ANALYSIS OF THE LEVEL OF SWIMMING PHYSICAL TRAINING BASED ON LIMB STRENGTH

ANÁLISE DO NÍVEL DE TREINAMENTO FÍSICO DE NATAÇÃO COM BASE NA FORÇA DOS MEMBROS

ANÁLISIS DEL NIVEL DE ENTRENAMIENTO FÍSICO EN NATACIÓN EN FUNCIÓN DE LA FUERZA DE LAS EXTREMIDADES

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Zhang Xin[1]
(Physical Education Professional)

1. Wenzhou University, College of Physical Education and Health, Wenzhou, Zhejiang, China.

Correspondence:
Zhang Xin
Wenzhou, Zhejiang, China. 325035.
tyxyzx@wzu.edu.cn

ABSTRACT

Introduction: Swimming has high criteria for physical ability and movement by athletes. Efficient strength training can not only improve the physical training level of athletes but also increase their sports ability. Therefore, it is an important link in swimming training. Objective: Explore the effect of limb strength training on athletes' fitness in swimming. Methods: In this experiment, 20 swimmers majoring in physical education at a university were selected to undergo limb strength training for six weeks. Before and after the sports training, the indices such as thigh circumference, calf circumference, lower limb jumping ability, lower limb maximal strength, and lower limb balance ability of the athletes were measured, and the results of butterfly, backstroke, breaststroke, and freestyle in 50m main events were recorded. Results: Efficient limb strength training can significantly promote the changes in athletes' lower limb muscle strength, improve their endurance and explosive power, improve swimmers' balance ability and movement stability, and significantly improve competitive swimming performance. Conclusion: It is necessary to intensify physical strength training in athletes to improve their physical training level and economic performance. This plan can be considered very useful. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Upper Extremity; Swimming; Resistance Training.

RESUMO

Introdução: A natação tem elevados critérios de capacidade física e de movimentação por parte dos atletas. O treinamento de força eficiente pode não apenas melhorar o nível de treinamento físico dos atletas, mas também aumentar suas capacidades esportivas. Portanto, é um importante elo no treinamento de natação. Objetivo: Explorar o efeito do treinamento de força dos membros sobre a aptidão física dos atletas na natação. Métodos: Nesta experiência, 20 nadadores formados em Educação Física em uma universidade foram selecionados para realizar o treinamento de força dos membros durante seis semanas. Antes e depois do treinamento esportivo, foram medidos os índices como circunferência da coxa, circunferência da panturrilha, capacidade de saltar dos membros inferiores, força máxima dos membros inferiores e capacidade de equilíbrio dos membros inferiores dos atletas, e foram registrados os resultados de borboleta, nado de costas, nado de peito e estilo livre em eventos principais de 50m. Resultados: O treinamento eficiente da força dos membros pode promover significativamente as mudanças da força muscular dos membros inferiores dos atletas, melhorar sua resistência e poder explosivo, melhorar significativamente a habilidade de equilíbrio e estabilidade de movimento dos nadadores, além de melhorar significativamente o desempenho competitivo da natação. Conclusão: É necessário intensificar o treinamento de força física nos atletas, no intuito de melhorar seu nível de treinamento físico e melhorar seu desempenho econômico. Este plano pode ser considerado de grande utilidade. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Extremidade Superior; Natação; Treinamento de Força.*

RESUMEN

Introducción: La natación tiene un alto criterio de capacidad física y de movimiento por parte de los deportistas. El entrenamiento de fuerza eficiente no sólo puede mejorar el nivel de entrenamiento físico de los atletas, sino también aumentar sus capacidades deportivas. Por lo tanto, es un eslabón importante en el entrenamiento de la natación. Objetivo: Explorar el efecto del entrenamiento de fuerza de las extremidades en la aptitud física de los atletas en la natación. Métodos: En este experimento, se seleccionaron 20 nadadores formados en Educación Física en una universidad para realizar un entrenamiento de fuerza de las extremidades durante seis semanas. Antes y después del entrenamiento deportivo, se midieron los índices como la circunferencia del muslo, la circunferencia de la pantorrilla, la capacidad de salto de las extremidades inferiores, la fuerza máxima de las extremidades inferiores y la capacidad de equilibrio de las extremidades inferiores de los atletas, y se registraron los resultados de las pruebas principales de mariposa, espalda, nado de pecho y estilo libre en 50 metros. Resultados: El entrenamiento eficaz de la fuerza de las extremidades puede promover significativamente los cambios de la fuerza muscular de las extremidades inferiores de los atletas, mejorar su resistencia y su potencia explosiva, mejorar significativamente la capacidad de equilibrio y la estabilidad del movimiento de los nadadores y mejorar significativamente el rendimiento de la natación competitiva.

