

ANALYSIS OF UPPER LIMBS STRENGTH TRAINING IN TABLE TENNIS



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ANÁLISE DO TREINAMENTO DE FORÇA EM MEMBROS SUPERIORES NO TÊNIS DE MESA

ANÁLISIS DEL ENTRENAMIENTO DE FUERZA EN MIEMBROS SUPERIORES EN EL TENIS DE MESA

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ABSTRACT

Introduction: The strength training of superior members currently practiced in the university courses does not correspond to the real necessities of the athletes, demanding the development of optimized methods for more expressive performance gains. To create these methods, it is necessary to collect data scientifically to consolidate a solid analysis for improvement. **Objective:** Analyze upper limbs strength training in table tennis players. **Methods:** During the experiment, 20 students were randomly divided into groups to perform daily training according to the original table tennis training plan. The experimental group received a schematized protocol improving the existing teaching by adding upper limb strength training. The experiment totaled eight weeks, with one hour of training conducted twice a week. **Results:** In the experimental group, the attack distance index increased by 25.378%, the one-minute attack swing index increased by 0.585%, the swing index increased by 12.795%, and the technical attack index increased by 11.452%. **Conclusion:** The improved upper limb strength training method presented in the protocol of this article can optimize athletes' muscle strength, increasing balance and swing ability, positively influencing the technical score and final sports performance. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Upper Limbs; Resistance Training; Physical Education and Training.

RESUMO

Introdução: O treinamento de força de membros superiores atualmente praticados nos cursos universitários não correspondem às reais necessidades dos atletas, exigindo o desenvolvimento de métodos otimizados para ganhos de desempenho mais expressivos. Para a confecção desses métodos, é necessário efetuar-se uma coleta de dados de maneira científica afim de consolidar uma análise sólida para aprimoramento. **Objetivo:** Analisar o treinamento de força dos membros superiores nos praticantes de tênis de mesa. **Métodos:** Durante o experimento, 20 estudantes foram aleatoriamente divididos em um grupo para efetuar o treinamento diário de acordo com o plano original de treinamento do tênis de mesa, enquanto o grupo experimental recebeu um protocolo esquematizado aprimorando o ensino existente, adicionando o treinamento de força para os membros superiores. O experimento totalizou 8 semanas, com uma hora de treino realizado duas vezes por semana. **Resultados:** No grupo experimental, o índice de distância de ataque aumentou 25,378%, o índice de balanço de ataque de um minuto aumentou 0,585%, o índice de balanço aumentou 12,795% e o índice técnico de ataque aumentou 11,452%. **Conclusão:** O método aperfeiçoado de treinamento de força dos membros superiores apresentados no protocolo deste artigo pode otimizar a força muscular dos atletas, aumentando a capacidade de equilíbrio e balanço, influenciando positivamente na pontuação técnica e desempenho esportivo final. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Membros Superiores; Treinamento de Força; Educação Física e Treinamento.

RESUMEN

Introducción: El entrenamiento de fuerza de miembros superiores actualmente practicado en los cursos universitarios no corresponde a las necesidades reales de los atletas, exigiendo el desarrollo de métodos optimizados para ganancias de rendimiento más expresivas. Para la confección de estos métodos, es necesario recopilar datos de forma científica con el fin de consolidar un análisis sólido para su mejora. **Objetivo:** Analizar el entrenamiento de fuerza de los miembros superiores en practicantes de tenis de mesa. **Métodos:** Durante el experimento, 20 estudiantes se dividieron aleatoriamente en un grupo para realizar un entrenamiento diario según el plan de entrenamiento original de tenis de mesa, mientras que el grupo experimental recibió un protocolo esquematizado que mejoraba la enseñanza existente añadiendo un entrenamiento de fuerza de las extremidades superiores. El experimento duró 8 semanas, con una hora de entrenamiento dos veces por semana. **Resultados:** En el grupo experimental, el índice de distancia de ataque aumentó un 25,378%, el índice de balanceo de ataque de un minuto aumentó un 0,585%, el índice de balanceo aumentó un 12,795% y el índice de ataque técnico aumentó un 11,452%. **Conclusión:** El método mejorado de entrenamiento de la fuerza de las extremidades superiores presentado en el protocolo de este artículo puede optimizar la fuerza muscular de los atletas, aumentando el equilibrio y la capacidad de balanceo, influyendo positivamente en la puntuación técnica y en el rendimiento deportivo final. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptores: Extremidades Superiores; Entrenamiento de Fuerza; Educación y Entrenamiento Físico.



