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Letter to editor

Exercise Intensity and Energy Expenditure of a Tabata Workout

Dear Editor-in-Chief

High-intensity interval training (HIIT) programs have become increasingly popular in recent years. "Tabata training," a term that is often used synonymously with HIIT, was first described by the Japanese scientist Izumi Tabata in 1996. Tabata and his colleagues (1996) conducted a study that compared moderate-intensity continuous training at 70% of maximal oxygen consumption (VO_2max) for 60 minutes, with HIIT conducted at 170% of VO_2max. HIIT consisted of eight, 20-second all-out exercise bouts followed by 10 seconds of rest for a total of 4 minutes of exercise. The study found that HIIT improved aerobic capacity to a similar degree as moderate-intensity continuous training, but also resulted in a 28% increase in anaerobic capacity. Those findings led to the development of a wide variety of HIIT programs. Although there are many different ways to perform HIIT, all of the programs are characterized by periods of very heavy effort combined with periods of either complete rest or low intensity recovery. Tabata training has evolved to include a variety of modes and exercises performed in the classic 20-10 pattern (i.e., 20 seconds of all-out effort followed by 10 seconds of rest). While the relative exercise intensity and physiological responses to traditional steady-state exercise are well-documented, there is limited research regarding the relative exercise intensity and energy expenditure of Tabata training. Therefore, the purpose of this study was to determine the relative exercise intensity and energy expenditure of a Tabata workout.

Sixteen trained volunteers (8♂: 35.3 ± 8.1 years, 1.81 ± 0.06 m, 93.7 ± 8.70 kg, 53.2 ± 0.6 ml·kg·min^{-1}; 8♀: 28.4 ± 9.3 years, 1.71 0.09 m, 71.9 ± 12.0 kg, 42.9 ± 11.3 ml·kg·min^{-1}) served as subjects and provided written informed consent. Initially, each subject performed a maximal exercise test on a treadmill to determine VO_2max and maximal heart rate (HRmax). Individual HR/VO_2 regression equations were developed for each subject using the HR and VO_2 responses during the last 30 seconds of each stage of the incremental treadmill test. These individual HR/VO_2 regressions were subsequently used to predict VO_2 and energy expenditure during Tabata training.

After practicing until proficient at all of the exercises, each subject completed two identical workouts. Each workout consisted of four, 4-minute "segments." Each segment consisted of performing the exercises listed in Table 1 twice in succession. Subjects completed as many repetitions of each exercise as possible in 20 seconds followed by 10 seconds of rest. There was 1 minute of rest between each segment. We chose to do the four segments of Tabata in succession, since one of the criticisms of Tabata training has been that individuals cannot burn a sufficient number of calories in 4 minutes to favourably impact energy balance.

During exercise, HR was measured each minute using radiotelemetry. Blood lactate was obtained at the completion of each 4-minute segment using a finger prick blood sample (Nova Biomedical Lactate Plus Blood Lactate Analyzer, Waltham, MA) and ratings of perceived exertion (RPE) were determined at the end of each segment using the 6–20 Borg RPE scale. HRs obtained during testing were inserted into the individual HR/VO_2 regression equations to predict VO_2 during each minute of exercise. Energy expenditure (kcals) was determined using the VO_2 data, assuming a constant of 5 kcal·L^{-1} of O_2 consumed.

The HR, VO_2, RPE, and blood lactate responses are presented in Figure 1, Panels A-D, respectively. As can be seen, responses for all variables increased in a stepwise fashion with each successive segment of Tabata. Heart rate during the two Tabata workouts averaged 156 ± 13 bpm (86% of HRmax) and predicted VO_2 averaged 34.8 ± 6.3 ml·kg·min^{-1} (74% of VO_2max). These values are at the upper range suggested by the American College of Sports Medicine (ACSM, 2010) for improving cardiorespiratory endurance. RPE for the two Tabata workouts averaged 15.4 ± 1.3, indicating that the workouts were rated as "hard" by the subjects. As further evidence of the vigorous intensity of Tabata, blood lactate concentration averaged 12.1 ± 2.2 mmol·L^{-1} at the conclusion the 20-minute Tabata sessions, which indicates that subjects were progressively accumulating lactate (e.g., above lactate steady state) (Foster and Cotter, 2005). Caloric expenditure averaged 14.5 ± 2.7 kcal·min^{-1}, which is very similar to the value found by Olsen (2013), who reported a slightly lower value of 13.4 kcal·min^{-1}. This was probably due to the fact that her study included 13 women and only 3 men. Total energy expenditure ranged from 240 to 360 kcals for the 20-minute workout, which is significantly higher than the estimated 54 kcals expended during the 4 minutes of exercise reported by Olson.

