RECOVERY METHODS FOR ATHLETES DURING HIGH-INTENSITY TRAINING

MÉTODOS DE RECUPERAÇÃO SOBRE OS ATLETAS DURANTE O TREINAMENTO DE ALTA INTENSIDADE

MÉTODOS DE RECUPERACIÓN EN ATLETAS DURANTE EL ENTRENAMIENTO DE ALTA INTENSIDAD

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ABSTRACT

Introduction: The continuous improvement of the level of modern sports competition compels continuous reform and constant updates on sports training theory; sports training research is migrating from continuous low-intensity to high-intensity interval, and many studies have shown that high-intensity interval training has a good effect on athletes. Objective: Investigate the effect of different recovery modalities during high-intensity interval training on the athletic performance of young male runners. Methods: Using body morphological index measurement, high-intensity intermittent exhaustion test, and statistical analysis, forty young male long-distance runners from sports schools were randomly divided into active recovery group (AR, n=20) and passive recovery group (PR, n=20), maximal oxygen uptake (VO2max) and maximal aerobic speed (MAV) were measured by incremental load exercise test, and interval exercise capacity and time to exhaustion (ET) were recorded. Results: Compared with pre-training, MAV and ET in both groups increased significantly after training (P<0.05); there was no significant difference in MAV on RA group after training (P>0.05). Conclusion: High-intensity interval training with active recovery can significantly improve athletic ability and performance in young male runners in the long term. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: High-Intensity Interval Training; Athletes; Sports.

RESUMO

Introdução: O aprimoramento contínuo do nível de competição esportiva moderna compele a reforma contínua e constantes atualizações sobre a teoria do treinamento esportivo, a pesquisa esportiva de treinamento está migrando de contínuo de baixa intensidade para intervalado de alta intensidade e muitos estudos demonstraram que o treinamento intervalado de alta intensidade tem um bom efeito sobre os atletas. Objetivo: Investigar o efeito de diferentes modalidades de recuperação durante o treinamento intervalado de alta intensidade no desempenho atlético de jovens corredores masculinos. Métodos: Usando medição do índice morfológico corporal, teste de exaustão intermitente de alta intensidade e análise estatística, quarenta jovens corredores masculinos de longa distância de escolas esportivas foram divididos aleatoriamente em grupo de recuperação ativa (AR, n=20) e grupo de recuperação passiva (PR, n=20), o consumo máximo de oxigênio (VO2max) e a velocidade aeróbica máxima (MAV) foram medidos pelo teste de exercício de carga incremental, e a capacidade de exercício intervalado e o tempo até a exaustão (ET) foram registrados. Resultados: Em comparação com o pré-treino, MAV e ET nos dois grupos aumentaram significativamente após o treinamento (P<0,05); não houve diferença significativa em MAV no grupo AR após o treinamento (P>0,05). Conclusão: O treinamento em intervalos de alta intensidade com recuperação ativa pode melhorar significativamente a capacidade atlética e o desempenho em corredores jovens masculinos em longo prazo. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Treinamento Intervalado de Alta Intensidade; Atletas; Esportes.*

RESUMEN

Introducción: La mejora continua del nivel de la competición deportiva moderna obliga a la reforma continua y a la actualización constante de la teoría del entrenamiento deportivo, la investigación del entrenamiento deportivo está migrando de la baja intensidad continua a la alta intensidad interválica y muchos estudios han demostrado que el entrenamiento interválico de alta intensidad tiene un buen efecto en los atletas. Objetivo: Investigar el efecto de diferentes modalidades de recuperación durante el entrenamiento de intervalos de alta intensidad en el rendimiento atlético de jóvenes corredores masculinos. Métodos: Mediante la medición del índice morfológico corporal, la prueba de agotamiento intermitente de alta intensidad y el análisis estadístico, se dividió aleatoriamente a cuarenta jóvenes corredores masculinos de larga distancia de escuelas deportivas en el grupo de recuperación activa (AR, n=20) y en el grupo de recuperación pasiva (PR, n=20), se midió el consumo máximo de oxígeno (VO2max) y la velocidad aeróbica máxima (MAV) mediante la prueba de ejercicio de carga incremental, y se registraron la capacidad de ejercicio a intervalos y el tiempo hasta el agotamiento (ET). Resultados: En comparación con el preentrenamiento, MAV y ET en ambos grupos aumentaron significativamente después del entrenamiento (P<0,05); no hubo diferencias significativas en

