercise, the muscles have been adapted before the injury recovers, and the muscle injury will not aggravate after repeated eccentric exercise, 3 weeks of continuous eccentric training maintained and enhanced the protective effect, the effects of Aiberto I on the EMG amplitude, EMG frequency and muscle fiber conduction velocity of the biceps femoris by two training methods of eccentric training and concentric training were found, compared with concentric training, the impact of eccentric training on muscle strength and muscle fiber conduction velocity is better than that of concentric training, the comprehensive training load is realized by the length of training time, pedal speed, and resistance, the accuracy of the training strength is determined by the target strength range, and the pedal stride and seat can also be adjusted to suit different physical conditions of athletes.<sup>4,5</sup>

Based on the above analysis, this study uses the lower limb eccentric training machine for athletes' training, and analyzes the effect of eccentric training on rapid strength.

## METHOD

### Group training of football players

The subjects of the study were 20 male football players of a provincial football team, and they were randomly divided into an experimental group and a control group of 10 each, the experimental group received eccentric training, while the control group only needed to perform daily training. The training period is 8 weeks, except that the training cannot be carried out normally due to the weather, the rest of the training is carried out according to the plan. On Tuesdays and Thursdays after 10 a.m., start with fitness training, abs and upper body strength, footsteps and jumping acceleration. The training content from Monday to Friday is aerobic stretching, ball control training, passing and catching, 5 on 5 training, square pulling, 2 on 2 lower body strength training, etc. Finish a match on Saturday afternoon, rest on Sunday. The experimental group additionally performed lower limb eccentric training twice a week per week.<sup>6</sup>

### Sports measurement of football players

The test sequence is 30-meter run, triangle run, Illinois run, standing long jump. For the 30-meter running test, a 3m-long marking line should be pasted at the starting point and the ending point, and the marking poles should be fixed at both ends of the marking line, the athlete should be in the starting position for about 2 seconds, and the starter will issue the starting command, at the finish line, the timekeeper will see When the athlete's body moves, the timer<sup>7</sup> is pressed. Each athlete is tested twice for each test item, and the final score is the best of the two. The indoor test items are 15s continuous vertical jump, 15s fast cadence, right foot vertical jump, left foot vertical jump, and vertical jump in situ, the test instrument is an infrared sensing device Opto Gait tester.<sup>8</sup> The 15s fast cadence refers to the preparation stage, the athletes keep their feet apart and keep the same width as the shoulders, the knees are slightly bent and kept horizontally standing, after hearing the start command, they quickly exercise at the fastest cadence, the duration is 15s, and the number of tests is only for 1 time. The 15s continuous vertical jump preparation stage is the same as the 15s fast cadence, the exercise process is the maximum speed and the maximum strength high jump, the test time is also 15s, and the number of tests is only 1 time. The maximum eccentric strength training was obtained by the instrument, the test speed was 23 steps/min, the left and right feet were alternately pedalled 6 times, the recorded data was the sub-maximum strength of the weak side foot.

## ETHICAL COMPLIANCE

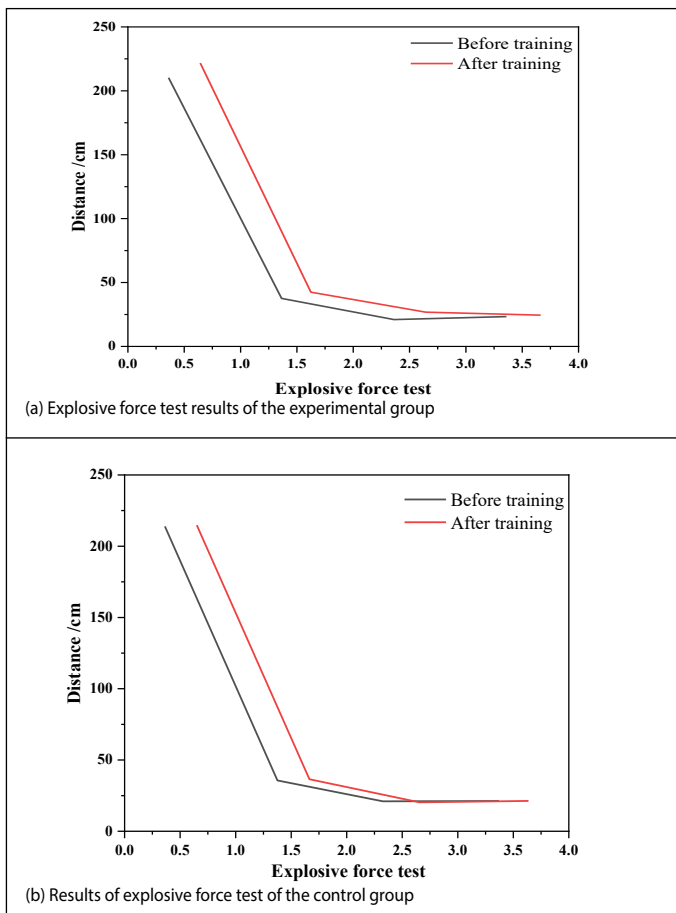
*Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Institute of Physical Education, Central China Normal University and Institute of Physical Education, Kashgar University following all guidelines, regulations, legal, and ethical standards as required for humans or animals.*

