

IMPACTS OF BALANCE UNDER LOWER LIMB TRAINING

IMPACTOS DO EQUILÍBRIO SOB TREINAMENTO DOS MEMBROS INFERIORES

IMPACTOS DEL EQUILIBRIO BAJO ENTRENAMIENTO DE LAS EXTREMIDADES INFERIORES



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ABSTRACT

Introduction: How to scientifically improve the sports balance ability of table tennis players is a frequent question among current researchers. Increasing the explosive power and stability of the lower limbs to improve competitive performance is one of the main focuses of current research. **Objective:** Analyze the impacts caused by lower limb training on the balance ability of table tennis players. **Methods:** Junior table tennis students from a university were randomly divided into experimental and control groups. The control group had routine training while the experimental group had a protocol with lower limb training added. **Results:** There was a statistical difference in the forward jump from 225.268 (\pm 13.229) cm before the experiment to 269.127 (\pm 9.331) cm after the experiment, and the left and right inclined jump values also followed this pattern after the experiment. The standing jump distance of the control group increased from 220.077 (\pm 21.124) cm before the experiment to 258.122 (\pm 15.1301) cm after the experiment. **Conclusion:** Habitual sports training positively impacts table tennis players, but the effect is relatively slow and has low training efficiency. The lower limb strength training scheme proposed in this study showed improved sporting efficiency in athletes and expressive gains in their lower limb strength, positively impacting dynamic balance ability. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Racquet Sports; Lower Limbs; Proprioception; Exercise Movement Techniques.

RESUMO

Introdução: Como melhorar cientificamente a capacidade de equilíbrio esportivo dos jogadores de tênis de mesa é uma questão frequente entre os pesquisadores atuais. Aumentar o poder explosivo e a estabilidade dos membros inferiores para melhorar o desempenho competitivo é um dos principais focos da pesquisa atual. **Objetivo:** Analisar os impactos provocados pelo treinamento dos membros inferiores sobre a capacidade de equilíbrio dos jogadores de tênis de mesa. **Métodos:** Os estudantes de tênis de mesa juniores de uma universidade foram divididos aleatoriamente em grupo experimental e grupo de controle. O grupo controle efetuou o treino de rotina enquanto ao grupo experimental foi adicionado um protocolo com treinamento dos membros inferiores. **Resultados:** Houve diferença estatística de salto frontal de 225.268 (\pm 13.229) cm antes do experimento para 269.127 (\pm 9.331) cm após o experimento, e os valores de salto inclinado à esquerda e à direita também seguiram esse padrão após o experimento. A distância de salto em pé do grupo de controle aumentou de 220.077 (\pm 21.124) cm antes do experimento para 258.122 (\pm 15.1301) cm após o experimento. **Conclusão:** O treinamento esportivo habitual revela impactos positivos sobre os jogadores de tênis de mesa, porém o efeito é relativamente lento e a eficiência do treinamento é baixa. O esquema de treinamento da força dos membros inferiores proposto neste trabalho demonstrou uma melhor eficiência esportiva nos atletas e ganhos expressivos de suas forças dos membros inferiores, impactando positivamente na capacidade de equilíbrio dinâmico. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Esportes com Raquete; Membros Inferiores; Propriocepção; Técnicas de Exercício e de Movimento.

RESUMEN

Introducción: Cómo mejorar científicamente la capacidad de equilibrio deportivo de los jugadores de tenis de mesa es una pregunta frecuente entre los investigadores actuales. Aumentar la potencia explosiva y la estabilidad de los miembros inferiores para mejorar el rendimiento competitivo es uno de los principales objetivos de la investigación actual. **Objetivo:** Analizar los impactos causados por el entrenamiento de las extremidades inferiores en la capacidad de equilibrio de los jugadores de tenis de mesa. **Métodos:** Los estudiantes de tenis de mesa de una universidad fueron divididos aleatoriamente en grupo experimental y grupo de control. El grupo de control realizó un entrenamiento rutinario mientras que al grupo experimental se le añadió un protocolo con entrenamiento de los miembros inferiores. **Resultados:** Hubo una diferencia estadística de 225,268 (\pm 13,229) cm de salto frontal antes del experimento a 269,127 (\pm 9,331) cm después del experimento, y los valores de salto inclinado izquierdo y derecho también siguieron este patrón después del experimento. La distancia de salto en pie del grupo de control aumentó de 220,077 (\pm 21,124) cm antes del experimento a 258,122 (\pm 15,1301) cm después del mismo. **Conclusión:** El entrenamiento deportivo habitual revela impactos positivos en los jugadores de tenis de mesa, pero el efecto es relativamente lento y la eficacia del entrenamiento es baja. El esquema de entrenamiento de la fuerza de los miembros inferiores propuesto en este trabajo mostró una mejor eficiencia



Descriptores: Deportes de Raqueta; Miembros Inferiores; Propiocepción; Técnicas de Ejercicio con Movimientos.