INTRODUCTION

With the development of mass sports, the popularity of table tennis in China is very high, and it has always enjoyed the title of national sport.¹ China has achieved excellent results in table tennis, and has won a place in various large-scale competitive competitions in the world. Table tennis is also very popular in China, with a high degree of public participation.² Sports enthusiasts and students are willing to participate in sports in their spare time. Because China has relatively advanced theoretical knowledge of table tennis, the contents of table tennis courses in colleges and universities also show diversity. The teaching mode and training mode have been very mature.³ In terms of the infrastructure of table tennis projects in China, table tennis venues can be seen everywhere in China.⁴ Daily table tennis can help students improve their physical condition, enhance their physical quality, and cultivate our indomitable will. The university stage is an important stage of life growth, and more sports are conducive to the development of students' physical and mental health.⁵ With the continuous improvement of living conditions, people have enough cost to invest in sports, and students will also actively pursue high-quality sports experience. Actively participate in daily training to improve the competitive level of table tennis.⁶ Because of the particularity of table tennis, it is a common technical action to hit the ball by waving the racket. It is a universally recognized training method to improve arm strength and help improve the technical level of table tennis.⁷ Strength training to improve sports performance is in line with the concept of faster and stronger sports development. Therefore, effective arm swing strength training methods obtained through analysis can help the development of table tennis courses in colleges and universities, and help students obtain better sports experience.⁸

METHOD

Research objects

The research object is selected from the undergraduate table tennis students of a university. After registration and preliminary screening, 20 table tennis students were selected as the research objects of this experiment, and they were divided into an experimental group and a control group in the form of dark box random sampling, with 10 students in each group. The study and all the participants were reviewed and approved by Ethics Committee of Civil Aviation University of China (NO.CAUA2020-PTF006). The basic information about the two groups of subjects is shown in Table 1. There is little difference in age, height, weight and time of table tennis training, thus eliminating the interference of the subjects' own personal factors on the experimental results.

Table 1. Basic information about the research object.

Index	Experience group	Control group	P
Age (age)	20.086±1.668	20.311±1.403	0.7308
Height (cm)	172.501±4.710	169.705±4.278	0.3884
Weight (kg)	63.364±10.588	65.922±8.431	0.8530
Special training time (year)	6.081±2.118	6.653±1.752	0.6740

Table 2. Analysis of arm strength before and after the experiment in the experimental group and the control group.

Option	Before experiment			After experiment		
	Experience group	Control group	p	Experience group	Control group	p
Badminton throw (m)	5.876±0.613	6.038±0.635	0.6264	6.989±0.722	6.169±0.790	0.0133
Preferred hand grip strength (kg)	30.361±9.815	28.202±7.213	0.7718	35.503±10.075	28.399±7.320	0.0020
30s fast dumbbell curl (times)	19.957±2.178	20.289±2.151	0.6590	21.400±2.165	20.543±1.879	0.0228
Half squat sideslip (s/40m turn back)	44.342±2.159	45.035±2.190	0.8260	39.781±2.159	43.326±2.349	0.0466
Weight bearing fast flexion and extension of forearm (piece/min)	32.734±1.374	32.655±1.429	0.7515	34.881±1.632	36.860±1.662	0.0478
Wrist strength (pcs/min/5kg dumbbells)	44.983±2.294	46.314±1.860	0.5434	47.633±2.426	51.002±1.930	0.0245

Training methods

During the experiment, the control group carried out daily training according to the original table tennis training plan, mainly including aerobic exercise, teaching of table tennis swing skills, and so on. The experimental group improved the existing teaching scheme, increased the arm strength training, and paid attention to both strength enhancement and skill improvement.