## RESULTS

### Results of eccentric training and explosiveness test results of football players

The experiment first performs K-S test on a single sample, after confirming that the data conforms to the normal distribution law ( $P > 0.05$ ), then carry out T-test on independent samples of different groups, and it is necessary to satisfy that there is no obvious difference between the two groups of data ( $P > 0.05$ ), finally, a paired sample T test was performed on the test data of different groups before and after training. The basic information of the experimental group and the control group is shown in Table 1, there is no significant difference in age, height, weight, and training years between the experimental group and the control group ( $P > 0.05$ ), so the data of the two groups are comparable.

The explosive power test results of the experimental group and the control group before and after training are shown in Figure 1(a) and (b), respectively, and the single test data passed the K-S test. The paired sample T test showed that the experimental group had a very significant difference before and after training ( $P < 0.01$ ), and the experimental group had a significant difference before and after training ( $P < 0.05$ ), compared with the control group, the four indexes of jumping ability of the football players in the experimental group were significantly improved. After training, compared with the control group, the standing long jump and the



**Figure 1.** Explosive power test results before and after training in the experimental group and the control group.

vertical jump in place increased by 10 cm and 1.7 cm, respectively, and the vertical jump of the left and right feet increased by 1.8 cm and 2.0 cm, respectively. Therefore, eccentric training can enhance the explosive power of football players.

### Dynamic test results of football players

The kinetic test results of the experimental group and the control group before and after training are shown in Table 2, and the single data tested all passed the K-S test. The maximum eccentric strength of the experimental group increased by 398.1N before and after training, and the 15s vertical jump power increased by 1.5W. In the control group, the maximum eccentric strength increased by 154.7N before

and after training, and the 15s vertical jump power increased by 0.5W. The paired sample T test showed that the experimental group and the control group showed a very significant increase before and after the maximum eccentric strength training ( $P < 0.01$ ), but the 15s vertical jump power was not significant ( $P > 0.05$ ). Compared with the control group after training, the maximum eccentric strength increased by 243.3N, and the 15s vertical jump power increased by 0.9W. Therefore, both the experimental group and the control group improved kinetic performance, but the experimental group improved faster.

## DISCUSSION

The effect of eccentric training on the rapid strength of football players is a hot topic that sports experts and scholars have paid close attention to in recent years. In view of the current situation of rapid strength training, this study uses a multifunctional eccentric training instrument to explore the effect of eccentric training of increasing load and speed on the rapid strength of football players.<sup>9</sup> The fast strength of football players is related to their game performance and is a core content in strength training, the impact of lower body eccentric strength training on the owners of fast strength of football players cannot be ignored, from the perspective of coaches, we should attach great importance to the eccentric strength training of the lower limbs, and apply it to the rapid strength training of football players reasonably, through the mutual cooperation with traditional training methods, a good training effect can be guaranteed.<sup>10</sup>

## CONCLUSION

The author's test results showed that after 16 eccentric training sessions, the average strength of the left and right feet of the athlete was 750N, and the target completion rate was about 80%. The standing long jump and in-situ vertical jump in the experimental group were increased by 12 cm and 4.77 cm, respectively, the paired sample T test showed that the experimental group was higher than the control group, the four indexes of jumping ability showed an obvious improvement trend before and after training. Compared with the control group after training, the maximum eccentric strength increased by 243.3N, and the 15s vertical jump power increased by 0.95W. The experimental group and the control group showed a very obvious improvement before and after the maximum eccentric strength training, and the 15s vertical jump power was not significant.

**Table 1.** Comparison of basic information between the experimental group and the control group (n=20).

project	test group (n=10)	control group (n=10)	T value	P value
Age (y)	14.9±0.3	14.8±0.3	0	1.0>0.05
Height (cm)	167.8±8.7	167.1±8.3	0.2	0.8>0.05
Weight (kg)	57.3±8.2	56.9±6.6	1.3	0.2>0.05
Years of training (years)	4.2±1.4	3.5±1.4	1.0	0.3>0.05

**Table 2.** Dynamic test results before and after training in the experimental group and the control group.

project	test group		control group	
	before training	after training	before training	after training
Maximum centrifugal force (N)	611.7±159.0	1009.8±172.0	477.2±191.3	631.8±167.2
15s vertical jump power (=W)	39.1±4.7	40.6±5.7	38.1±5.3	38.7±5.9

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