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INTRODUCTION

Table tennis is China's "national game" and has a very broad foundation in China. From the first World Table Tennis Championship in 1926 to the present, the techniques and tactics, training methods, equipment, etc. of table tennis have been constantly changing in different stages. High intensity training is an essential training method in table tennis training.¹ Such methods can effectively improve the athletes' sports skills, tactical skills and special physical quality. It plays an important role, so it is widely recognized and used by coaches at all levels. However, after long-term table tennis training, most athletes' body shape and physical fitness will change.² For example, the arm circumference of the dominant arm is larger than that of the non-dominant arm; The grip strength of the dominant arm is greater, and compared with the non-dominant arm, the left-right imbalance will affect the ability of the athlete to control the posture, reduce the balance and other skill levels, increase the possibility of injury, and affect the athletic ability and technical level.³ In table tennis technology, based on the force generated by many muscle groups in multiple dimensions, the force is transferred to the racket by the arm and wrist in a coordinated and controllable manner, so as to accurately hit the table tennis.⁴ In the step movement, the strength of the calf muscle is changed to make a quick response to the movement, so that the human body can move to a suitable position in the shortest time to strike, and cooperate with the arm to complete effective technical actions.⁵ By analyzing the characteristics of table tennis, we can see that the strong sports ability is related to the stretching reflex of muscles and the rapid contraction of muscle fibers. The muscles will automatically contract and stretch during the whole exercise process and provide certain strength. Its elastic storage capacity is very high, it can automatically swing in place, and automatically improve centripetal contraction and muscle endurance.⁶ The speed of centripetal contraction will eventually cause the lower limbs to move faster and have more force to pull off the ground. Therefore, while strengthening the lower limb training of athletes and improving their strength and sensitivity, improving the athletes' Sports balance ability can better improve the athletes' table tennis competitive ability and obtain more excellent results.⁷ This paper studies this topic.

METHOD

According to the principle of full voluntariness, after carefully explaining the training needs and experimental requirements, 40 students were selected as the research objects. The study and all the participants were reviewed and approved by Ethics Committee of Dalian Jiaotong University (NO.19DLJTSI-34). According to the method of random sampling, they were divided into experimental group and control group. The basic indexes of the two groups of subjects are shown in Table 1, $P > 0.05$, indicating that there is no significant difference.

The experiment lasted for 8 weeks. The experimental group and the control group maintained normal study and life outside the training

Table 1. Analysis of basic indicators of experimental subjects.

Basic indicator	Test group	Control group	P
Height	167.761±5.900	172.153±5.239	>0.05
Weight	64.476±5.562	65.323±4.554	>0.05

period. One hour of lower limb training program was conducted every Tuesday, Thursday and Saturday. Among them, the training contents of the experimental group include sitting up and kicking, shoulder carrying barbell turning, shoulder carrying barbell back squatting, rotating side pulling weights and shoulder carrying barbell stepping. The specific training intensity is shown in Table 2. The training contents of the control group are 4-meter platform touching, frog jumping, rope skipping (double shaking), standing long jump, abdominal tucking jump and straight back half squat. The training intensity is shown in Table 2.

During the competition, table tennis players are often in the process of high-speed movement and change. Therefore, the most common standing moment of table tennis players is the state of one foot landing, rather than two feet. Therefore, in the measurement of balance ability, three indexes, i.e. overall stability index (SI), anterior posterior stability index (APSI) and left-right stability index (mlsi), are selected as the judgment criteria. Each index is divided into left and right. In order to ensure the preciseness and accuracy of the experiment, better analyze the changes of athletes' balance ability. Before the beginning of the experiment, 4 weeks after the beginning of the experiment, and 8 weeks after the beginning of the experiment, the measurement was completed with the help of relevant personnel, and the measurement was conducted 5 times each time, and the average value was taken.

RESULTS

Effect of lower limb training on table tennis players

The training effect of table tennis players' lower limbs is shown in Table 3. The specific functions and data analysis results are as follows:

Table 2. Training program.

Time	Test group		Control group	
	Training content	Training intensity	Training content	Training intensity
Tuesday	Sit and kick on your legs	6*5	4 meters touched platform	20*5
	Turn the barbell with a barbell	12*4	leapfrog	5*4
Thursday	Squat after carrying the barbell	6*4	Jump rope (double shake)	30*4
	Turn on the side of the rotor	12*5	Standing long jump	2*5
Saturday	Shoulder -to -shoulder barbells kicking steps	8*5	Abdomen jump	25*5
	Turn the barbell with a barbell	12*4	Straight back squat	2*4

Table 3. Lower limb training effect of table tennis players.

