INTERVAL TRAINING EFFECTS ON CARDIORESPIRATORY CAPACITY OF SWIMMERS

EFEITO DO TREINAMENTO INTERVALADO SOBRE A CAPACIDADE CARDIORRESPIRATÓRIA DE NADADORES

EFECTO DEL ENTRENAMIENTO POR INTERVALOS EN LA CAPACIDAD CARDIORRESPIRATORIA DE NADADORES

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ABSTRACT

Introduction: Cardiopulmonary function is directly related to the body's ability to perform metabolism under aerobic conditions. It is a key characteristic for the training of professional swimmers. It is believed that adding interval training to traditional workouts may contribute to the aerobic endurance of these athletes. Objective: Evaluate the interval training effects on the cardiorespiratory capacity of swimmers. Methods: Twenty volunteer swimmers were randomly divided into two groups for seven weeks. There were 4 hours of class per week, totaling 28 hours of training. In the formal training stage, the experimental group performed intermediate-intensity training, while the control group continued to perform traditional swim team training. The experimental indicators pertinent to the evaluated athletes were collected, tested, and analyzed before and after the experiment. Results: The VO2 of the athletes in the experimental group increased from 3.90±0.67L/min before the experiment to 4.06±0.73L/min after the experiment; VE increased from 156.08±35.76L before the experiment to 180.08±39.42L after the experiment; underwater endurance time increased from 46.80±8.43s before the experiment to 55.49±7.60s after the experiment. Conclusion: Intermittent training improves athletes' physical fitness and sports capacity, being an effective method to improve cardiopulmonary function. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Swimming; Endurance Training; Test, Cardiopulmonary Exercise; Fitness, Physical.

RESUMO

Introdução: A função cardiopulmonar está diretamente relacionada à capacidade do organismo de executar a metabolização sob condições aeróbicas. É uma característica chave para os treinamentos de nadadores profissionais e acredita-se que a adição do treinamento intervalado nos treinos tradicionais possa contribuir à resistência aeróbica desses atletas. Objetivo: Avaliar o efeito do treinamento intervalado sobre a capacidade cardiorrespiratória dos nadadores. Métodos: Vinte nadadores voluntários foram divididos aleatoriamente em dois grupos durante 7 semanas. Foram 4 horas de aula por semana, totalizando 28 horas de treino. Na etapa de treinamento formal, o grupo experimental realizou essencialmente o treinamento de intensidade intermediária, enquanto o grupo de controle permaneceu executando o treinamento tradicional da equipe de natação. Os indicadores experimentais pertinentes aos atletas avaliados foram coletados, testados e analisados antes e depois do experimento. Resultados: O VO2 dos atletas do grupo experimental aumentou de 3,90±0,67L/min antes do experimento para 4,06±0,73L/min após o experimento; o VE aumentou de 156,08±35,76L antes do experimento para 180,08±39,42L após o experimento; o tempo de resistência subaquática aumentou de 46,80±8,43s antes do experimento para 55,49±7,60s após o experimento. Conclusão: O treinamento intermitente contribui para melhorar a aptidão física e a capacidade esportiva dos atletas, sendo um método eficaz no aprimoramento da função cardiopulmonar. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Natação; Treino Aeróbico; Teste de Esforço Cardiopulmonar; Aptidão Física.*

RESUMEN

Introducción: La función cardiopulmonar está directamente relacionada con la capacidad del organismo para realizar el metabolismo en condiciones aeróbicas. Es una característica clave para los entrenamientos de los nadadores profesionales y se cree que la adición del entrenamiento interválico en los entrenamientos tradicionales puede contribuir a la resistencia aeróbica de estos atletas. Objetivo: Evaluar el efecto del entrenamiento por intervalos sobre la capacidad cardiorrespiratoria de los nadadores. Métodos: Veinte nadadores voluntarios fueron divididos aleatoriamente en dos grupos durante 7 semanas. Se impartieron 4 horas de clase a la semana, totalizando 28 horas de entrenamiento. En la etapa de entrenamiento formal, el grupo experimental realizó esencialmente un entrenamiento de intensidad intermedia, mientras que el grupo control permaneció realizando el entrenamiento tradicional del equipo de natación. Los indicadores experimentales pertinentes a los atletas evaluados fueron recogidos, testados y analizados antes y después del experimento. Resultados: El VO2 de los atletas del grupo experimental aumentó de 3,90±0,67L/min antes del experimento a 4,06±0,73L/min después del experimento; el VE aumentó de 156,08±35,76L antes del experimento a 180,08±39,42L después del experimento; el tiempo de resistencia subacuática aumentó de 46,80±8,43s antes del experimento a 55,49±7,60s después del experimento.