MAV en el grupo de AR después del entrenamiento (P>0,05). Conclusión: El entrenamiento de intervalos de alta intensidad con recuperación activa puede mejorar significativamente la capacidad atlética y el rendimiento de los corredores masculinos jóvenes a largo plazo. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Entrenamiento de Intervalos de Alta Intensidad; Atletas; Deportes.*

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INTRODUCTION

Due to the continuous improvement of the level of competition in the field of modern sports competition, forcing the continuous reform and updating of the theory of competitive sports training, in today's competitive sports research and training hotspots are gradually shifting from low-intensity continuous training to high-intensity interval training. Many studies have shown that, high-intensity interval training has a very good training effect for athletes and the general population, for athletes, HIIT can improve the athlete's maximum oxygen uptake and aerobic capacity, maintain the stability of technical movements during competitions, and save energy at the same time. training time and improve training efficiency.[1] For the general population, HIIT can increase the activity of oxidase in the body of the general population and improve the oxidative capacity of fat, compared with LICT, it is a time-saving and efficient exercise method.[2,3]

Studies have shown that active recovery (moderate to low-intensity exercise or muscle stretching) between periods of high-intensity training is better than passive recovery (complete rest) for athletes' athletic performance and performance, but strong evidence is still lacking, and some studies Negative results were obtained, and even conflicting conclusions appeared.[4,5] Therefore, the author took young male long-distance runners as subjects, and the purpose was to compare the effects of different recovery methods on VO_{2max}, MAV, time to exhaustion, $T90VO_{2max}$ and $T95VO_{2max}$ during 8 weeks of 30s (105-110mv intensity), so as to formulate and improve the athletes, the optimal training methods for athletic ability and athletic performance provide theoretical and practical basis.[6,7]

METHOD

Research object

Forty young male long-distance runners from sports schools (the main event is middle and long-distance running, all national first-level athletes) voluntarily participated in this experiment. They were randomized into an active recovery group (AR, n=20) and a passive recovery group (PR, n=20), with active recovery (continued low-intensity exercise during the 8-week HIIT (30sIT) period) and passive recovery (complete rest during the interval).[8]

The author was reviewed and approved by the Ethics Committee of xxx University (202103056). This experiment was completed in the Sports Human Science Laboratory of the Institute of Sports Science.[9] The general characteristics of the subjects are shown in Table 1, there were no significant differences in baseline variables such as age, height, weight, body mass index, body fat percentage, and training years between the two groups of subjects before the test (P>0.05).

Table 1. Comparison of baseline variable characteristics of subjects in the two groups before the trial.

	AR group(n=20)	PR group(n=20)
age(y)	22.5±3.6	21.7±3.2
height(m)	1.81±0.03	1.79±0.04
weight(kg)	63.8±7.9	64.5±6.3
Body mass index(kg/m^2)	19.6±25	20.1±2.3
body fat percentage(%)	14.5±2.0	14.7±1.8
Years of training (years)	8.5±1.7	9.0±2.2

Experimental Design

Subjects performed a total of 3 tests and 8 weeks of training. Test 1: Familiarize yourself with the laboratory environment and testing procedures, conduct questionnaires and measure body morphological indicators (height, weight, body mass index, body fat percentage, etc.). Test 2: The maximal aerobic capacity was determined using an incremental load exercise test, and VO_{2max} and MAV were recorded. Test 3: Interval exercise capacity was measured using a high-intensity interval failure test. The above adjacent tests are at least 2d apart and completed within 2 weeks. Afterwards, subjects performed HIIT for 8 weeks, and the above tests were repeated 48 hours after the last training session, all tests were performed at 7:00-9:00 am to reduce the influence of biological rhythms, the test sequence of subjects was randomized.

Determination of body morphological indicators

The measurement requires an empty stomach in the morning, emptying of urine, light clothing, and bare feet. The height (m) and weight (kg) were measured by the physique detection component, and the error was accurate to 0.01m and 0.1kg, respectively, and the body mass index was calculated = weight (kg)/height (m)2 . Body fat percentage was determined by impedance method using a body composition analyzer.

High-intensity intermittent exhaustion test

Subjects performed repeated high-intensity interval exercise on a motorized treadmill until exhaustion. First perform 10 minutes of preparatory activities (5 minutes of jogging, 3 minutes of stretching, 10 times of 10m accelerated sprints), and then start the formal test after 5 minutes of rest. Both groups exercised at 105MAV intensity for 30s repeatedly with 30s interval (the PR group continued to exercise at 50MAV during the interval, while the AR group stood on the treadmill to rest completely until exhaustion, and the exhaustion time was recorded.