Project	Group	Before	After	P
Standing long jump (cm)	test group	225.268±13.229	269.127±9.331	<0.01
	Control group	220.077±21.124	258.122±15.130	<0.01
Squat jump height (cm)	test group	34.635±3.657	46.364±2.840	<0.01
	Control group	34.101±3.351	43.091±4.049	<0.01
30M Running Score (s)	test group	4.648±0.112	3.959±0.109	<0.01
	Control group	4.685±0.148	4.078±0.169	<0.01

Standing long jump refers to the long jump that starts from the standing posture without help. It is a movement that integrates bouncing, explosive power, physical coordination and technology. In terms of stand-up jump remote distance, the experimental group was raised from the test (225.268 ± 13.229) CM before the experiment to the experiment (269.127 ± 9.331) CM, and the control group was increased from the experiment (220.077 ± 21.124) CM before the experiment to the experiment ($258.122 \pm \pm 15.1301$) CM, both of the two groups of $P < 0.01$, indicating that there are very significant differences in the existence. From the comparative analysis, it can be seen that the experimental group has a fixed-jump remote growth rate far greater than that of the control group.

It can be seen through the above analysis that the lower limb training plan proposed in this article is better, which can improve the comprehensive strength of the lower limb of table tennis players and provide better help for the improvement of the athlete's competitive power.

Impact of lower extremity training on the balance of balance of table tennis player

The impact of lower limb training on the balance of the balance of table tennis players is shown in Figure 1, Figure 2, and Figure 3. The specific functions and data analysis results are as follows:

Si index is the overall stability index. In short, it is the swing range of the athlete in the overall range when standing. Therefore, the lower the Si index, the higher the overall stability. It can be seen from Fig. 1 that before the experiment, the left and right Si values of the experimental group and the control group did not differ much, and remained in the range of 1.3 to 1.35. After the experiment, the left and right Si values of the experimental group and the control group showed a downward trend, and the rate of decline in the experimental group was significantly higher than that in the control group. This shows that the optimization efficiency of the lower limb strength training method proposed in this paper on the overall stability index is higher than the traditional lower limb training method.

APSI is the anteroposterior stability index. In short, it is the swing amplitude of the athlete on the sagittal plane. The sagittal plane is anatomically used to represent the section between the left and right parts of the human body. Therefore, from the perspective of three dimensions, the anteroposterior stability index is a plane disassembly part of the overall stability index. From the overall trend, it can be seen that the stability index in the front and rear directions of the experimental group and the control group both showed a certain downward trend when standing on one foot. Moreover, the lower limb training mode proposed in this paper has a higher impact on the falling frequency of APS I, which proves the effectiveness of this scheme.

MSI is the left-right stability index. In short, it is the swing amplitude of the athlete on the frontal plane. The frontal sagittal plane is anatomically used to represent the section between the front and rear parts of the human body. Therefore, from the perspective of three dimensions, the left-right stability index is a plane disassembly part of the overall stability index. From the overall trend, it can be seen that except for the left and right stability indexes in the control group, the other three mlsi indexes all showed a stable downward trend, and the frequency of the left and right indexes in the experimental group was much higher than that in the control group.

DISCUSSION

The introduction of lower limb strength training in table tennis can speed up the reaction speed and improve the speed of table tennis. In the game, the opportunity is fleeting, so the body movement speed and

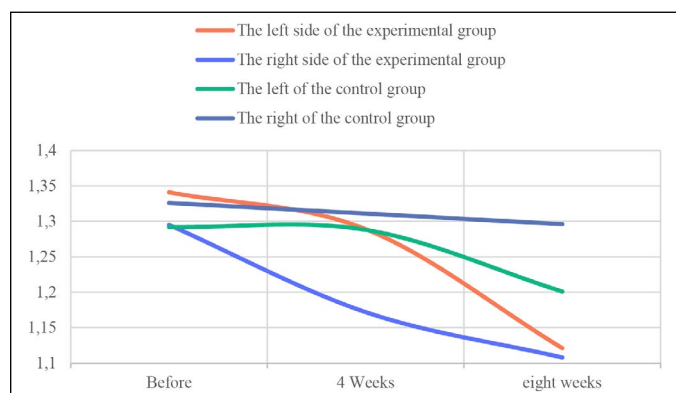


Figure 1. Changes in Si indexes in the experimental group and the control group (standing on one foot).

