EFFECTS OF LOWER LIMB FLEXIBILITY EXERCISE ON TABLE TENNIS PLAYERS PHYSICAL FITNESS

EFEITOS DO EXERCÍCIO DE FLEXIBILIDADE DOS MEMBROS INFERIORES SOBRE A APTIDÃO FÍSICA DOS JOGADORES DE TÊNIS DE MESA

EFECTOS DEL EJERCICIO DE FLEXIBILIDAD DE LAS EXTREMIDADES INFERIORES EN LA APTITUD FÍSICA DE LOS JUGADORES DE TENIS DE MESA

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Wenhong Wang[1]
(Physical Education Professional)
Guohai Zhou[1]
(Physical Education Professional)

1. Jinling Institute of Technology, Nanjing, Jiangsu, China.

Correspondence:
Wenhong Wang
Nanjing, Jiangsu, China. 211169.
wwh@jit.edu.cn

ABSTRACT

Introduction: the main fitness requirements of table tennis players are highly automated motor skills and a strong body control ability; this combination is believed to benefit from flexibility exercises. Objective: Study the effects of lower limb flexibility training on physical fitness in table tennis players. Methods: The controlled experiment randomly divided 20 volunteers into two groups with no statistical differences between them. The control group continued using the existing table tennis teaching program, while the experimental group adopted the optimized lower limb flexibility training program. The course design was organized according to the physical education teacher's table tennis player talent training plan. Results: In the experimental group, the number of right body turns for throwing and blocking increased to 60.41 ± 4.67 times after the experiment; the number of right body turns increased to 64.045 ± 5.22; in the control group, the number of right push and blocks increased to 56.78 ± 3.67 times after the experiment. After the experiment, the number of fixed point swing speed of the whole station increased to 64.66 ± 3.95 (P<0.05). Conclusion: Adding lower limb flexibility exercises to table tennis flexibility training has been shown to improve athletes' static and dynamic flexibility, positively optimizing players' fitness. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Muscle Stretching Exercises; Lower Limbs; Racquet Sports; Physical Fitness.

RESUMO

Introdução: os principais requisitos de aptidão física dos jogadores de tênis de mesa são habilidades motoras altamente automatizadas e uma forte capacidade de controle corporal, acredita-se que essa combinação possa ser beneficiada com exercícios de flexibilidade. Objetivo: Estudar os efeitos do treinamento de flexibilidade dos membros inferiores sobre a aptidão física em jogadores de tênis de mesa. Métodos: O experimento controlado dividiu 20 voluntários, aleatoriamente, em dois grupos sem diferenças estatísticas entre si. O grupo de controle continuou a utilizar o programa de ensino do tênis de mesa existente, enquanto o grupo experimental adotou o programa de ensino de treinamento de flexibilidade dos membros inferiores otimizado. O projeto do curso foi organizado de acordo com o plano de treinamento de talentos de jogadores de tênis de mesa do professor de educação física. Resultados: No grupo experimental, o número de voltas à direita do corpo para arremesso e bloqueio aumentou para 60,41 ± 4,67 vezes após o experimento; o número de voltas à direita do corpo aumentou para 64,045 ± 5,22; no grupo de controle, o número de arremessos e bloqueios à direita aumentou para 56.78 ± 3.67 vezes após o experimento. Após o experimento, o número de velocidade de oscilação de ponto fixo de toda a estação aumentou para 64.66 ± 3.95 (P<0,05). Conclusão: Adicionar exercícios de flexibilidade dos membros inferiores ao treinamento de flexibilidade do tênis de mesa demonstrou melhorar a flexibilidade estática e dinâmica dos atletas, contribuindo positivamente para a otimização da aptidão física nos jogadores. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Exercícios de Alongamento Muscular; Membros Inferiores; Esportes com Raquete; Aptidão Física.*