Statistical analysis

Statistical analysis and processing of data were performed using SPSS 20.0. The data are expressed as "mean ± standard deviation", the independent samples T test was used for the comparison between AR and PR groups, and the paired T test was used for the comparison within the group before and after training. P<0.05 was considered significant difference.[10]

Ethical Compliance

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of University of Visayas Graduate School following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

RESULTS

Comparison of MAV and VO_{2max} in two groups of incremental loading test

MAV: Compared with before training, the MAV of both groups increased significantly in the 5th week of training and after training (P<0.05); Compared with the 5th week of training, there was no significant difference in

MAV between the two groups after training (P>0.05); Compared with the AR group, there was no significant difference in MAV at each time point in the PR group (P>0.05) (Table 2 and Figure 1). VO_{2max}: Compared with before training, the absolute value (L/min) and relative value (mL/kg/min) of VO_{2max} in AR group increased significantly after training (P<0.05), but there was no significant change in PR group (P> 0.05); Compared with the PR group, the absolute and relative values of VO_{2max} in the AR group were significantly increased after training (P<0.05). (Table 2)

Comparison of ET, $T90VO_{2max}$ and $T95VO_{2max}$ in the high-intensity intermittent exhaustion test between the two groups

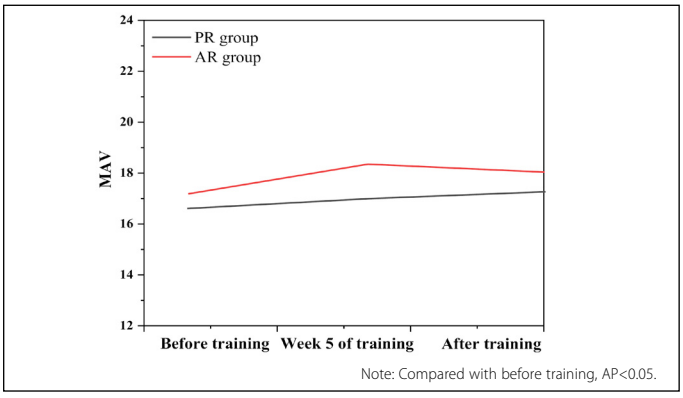
ET: Compared with before training, ET in both groups increased significantly after training (P < 0.05); Compared with PR group, ET in AR group before and after training increased significantly(P < 0.05) (Table 3). Absolute values of $T90VO_{2max}$ and $T95VO_{2max}$: Compared with before training, the absolute values of $T90VO_{2max}$ and $T95VO_{2max}$ in AR group increased significantly after training (P<0.05), while there was no significant change in PR group (P>0.05); Compared with the PR group, the absolute values of $T90VO_{2max}$ and $T95VO_{2max}$ in the AR group were significantly increased before and after training (P<0.05) (Table 3).

Relative values of $T90VO_{2max}$ and $T95VO_{2max}$ (ET): Compared with those before training, there was no significant change in the relative values of $T90VO_{2max}$ and $T95VO_{2max}$ in both groups after training (P>0.05); Compared with the PR group, the relative values of $T90VO_{2max}$ and $T95VO_{2max}$ in the AR group were significantly increased before and after training (P<0.05). (Table 3)

Table 2. Comparison of MAV and VO_{2max} before and after training in the two groups.

		AR group	PR group
MAV (km/h)	Before training	17.1±1.8	16.6±16
	After training	18.1±1.5A	17.3±1.9A
VO_{2max} (L/min)	Before training	3.9±0.6	3.8±0.5
	After training	4.3±0.7Ab	3.9±0.5
VO_{2max} (mL/kg/min)	Before training	61.2±5.8	59.3±4.7
	After training	65.3±6.0Ab	60.6±5.6

Note: Compared with before training, AP<0.05; Compared with PR group, BP<0.05.



Note: Compared with before training, AP<0.05.

Figure 1. Time course changes of MAV before training, training week 5 and after training.

Table 3. Comparison of ET, $T90VO_{2max}$ and $T95VO_{2max}$ before and after training in the two groups.

		AR group	PR group
ET (s)	Before training	1988.5±453.6b	1015.2±388.0
	After training	3125.5±836.5Ab	1206.2±510.3
$T90\%VO_{2max}$ (s)	Before training	937.8±297.6b	289.7±87.6
	After training	1535.5±512.0Ab	316.7±103.6
$T90\%VO_{2max}$ (%ET)	Before training	47.6±8.9b	28.6±4.3
	After training	49.1±10.1b	26.2±5.8
$T95\%VO_{2max}$ (s)	Before training	426.2±115.6b	105.7±26.8
	After training	778.5±201.0Ab	116.9±31.2
$T90\%VO_{2max}$ (%ET)	Before training	21.9±6.6b	10.3±3.8
	After training	24.7±5.3b	9.7±2.9

Note: Compared with before training, AP<0.05; Compared with PR group, BP<0.05.