Conclusión: El entrenamiento por intervalos contribuye a mejorar la forma física y la capacidad deportiva de los atletas, siendo un método eficaz para mejorar la función cardiopulmonar. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Natación; Entrenamiento Aeróbico; Prueba de Esfuerzo Cardiopulmonar; Aptitud Física.*

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INTRODUCTION

Compared with other sports, swimming requires a higher level of cardiopulmonary function.[1] Because the body is almost completely immersed in water during swimming, the water resistance is much greater than that in the land environment. Therefore, a specific distance in water consumes more oxygen and physical strength than the same distance on land.[2] Therefore, the quality of cardio pulmonary training will also affect the swimming performance, which is why more and more sports academics are studying the improvement of lung capacity in the swimming training center to learn how to quickly improve the vital capacity, breathe more regularly and swim more easily.[3] Many scientific researches have shown that exercise ability is closely related to cardiorespiratory function, so we can take cardiorespiratory function as a standard to evaluate a person's exercise ability and health status.[4] Sports practice shows that high-intensity interval training can increase the maximum oxygen uptake of athletes, improve cardiopulmonary function, and reduce body fat. Intermittent exercise is used by athletes to maintain high physiological response and achieve better results in many sports fields.[5] The significance of this study is to observe the changes of cardiorespiratory function of swimmers through a certain interval training, so as to provide a reference for improving the training performance of swimmers in many aspects.[6]

METHOD

Selection of experimental objects

According to the research purpose and research focus, 20 amateur swimmers aged 17-19 were selected from a swimming club in a city before the experiment began, and all of them had been in sports for more than 7 years. The study and all the participants were reviewed and approved by Ethics Committee of Gannan Normal University (NO. GANNUF082). In order to ensure the smooth implementation of the experiment and the safety of the tested athletes, we confirmed with the coaches and athletes that they are in good physical condition and have no physical diseases in the near future, so we can participate in the experiment process. On the basis of understanding the purpose of this experiment, the consent form was signed and the pre experiment test was conducted. The athletes were divided into groups according to the principle of randomization. The basic information of the experimental group and the control group is shown in Table 1.

From the basic information data of the tested athletes in Table 1, there is no significant difference in age, height, weight and training years between the selected experimental group and the control group, which meets the basic requirements of this experiment.

Experimental control

The experiment lasts for 7 weeks, with 4 class hours per week and 28 class hours in total. The weekly training time is Monday, Wednesday, Thursday and Saturday. Each class hour is 90 minutes, mainly including 20 minutes of preparation activities, 50 minutes of formal training and rest intervals, and 20 minutes of relaxation after training. The preparation and relaxation activities of the experimental group and the control group are basically the same. In the formal training stage, the experimental group mainly conducts intermediate intensity interval training, while the control group does not change according to the original traditional training mode of the swimming team. The intermittent exercise of the experimental group was controlled at medium intensity according to the load of 17-19 year old athletes, and the height of the running platform used for training was consistent. Before and after the experiment, the relevant experimental indicators of the tested athletes were tested and recorded. The experimental equipment and measurement methods used were checked by professionals, and the recording staff were the same before and after the experiment.

During the experiment, in order to ensure the effectiveness of the experiment and avoid the influence of external factors as much as possible, except for special circumstances, the tested athletes did not miss classes at will, and successfully completed the relevant training according to the established training plan. In addition, the daily diet and living habits of the athletes were relatively consistent during the experiment. In addition to the weekly experimental training, do not carry out additional high-intensity exercise training, and try to keep adequate sleep and regular work and rest.

Experimental indicators and test methods

The measurement of the direct indexes of the cardiopulmonary capacity of the tested athletes mainly includes VO2 (oxygen uptake), V02/kg (kg oxygen consumption), VE (ventilation per minute) and HR (heart rate). The oxygen consumption and ventilation were measured with the CORTEX cardiopulmonary function instrument made in Germany

Table 1. Basic information of experimental group and control group.