RESUMEN

Introducción: los principales requisitos de aptitud física de los jugadores de tenis de mesa son unas habilidades motoras muy automatizadas y una gran capacidad de control corporal; se cree que esta combinación puede beneficiarse de los ejercicios de flexibilidad. Objetivo: Estudiar los efectos del entrenamiento de la flexibilidad de las extremidades inferiores en la aptitud física de los jugadores de tenis de mesa. Métodos: El experimento controlado dividió a 20 voluntarios, al azar, en dos grupos sin diferencias estadísticas entre ellos. El grupo de control siguió utilizando el programa de enseñanza de tenis de mesa existente, mientras que el grupo experimental adoptó el programa de enseñanza optimizado de entrenamiento de la flexibilidad de las extremidades inferiores. El diseño del curso se organizó de acuerdo con el plan de entrenamiento de talentos de jugadores de tenis de mesa del profesor de educación física. Resultados: En el grupo experimental, el número de giros del cuerpo derecho para lanzar y bloquear aumentó a 60,41 ± 4,67 veces después del experimento; el número de giros del cuerpo derecho aumentó a 64,045 ± 5,22; en el grupo de control, el número de empujes y bloqueos derechos aumentó a 56,78 ± 3,67 veces después del

experimento. Después del experimento, el número de velocidad de swing de punto fijo de toda la estación aumentó a 64,66 ± 3,95 (P<0,05). Conclusión: Se ha demostrado que añadir ejercicios de flexibilidad de las extremidades inferiores al entrenamiento de flexibilidad del tenis de mesa mejora la flexibilidad estática y dinámica de los atletas, contribuyendo positivamente a la optimización de la aptitud física de los jugadores. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Ejercicios de Estiramiento Muscular; Extremidades Inferiores; Deportes de Raqueta; Aptitud Física.*

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INTRODUCTION

Although table tennis has a small requirement on the field, the amount of exercise of athletes is very large. In the limited field, players can quickly adjust their positions according to the situation of the game and complete different hitting actions.[1] Therefore, table tennis can be said to be the most flexible ball game in the ball game, with high requirements for players' ability to react on the spot, and high requirements for agility. China's table tennis has developed well. In addition to the existing achievements, we should also strengthen the training of follow-up forces. In the training of the younger generation of athletes, the optimization of sensitivity quality is a major focus of research.[2] In order to have a further understanding of the optimization of the sensitivity quality of table tennis, the author has studied and analyzed the game video of the current excellent table tennis players, read a large number of literature books, and sorted out the sensitivity quality of the players suitable for the characteristics of table tennis.[3] First of all, athletes have extremely fast reaction ability and dodge ability when completing the technical actions related to table tennis. Secondly, in addition to the fast speed of changing direction and reaction ability, athletes should also have the ability to stop at any time, that is to say, athletes have strong control over the changes of body space position.[4] Third, athletes should comprehensively use all aspects of the body to show their comprehensive quality level when performing table tennis technical actions. Only by achieving the above three points can athletes improve their control ability and initiative on the field, optimize their sensitivity quality and improve their competitive level.[5] The literature interprets the main sensitivity requirements of table tennis players as highly automated skills and strong body control ability, and believes that the combination of the two is a strategy to improve the sensitivity quality of athletes.[6] According to the literature, table tennis needs to complete a large number of changes of direction and sudden stops in a short time, and the risk of sports injury to joints and muscles is high, and strengthening the coordination training of athletes can alleviate this kind of sports injury.[7] After carefully studying the above documents, this paper, based on the actual situation of the author's research area, takes table tennis players in a professional sports college as the research object, discusses the impact of lower limb exercises on the sensitivity of athletes, and wants to further optimize the existing research system, select more suitable training methods for athletes, so as to provide their own strength for the training of Chinese table tennis reserve talents.[8]

METHOD

After using the literature research method to have a relatively deep understanding of the research topic of this article, the author went to a professional sports school in the research area for research and volunteer recruitment. The study and all the participants were reviewed and approved by Ethics Committee of Jinling Institute of Technology (NO. JLITU20Z06). After obtaining the permission of the coach, I communicated with the coaches of the school, sorted out the training programs for the students' sensitive qualities, and communicated with the student representatives to understand their advantages and disadvantages in table tennis, and obtained first-hand information. Sort out the existing data, introduce lower limb flexibility exercises, and optimize and modify the shortcomings of the current sensitivity training program. After obtaining the preliminary experimental plan of this paper, the expert review method was used to ask six senior physical education teachers and sports experts to obtain their evaluation of the experimental plan and adjust it, and finally the experimental plan of this paper was obtained.

