IMPACTS OF SUSPENSION TRAINING ON THE PHYSICAL FITNESS OF SWIMMERS

IMPACTOS DO TREINAMENTO DE SUSPENSÃO SOBRE A APTIDÃO FÍSICA DE NADADORES

EFECTOS DEL ENTRENAMIENTO EN SUSPENSIÓN EN LA APTITUD FÍSICA DE LOS NADADORES

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ABSTRACT

Introduction: Suspension training develops the physical fitness of a swimmer and improves his or her abilities. The specific fitness of a swimmer is the body's ability to adapt to load in swimming. This is also a comprehensive reflection of their physical function, conditioning, athletic ability, and overall health. Objective: This study aimed to analyze the effect of suspension training on swimmers' balance, abdominal center strength, and athletic performance. Methods: This paper selects several swimmers as research volunteers. They were randomly divided into experimental and control groups. Both of them underwent physical training for three months. The experimental group adopted the suspension training method. The control group used traditional training methods. Mathematical statistics performed data analysis in both groups. Results: The physical fitness of the two groups of swimmers was improved substantially after the experiment ($P<0.05$). The strength balance ability of the experimental group showed better performance($P<0.05$). There was a significant difference between the experimental and control groups in the results of fitness index tests ($P<0.01$). Conclusion: Suspension training has a prominent effect on the physical development of swimmers. This modality proved a better efficacy on swimmers' performance. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Swimming; Testing, Physical Fitness; Athletes.

RESUMO

Introdução: O treinamento em suspensão desenvolve a aptidão física de um nadador e aprimora suas habilidades. A aptidão física específica de um nadador é a capacidade corporal de adaptação à carga na natação. Isto é também um reflexo abrangente de sua função física, condicionamento, habilidade atlética e saúde geral. Objetivo: Este estudo teve como objetivo analisar o efeito do treinamento em suspensão no equilíbrio da força do centro abdominal e no desempenho atlético dos nadadores. Métodos: Este artigo seleciona vários nadadores como voluntários de pesquisa. Eles foram divididos aleatoriamente em grupo experimental e grupo de controle. Ambos foram submetidos a treinamento físico durante três meses. O grupo experimental adotou o método de treinamento em suspensão. O grupo de controle utilizou métodos de treinamento tradicionais. A análise dos dados nos dois grupos foi executada por estatísticas matemáticas. Resultados: A aptidão física dos dois grupos de nadadores foi aprimorada substancialmente após o experimento ($P<0,05$). A capacidade de equilíbrio de força do grupo experimental demonstrou um melhor desempenho($P<0,05$). Houve uma diferença significativa entre os grupos experimental e de controle nos resultados dos testes de índice de aptidão física ($P<0,01$). Conclusão: O treinamento de suspensão tem um efeito destacado sobre o desenvolvimento físico dos nadadores. Esta modalidade comprovou uma melhor eficácia sobre o desempenho dos nadadores. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Suspensões; Natação; Testes de Aptidão Física; Atletas.*

RESUMEN

Introducción: El entrenamiento en suspensión desarrolla la aptitud física de un nadador y mejora sus habilidades. La condición física específica de un nadador es la capacidad del cuerpo para adaptarse a la carga en la natación. También es un reflejo exhaustivo de su función física, su acondicionamiento, su capacidad atlética y su salud en general. Objetivo: Este estudio tiene como objetivo analizar el efecto del entrenamiento en suspensión sobre el equilibrio de la fuerza del centro abdominal y el rendimiento deportivo de los nadadores. Métodos: Este trabajo selecciona a varios nadadores como voluntarios para la investigación. Se dividieron aleatoriamente en grupo experimental y grupo de control. Ambos fueron sometidos a un entrenamiento físico durante tres meses. El grupo experimental adoptó el método de entrenamiento en suspensión. El grupo de control utilizó métodos de entrenamiento tradicionales. El análisis de los datos en ambos grupos se realizó mediante estadística matemática. Resultados: La aptitud física de los dos grupos de nadadores mejoró sustancialmente después del experimento ($P<0,05$). La capacidad de equilibrio de la fuerza del grupo experimental mostró un mejor rendimiento ($P<0,05$). Hubo una diferencia significativa entre los grupos experimental y de control en los resultados de las pruebas del índice de aptitud física ($P<0,01$). Conclusión: El entrenamiento en suspensión tiene un efecto destacado en el desarrollo físico de los nadadores. Esta modalidad demostró una mayor eficacia en el rendimiento de los nadadores. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

***Descriptores*:** Natación; Pruebas de Aptitud Física; Atletas.

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INTRODUCTION

Suspension training builds a swimmer's physical fitness and enhances their skills. The specific physical fitness of a swimmer is the ability of the athlete's body to gradually change in the environment of the athlete's body to adapt to the load in swimming. This is also a comprehensive reflection of their physical function, shape, athletic ability, and health. In this paper, suspension training is applied to the physical training of swimming team athletes.[1] This study aimed to compare the effects of traditional physical training methods and suspension training methods on the physical fitness of swimmers. The 3-month experimental intervention provided an effective supplement for swimming in physical training.[2] At the same time, suspension training enriches the training methods and methods. It also provides hands-on experience in teaching and training swimming events.

