

# OPTIMIZATION METHOD FOR ANKLE STRENGTH TRAINING DURING EXERCISE



ORIGINAL ARTICLE  
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MÉTODO DE OTIMIZAÇÃO NO TREINO DE FORÇA DO TORNOZELO DURANTE O EXERCÍCIO

MÉTODO PARA OPTIMIZAR EL ENTRENAMIENTO DE LA FUERZA DEL TOBILLO DURANTE EL EJERCICIO

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## ABSTRACT

**Introduction:** Good ankle joint strength is a precondition for high-quality exercise and is an important factor in preventing joint injuries. **Objective:** Explore the method of optimizing ankle strength training during exercise. **Methods:** 40 volunteers were selected and randomly divided into an experimental group and a control group. The 20 athletes in the experimental group were trained three times a week for six weeks using a control variable method, while the control group performed only professional daily physical training. Pre-training and post-training methods were used to collect and investigate the data regarding the effect of strength training on the ankle joint and its impact on skill and strength tests submitted to the athletes. **Results:** Ankle strength training can improve ankle muscle strength and athletes' ability to run and jump ( $P > 0.05$ ). **Conclusion:** Ankle joint strength training may improve athletes' baseline sporting ability, improve ankle joint muscle strength, reduce the likelihood of joint injuries, and contribute to improved outcomes of various abilities, meriting further study and replication. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

**Keywords:** Ankle Joint; Resistance Training; Athletic Performance.

## RESUMO

**Introdução:** A boa força articular do tornozelo é uma pré-condição para exercícios físicos de alta qualidade além de ser um fator importante na prevenção de lesões articulares. **Objetivo:** Explorar o método de otimização do treino de força do tornozelo durante o exercício físico. **Métodos:** 40 voluntários foram selecionados e aleatoriamente divididos em grupo experimental e grupo de controle. Os 20 atletas do grupo experimental foram treinados três vezes por semana durante 6 semanas usando um método de variáveis de controle enquanto o grupo controle efetuou apenas o treinamento físico diário profissional. Foram utilizados métodos pré-treino e pós-treino para coleta e investigação dos dados quanto ao efeito do treinamento de força sob a articulação do tornozelo e seu impacto em testes de habilidade e força submetidos aos atletas. **Resultados:** O treinamento de força do tornozelo pode melhorar a força muscular do tornozelo e melhorar a capacidade dos atletas de correr e saltar ( $P > 0,05$ ). **Conclusão:** O treino de força articular do tornozelo pode melhorar a capacidade esportiva basal dos atletas, melhorar a força muscular da articulação do tornozelo, reduzir a probabilidade de lesões articulares e contribuir na melhoria dos resultados de várias habilidades, merecendo maiores estudos e replicação. **Nível de evidência II; Estudos terapêuticos - investigação dos desfechos do tratamento.**

**Descritores:** Articulação do tornozelo; Treinamento de força; Desempenho Atlético.

## RESUMEN

**Introducción:** Una buena resistencia de la articulación del tobillo es una condición previa para la realización de ejercicio físico de alta calidad y un factor importante en la prevención de lesiones articulares. **Objetivo:** Explorar el método para optimizar el entrenamiento de la fuerza del tobillo durante el ejercicio. **Métodos:** Se seleccionaron 40 voluntarios y se dividieron aleatoriamente en grupo experimental y grupo de control. Los 20 atletas del grupo experimental se entrenaron tres veces a la semana durante 6 semanas con un método variable de control, mientras que el grupo de control sólo realizó un entrenamiento físico profesional diario. Se utilizaron métodos de pre-entrenamiento y post-entrenamiento para recoger e investigar los datos relativos al efecto del entrenamiento de fuerza bajo la articulación del tobillo y su impacto en las pruebas de habilidad y fuerza a las que se sometieron los atletas. **Resultados:** El entrenamiento de la fuerza del tobillo puede mejorar la fuerza muscular del tobillo y mejorar la capacidad de los atletas para correr y saltar ( $P > 0,05$ ). **Conclusión:** El entrenamiento de la fuerza de la articulación del tobillo puede mejorar la capacidad deportiva de base de los atletas, mejorar la fuerza muscular de la articulación del tobillo, reducir la probabilidad de lesiones articulares y contribuir a mejorar los resultados de varias habilidades, mereciendo más estudios y réplicas. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