After designing the experiment, we recruited table tennis players from the professional sports school. They are required to be about 20 years old, have a good sports foundation and have little difference in performance. During the whole training process, we should always follow the requirements of the researchers, actively cooperate to complete the relevant sports training, and there should be no absence and perfunctory. In the process of exercise, stretch and relax carefully to prevent sports injury. If sports injury occurs, the data of the member will be deleted. Finally, a total of 20 volunteers were recruited, and their basic information is shown in Table 1: the basic information of weight, height and performance are not significantly different when the age is about 20. According to the form of random sampling, they were divided into experimental group and control group, with 10 members in each group.

In the way of control experiment, the control group continued to use the existing table tennis sensitivity teaching scheme, while the experimental group adopted the optimized lower limb flexibility training teaching scheme mentioned above. The curriculum is designed according

Table 1. Summary of characteristics of experimental and control group members.

Experience group			
Number	**Age (yr)**	**Height (cm)**	**Body weight (kg)**
1	19.92	183.15	73.27
2	20.46	178.45	73.85
3	20.32	177.52	73.15
4	20.73	180.68	78.1
5	20.53	180.13	78.53
6	20.47	178.57	76.24
7	20.05	175.39	74.81
8	20.74	178.52	76.24
9	19.87	181.8	73.95
10	21.01	180.44	76.16
Control group			
Number	**Age (yr)**	**Height (cm)**	**Body weight (kg)**
1	19.84	178.64	78.09
2	19.92	176.71	75.14
3	20.26	178.52	78.63
4	19.37	181.52	76.25
5	20.55	182.18	74.87
6	20.15	179.2	78.29
7	20.13	180.07	76.81
8	21.02	178.65	75.27
9	22.65	177.7	78.05
10	20.47	180.27	75.88

to the table tennis talent training plan of the physical education teachers. This is a closed school, so the work and rest and diet problems among the members are basically eliminated, so that the experimental results are more rigorous.

Before and after the experiment, collect relevant data for testing, sort out and analyze the data, as shown in the following section.

RESULTS

Effect of lower limb flexibility exercise on table tennis players

Table 2 selects three indicators of 1RM squat, CMJ jump and 1min squat as the change judgment of table tennis players' lower limb strength to explore the impact of lower limb flexibility training on table tennis players' lower limb strength. In the experimental group, 1RM squat strength increased to (79.653 ± 9.5901) kg, P<0.05; The jumping height of CMJ in the experimental group increased to (34.923 ± 4.7450) cm, P<0.05; The number of squats in the experimental group increased to (52.880 ± 5.4616) times in 1 min, P<0.01. In the control group, 1RM squat strength decreased to (77.985 ± 9.3268) kg, P>0.05; The jumping height of CMJ in the experimental group increased to (33.961 ± 4.2288) cm, P>0.05; The number of squats in the experimental group decreased to (52.411 ± 5.8042) times (P>0.05). (Table 3)