Conclusión: Es necesario intensificar el entrenamiento de la fuerza física en los deportistas, para mejorar su nivel de entrenamiento físico y mejorar su rendimiento económico. Este plan puede considerarse de gran utilidad. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Extremidad Superior; Natación; Entrenamiento de Fuerza.*

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INTRODUCTION

Swimming is a sport combining technology and strength. The foundation of good strength and physical quality is the premise of improving swimming technology. Good swimming technology can perfectly reflect the strength and quality of athletes. Therefore, scientific swimming technology and good strength quality have become the two development goals of coaches and athletes.[1] By relying on repetitive scientific swimming technology to cultivate athletes' swimming skills and improve their strength quality. In addition to various forms of underwater strength training, it is also an effective supplement to underwater strength training.[2] With the development of various new training concepts and various training methods and technologies related to these concepts, under the background of the continuous progress of science and technology, new training equipment for Cultivating Athletes' competitive ability is also constantly being designed, all of which provide comprehensive services for athletes' training and competition.[3] Therefore, in order to participate in high-level competitions, especially to achieve good results in major international competitions, or even win the championship, athletes need to have good swimming skills and excellent strength quality. Athletes need to overcome physical fatigue and retain their physical strength to beat their opponents in the final sprint stage.[4] Athletes' lower limb strength plays an important role in the competition. Good lower limb strength plays an important role not only in some track and field events, but also in other events. In swimming, good water drawing technology can enable athletes to maintain a high body posture when swimming, so as to reduce resistance and make swimming smoother.[5] However, if swimmers want to ensure good coordination, they must mobilize the participation of the lower limb group, so that the body can bear the pressure of the upper limb while maintaining balance. In addition, good lower limb strength can also improve the stability of athletes in sports.[6] This paper studies the influence of limb strength on swimming physical fitness training, so as to explore a better swimming limb training scheme and promote the improvement of swimming physical fitness level.

METHOD

Research object and research method

In this experiment, 20 swimmers majoring in Physical Education in a university are selected. The study and all the participants were reviewed and approved by Ethics Committee of Wenzhou University (NO.2020WUSYU02). The basic information of the research objects is shown in Table 1.

This experiment adopts the method of intra group comparison to carry out limb strength training for six weeks, four times a week, about 60 minutes each time. Good stretching and relaxation actions are carried out before and after exercise. Before and after sports training, the indexes such as thigh circumference, calf circumference, lower limb bouncing ability, maximum strength of lower limbs and lower limb balance ability of athletes were measured, and the results of butterfly, backstroke, breaststroke and freestyle in 50m main events were recorded.

This paper arranges and records the indexes measured before and after exercise by using Excel software, analyzes the data by using SPSS software, and determines its p value and F value. In order to better analyze its change trend, the method of P value determination is adopted. If $P < 0.01$, there is a very significant difference; If $P < 0.05$, there is a significant difference; If $P > 0.05$, there is no significant difference.

Table 1. Analysis of the basic situation of the research object.

Option	Study object
Age (year old)	20.399 ±1.128
Height (m)	1.743 ±0.070
Weight (kg)	68.716 ±12.976
BMI	22.545 ±5.120
Long training period (year)	11.088 ±2.969

RESULTS

Analysis on the changes of athletes' lower limb circumference before and after strength training

Limb strength training will make certain changes in muscles, so as to improve athletes' physical quality and improve their physical fitness. The changes of muscle strength and muscle volume in athletes' body shape are the changes of lower limb circumference. Therefore, in this section, athletes' thigh circumference and lower leg circumference are measured. The research results are as follows:

It can be seen from the data in Table 2 that the circumference of athletes' lower limbs and thighs changed from (47.738 ± 6.252) cm to (48.049 ± 5.842) cm before and after strength training, which increased slightly, $P > 0.05$, and there was no significant difference; The circumference of lower limbs changed from (32.004 ± 3.176) cm to (31.498 ± 4.975) cm, which decreased slightly ($P > 0.05$). It can be seen that strength training can make certain changes in the circumference of athletes' lower limbs, but there is no significant difference due to the complex changes of the body.

Analysis on the changes of lower limb indexes of athletes before and after strength training

In this section, the physical condition of athletes before and after strength training is analyzed by three indexes: lower limb bounce ability, maximum strength and balance ability.

