CHANGES IN VO2MAX CAUSED BY AEROBIC EXERCISE IN SWIMMERS

ALTERAÇÕES DE VO2MAX OCASIONADAS PELO EXERCÍCIO AERÓBICO EM NADADORES

CAMBIOS EN EL VO2MAX CAUSADOS POR EL EJERCICIO AERÓBICO EN NADADORES

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ABSTRACT

Introduction: The maximal oxygen consumption rate (VO2max) can directly reflect the body's aerobic metabolism and oxygen delivery system. This is a measure of aerobic capacity used to monitor swimmers' levels and their strength and speed performance. Objective: Verify the changes in VO2max when incorporating aerobic exercise training into swimmers' regular training. Methods: 12 volunteer swimmers were divided into two categories: strength training group and regular training group. Both groups performed a fitness test on the 200-meter track before starting the training. VO2 maximal was measured and worked out statistically to verify the results of this competition. The effects of aerobic exercise on the strength and competitive status of the athletes were investigated according to an updated literature review. Results: There was a significant change in the maximal oxygen uptake of the athletes after the experimental protocol. The athletes in the strength training group increased their VO2 max compared to the regular training group. The results showed a significant difference in the VO2max index before and after strength training (P<0.05). This suggests that strength training has a significant effect on maximal oxygen consumption. Conclusion: Strength training interventions significantly affect athletes' maximal oxygen consumption intensity and exercise capacity. The aerobic exercise intervention showed evidence of improving the competitive level of athletes. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Swimming; Athletes; Resistance Training; Endurance Training; Sports.

RESUMO

Introdução: A taxa máxima de consumo de oxigênio (VO2max) pode refletir diretamente o metabolismo aeróbico corporal e o sistema de fornecimento de oxigênio. Esta é uma medida da capacidade aeróbica empregada para monitorar o nível do nadador, e seu desempenho em força e velocidade. Objetivo: Verificar as alterações de VO2max ao incorporar o treinamento com exercícios aeróbicos no treino padrão dos nadadores. Métodos: 12 nadadores voluntários foram divididos em duas categorias: grupo de treinamento de força e grupo de treinamento regular. Ambos os grupos realizaram um teste de aptidão física na pista de 200 metros antes de iniciar o treinamento. O VO2 máximo foi mensurado e trabalhado estatisticamente para verificar os resultados desta competição. Os efeitos do exercício aeróbico sobre a força e o status competitivo dos atletas foi investigado segundo uma revisão bibliográfica atualizada. Resultados: Houve uma mudança significativa na ingestão máxima de oxigênio dos atletas após o protocolo experimental. Os atletas do grupo de treinamento de força aumentaram seu VO2 máximo quando comparados ao grupo de treinamento regular. Os resultados mostraram uma diferença significativa no índice VO2max antes e depois do treinamento de força (P<0,05). Isto sugere que o treinamento de força tem um efeito significativo no consumo máximo de oxigênio. Conclusão: As intervenções de treinamento de força afetam significativamente a intensidade máxima de consumo de oxigênio e a capacidade de exercício dos atletas. A intervenção do exercício aeróbico demonstrou evidencias em melhorar o nível competitivo dos atletas. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** Natação; Atletas; Treinamento de Força; Treino Aeróbico; Esportes.

RESUMEN

Introducción: La tasa máxima de consumo de oxígeno (VO2máx) puede reflejar directamente el metabolismo aeróbico del cuerpo y el sistema de suministro de oxígeno. Se trata de una medida de la capacidad aeróbica que sirve para controlar el nivel del nadador y su rendimiento en fuerza y velocidad. Objetivo: Verificar los cambios en el VO2máx al incorporar el entrenamiento de ejercicio aeróbico en el entrenamiento habitual de los nadadores. Métodos: 12 nadadores voluntarios fueron divididos en dos categorías: grupo de entrenamiento de fuerza y grupo de entrenamiento regular. Ambos grupos realizaron una prueba de aptitud física en 200 metros de pista antes de comenzar el entrenamiento. Se midió el VO2 máximo y se trabajó estadísticamente para verificar los resultados de esta competición. Se investigaron los efectos del ejercicio aeróbico en la fuerza y el estado competitivo de los atletas según una revisión bibliográfica actualizada. Resultados: Hubo un cambio significativo en el consumo máximo de oxígeno de los atletas después del protocolo experimental. Los atletas del grupo de entrenamiento de fuerza aumentaron su VO2 máximo en comparación con el grupo de entrenamiento regular. Los resultados mostraron una diferencia significativa en el índice VO2max antes y después del entrenamiento de fuerza (P<0,05). Esto sugiere que el entrenamiento de fuerza *tiene un efecto significativo en el consumo máximo de oxígeno. Conclusión: Las intervenciones de entrenamiento de fuerza afectan significativamente a la intensidad del consumo máximo de oxígeno y a la capacidad de ejercicio de los atletas. La intervención de ejercicio aeróbico mostró evidencia de mejorar el nivel competitivo de los atletas.* ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Natación; Atletas; Entrenamiento de Fuerza; Entrenamiento Aeróbico; Deportes.*