Experience group	Age (years)	Height (cm)	Weight (kg)	Years of Exercise (years)	Control group	Age (years)	Height (cm)	Weight (kg)	Years of Exercise (years)
1	18.22	177.32	74.7	8.41	1	18.53	182.32	68.92	10.3
2	18.2	179.43	74.45	8.03	2	18.09	175.63	75.72	7.87
3	18.61	178.16	73.47	8.69	3	18.35	179.99	68.17	7.16
4	18.75	182.24	74.66	8.01	4	19.16	180.48	70.11	10.2
5	18.21	178.26	71.15	7.45	5	17.44	177.18	70.16	7.75
6	18.88	179.4	72.78	7.09	6	18.17	176.06	73.78	9.63
7	17.24	178.62	69.11	9.49	7	18.9	176.98	75.56	9.94
8	18.93	176.03	70.95	9.97	8	18.38	181.49	72.35	8.4
9	18.16	175.55	71.55	7.37	9	17.75	180.52	72.59	10.09
10	17.49	181.74	75.59	7.95	10	19.28	175.76	70.22	7.84

and mercury 4.0 treadmill. During the measurement process, the test athletes are required to first carry out 5 minutes of preparatory activities, set the running platform to a slope of 2 °, and the speed of 5 km/h starts to increase gradually, increasing the speed of 1 km every 2 minutes until the strength limit position of the test subjects. The heart rate test uses the pulse test method in the quiet state, and the maximum heart rate under the exercise conversion is continuously monitored by the POLARRS800 heart rate meter made in Finland, which can monitor the maximum heart rate value under the exercise limit state.

The indirect indexes of cardiopulmonary capacity of the tested athletes mainly include explosive force, endurance and underwater air holding time. The explosive force mainly measures the standing long jump and solid ball throwing. The solid ball is thrown in a sitting position. When holding the ball, hold both sides of the ball, and throw the ball from the back of the head upwards at an angle of 45 ° with the force of stepping on the ground and swinging the arm. Sport endurance mainly measures push ups and 1.5 mile running results. The equipment required for indirect indicator measurement mainly includes meter ruler, stopwatch, solid ball and yoga mat for sports.

The relevant indicators were measured in the indoor gymnasium used by athletes during training. The temperature was controlled at about 25 °C and the relative humidity was maintained at about 40%.

RESULTS

The direct index of interval training on the improvement of swimmers' cardiopulmonary capacity

After 7 weeks of experiment, this paper first measured the four indexes of the tested athletes' cardiopulmonary capacity, and compared them with the results before the experiment. The measurement results of VO2, V02/kg, VE and HR of test athletes are shown in Table 2.

Therefore, according to the results in Table 2, after a period of training, whether intermittent training or basic swimming training methods, the cardiorespiratory function of athletes will be significantly improved. But in contrast, intermittent exercise with a certain intensity can provide more obvious improvement. Swimming has a high demand on cardiorespiratory function, so appropriate interval training can be applied to daily training to improve the cardiorespiratory function of athletes.

Indirect indicators of interval training for improving swimmers' cardiopulmonary capacity

In addition to the basic indexes of cardiopulmonary function, the indexes of exercise ability related to swimming can also indirectly reflect whether the cardiopulmonary function of the tested athletes has changed. Therefore, after the experiment, the explosive force, sports endurance and underwater breathing time of the athletes were tested. The results of the three indicators are shown in Table 3, Table 4 and Table 5 respectively.

The comparison results of the impact of interval training on swimmers' explosive power before and after the experiment are shown in Table 3.

The data in Table 3 shows that moderate intensity interval training can significantly improve the explosiveness of swimmers. Because the intensity of intermittent training is higher than that of general training, and the alternating exercise and rest exercise has a strong effect on the cardiopulmonary function of the subjects, the improvement of cardiopulmonary and sports functions is conducive to the enhancement of muscle explosive force. The general training conducted by the control group is more to improve the physical quality of the subjects as a whole, and has less effect on improving the special function of explosive force.

The exercise endurance of the tested athletes was compared before and after the test, and the results are shown in Table 4.

Table 4 shows that the intermediate intensity interval training has a significant effect on improving the exercise endurance of the subjects, while the improvement effect of general physical fitness training is limited. In the training process of swimmers, targeted interval training can be appropriately increased, which has a significant effect on improving the overall sports ability of swimmers.

In order to further verify the effect of interval training on the specific sports ability of swimmers, the time of underwater breath holding was tested. The comparison results before and after the experiment are shown in Table 5.

Table 4. The Effect of Interval Training on Swimmers' Sports Endurance.

Experience group	Push ups (pcs.)	1.5 miles (min)	Control group	Push ups (pcs.)	1.5 miles (min)
Before experiment	14.81±5.133	14.27±1.386	Before experiment	15.73±7.007	14.07±1.314
After experiment	21.73±6.291	12.85±1.225	After experiment	16.21±6.844	13.85±1.267
P	0.0084	0.0442	P	0.0647	0.0306

Table 5. Effect of Interval Training on Underwater Breath Retention of Swimmers.

