INTRODUCTION

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Physical activity guidelines in adults recommend 150 min/week of moderate intensity continuous training (MICT), or 75 min/week of vigorous activity (8). The frequency of participation in physical activity is low (4) which is due to lack of time (19). This inactivity reduces cardiorespiratory fitness (maximal oxygen uptake VO_2max) and alters morbidity and mortality, as data (11, 13) show that VO_2max is related to health status and risk of cardiac event.

High intensity interval training (HIIT) is defined as brief, intense bursts of activity, separated by recovery. HIIT and its more intense form, sprint interval training (SIT) require less time than MICT which makes them more time-efficient. Studies conducted in healthy adults show that chronic HIIT and SIT lead to similar (3, 6) or superior adaptations (14) versus MICT. HIIT is typically performed in a laboratory setting requiring use of cycle ergometers and motor-driven treadmills. In addition, experienced personnel construct all exercise protocols and provide substantial support and motivation to the participant, which reduces the "real-world" application of HIIT outside the lab setting.

A popular smartphone application called the 7 Minute Workout (7Min) claims to be scientifically proven to promote weight loss and improve cardiovascular function. The application has 10 million downloads and has been used by 350,000 people. A study in active men and women (15) showed that 24 sessions of 7Min significantly increased muscle endurance, but did not change VO_2max or body fat. Another study showed small reductions in body fat and waist circumference when 7Min was performed daily for 6 wk (12). It is evident that adaptations to exercise training are the accumulated effect of specific transcriptional and translational 'micro-adaptations' occurring after acute exercise (5), and the magnitude of the stimulus

received from acute bouts may partially underlie individual variation in long-term training responses.

The aim of the present study was to compare acute physiological and perceptual responses between a single session of cycling-based high intensity interval exercise (HIIE) and 7Min. We hypothesized that HIIE would elicit higher VO_2 responses versus 7Min.

METHODS

Subjects: Active men (n=7) and women (n=7) who regularly complete resistance training, non-competitive sport, CrossFit, surfing, or aerobic exercise participated in this study. Their mean age and VO_2max were equal to 25.4 ± 8.3 yr and 40.5 ± 6.4 mL/kg/min. Participants provided written informed consent, and all procedures were approved by the University Institutional Review Board.

Design and Procedures: Subjects completed 3 sessions over a 2 wk period which were held at the same time of day within subjects. Before each session, they abstained from physical activity for 24 h and were 3 h post-meal. On day 1, participants performed incremental exercise on a cycle ergometer (Velotron Dynafit Pro, RacerMate Inc., Seattle, WA) to measure VO_2max and peak power output (PPO). Exercise began with a 2 min warm up at 40 – 60 W followed by 20 - 30 W/min increases in work rate until volitional exhaustion.

The 7 Minute workout and high intensity interval exercise: Both protocols were preceded by a 5 min warm-up at 20 % PPO. The 7Min workout consisted of twelve 30 s bouts including these exercises in the following order: jumping jacks, wall sit, push-ups, abdominal crunches, step-up onto chair, squats, triceps dips on chair, planks, high knees, lunges, push-up with rotation, and side planks. Participants were told to perform as many repetitions as possible during each 30 s bout, which was followed by 10 s of passive recovery during which participants quickly changed

body position to prepare for the subsequent bout. During HIIE, participants cycled for 7 min at a self-selected cadence between 60 – 90 rev/min. Duration of this bout was matched to 7Min, and both protocols involved 6 min of work. During HIIE, twelve 30 s bouts at 70 %PPO were completed, with each bout separated by a 10 s active recovery at 20 %PPO. This protocol elicits approximately 80 – 90 %HRmax, similar to that used in previous studies (1, 18).

VO_2 values were averaged from the two 15 s data points obtained during each 30 s bout and the one following it in recovery. Blood lactate concentration (BLa) was obtained pre-exercise with the participant seated, and at 33 % (immediately after bout 4) and 66 % of bout duration (immediately after bout 8) and 3 min post-exercise. Twenty microliters of blood were taken from the fingertip using a lancet (Owen Mumford, Inc., Marietta, GA), and a portable monitor (Lactate Plus, Nova Biomedical, Waltham, MA) which was used to determine BLa.

Statistical analyses: Data were analyzed using SPSS Version 20.0 (Chicago, IL). Two-way ANOVA with repeated measures was used to compare changes in dependent variables across time and protocol (HIIE vs. 7Min). If a significant F ratio was obtained, Tukey's post hoc test was used to identify differences between means. Statistical significance was set at $p < 0.05$.

RESULTS

Change in VO_2: Figure 1a shows that VO_2 increased during exercise ($p < 0.001$) and there was a time X protocol interaction ($p < 0.001$). Post hoc analyses showed that VO_2 was significantly higher in response to HIIE versus 7Min at all time points. VO_2 during HIIE steadily increased from bout 1 (1.52 ± 0.32 L/min) to bout 8 (2.38 ± 0.48 L/min) and increased further to bout 11 when it peaked at 2.49 ± 0.47 L/min, equal to 83 %VO_2max. VO_2 varied during 7Min, as it increased from bout 1 to bout 2 (0.92 ± 0.19 to 1.27 ± 0.31 L/min, jumping jacks to wall sit), then decreased for pushups. VO_2 continued to rise until bout 7 (2.06 ± 0.44 L/min, triceps dips).