The whole experiment lasted for 8 weeks. The total amount of exercise load of the two groups of athletes remained basically the same, and the training was conducted twice a week, each time in the form of one hour.

Mathematical Statistics

The research goal of this paper is to analyze the results of arm swing strength training and table tennis, so the selection of judgment criteria can be divided into two categories. The first is the analysis of arm swing strength. The indexes such as badminton long throw, hand grip strength, 30s fast dumbbell curl, half squat sideslip, weight bearing fast forearm flexion and extension, wrist strength, and so on were selected. The results of the experimental group and the control group before and after the experiment were statistically analyzed, and their changes were calculated. The second is the analysis of table tennis swing skills and sports results. The indexes such as long smash, 1 min forehand attack swing, forehand pull backspin ball, backhand pull backspin ball, forehand continuous force attack, backhand continuous force attack, left push and right attack techniques were selected, and the specific data before and after the experiment and its change rate were also calculated. Through the comparison of data, the research results are more significant.

RESULTS

Analysis of arm swing strength of two groups of athletes before and after the experiment

As shown in Table 2 and Table 3, it is the data analysis and calculated change rate of the arm strength of the experimental group and the control group before and after the experiment, from which the optimization effect of arm swing strength training on arm strength can be analyzed.

Table 2 shows the specific statistical results of data. It can be seen from Table 2 that the distance of badminton throw in the experimental group has increased from (5.876 ± 0.613) m to (6.989 ± 0.722) m after the experiment, the grip strength of the dominant hand has increased

Table 3. Change rate of arm strength before and after the experiment in the experimental group and the control group.

Option	Experience group	Control group
Badminton throw	18.946%	2.182%
Preferred hand grip strength	16.937%	0.698%
30s fast dumbbell curl	7.232%	1.256%
Half squat sideslip	10.286%	3.795%
Weight bearing fast flexion and extension of forearm	6.560%	12.879%
Wrist strength	5.890%	10.122%

from (30.361 ± 9.815) kg to (35.503 ± 10.075) kg after the experiment, and the number of quick dumbbell bends in 30s has increased from (19.957 ± 2.178) times to (21.400 ± 2.165) times after the experiment, The turn back time of the squatting side slide 40m was shortened from (44.342 ± 2.159) s to (39.781 ± 2.159) s after the experiment, the number of fast flexion and extension forearms with load per minute was increased from (32.734 ± 1.374) to (34.881 ± 1.632) after the experiment, and the wrist strength measured by the 5kg dumbbell bent arm per minute was increased from (44.983 ± 2.294) to (47.633 ± 2.426) after the experiment. This shows that there is no significant difference between the experimental group and the control group in the results of relevant index data before the start of the experiment, P is greater than 0.05, indicating that there is no significant difference, and the initial performance of the two groups of athletes will not interfere with the experimental results. Secondly, the data of the experimental group and the control group were optimized before and after the experiment, indicating that both traditional table tennis skill training and strength training, or targeted arm swing strength training, can improve the arm strength of table tennis athletes and improve their related indicators.

The data results in Table 2 are not intuitive enough, so the change rate is calculated and the data is shown in Table 3. In the experimental group, the long throw index of badminton increased by 18.946%, and the grip strength index of the dominant hand increased by 16.937%; the index of 30s fast dumbbell bending lift increased by 7.232%; the index of half squat sideslip increased by 10.286%; the index of weight bearing fast flexion and extension of forearm increased by 6.560%; the wrist strength index increased by 5.890%. In the control group, the index of badminton long throw increased by 2.182%; the grip strength of the dominant hand increased by 0.698%; the index of 30s fast dumbbell curling increased by 1.256%; the index of half squat sideslip increased by 3.795%; the index of weight bearing fast flexion and extension of forearm increased by 12.879%; the wrist strength index increased by 10.122%. It can be seen that the arm strength of the experimental group and the control group has improved after 8 weeks of training.