It can be seen from the data in Table 3 that before and after strength training, the jumping height of SJ form of athletes' lower limbs increased from (38.564 ± 7.051) cm to (42.651 ± 8.251) cm, $P < 0.05$, and the jumping time increased from (0.492 ± 0.059) s to (0.510 ± 0.057) s, $P < 0.05$, indicating that there was a significant difference; The jumping height of CMJ form of athletes' lower limbs increased from (40.282 ± 8.599) cm to (42.333 ± 8.975) cm, $P < 0.05$, and the jumping time increased from (0.501 ± 0.086) s to (0.526 ± 0.089) s, $P < 0.01$, indicating that there was a very significant difference. It can be seen that before and after limb strength training, the athletes' lower limb bounce ability has been significantly improved, and their basic physical fitness has also made some progress.

Table 2. Changes of lower limb circumference of athletes before and after strength training.

Option	Before training	After training	F	P
Thigh circumference	47.738 ±6.252	48.049 ±5.842	0.0030	0.9940
Calf circumference	32.004 ±3.176	31.498 ±4.975	0.0299	0.9719

It can be seen from the data in Table 4 that before and after strength training, the maximum strength of athletes' lower limb squat increased from (105.715 ± 25.227) kg to (143.826 ± 19.428) kg, P < 0.05, indicating that there was a significant difference; The maximum strength of lower limb squatting increased from (88.238 ± 27.280) kg to (129.489 ± 28.324) kg, P < 0.05, indicating that there was a significant difference. It can be seen that after specific strength training, the maximum strength of athletes' lower limbs has been significantly improved in deep squat and semi squat, and the explosive power of athletes' lower limbs has been greatly increased, which has a good promotion for the improvement of physical fitness and sports performance.

It can be seen from the data in Table 5 that the left front balance ability of athletes' lower limbs increased from (65.968 ± 7.160) to (71.730 ± 5.67) before and after strength training, P < 0.01, indicating that there was a very significant difference; The left internal balance ability of athletes' lower limbs increased from (106.963 ± 9.358) to (117.523 ± 6.370), P < 0.01, indicating that there was a very significant difference; The right external balance ability of athletes' lower limbs increased from (102.857 ± 11.060) to (116.711 ± 3.360), P < 0.01, indicating that there was a very significant difference; The right internal balance ability of athletes' lower limbs increased from (106.221 ± 8.391) to (117.958 ± 6.295), 0.01 < p < 0.05, indicating that there was a significant difference; The left lateral balance ability of athletes' lower limbs increased from (108.333 ± 13.829) to (116.711 ± 6.110), P > 0.05; The right anterior balance ability of athletes' lower limbs increased from (63.763 ± 7.937) to (70.815 ± 5.693), P > 0.05. It can be seen that strength training can greatly improve the balance ability of athletes' lower limbs, so as to enhance the stability of their movements and play a better role in the process of swimming.

Analysis of athletes' performance changes before and after strength training

Swimming, as a competitive sport, the ultimate goal of improving physical fitness is to improve competitive performance. Therefore, this section analyzes the performance changes of athletes before and after limb strength training, and selects four events: butterfly, backstroke, breaststroke and freestyle to measure and compare the performance of athletes in the main event of 50m.

Table 3. Changes of athletes' lower limb bouncing ability before and after strength training.

Option		Before training	After training	F	P
SJ form	Height (cm)	38.564 ±7.051	42.651 ±8.251	7.6870	0.0269
	Time (s)	0.492 ±0.059	0.510 ±0.057	1.5274	0.0491
CMJ form	Height (cm)	40.282 ±8.599	42.333 ±8.975	32.0685	0.0030
	Time (s)	0.501 ±0.086	0.526 ±0.089	10.5937	0.0040

Table 4. Changes of athletes' maximum lower limb strength before and after strength training (kg).

Option	Before training	After training	F	P
Half squa	105.715 ±25.227	143.826 ±19.428	4.5336	0.0202
Deep squat	88.238 ±27.280	129.489 ±28.324	4.0743	0.0301

Table 5. Changes of athletes' lower limb balance ability before and after strength training.