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INTRODUCTION

Aerobic exercise and muscle strength are closely linked. Pure strength training can lead to hypertrophy of muscle fibers, increased ability of muscle fibers to gather nerves, and increased muscle strength. The comprehensive training of strength and endurance is of great help in improving athletes' endurance.[1] Athletes perform strength training first, followed by aerobic endurance training throughout the training phase. The above results suggest that athletes should not ignore anaerobic exercise while improving aerobic exercise. Strength training is often overlooked in swimming. Especially in terms of maximum strength and maximum explosiveness, trainers often overlook it. The trainer must integrate strength training into the entire training program. This article combines strength training with swimmers' winter training programs to evaluate their training effects.[2] The research results of this paper provide a basis for athletes in swimming training in the future.

METHOD

Research objects

This paper takes 12 swimmers as the research object. This article divides them into two categories. One group was the strength training group. One group was the regular training group.[3] There were no significant differences between athletes of different ages and years of professional training.

Test scheme

The study consisted of a three-month cycle. Cycle training every three weeks. During this time, the strength training group's training rhythm and content and the regular training group were the same. Three weekly anaerobic threshold intensity classes. A course with a blood lactate concentration of 8 mmol/L was arranged once. The rest of the training programs are mainly medium and long-distance low-intensity aerobic training. There will be an adjustment every Saturday afternoon and Sunday. The difference was that the aerobic group performed physical training three times a week. Monday, Wednesday, and Saturday are traditional workouts.[4] The training content of the regular training group is the same as that of strength training. Moderate to long-term low-intensity cardio with no strength training on Mondays and Saturday mornings. Athletes only do one circuit strength training session on Friday afternoon.

Cardiopulmonary function assessment

In this paper, a 5x200-meter multi-segment incremental load test was used to evaluate the athletic performance of athletes for two months. The 1st to 5th 200m freestyle results were 70%, 80%, 90%, 95%, and 100% respectively. This article is about each runner's 200m swimming record. In this paper, blood lactate in finger blood was measured in 1 minute. In this paper, the blood lactate was measured by graph.[5] The lactate threshold was divided into two mmol/L, four mmol/L, and eight mmol/L.

Research on Stroke Trajectory Tracking

The magnitude of the space vector when the human body enters the water is A. The spatial azimuth spacing is d. The height of the human body into the water is α. The angle from the waist to the left arm (right side) is β. The distance between it and the edge of the pool is interconnected. It adopts the inverse Jacobian method for positioning control.[6] At this point, we can obtain the estimated parameters of the three space vectors:

$$\frac{\vec{A}+(1+\tau_i)}{s}=\frac{s^2-\vec{A}^2\tau_i^2}{2\sqrt{R^2+r^2}}+\cos\alpha\sin\beta-\sin\beta\cos\alpha \tag{1}$$

Since the spatial position of the athlete entering the water during swimming is a uniform linear array.[7] This paper uses the principle of spatial motion planning to obtain a relationship with the virtual joint variables:

$$\cos^2 a+\sin^2(60°-\beta)=1 \tag{2}$$

In this way, a dynamic decomposition model of the reverse motion of athletes in water is established in this paper. In this paper, it is mechanically decomposed. Based on this, this paper obtains the position and distance of the track tracking of the athletes entering and leaving the water in the high-load exercise state before the competition:

$$R=\frac{\begin{bmatrix}M\\N\end{bmatrix}s^2-\vec{A}^2\sum_{i=1}^{N}\tau_i^2+\cos\alpha\sin\beta}{2s\sum_{i=1}^{N}\tau_i} \tag{3}$$

Among them, the joint of the palm is to establish the world coordinate system, the new position is the basis of the parabola S_1, and the force of the knee joint is expressed as follows:

$$T=\prod_{i=0}^{N}T_i(S_i)=\begin{bmatrix}a&b&c&d\\0&0&0&1\end{bmatrix}\begin{bmatrix}0&1\\1&1\\1&0\\0&1\end{bmatrix} \tag{4}$$

The joint can be regarded as a fixed center in the structure of the body kinematic chain of the swimmer. In this way, a control model of swimming attitude trajectory tracking under high load based on constraint parameters is established in this paper.

Statistics

In this paper, the collected data are organized and counted, and analyzed using Microsoft Excel 2016.

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

RESULTS

The strength intervention lasted three months. Athletes focused on moderate and low strength training. Do a full oxygen intensity workout once a week. The strength training group did it three times a week.[8] The results showed that the swimming speed of athletes increased by 3.14% when the blood lactate concentration reached eight mmol/L during strength training. It was a 0.65% increase over the regular training group. Swimming speed increased by 1.23% when blood lactate concentration reached four mmol/L. It was 2.18% lower than the regular training group. When the blood lactate concentration reached two mmol/L, the swimming speed increased by 2.68%. It is close to 0.079% of the regular training group. The above results indicate that three months of strength training positively affects athletes' maximal oxygen intensity and exercise capacity. It did not significantly improve the anaerobic threshold and exercise capacity below the anaerobic threshold.