**Descriptor:** Articulación del Tobillo; Entrenamiento de Fuerza; Rendimiento Atlético.



## INTRODUCTION

In various sports, there is interaction and coordination between various joints of the body. Ankle joint is one of the more important joints. Almost all running and jumping sports need ankle joint to participate.<sup>1</sup> Generally speaking, the ankle joint refers to the joint between the ankle and the lower leg. The ankle joint is composed of three groups of main ligaments: medial collateral ligament and triangular ligament. In the ankle joint, the ligament strength is relatively high and the injury risk is relatively low. There are three bundles of lateral collateral ligament, which stop at the anterolateral side of talus, posterolateral side of talus and posterior side of talus. It is the most vulnerable part of ankle tissue, and the risk of injury is quite high. The lower tibiofibular ligament, also known as the transverse tibiofibular ligament, connects the tibia and fibula with the front and rear of the lower end of the tibia and fibula respectively, which has the function of stabilizing the joint.<sup>2</sup> From the overall point of view, the ankle has a high risk of injury. Usually, we need to pay attention to the training of its strength and surrounding tissues. The ankle will often be in direct drive position, resulting in internal and external reaction, and a large part of the ankle will be damaged due to sudden stress.<sup>3</sup> Cause the consequence of ligament perforation, even serious fracture and joint dislocation. Individual patients will have habitual ankle injury. A little carelessness will cause joint injury. Poor healing may also lead to knee relaxation and repeated injury. Having good ankle strength is not only the premise of high-quality sports, but also an important factor to effectively prevent ankle sports injury.<sup>4</sup> In the process of sports, we should have enough self-safety awareness, and pay attention to the targeted training of ankle strength at ordinary times. How to effectively formulate training methods is the subject we need to study in depth.<sup>5</sup> Through the accumulation of experience and the practice of training activities, we summarized the optimization methods of ankle strength training.

## METHOD

In this paper, through the form of volunteer recruitment, 40 volunteers were selected and divided into experimental group and control group by lot, with 20 athletes in each group. The study and all the participants were reviewed and approved by Ethics Committee of Handan University (NO.2019HDUS-FK02). The specific information is shown in Table 1.

In order to reduce the interference of the experiment on students' daily learning and life as much as possible, the experiment adopts the control variable method, which lasts for 6 weeks and carries out training three times a week. The control group only completed their own professional daily physical training, and the experimental group increased the practice of ankle strength training on the basis of daily physical training, including weight-bearing heel lifting, meter jump, high-low jump, z-jump and continuous forward jump. The duration of ankle training in the experimental group was 40 minutes, including 5 minutes of warm-up exercise, 30 minutes of various ankle training actions and 5 minutes of relaxation exercise. In addition, the basic study, life and diet of the experimental group and the control group are consistent, so as to reduce the interference of irrelevant factors as much as possible. In terms of data measurement, pre-test and post-test were used to explore the impact of 6-week ankle strength training on athletes.

**Table 1.** Basic information of experimental group and control group.

Item	Test group	Control group	P
Age	21.642±1.133	21.283±1.145	0.680
Height (cm)	179.359±5.756	180.327±8.208	0.831
Weight (kg)	69.052±9.214	73.464±14.310	0.492
Training Years	6.102±2.664	6.175±2.521	0.921

In the measurement of muscle strength, bi0dex system 3 0 isokinetic force test system, the centripetal force and centrifugal force of ankle plantar flexor group and ankle dorsal flexor group were measured and analyzed, and the added values of the two groups before and after the experiment were discussed.

In terms of the measurement of sports ability, taking the running ability, including 30m running (unit: s), 60m running (unit: s), 30m running (unit: s) and jumping ability, including standing long jump (unit: cm), standing triple jump (unit: cm) and five step run-up touch height (unit: cm) as the judgment index, the running ability was measured before and after the experiment, and the obtained data were processed.

## RESULTS

### Effect of ankle strength training on muscle strength

The most fundamental index of ankle muscle strength training is the change of ankle related muscle strength. Therefore, bi0dex system 3 is used in this section. The increment of centripetal force and centrifugal force of ankle muscle were measured by 0 isokinetic force test system.

