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Original Article

Performance for Short High-intensity Interval Training Program: Active Recovery vs. Passive Recovery

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ABSTRACT

This study aimed to examine the effect of a 8-week high-intensity intermittent training (HIIT)-based running plan with different recovery modes (passive, active) on anthropometric indices, athletic performance, and physiological responses, during a Vameval test and 30–15 intermittent fitness test, before and after the HIIT period. Twenty eight subjects were matched into 3 groups: active recovery group (ARG), passive recovery group (PRG), and control group (CG). The CG was asked to maintain their normal training routines. HIIT program improved significantly VMA and VO_{2max} regardless of the mode of recovery. Also, the results of present study showed that HIIT program can increase aerobic performance without having any change on RPE, heart rate and lactate concentration.

Keywords: High-intensity interval training, active recovery, passive recovery, performance

INTRODUCTION

High-intensity intermittent training (HIIT) is considered one of the most effective methods of exercise for improving the physical performance of athletes (Buchheit & Laursen, 2013; Laursen et al. 2010; Billat et al. 2001). Previous studies defined that HIIT generally refers a repeated short to long sprint of high-intensity exercise with 100% to 105% of VO_{2max}, interspersed with different recovery periods and modes. Various types of HIIT program have been shown to improve endurance performance in runners (Kohn et al. 2011; Bangsbo et al. 2009) and cyclists (Laursen et al. 2005; Creer et al. 2004).

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It is well documented by coaches and researches that intermittent exercise models and the recuperation mode (active or passive) can modify the physical performance during intermittent exercise.

The intermittent exercise was characterized according to their intensity, duration of exercise, number of repetitions and the recovery intervals which cause a different physiological stress level and fatigue. Billat et al. (2001) proved that the alternation of 30s intervals at the speed associated with maximal VO_{2max} oxygen uptake with 30s of active recovery (50% of VO_{2max}) is an effective form of exercise to sustainably solicit VO_{2max}. However, during intermittent exercises, the intensity of the recovery intervals is more difficult to calibrate because a too low intensity reduces the level of cardio-ventilator stress and a too intense recovery induces a significant participation of lactic anaerobic metabolism (Fox et al. 1969). Many complementary studies are still needed to define the most effective exercise and recovery model for developing endurance performance.

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Some suggest that during an active recovery, there is more physical stress than during a passive recovery.

Accordingly, the current study was designed to determine the influence of 8 weeks of a high-intensity interval training (HIIT) program using two differents recovery modes (passive vs. active) on physical performance and physiological markers.

METHODS

Subjects

Twenty four subjects were randomized to either of three training groups (ARG: active recovery group, n=10; PRG: passive recovery group, n=10; CG: control group: n=9). Their anthropometric characteristics were evaluated before and after 8 weeks of HIIT program and they displayed in Table 1. All participants agreed to participate in this study on a voluntary basis and after receiving a written explanation of the experimental design and risks of this study. The present study was conducted according to the declaration of Helsinki and approval by the Ethic committee of the university. All participants underwent a medical examination and reported that anyone have any neuromuscular disease or musculoskeletal injuries and none of them were taking any medication or performance supplements during training program and during evaluation tests.

Experimental Design

Participant performed two tests before and after training program: Vameval test (Leger et al. 1993) and 30/15 intermittent exercise test (Buchheit, 2008).

Only control group performed those test without having a HIIT training program. All testing sessions were performed at the same time of the day (9±1 h) with a temperature ranging between 20°c and 25° c, and humidity ≤ 50%, with wind speed ≤ 2 m/s.

Maximal Graded Test

Maximal graded test begins with a running speed of 8 km.h-1 and increases by 0.5 km.h^{-1} every minute until exhaustion. The participants adjusted their running speed to the auditory signals at 20-m intervals, delineated by marks placed at 20 m intervals along a 400 m athletics track. The test ended when the subject could no longer maintain the required running speed dictated by the pre-recorded audio beeps, for 2 consecutive occasions. The Maximal Aerobic Speed (MAS) corresponds to the last stage speed completed. (Cazorla & léger, 1993). VO_{2max}, HRmax, RPEpost test (CR10; Borg, 1998), lactate post-training were determined.

The 30–15 Intermittent Fitness Test

The test consists of 30 s shuttle runs interspersed with 15 s passive recovery periods. Subjects performed shuttles between two lines (40 m apart) at a given pace of pre-recorded audio beeps. The test starts at a velocity of 8 km/h and increases by 0.5 km/h for each successive 30 s stage. The test ended, when the player was totally exhausted and stopped or can't maintain the required running speed dictated by the audio beeps. MAS, VO_{2max}, HRmax, RPEpost test (0-10), and lactate post-training were evaluated.

HIIT Program

During 8 weeks of HIIT program, participant performed [2*(8* 30 s)] to [2*(10*30s)] sprint at 100%-105% (MAS) with 30s active recovery (50% MAS for AGR; passive recovery for PGR) and 5min passive recovery between series on track. The distance was covered during the 30s maximal runs at 100%-105% was calculated.

Statistical Analyses

Data were expressed as means and standard deviations (SD). Normality of data was assessed and confirmed using the Kolmogorov-Smirnov test. Two-way repeated measures ANOVA (3 groups * 2 periods) were used to compare the anthropometric and physiological indices between groups across periods. The level of significance was set at p≤ 0.05. The level of significance was set at p≤ 0.05. All analyses were carried out using SPSS 16 for Windows (SPSS, version 16 for Windows. Inc., Chicago, IL, USA).