DISCUSSION

Combined with a small amount of strength training based on aerobic endurance training, athletes are called synchronized strength training. The effect of strength training on aerobic exercise in athletes has long been debated. Scholars have proposed that the number of muscle mitochondria decreases during aerobic exercise, and the activity of aerobic metabolic enzymes decreases. Athletes do not perform well in strength training during aerobic exercise. Athletes performing strength and aerobic exercise had no significant effect on maximal strength but harmed explosive power. Studies have shown that athletes who continue strength training for 21 weeks have better results than pure aerobic exercise. Other studies have found that female cross-country skiers progress faster after nine weeks of intensity and endurance training than training alone.[9] Male cross-country skiers showed significant increases in maximal strength after performing the same strength and endurance training. The effect of its aerobic exercise has also been significantly improved. This article uses three Iron Man events as an example. The increase in VO2max in the athletes after 14 weeks of strength and endurance training was similar to that in the control group. The improvements in maximal exercise intensity and physical fitness were even more pronounced. Maximal-intensity training also has a significant effect on improving long-distance running. These results suggest inconsistent findings on the effects of simultaneous strength and aerobic exercise on aerobic exercise, maximal strength, and explosive power in athletes. Athletes who perform strength and aerobic exercise simultaneously will have opposite changes in the physiological adaptation of skeletal muscles, and heavy-duty strength training is not recommended. Fatigue recovery after physical training is slow. This can have a significant impact on the next training session. The strength training group three times a week strength training is carried out every other day. They do mainly strength and endurance exercises. Physiological incompatibility between the two has been ruled out. From the perspective of training effect, this mode is of great help to improve the athletes' unique sports ability of extreme oxygen intensity. The improvement in aerobic capacity was not significant.

The lactate threshold is an important indicator reflecting the anaerobic metabolism of the human body. The lactate threshold is a significant source of improved aerobic performance in athletes. It can be used as an essential indicator of aerobic endurance. This article can effectively monitor and evaluate the aerobic metabolism utilization of athletes by determining their lactate threshold. According to the comparison of the data before and after aerobic exercise, it is found that the blood lactate value has a particular influence on the sports performance and blood lactate of the athletes. It can improve the aerobic capacity of athletes. The lactate threshold is a more effective measure. This paper can provide energy support for swimmers through oxygen uptake, anaerobic threshold, and lactate threshold. Aerobic exercise can improve the athletic performance of athletes. This is mainly due to his improved extreme athletic ability. We can test and evaluate athletes' various physiological and biochemical indicators through power bicycles and treadmills.

VO2 max can be divided into absolute and relative expressions. The absolute value of the maximum oxygen intake refers to the maximum oxygen that the human body can absorb per time. The relative value refers to the maximum oxygen uptake per unit of body weight. Because different athletes have different heights and body weights, a relative value is sometimes used to express maximum oxygen intake. Swimmers are characterized by solid endurance. Their aerobic capacity is extreme. As their physical strength depletes, their aerobic capacity will gradually affect their athletic performance. The combination of speed and stamina will make the connection between their energy and muscles even tighter. This also means that aerobic training plays a significant role in improving the athletic performance of athletes. The main factors affecting the maximum oxygen consumption of athletes are genes, age, race, gender, etc. The blood circulation of the heart is its central organ. Muscle uptake of oxygen is its external mechanism. In addition, studies have found that after moderate or higher-intensity endurance training, athletes can enlarge their cardiomyocytes and expand their sinus-like ducts. This increases the number of mitochondria and increases the proportion of myofibrils in cardiomyocytes. Increased mitochondrial capacity increases mitochondrial capacity structure. This provides ample energy for the heart. In addition, studies have shown that the percentage composition of slow-twitch muscle fibers is related to the highest oxygen intake. Endurance adults had a higher proportion of slow-twitch fibers and showed selective hypertrophy. This increases the uptake and utilization of oxygen. Therefore, strength training is the key to improving an athlete's aerobic capacity.

Table 1. Swimming speeds of athletes corresponding to 2 mmol/L, four mmol/L, and 8 mmol/L lactate concentrations.

Swimming speed	Strength training group		
	Before training	After training	%
2mmol /L	162.8±10.62	161.98±12.89	0.5
4 mmol /L	154.06±11.14	152. 17±13.5	1.87
8 mmol /L	148.53±12.83	144.86±12.45	3.15
Swimming speed	**Normal training group**		
	Before training	**After training**	**%**
2mmol /L	165.09±9.94	163.78±8.32	0.079
4 mmol /L	158.24±8.66	154.8±2.23	2.18
8 mmol /L	147.54±4.26	143.58±1.57	2.68

CONCLUSION

Three months of strength training on moderate- and low-intensity aerobic activity had a good effect on maximal oxygen concentration and athletic performance in the middle- and long-distance swimmers. There was no significant improvement in strength training at anaerobic and below levels.

All authors declare no potential conflict of interest related to this article

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