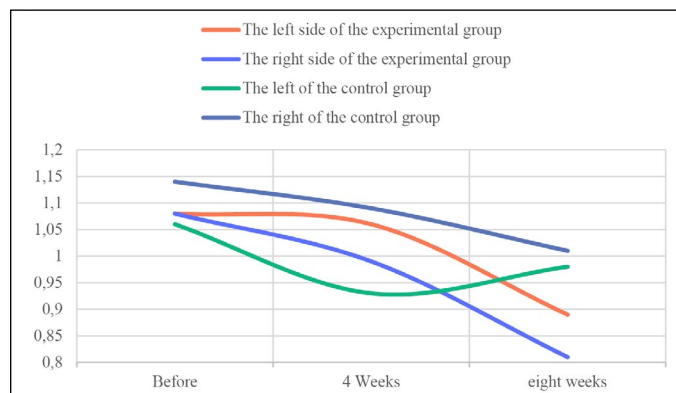


Figure 2. Changes in APSI indexes of the experimental group and the control group (standing on one foot).

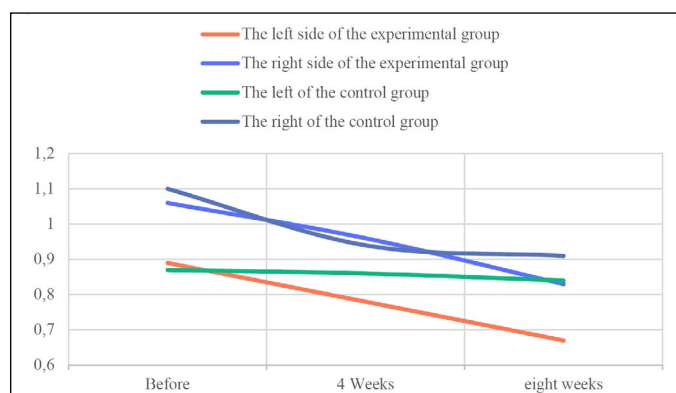


Figure 3. Changes in mlsi indexes of the experimental group and the control group (standing on one foot).

reaction speed are very important. While quickly judging the direction of the ball, it is necessary to mobilize the muscle groups required for the movement and try to return the ball in the shortest time. The ability of the athlete's step change depends on the core muscle strength of the lower limbs, waist and hip joints, and is related to the movement of the legs. The athlete with strong lower limb strength can quickly respond and make appropriate actions. It is necessary to improve the training load intensity according to the technical level of the athletes. Under the high load environment, the lower limb muscles of the athletes with strong core strength can be relaxed during the exercise to prepare for the next shot. According to the physiological level and training level of athletes, it is suggested to increase the weight of weight-bearing during training. Different training methods have different training effects. With the gradual improvement of sports training level, the training plan of the athletes is also constantly adjusted, and the physical training method of table tennis is more reasonable and effective. Through 1.5-5 months of strength training cycle, more obvious

results can be achieved. If greater progress is needed, it is necessary to change the training methods, put forward new and higher requirements, and overcome the stagnation of muscle function development caused by adaptation, including load and contraction.

The cycle of lower limb strength training in this experiment is 18 weeks. The test proves that this training method has a significant effect on increasing muscle strength and promoting the significant improvement of speed quality. It remains to be seen how to adjust the training in the next cycle and whether it can improve the speed. Improve the ability to control the center of gravity under unbalanced conditions. In table tennis, players often hit the ball in an unbalanced state. In this case, athletes with weak physical strength will lose their body center of gravity, resulting in the displacement of the hitting ball and incoherent technical movements. In this state, if the technical action is not performed well, the next shot will be affected. Athletes with strong lower limb strength can effectively adjust the center of gravity by controlling the lower limb strength when they encounter an unbalanced movement background, and successfully complete the movement, which is reflected in the ability to control the center of gravity in an unbalanced situation.

CONCLUSION

The threshold of table tennis is low, but its technical content is relatively high. Therefore, in the preparation process of high-level table tennis competition, coaches will strive to improve the training efficiency of athletes and improve their table tennis level as soon as possible while ensuring safety. Lower limb strength training can improve the balance ability and lower limb explosive power of athletes, and make them more flexible in the field. Therefore, it is an important part of routine training. The research results of this paper show that the combined lower limb training program represented by sitting up and kicking, shoulder carrying barbell turning, shoulder carrying barbell back squatting, rotating side pulling weights and shoulder carrying barbell stepping is more efficient than the current lower limb training methods, which can improve the strength balance and explosive power of the lower limbs of the athletes, improve the dynamic balance ability of the athletes, so that the athletes can get better play on the sports ground, so this scheme is worth promoting.

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AUTHORS' CONTRIBUTIONS: The author has completed the writing of the article or the critical review of its knowledge content. This paper can be used as the final draft of the manuscript. Every author has made an important contribution to this manuscript. Zhongjie Wang: writing and execution.

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