RESULTS

Table 1 represents the effect of the anthropometrics characteristics of subjects before and after HIIT program. No significant differences were observed in height, weight, and BMI before and after the HIIT program.

Table 2 represents the effect of physiological characteristics on subjects before and after HIIT program. The results of this study showed that active

Table 1: Mean (±SD) data measured for the anthropometrics characteristics of subjects before and after HIIT program

	ARG		PRG		CG	
	Pre-training	Post-program	Pre-training	Post-program	Pre-training	Post-program
Age (years)	19.4±0.5	19.4±0.5	20±0.3	20±0.3	20.1±0.7	20.1±0.7
Height (cm)	181.7±0.8	181.7±0.8	179.6±0.2	179.6±0.2	175.3±0.9	175.3±0.9
Weight (kg)	77.4±0.5	77.2±0.5	74.1±0.7	73.6±0.7	66.5±0.2	67.2±0.2
BMI ($kg.m^{-1}$)	20.2±0.7	20±0.5	22.5±0.6	22.1±0.2	21.1±0.3	22.5±0.7

ARG: Active Recovery Group; PRG: Passive Recovery Group; GC: Control group; BMI: Body mass index.

Table 2: Mean (±SD) data measured for the physiological characteristics of subjects before and after HIIT program

Tests	Variables	ARG		PRG		CG	
		Pre-training	Post-training	Pre-training	Post-training	Pre-training	Post-training
Vameval Test	VMA ($km.h^{-1}$)	18.4±7.8	19.3±1.2 ¥	15.6±1.4	16.6±1.5*	16.5±0.3	16±0.4
	VO_{2max} ($ml.min^{-1}.kg^{-1}$)	59.4±9.3	62.9±10.3¥	58.7±5.7	60.4±6*	60.4±2.7	60±4.2
	HRmax (bpm)	198±6	197±6	200.1±5.2	198±4.7	200±6	199±3
	RPE post-test	9±1	9±1	9±1	8±2	9±1	10±0
The 30–15 intermittent fitness test	HRmax (bpm)	197±6	198±6	198±5	199±4.7	200±5	199±3
	VO_{2max} ($ml.min^{-1}.kg^{-1}$)	59.5±9	63.2±7.3¥	59.2±6.1	60.9±5.1*	60±1.2	59±3.1
	RPE post-test	8±2	9±1	9±1	9±1	9±0	8±2
	[La]post-test	16.5±1.8	16.9±1.2	16.9±1.4	16.8±1.4	16.9±0.9	16.1±1.2

ARG: Active Recovery Group; PRG: Passive Recovery Group; GC: Control group; HR max: Heart rate maximal; La: Lactate; RPE: Rated perceived exertion; *Significant difference from PRG between pre-training and post-training ($p \leq 0.05$); ¥Significant difference from ARG between pre-training and post-training ($p \leq 0.05$).

or passive recovery during intermittent exercise favors a significant improvement in MAS and VO_{2max} ($p \leq 0.05$) compared with control group. While, no significant difference was observed for HR, RPE, and Lactate for both modalities of recovery before or after the training program.

DISCUSSION

The aim of this study was to compare the different recovery modes an aerobic performance before and after high-intensity interval training program.

The present study showed, that after the HIIT program for the ARG or PRG, MAS and VO_{2max} improved significantly during Vameval test and the 30–15 intermittent fitness test, whether no significant change observed for PRG or CG. Our results confirmed with previous studies which proved that the significant improvement of HIIT training does not depend on the recovery mode (passive, active) (Dorado et al. 2004; Thevenet et al. 2007). Indeed, Thevenet et al. (2007) demonstrated that no influence of recovery mode on absolute 90%-95% of VO2 max mean values despite significantly longer time to exhaustion values for 30/30 s intermittent exercise with passive recovery than for 30/30 s intermittent exercise with active recovery. The objective of our study was to determine the best recovery modality for increasing VMA. Our results showed that the two modes of recovery allow a significant improvement of the VMA in comparison with the control group. Eight weeks of training therefore make it possible to increase the earlier VMA for the PRG group (≈6%) than that of the ARG group (≈5%). It can therefore be assumed from these results that the use of active recovery can be more effective than a passive recovery to increase VMA over a short period (3 weeks) (Billat et al. 1999; Smith et al.1999; Denadai et al. 2006).

Regardless of the group before or after the training period, the 30–15 intermittent fitness test resulted in increase in similar lactate levels between the three

groups. The eight weeks of intermittent training followed by our population does not seem to influence the evolution of lactate concentration in response to a progressively increasing load test. This can perhaps be explained by a lower solicitation of lactic anaerobic metabolism during this type of training.

On the other hand, results of the current study showed no significant difference in RPE, and HRmax between PRG and ARG despite a significant increase in MAS and VO_{2max}. This suggests that subjects were able to run with higher MAS with the same feeling of effort and fatigue compared to control group. This is in accordance with several studies which have shown HIIT program increase performance without any significant change an RPE, HRmax and lactate (Nytroen et al. 2012; Pinillos et al. 2017).

CONCLUSION

In summary, we have demonstrated that HIIt program improved VMA and VO_{2max} regardless of the mode of recovery. The results proved that HIIT program can increase aerobic performance without having any change on RPE, heart rate and lactate concentration.

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