As shown in Table 2, in terms of centripetal Pt increment of ankle plantar flexor muscle group, the increment of the experimental group was 112.656 ± 67.313, which was significantly higher than 9.612 ± 1.362 in the control group, P < 0.05, indicating that there was a significant difference; In terms of centrifugal Pt increment of ankle dorsal flexor group, the increment of the experimental group was 9.258 ± 12.764, which was slightly higher than that of the control group (2.026 ± 0.563, P < 0.05). In terms of centripetal Pt increment of ankle dorsal flexor group, the increment of experimental group was 5.672 ± 9.855, which was slightly higher than that of control group (2.281 ± 2.410, P > 0.05); In terms of centrifugal Pt increment of ankle plantar flexor group, the increment of the experimental group was 115.663 ± 68.340, which was significantly higher than that of the control group (8.261 ± 3.027, P > 0.05). It can be seen that daily physical training can also enhance ankle muscle strength, but in comparison, special ankle strength training can better help improve ankle muscle strength.

### Influence of ankle strength training on ankle movement ability

As shown in Table 3, in terms of 30m running time, the experimental group decreased from 4.500 ± 0.198s before strength training to 4.028 ± 0.178s after intervention, and the control group decreased from 4.472 ± 0.172s before strength training to 4.180 ± 0.237s after intervention.

**Table 2.** Effect of ankle strength training on muscle strength.

Item	Test group	Control group	P
Ankle flexor group to heart PT value	112.656±67.313	9.612±1.362	0.009
Advanced flexor group to the heart PT value	5.672±9.855	2.281±2.410	0.076
Akleum flexor group centrifugal PT value added	115.663±68.340	8.261±3.027	0.052
Adjuvant PT value-added	9.258±12.764	2.026±0.563	0.009

**Table 3.** Effect of ankle strength training on improving running ability.

Item	Before	After	P	
30m run (s)	Test	4.500±0.198	4.028±0.178	0.000
	Control	4.472±0.172	4.180±0.237	0.000
60m run (s)	Test	8.014±0.474	7.434±0.387	0.000
	Control	8.075±0.499	7.708±0.524	0.000
Traveling space 30m (s)	Test	3.535±0.424	3.406±0.285	0.645
	Control	3.688±0.385	3.647±0.314	0.195

The time tightening range of the experimental group was significantly higher than that of the control group,  $P < 0.05$ , indicating that there was a significant difference; In terms of 60m running time, the experimental group decreased from  $8.014 \pm 0.474s$  before strength training to  $7.434 \pm 0.387s$  after intervention, and the control group decreased from  $8.075 \pm 0.499s$  before strength training to  $7.708 \pm 0.524s$  after intervention. The time tightening range of the experimental group was significantly higher than that of the control group ( $P < 0.05$ ); In terms of the time of 30 meters during the journey, the experimental group decreased from  $3.535 \pm 0.424s$  before strength training to  $3.406 \pm 0.285s$  after intervention, and the control group decreased from  $3.688 \pm 0.385s$  before strength training to  $3.647 \pm 0.314s$  after intervention. The time tightening range of the experimental group was significantly higher than that of the control group, but  $p > 0.05$ , indicating that there was no significant difference. It can be seen that ankle strength training can better improve athletes' running ability on the basis of daily training, but there are some problems in P value, so further research and analysis are needed in the 30-meter movement between walks.

As shown in Table 4, in terms of standing long jump distance, the experimental group increased from  $243.213 \pm 13.837cm$  before strength training to  $265.915 \pm 17.616cm$  after intervention, and the control group increased from  $231.714 \pm 11.587cm$  before strength training to  $253.577 \pm 10.292cm$  after intervention. The distance increase of the experimental group was significantly higher than that of the control group ( $P < 0.05$ ). The distance of standing triple jump in the experimental group increased from  $703.199 \pm 40.082cm$  before strength training to  $821.155 \pm 61.908cm$  after intervention, and that in the control group increased from  $688.806 \pm 45.281cm$  before strength training to  $760.428 \pm 51.970cm$  after intervention. The distance increase in the experimental group was significantly higher than that in the control group ( $P < 0.05$ ); In terms of five step run-up touch height distance, the experimental group increased from  $50.411 \pm 9.392cm$  before strength training to  $72.588 \pm 10.750cm$  after intervention, and the control group increased from  $47.160 \pm 6.179cm$  before strength training to  $64.586 \pm 4.894cm$  after intervention. The distance increase of the experimental group was significantly higher than that of the control group ( $P < 0.05$ ). It can be seen that strengthening ankle strength training can significantly improve the performance of athletes' jumping indicators, so as to greatly improve athletes' jumping ability, which has a strong promotion value for some sports types that depend on or demand jumping ability.