In bout 8 (1.70 ± 0.36 L/min, planks), it was reduced, yet increased again to a peak value equal to 73 %VO_2max during bout 10 (2.18 ± 0.48 L/min, lunges). Mean (1.49 ± 0.32 L/min vs. 1.83 ± 0.41 L/min, $p < 0.001$) and peak VO_2 (2.45 ± 0.50 L/min vs. 2.73 ± 0.54 L/min, $p = 0.001$) was lower in 7Min compared to HIIE.

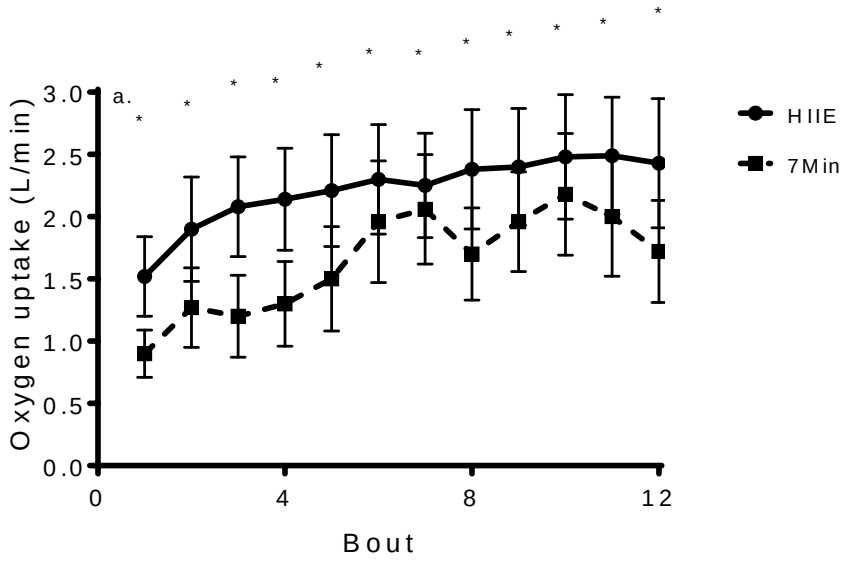

Figure 1: Change in VO_2 during HIIE versus 7Min (mean ± SD).

Change in blood lactate concentration: Pre-exercise BLa was similar between regimes and increased during exercise ($p < 0.001$), but there was no time X protocol interaction ($p = 0.07$). Although, BLa values acquired at bout 8 (6.4 ± 1.8 mM vs. 5.6 ± 1.4 mM) and post-exercise (7.4 ± 1.4 mM vs. 6.2 ± 2.0 mM) were higher in 7Min versus HIIE.

DISCUSSION

Our study compared the acute responses of a lab-based HIIE regime to a whole-body 7-minute workout which can be performed at home without specialized equipment or supervision. The peak VO_2 of 7Min was 81 %VO_2max which would require bursts of relatively intense exercise similar to that found in HIIE. Nevertheless, the higher mean and peak VO_2 in HIIE

suggests a greater acute cardiorespiratory strain than 7Min, which places 7Min at a lower intensity similar to MICT.

Data show 10 – 40 % higher VO_2 during HIIE versus 7Min (Figure 1) as well as higher mean and peak VO_2. Despite the lower mean and peak VO_2 observed in 7Min versus HIIE, it is characterized by bursts of activity requiring near-maximal effort. Nevertheless, the mean HR of 7Min was equal to 73 %HRmax which is classified as moderate exercise according to ACSM (8). In fact, the mean HR of 7Min is similar to that seen with 50 min of MICT at 70 %HRmax (17). In contrast, the mean HR value characteristic of HIIE (159 b/min) is similar to that reported in men completing the 4 X 4 or 16 X 1 HIIE bouts (20), and approximately 20 b/min higher than that elicited from 7Min. Together, these findings suggest that 7Min as currently developed is not a suitable form of HIIE.

Blood lactate concentration increased in response to both HIIE and 7Min to values greater than 4 mM, which is associated with onset of the lactate threshold (10) and a transition to higher intensity exercise. The slightly greater BLa values in 7Min versus HIIE may be caused by the recruitment of more fast-twitch muscle fibers of the trunk, upper body, and gluteals required to perform exercises including planks, push-ups, tricep dips, lunges, and squats. Our BLa values are lower than those reported for Wingate-based sprint interval training (9). However, BLa values from 7Min are similar to those (~ 6.0 mM) in women performing whole-body resistance exercise (2). The activation of all fiber types throughout the body would elicit higher BLa than when solely the leg muscles are activated (7).

Compared to 7Min, our data show that despite similar exercise duration, a session of cycling-based HIIE elicits higher mean and peak VO_2. Recent studies (12, 15) show small increases in VO_2max and muscle endurance and lower fat mass in response to chronic 7Min, but these

adaptations did not occur in all participants. Future research should compare long-term responses to this protocol, especially considering that 7Min is easily accessible.

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