Analysis of table tennis swing skills and sports performance of the two groups of athletes before and after the experiment

As shown in Table 4 and Table 5, it is the data analysis and change rate calculation of table tennis swing skills and sports performance of the experimental group and the control group before and after the experiment.

Table 4 shows the specific statistical results of table tennis swing skills and sports results. It can be seen from the table that the distance of smash hit in the experimental group has increased from (7.662 ± 1.095) m to (9.606 ± 1.060) m after the experiment, the number of forehand attack swings in one minute has increased from (67.827 ± 6.374)

to (68.224 ± 6.293), and the number of forehand pull downturns in one minute has increased from (36.251 ± 6.660) to (40.889 ± 7.065) after the experiment, The number of one minute backhand pull backspin balls increased from (30.152 ± 6.274) to (34.967 ± 6.892) after the experiment, the number of one minute forehand continuous serve balls increased from (86.090 ± 2.727) to (91.779 ± 3.275) after the experiment, and the number of one-minute backhand continuous serve balls increased from (61.198 ± 4.415) to (66.984 ± 4.374) after the experiment, The number of left push and right attack in 1 minute increased from (41.023 ± 5.789) to (45.721 ± 6.699) after the experiment. The P value of various data results of the experimental group and the control group before the start of the experiment is greater than 0.05, which indicates that the performance of the two groups of athletes is not different, and will not cause artificial interference to the experimental results. After the end of the experiment, the data comparison of the two groups can also be seen to be optimized.

The data in Table 4 are further calculated in Table 5. In the experimental group, the spike hit distance index increased by 25.378%, the one-minute forehand attack swing index increased by 0.585%, the forehand pull backspin index increased by 12.795%, the backhand pull backspin index increased by 15.966%, the forehand continuous serve attack index increased by 6.609%, the backhand continuous serve attack index increased by 9.454%, and the left push right attack technical index increased by 11.452%. In the control group, the spike hit distance index increased by 1.464%, the one-minute forehand attack swing index increased by 0.524%, the forehand pull backspin index increased by 6.681%, the backhand pull backspin index increased by 6.000%, the forehand continuous serve attack index increased by 6.006%, the backhand continuous serve attack index increased by 9.148%, and the left push right attack technical index increased by 14.169%.

DISCUSSION

Strength training of arm swing in table tennis teaching

Strength attribute is the core foundation of physical fitness, and the core of all kinds of training is also strength training. The strength

Table 5. The change rate of swing and table tennis performance of the experimental group and the control group before and after the experiment.

Option	Experience group	Control group
Long smash	25.378%	1.464%
1min forehand attack swing	0.585%	0.524%
Forehand pull down spin ball	12.795%	6.681%
Backhand pull down spin ball	15.966%	6.000%
Forehand continuous power attack	6.609%	6.006%
Backhand continuous attack	9.454%	9.148%
Left push and right attack techniques	11.452%	14.169%

Table 4. Analysis of the swing and table tennis performance of the experimental group and the control group before and after the experiment.