Comprehensive analysis of Table 3 and 4 shows that ankle strength training can effectively improve athletes' running and jumping ability, and running and jumping are the basic actions of many sports types. Running and jumping are the most basic sports ability that athletes need to master, whether it is track and field sports or basketball, football, volleyball and other sports. The improvement of running and jumping ability will greatly promote the improvement of athletes' basic level, indirectly drive the progress of relevant professional skills, and finally

improve their sports performance. Through the comparison results between the experimental group and the control group, it can be seen that the existing sports training can enhance the athletes' running and jumping ability, but the addition of ankle strength training undoubtedly makes the improvement of athletes' relevant ability more significant. Therefore, in the basic training of various sports, we should consciously add ankle strength training, so as to enhance ankle muscle strength, reduce sports injury and improve athletes' sports ability.

## DISCUSSION

In view of the poor flexibility and long-term stiffness of the ankle, we should pay attention to the activity of the ankle joint, regularly do the training related to lifting the heel, keep the legs upright, the arms droop naturally, lift the heel, the toes touch the ground and the heel is off the ground. This can increase the flexibility and strength of the joint, prevent the aging of Achilles tendon, and increase the elasticity of Achilles tendon, ligament and other soft tissues. Focus on matching back extension exercise. Back extension exercise can make the joints relaxed enough. Back extension exercise should be trained in groups, with fixed times in each group, 4 to 6 groups at a time, and cooperate with ankle rotation exercise at the same time. After the ankles are fully relaxed, then do valgus or varus exercises. Similarly, practice in groups, and fix the number of groups and the times of each group.

To be proficient in technical movements, training should be carried out under the guidance of professional sports instructors in the early stage of training. Learn relevant standard technical movements to avoid sports injury caused by non-standard training movements. Reduce training efficiency. Warm up before training. Warm up activities make the body enter a state of motion, and the nervous system plays an adequate role in improving the flexibility and elasticity of soft tissue. Make the flexibility of joints meet the basic requirements of training. It can effectively reduce the sports injury caused by training. Cultivate self-protection awareness. When training, we should act according to our ability, carry out difficulty increasing training regularly, and resolutely refuse cross difficulty training. Pay attention to the weather and avoid sports injury caused by insufficient preparation in cold weather. In case of injury, stop training immediately and go to the hospital to ask a doctor for examination and diagnosis in time. The severity of injury cannot be judged by the intensity of pain, so as to avoid making mistakes in self judgment and causing secondary injury to the injury.

## CONCLUSION

Through the research results of this paper, it can be seen that consciously increasing ankle strength training in sports can not only enhance the muscle strength of relevant positions and reduce the problem of ankle injury, but also improve the athletes' running ability and jumping ability, so as to lay a solid foundation for the improvement of athletes' competitive ability. Through this experiment, it can be seen that ankle strength training can be added to many different types of sports. As a part of basic training, it can be combined with other training to improve the comprehensive quality of athletes. Coaches should also seriously study this knowledge, and further combine the content of ankle strength training with the content of professional sports training, so as to provide better guidance for athletes.

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All authors declare no potential conflict of interest related to this article

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**Table 4.** Effect of ankle strength training on the improvement of jumping ability.

Item		Before	After	P
Long jump far (cm)	Test	243.213±13.837	265.915±17.616	0.000
	Control	231.714±11.587	253.577±10.292	0.000
Standing three-level jump (cm)	Test	703.199±40.082	821.155±61.908	0.000
	Control	688.806±45.281	760.428±51.970	0.001
Five steps to play high (cm)	Test	50.411±9.392	72.588±10.750	0.000
	Control	47.160±6.179	64.586±4.894	0.000

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