Table 2 selects six indicators, including sitting forward flexion, hip flexion, hip extension, sitting forward flexion, hip flexion and hip extension, as the change judgment of table tennis players' lower limb flexibility to explore the impact of lower limb flexibility training on table tennis players' lower limb flexibility. In the experimental group, the forward bending distance in the sitting position was increased to (28.450 ± 8.7495) cm, P<0.05; The hip flexion angle expanded to (113.924 ± 10.7408) °, P<0.05; The hip extension angle expanded to (12.114 ± 4.1516) °, P<0.05; The knee flexion angle expanded to (130.031 ± 7.9293) °, P<0.05; The flexion angle of ankle and toe was enlarged to (41.782 ± 7.1076) °, P<0.05; The ankle dorsiflexion angle expanded to (20.333 ± 3.2951) °, P<0.01. In the control group, the forward bending distance in the sitting position was increased to (25.651 ± 6.6634) cm, P>0.05; The hip flexion angle decreased to (110.134 ± 9.4602) °, P>0.05; The hip extension angle expanded to (9.947 ± 3.9098) °, P>0.05; The knee flexion angle decreased to (128.175 ± 8.3445) °, P>0.05; The flexion angle of ankle and toe decreased to (40.979 ± 7.4649) °, P>0.05; The ankle dorsiflexion angle expanded to (16.858 ± 3.4463) °, P>0.05.

Table 2. Effect of lower limb flexibility training on lower limb strength of table tennis players.

Experience group			
Option	**1RM squat (kg)**	**CMJ jump (cm)**	**1 min squat (times)**
Before experiment	79.255±8.4325	34.553±5.1532	51.919±6.4290
After experiment	79.653±9.5901	34.923±4.7450	52.880±5.4616
P	0.02667	0.01633	0.00493
Control group			
Option	**1RM squat (kg)**	**CMJ jump (cm)**	**1 min squat (times)**
Before experiment	78.127±9.4853	33.435±4.6638	52.470±5.8848
After experiment	77.985±9.3268	33.961±4.2288	52.411±5.8042
P	0.97561	0.59444	0.74252

Table 3. Effect of lower limb flexibility training on lower limb flexibility of table tennis players.

Experience group			
Option	**Forward flexion in sitting position (cm)**	**Hip flexion (°)**	**Hip extension (°)**
Before experiment	25.786±9.1444	109.575±12.3437	10.147±3.4463
After experiment	28.450±8.7495	113.924±10.7408	12.114±4.1516
P	0.03810	0.04760	0.01886
Option	Knee flexion (°)	Ankle toe flexion (°)	Ankle dorsiflexion (°)
Before experiment	129.299±7.6103	41.002±6.8110	16.574±4.9578
After experiment	130.031±7.9293	41.782±7.1076	20.333±3.2951
P	0.03670	0.04076	0.00695
Control group			
Option	**Forward flexion in sitting position (cm)**	**Hip flexion (°)**	**Hip extension (°)**
Before experiment	25.277±8.6932	111.197±11.0154	9.866±3.5773
After experiment	25.651±6.6634	110.134±9.4602	9.947±3.9098
P	0.97059	0.68255	0.20350
Option	Knee flexion (°)	Ankle toe flexion (°)	Ankle dorsiflexion (°)
Before experiment	128.360±8.4927	41.093±7.5001	16.314±4.7462
After experiment	128.175±8.3445	40.979±7.4649	16.858±3.4463
P	0.58857	0.72103	0.56781

Effect of lower limb flexibility exercise on the sensitivity of table tennis players

Table 4 selects three indicators, namely, 30m run, cross jump and splay step, as the change judgment of table tennis players' sensitivity to explore the impact of lower limb flexibility training on table tennis players' sensitivity. Cross-quadrant jump is a common evaluation standard used to test the sensitivity quality of athletes. Under the guidance of visual signals, athletes operate their bodies to jump into the corresponding quadrants. This process can also simulate the sensitivity and reaction on the field. Athletes should first have strong reaction ability, be able to quickly identify the information seen by their eyes and transmit it to the sports center. The sports center should operate the body to complete the correct jump in a short time, which also requires high sensitivity.