Option	Before training	After training	F	P
Left front	65.968 ±7.160	71.730±5.673	4.5094	0.0000
Left outside	108.333 ±13.829	116.711 ±6.110	6.7467	0.6327
Within the left	106.963 ±9.358	117.523 ±6.370	8.2908	0.0061
Right front	63.763 ±7.937	70.815 ±5.693	5.6001	0.3132
Right outside	102.857 ±11.060	116.711 ±3.360	12.1369	0.0060
Upper right	106.221 ±8.391	117.958 ±6.295	9.5039	0.0209

It can be seen from the data in Table 6 that the duration of 50m butterfly stroke of athletes before and after strength training increased from (31.585 ± 3.514) s decreased to (29.791 ± 2.416) s, and the score was improved, but p > 0.05, indicating that there was no significant difference; The duration of the 50 meter backstroke is determined by (36.078 ± 6.551) s decreased to (34.666 ± 0.213) s, and the score was improved, but p > 0.05, indicating that there was no significant difference; The duration of 50m breaststroke was reduced from (35.965 ± 5.725) s to (33.780 ± 2.664) s, and the result was improved, but p > 0.05, indicating that there was no significant difference; The duration of 50 meter freestyle decreased from (25.739 ± 3.431) s to (24.056 ± 3.522) s, and the result was improved, but p > 0.05, indicating that there was no significant difference. It can be seen from the experimental results that although there are some differences in P values, on the whole, the exercise duration of the four swimming events is reduced and the performance is improved, which is inseparable from the improvement of physical fitness level. Therefore, strength training plays a good role in promoting the progress of athletes' performance.

DISCUSSION

Swimming is an intense competitive sport. The main activity area is located in the water. Therefore, compared with land sports, it has more strict respiratory system requirements, which is inseparable from the characteristics of water. Because the density of water is higher than that of air, people feel more pressure when breathing in water. In addition, the resistance that athletes need to overcome when moving in water is much greater than that on land, and it is difficult to control a reasonable breathing rhythm. In the process of swimming, the rhythm of swimming technical action will affect the breathing rhythm of athletes, so the beat cannot be adjusted at will. In the process of swimming, the regulation of respiratory rhythm depends on the fine control of nerve center, which belongs to the form of free respiratory control. By strengthening the training of the central nervous system, we can form an appropriate breathing rhythm, master reasonable technical movements, and adjust breathing and technical movements in real time. Swimming has a high energy demand, so it has high requirements for energy metabolism system. The functional characteristics of swimming at different distances are also different: the long-distance functional characteristics are mainly aerobic oxidation system, while the medium and short-distance are anaerobic glycolysis and phosphate system. Due to the high specific heat capacity of water, under the same conditions, the energy consumption of moving in water is higher than that on land, so there is a higher demand for energy conservation. When moving in the water, due to the existence of hydrostatic pressure, the movement resistance increases, which will lead to the increase of human blood pressure. Cold will lead to the contraction of capillaries and muscles, resulting in the decrease of blood flow, which will affect the blood circulation. Therefore, swimming requires the central nervous system to have high circular control ability, and the blood flow and blood pressure should be adjusted reasonably.

In the process of sports, athletes need to keep their bodies in a stable position and streamline as much as possible, so as to reduce the projection section and differential pressure resistance, which is conducive to improving the swimming speed. Wave resistance is the resistance generated by

Table 6. Changes of athletes' 50m main event performance before and after strength training (s).

Option	Before training	After training	F	P
Butterfly	31.585 ±3.514	29.791 ±2.416	-0.9356	0.0530
Retro	36.078 ±6.551	34.666 ±0.213	-0.2780	0.5298
breaststroke	35.965 ±5.725	33.780 ±2.664	0.1090	0.6468
Freestyle	25.739 ±3.431	24.056 ±3.522	0.1617	0.2494

waves when the human body swims in the water. In order to reduce the resistance of waves, try to avoid big waves when swimming, and tighten the muscles of athletes' trunk, arms and legs, especially the deep small muscles. The sensitive neuromuscular system can effectively regulate the technical movement of swimming and help to improve the energy storage level of movement. For example, in the process of freestyle, the position of the body should be "sharp, tight, flat and straight".

CONCLUSION

Comprehensive analysis of the research results of this paper shows that effective limb strength training can significantly promote the changes of athletes' lower limb muscle strength, improve their endurance and explosive power, and significantly improve the balance ability and movement stability of swimmers. It shows the effect of shortening the exercise time in competition, which can significantly improve the competitive performance of swimming. Therefore, athletes and coaches should purposefully improve the training of limb strength in the daily training process. Coaches should reasonably design scientific training programs according to the actual situation of athletes, so as to promote the improvement of basic physical fitness and enhance physical strength. Athletes should also carefully complete the training items arranged by the coach and give feedback to the coach in time, so as to improve their self-physical ability. In this way, we can improve our physical strength and physical reserves as much as possible, so as to improve our competitive level and sports performance.

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