Option	Before experiment			After experiment		
	Experience group	Control group	p	Experience group	Control group	p
Long smash (m)	7.662±1.095	7.891±0.915	0.8291	9.606±1.060	8.007±1.164	0.0010
1min forehand attack swing (times)	67.827±6.374	66.051±8.452	0.7973	68.224±6.293	66.398±8.140	0.0061
Forehand pull down spin ball (pieces/more balls per minute)	36.251±6.660	38.151±5.601	0.8579	40.889±7.065	40.699±6.610	0.0455
Backhand pull down spin ball (pieces/more balls per minute)	30.152±6.274	32.753±7.366	0.6324	34.967±6.892	34.718±8.082	0.0122
Forehand continuous power attack (pieces/more than one ball per minute)	86.090±2.727	85.021±2.564	0.9267	91.779±3.275	90.127±2.939	0.0179
Backhand continuous attack (pieces/more than one ball per minute)	61.198±4.415	62.435±4.601	0.9471	66.984±4.374	68.146±4.750	0.0296
Left push and right attack techniques (pieces/multiple balls per minute)	41.023±5.789	16.949±4.166	0.6254	45.721±6.699	19.351±4.631	0.0178

training for table tennis mainly consists of upper and lower limbs. The improvement of lower limb strength will help to improve the speed during exercise. The training of upper limb strength can help to give the ball enough energy when the upper limb swings and hits the ball in the actual combat process, and help to improve the offensive ability of table tennis. Strength is the ability of the human body to contract through muscles. Strength is usually related to muscle volume, muscle density, and the way of exerting force. Through the principle of movement, it can be found that the power required by table tennis is mainly dynamic power. The whole body muscles participate in the technical action of the swing, mainly from the upper limbs. Therefore, the practice of upper limb swing can help improve the offensive ability.

Precautions for arm swing strength training

Although strength training can greatly improve performance. But blind training should also be avoided in the training process. Students with a history of arm injuries should minimize training intensity. Because there are many weak joints in the arm. Excessive exercise intensity is likely to cause the recurrence of old injuries. High quality sports aids should be selected during training. The quality of professional sports equipment has been strictly tested, which can provide enough safety

for training. Poor quality sports equipment is likely to cause serious consequences during the training process, such as parts falling off and the trainer getting rid of them. In the training process, we should first learn the standard training actions, which can help the trainers have efficient training effects. Irregular training actions are likely to cause errors in the power generation link, and the wrong power generation mode will cause excessive joint pressure and various joint injuries. The training shall be conducted in a professional training venue. The professional training ground can provide enough friction. It can effectively avoid falls and injuries.

CONCLUSION

In this paper, the existing arm strength training method is improved to make it more integrated with the needs of athletes. The research results show that the improved arm strength training method in this paper can better optimize the arm muscle strength of athletes, and improve their swing strength and technical score, so that athletes can obtain more sports advantages and improve their competitive level.

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REFERENCES

1. Kurimay D, Pope-Rhodus A, Kondric M. The relationship between stress and coping in table tennis. *J Hum Kinet.* 2017;55(1):75-81.
2. Michalski SC, Szpak A, Saredakis D, Ross TJ, Billingham M, Loetscher T. Getting your game on: Using virtual reality to improve real table tennis skills. *PLoS One.* 2019;14(9):e0222351.
3. Zagatto AM, de Mello Leite JV, Papoti M, Beneke R. Energetics of table tennis and table tennis-specific exercise testing. *Int J Sports Physiol Perform.* 2016;11(8):1012-7.
4. Malagoli Lanzoni I, Di Michele R, Merni F. A notational analysis of shot characteristics in top-level table tennis players. *Eur J Sport Sci.* 2014;14(4):309-17.
5. Ak E, Koçak S. Coincidence-anticipation timing and reaction time in youth tennis and table tennis players. *Percept Mot Skills.* 2010;110(3):879-87.
6. Bańkosz Z, Winiarski S. The kinematics of table tennis racquet: differences between topspin strokes. *J Sports Med Phys Fitness.* 2016;57(3):202-13.
7. Rossi J, Vigouroux L, Barla C, Berton E. Potential effects of racket grip size on lateral epicondylalgia risks. *Scand J Med Sci Sports.* 2014;24(6):e462-70.
8. Sung DJ, Park SJ, Kim S, Kwon MS, Lim YT. Effects of core and non-dominant arm strength training on drive distance in elite golfers. *J Sport Health Sci.* 2016;5(2):219-25.