DISCUSSION

The authors' main objective was to compare different recovery modalities (positive recovery vs passive recovery) during the 8-week HIIT interval, effects on athletic performance in young male distance runners. Several previous studies have reported the acute physiological effects of HIIT. In the HIIT program formulated in this study, the exercise intensity was 105-110MAV, the exercise time and recovery time were both 30s, and the recovery period was passive recovery or active recovery (50MAV). The weekly training load was obtained by multiplying the average exercise intensity, duration, number of completed sets and exercise frequency during HIIT, and the results showed that the training load was basically the same between different recovery methods.

CONCLUSION

The purpose of this study was to observe the long-term physiological effects of HIIT (30sIT mode), and to explore the impact of different recovery methods on athletic ability and athletic performance in young male long-distance runners, the results showed that, 8 weeks of training can increase the MAV and ET of both groups, but has no effect on the relative values of $T90VO_{2max}$ and $T95VO_{2max}$, there is no significant difference in MAV between the two groups, and ET in the AR group is significantly higher than that in the PR group, in addition, after training, only the absolute values of VO_{2max}, $T90VO_{2max}$ and $T95VO_{2max}$ in AR group increased. Therefore, from a practical point of view, if the goal of HIIT training is to improve VO_{2max}, the use of active recovery (50MAV) during the interval can significantly improve the athletic ability and sports performance of athletes. However, the optimal exercise load for HIIT and the optimal training method to improve VO_{2max} and exercise performance still need further research to confirm.

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

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. Mingzhe Yang: writing; Dan Meng: data analysis; Cresencio L. Mejarito: article review and intellectual concept of the article.

REFERENCES

1. Li X. Real-Time Collection of Training Distance of Long-Distance Runners Based on Wireless Sensor Network. Secur Commun Netw. 2021;2021(8):1-11.
2. Depiazzi J, Smith N, Gibson N, Wilson A, Langdon K, Hill K. Aquatic high intensity interval training to improve aerobic capacity is feasible in adolescents with cerebral palsy: pilot randomised controlled trial. Clin Rehabil. 2021;35(2):222-31.
3. Baker CJ, Min D, Gerofi J, Wang X, Hocking SL, Colagiuri S, et al. 233-OR: Circulating Inflammatory Biomarkers Are Not Improved with Combined Low-Volume High-Intensity Interval Training and Progressive Resistance Training in Prediabetes. Diabetes. 2021;70(Suppl 1):233-OR.
4. Magalhães F, Aguiar PF, Tossige-Gomes R, Magalhães SM, Ottone VO, Fernandes T, et al. High-intensity interval training followed by postexercise cold-water immersion does not alter angiogenic circulating cells, but increases circulating endothelial cells. Appl Physiol Nutr Metab. 2019;45(1):101-11.
5. Li X, Han T, Zou X, Zhang H, Zhang L, Fang G, et al. Effect of Long-term High-intensity Interval Training on Serum 25(OH)D3Concentrations In Elderly Adults: 745. Med Sci Sports Exerc. 2021;53(Suppl 8):250.
6. Fujii Y. Dental Treatment for Low Back and Hip Pain in a Long-Distance Runner: A Case Report. APE. 2021;11(1):135-40.
7. Zhou WT, Yang H. [Feasibility study of using SNPs in the NADPH oxidase p22phox gene as molecular marker for talent selection of long distance runner]. Zhongguo Ying Yong Sheng Li Xue Za Zhi. 2019;35(6):506-9.
8. Jafar O, Friedman J, Bogdanowicz I, Muneer A, Thompson PD, Ling J, et al. Assessment of Coronary Atherosclerosis Using Calcium Scores in Short- and Long-Distance Runners. Mayo Clin Proc Innov Qual Outcomes. 2019;3(2):116-21.
9. Ahmadizad S, Rahmani H, Khosravi N, Falakdin Z, Connes P, Daraei A. Acute responses of platelet count and ADP-induced platelet aggregation to different high intensity interval exercise modes. Clin Hemorheol Microcirc. 2020;75(4):467-74.
10. Burns S, Gasdia F, Simpson JJ, Marshall RA. 3-D FDTD Modeling of Long-Distance VLF Propagation in the Earth-Ionosphere Waveguide. IEEE Trans Antennas Propag. 2021;69(11):7743-52.