The results of this study indicate that a 20-minute

Table 1. Exercises included in the 20-minute Tabata workout

	Minute 1	Minute 2	Minute 3	Minute 4
Segment 1	High Knee Run	Plank Punch	Jumping Jacks	Side Skaters
Segment 2	Jump Rope	In/Out Boat	Line Jumps	Push-Ups
Segment 3	Burpees	Russian Twists	Squats	Lunges
Segment 4	Mt. Climbers	Push-Ups	Split Squat	Box Jumps

Each exercise was repeated twice at a ratio of 20 sec exercise/10 sec rest

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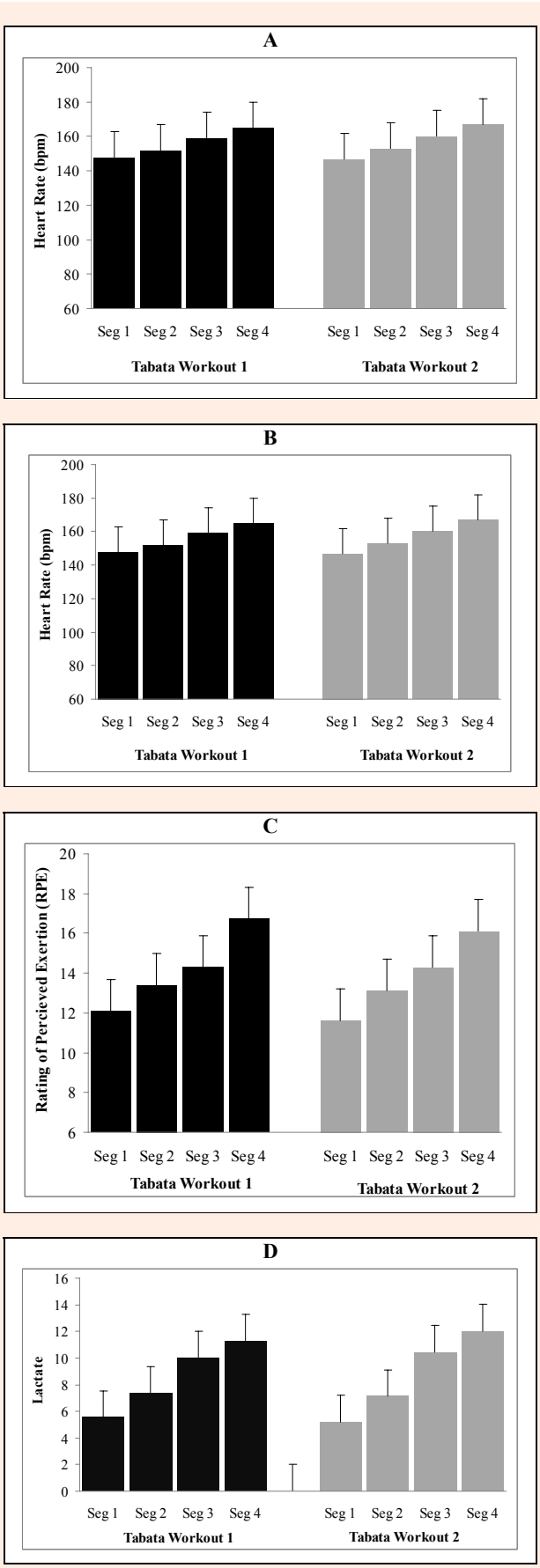

Figure 1. Average heart rates (A), estimated VO_2 (B), RPE (C) and lactate responses (D) for each 4-minute Tabata segment. Values represent mean ± standard deviation.

Tabata session, which utilized multiple rounds of body-weight and plyometric exercises, meets ACSM guidelines for improving cardiorespiratory endurance. Additionally, the multiple rounds of exercise were well tolerated by subjects and resulted in an increase in caloric expenditure beyond what would normally be seen if only 4 minutes of exercise was completed.

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