Pushing, blocking, side and right are the common training footwork requirements of athletes in table tennis training. First, the players attack the ball with backhand, then catch the ball with forehand position, and then use cross steps to move to the right to complete the action of receiving the ball. This series of actions requires high inertia and speed, which requires the athletes to be familiar with the action, have high reaction ability, and also have strong sensitivity, Therefore, it can be used as a main evaluation standard. The fixed-point swing speed of the whole station is a further test of athletes' ability. In this test, there is no well-designed action routine. The coach serves the ball at random, and the players receive the ball on the other side according to their own experience and reaction. This is completely a simulation of the game scene, showing the actual combat ability of the players. Table 5 selects three indicators, namely, 3m sideslip, push and block sideslip, and swing speed of the whole platform at fixed points, as the change judgment of table tennis players' competitive performance, and discusses the impact of lower limb flexibility training on table tennis players' competitive performance.

Table 4. The Effect of Lower Limb Flexibility Exercise on the Sensitivity of Table Tennis Players.

Experience group			
Option	**30m run (s)**	**Cross jump (correct number)**	**Eight character stamp (s)**
Before experiment	5.403±0.2306	24.547±2.8962	21.257±2.6200
After experiment	5.231±0.1114	27.343±3.0773	19.824±1.6828
P	0.01362	0.00645	0.03330
Control group			
Option	**30m run (s)**	**Cross jump (correct number)**	**Eight character stamp (s)**
Before experiment	5.413±0.1404	23.953±2.5966	21.628±2.1464
After experiment	5.251±0.2025	25.408±2.0846	20.882±2.2975
P	0.02827	0.03256	0.06190

Table 5. Effect of lower limb flexibility training on table tennis players' competitive performance.

Experience group			
Option	**3m sideslip (times)**	**Push to the right (times)**	**Unscheduled swing speed of the whole set (times)**
Before experiment	26.655±1.2333	56.813±3.3356	60.792±5.5422
After experiment	28.162±1.3266	60.411±4.6755	64.045±5.2299
P	0.02495	0.03145	0.01286
Control group			
Option	**3m sideslip (times)**	**Push to the right (times)**	**Unscheduled swing speed of the whole set (times)**
Before experiment	26.695±1.3035	56.682±3.1958	64.171±3.9602
After experiment	27.358±1.2253	56.782±3.6729	64.664±3.9501
P	0.06977	0.02075	0.02358

DISCUSSION

The flexibility exercise of lower limbs can be divided into static flexibility and dynamic flexibility according to different types of training. Static flexibility is simply understood as the stretching of joints and muscles by means of external forces in a quiet state. In this process, the joint can be kept in a stretch state by giving a certain amount of external force without additional muscle movement. The limiting factor of static flexibility is not only the external force, but also the endurance of the athletes themselves. The general measurement form is to stretch a certain joint of the athlete as far as possible until the athlete feels pain, then this data threshold is the evaluation standard of the maximum static flexibility. Dynamic flexibility refers to the range of joint activities completed under the influence of athletes' own muscle contraction. When the force is applied, there is a certain dynamic potential energy, so the range of joint activity corresponding to dynamic flexibility is often greater than that of static flexibility. However, dynamic flexibility is instantaneous and cannot be fixed and retained. Static flexibility and dynamic flexibility are also directly related, and they are in direct proportion. The stronger the static flexibility, the stronger the dynamic flexibility of the athletes. When conducting dynamic flexibility training, you can also conduct a series of static flexibility training first, so that the joints of the athletes can be extended, so that the dynamic flexibility training can more effectively improve the flexibility effect of the athletes.

CONCLUSION

It is very important to cultivate the reserve force of table tennis talents, and the existing research program needs to be optimized and improved again. This paper introduces the lower limb flexibility exercise into the sensitivity training, and discusses the effect of the lower limb flexibility exercise on the sensitivity improvement of table tennis players using the principles of sports physiology. The research results show that adding lower limb flexibility exercises to table tennis flexibility training can better improve the static flexibility and dynamic flexibility of athletes, and has a good effect on optimizing the level of athletes' sensitivity quality, so it is worth promoting.

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