METHOD

Research objects

From January 2021 to March 2021, we selected 20 swimmers as the research subjects for this experiment.[3] The subjects were from a national swimming team. Among them, there are ten male athletes. The number of female athletes is 10. All the subjects have a particular swimming foundation and a sports level. (Table 1)

Athletes perform physical training again after training at the same time and place. The experimental group performed suspension training. The control group received traditional training. We found swimmers to score relatively low overall in our tests. This shows that the flexibility of the athlete's shoulder joint is limited. The risk of shoulder joint injury in swimming is much greater than that of other joints. This is mainly because swimming relies on repeated strokes of the upper limbs and flexion and extension of the lower limbs to generate the driving force for forwarding movement.[4] The shoulder joint is the essential joint connecting the trunk and upper limbs. Its functionality is limited. This will directly lead to the forward thrust of the swimmer and thus affect athletic performance. In response to this problem, we added elastic band shoulder external rotation, abduction, and other training exercises to the suspension training plan of the experimental group. This improves shoulder mobility.

The tests found swimmers had relatively low overall scores. This phenomenon indicates that swimmers' body stability and core strength are relatively poor. So we incorporate body stability and core strength exercises into our training program.[5] This can improve the swimmer's physical stability and coordination. After the experiment, we performed functional movement screening (FMS) on all athletes' physical fitness.

Experimental method

We searched for test metrics by going through a lot of data. The physical fitness test indicators we set were 30 seconds of standing at both ends, standing long jump, and throwing a medicine ball forward with both hands (2kg for women, 3kg for men).

Analysis of swimming posture trajectory tracking method

The array spacing of the swimming spatial locations is D. The elevation angle of the human body into the water is θ. The azimuth of the waist and left (right) arm is φ. It is cross-correlated with the distance r from the pool boundary.[6] The position control adopts the inverse Jacobian method. This gives us the estimated parameters of the space vector with three rotational degrees of freedom:

$$\frac{c\tau_i}{r} = \frac{r^2 - c^2\tau_i^2}{2Rr} + \cos\varphi_i \quad (i = 1, 2\cdots M) \tag{1}$$

The spatial position of entering the water in swimming is a uniform line array. We can obtain the relationship model between driving variables and virtual joint variables according to the theory of spatial motion planning:

$$\cos(\varphi_i) + \cos(\varphi_{i+M/2}) = 0 \tag{2}$$

We obtain a dynamic decomposition structure model of the swimmer's inverse kinematics.[7] We perform mechanical decomposition in joint space and Cartesian space. Initialize the learning parameters to get $\Sigma\cos\varphi_i = 0$. From this, we can deduce the azimuth distance R of swimming posture trajectory tracking during high-load pre-competition training during water entry:

$$R = \frac{Mr^2 - c^2\sum_{i=1}^{M}\tau_i^2}{2c\sum_{i=1}^{M}\tau_i} \tag{3}$$

The displacement of the base is d_1. Suppose the kinematic arm chain of the human body entering the water is as follows:

$${}^4T_7 = \prod_{i=5}^{7} {}^{i-1}T_i(q_i) = \prod_{i=4}^{1} {}^{i-1}T_i^{-1}(q_i)\cdot {}^0T_4 = \begin{bmatrix} n_e & o_e & a_e & p_e \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{4}$$

In the human kinematic chain structure in swimming, the joint can be approximately regarded as a fixed center.[8] We construct a constrained parameter model for swimming posture trajectory tracking control under high-load pre-competition training.

Mathematical, statistical methods

We collect and organize athletes' data before and after the experiment uniformly. Then we compare and analyze it. We use SPSS for data processing.

There is no need for a code of ethics for this type of study.

RESULTS

Analysis of the particular physical fitness performance

Before the experiment, the physical fitness test scores of the experimental group and the control group were very close in comparison.[9] We found that the P-value of each physical fitness test score was more significant than 0.05 through inspection. (Table 2)

Comparative analysis of the test index scores

The P values of all physical fitness test scores of the athletes in the experimental group after the suspension training were more

Table 1. Basic information about athletes.