Experience group	Underwater closed air (s)	Control group	Underwater closed air (s)
Before experiment	46.80±8.438	Before experiment	49.38±7.705
After experiment	55.49±7.606	After experiment	50.99±8.089
P	0.0021	P	0.0693

Table 2. Effect of interval training on ventilatory capacity and heart rate of swimmers.

Experience group	VO_2 (L/min)	$V0_2$/kg (ml/kg/min)	Control group	VO_2 (L/min)	$V0_2$/kg (ml/kg/min)
Before experiment	3.90±0.678	52.27±5.406	Before experiment	3.56±0.558	51.18±4.679
After experiment	4.06±0.737	53.39±5.872	After experiment	3.72±0.619	53.05±0.738
P	0.0079	0.0196	P	0.0112	0.0143
Experience group	VE(L)	HR (Times/min)	Control group	VE(L)	HR (Times/min)
Before experiment	156.08±35.760	184.27±13.396	Before experiment	133.33±38.709	176.89±9.467
After experiment	180.08±39.420	180.64±11.279	After experiment	140.23±28.798	169.28±7.581
P	0.0034	0.0216	P	0.0195	0.0463

Table 3. The effect of interval training on the explosiveness of swimmers.

Experience group	Standing long jump (m)	Push the solid ball forward in sitting position (m)	Control group	Standing long jump (m)	Push the solid ball forward in sitting position (m)
Before experiment	2.48±0.061	4.98±0.140	Before experiment	2.12±0.102	4.46±0.249
After experiment	2.65±0.050	5.42±0.142	After experiment	2.04±0.102	4.41±0.279
P	0.0318	0.001	P	0.0355	0.0675

The data in Table 5 shows that after 7 weeks of experiment, the underwater air holding time of the experimental group undergoing intermittent training has changed significantly before and after the experiment ($P<0.01$), from 46.80 ± 8.438s before the experiment to 55.49 ± 7.606s after the experiment. However, the underwater breath holding time of the control group only receiving traditional training did not change significantly before and after the experiment, only increased slightly, from 49.38 ± 7.705s before the experiment to 50.99 ± 8.089s after the experiment. This is mainly because interval training can improve the cardiopulmonary function of the athletes under test, and cardiopulmonary function is an important reason for affecting the length of underwater air holding time.

DISCUSSION

Sports endurance is one of the benchmarks of human sports ability, and also an important indicator of swimmers' cardiopulmonary ability. It is one of the most important selection criteria for endurance athletes and an important indicator of human aerobic capacity. The improvement of sports endurance reflects the achievement of high aerobic capacity and high standard aerobic exercise. The research shows that the aerobic ability of swimming is closely related to sports performance. Intermittent training can stimulate aerobic and anaerobic energy transmission systems, and increase the peak value of anaerobic capacity in repeated high-intensity circular exercise, thus improving the body's ability to extract oxygen from the periphery. Other studies have shown that moderate and high intensity intermittent exercise increases the number, activity and protein content of mitochondria, thus improving the body's ability to use oxygen and significantly improving the oxidation capacity of skeletal muscle. Therefore, the data of this experiment shows that after 7 weeks of training, there is no significant difference in resting heart rate between the experimental group and the control group. Because to achieve the change of resting heart rate, two conditions must be met: a certain training intensity and enough training time. However, due to insufficient time, even though the exercise intensity of the athletes in the experiment reached the due level, the resting heart rate did not change significantly. However, there is a significant difference in exercise heart rate. As shown in Table 2 of this paper, after a certain period of professional training, the experimental group with intermittent training and the control group with basic swimming training have significantly improved their cardiopulmonary functions. But generally speaking, the improvement effect of intermittent exercise is more obvious.

CONCLUSION

As a form of high-intensity pulse training, interval training has different effects on different people. Genetics, lifestyle, physical ability and other factors make significant differences in the level of benefits brought by training. Integrating interval training into swimming training will help improve the freshness and enthusiasm of athletes. The coach must have a positive attitude to guide students correctly and create a positive and active training atmosphere. However, the interval training method used in swimming training must be scientific and reasonable, and should be carried out at an appropriate time and intensity according to the physiological and psychological characteristics of the athletes, and be result oriented. At the same time, the coaching team must constantly improve its professional level. In order to ensure the safety of athletes, it is necessary to develop more intermittent training programs suitable for athletes, increase their freshness and build harmonious and pleasant training activities. Intermittent training can not improve cardiopulmonary function and performance in a short time, but requires long-term training to achieve good results.

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