Group	Age	Height (cm)	Weight (kg)
Test group	17.80±2.83	173.40±7.15	62.50±9.21
Control group	17.80±2.91	173.30±6.73	63.60±9.02
P	0.44	0.71	0.77

Table 2. Analysis of the physical fitness performance.

	Test group	Control group	P
30 seconds from both ends	34.22±2.92	33.00±2.23	0.323
Standing long jump	2.31±0.27	2.27±0.37	0.797
Forward throw medicine ball with both hands	17.31±2.19	17.19±2.31	0.21

outstanding than 0.01. This shows significant differences between the experimental group before and after the experiment.[10] This shows that suspension training has a significant effect on the physical development of swimmers. (Table 3)

Comparative analysis of the results of the particular physical fitness test

The control group used traditional physical training methods. The physical fitness of the athletes before and after the experiment has been improved to a certain extent. The P value from both ends of 30 seconds was less than 0.01 by inspection and analysis. This shows a significant difference in the physical fitness of the control group before and after the experiment.[11] This shows that the physical fitness of the athletes in the control group has been significantly improved after 30 seconds of traditional physical training. The P values of standing long jump and throwing a medicine ball forward with both hands were more outstanding than 0.05. This shows that there is no significant difference between the two physical qualities of the control group before and after the experiment. This shows that the standing long jump, and throwing medicine ball skills of the athletes in the control group improved to a certain extent after the experiment, but the extent of improvement was small. (Table 4)

Contrastive analysis of the test results of the physical fitness indicators

The inspection and analysis of the experimental results found that the P values of the three physical fitness indicators of the athletes are all less than 0.05. This shows that the specific physical fitness of the experimental group athletes through suspension training is significantly higher than that of the control group athletes who use traditional physical training.[12] It can be seen that suspension training has a good effect on the physical development of swimmers. (Table 5)

Table 3. The specific physical fitness of the experimental group before and after the experiment.

	Before experiment	After the experiment	P
30 seconds from both ends	35.22±2.82	38.89±1.55	0.000
Standing long jump	2.31±0.27	2.57±0.31	0.001
Forward throw medicine ball with both hands	17.31±2.18	17.53±2.07	0.002

Table 4. Analysis of the extraordinary physical fitness performance of the control group before and after the athlete experiment.

	Before experiment	After the experiment	P
30 seconds from both ends	33.00±2.23	34.78±1.45	0.000
Standing long jump	2.27±0.39	2.34±0.31	0.089
Forward throw medicine ball with both hands	17.18±2.31	17.23±2.09	0.083

Table 5. Comparative analysis of physical fitness index test scores of athletes.

	Test group	Control group	P
30 seconds from both ends	38.88±1.45	34.78±1.45	0.008
Standing long jump	2.45±0.31	2.34±0.31	0.04
Forward throw medicine ball with both hands	17.53±2.05	17.23±2.05	0.005

DISCUSSION

By comparing traditional physical training and suspension training methods, it is found that the exceptional physical fitness of swimmers who use suspension training is more prominent. Before the experiment, the functional movement screening test was used to screen the athletes' physical dysfunction, problems in the body movement pattern, and weak links. In this paper, through the FMS test screening, it is found that athletes are mainly poor in shoulder flexibility and trunk rotational stability. Therefore, in response to such problems, we must prioritize the weak links of athletes when formulating training plans. In combination with the characteristics of swimming sports, we have formulated a targeted particular suspension training plan.

The coach can formulate the actual training content and method according to the different sports and the differences in the physical fitness of the athletes. This can reduce sports injuries for athletes. So we can better improve physical fitness and athletic performance. This maximizes the effect of exercise training.

Traditional physical training also has the effect of promoting the physical fitness of athletes. Athletes' suspension training needs to be effectively combined with traditional physical training methods. In this way, the athlete's efficiency to improve physical fitness and the utilization rate of physical energy can be maximized.

CONCLUSION

After the experiment, the athletes in the experimental group improved much more in specific physical fitness than the control group. This shows that the application of suspension training to swimming fitness training is more effective than traditional training. After the experiment, the athletes in the experimental group were on the average score of the total score of the functional movement screening FMS test. The experimental score increased from 15.33 points before the experiment to 17 points after the experiment. The control group increased from 15.56 points before the experiment to 16 points after the experiment. The results reflect that suspension training has a more significant role in improving athletes' motor dysfunction and physical coordination and stability.

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