

Acute Metabolic and Enjoyment Responses of Three Walking Protocols

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Abstract Encouraging physical activity is a key component of public health. The purpose of this study was to test the hypothesis that interval walking would produce higher oxygen uptake ($\dot{V}O_2$) and similar enjoyment responses during and following exercise compared to continuous walking. Ten healthy adults (4 women, 6 men; mean age = 24 ± 5 years) completed the following 3 walking bouts in counterbalanced order and equated for total volume (90 MET min): 1) 30 min of low-moderate continuous walking (3 METs; ~ 4.8 km/h), 2) 24 min and 24 s of interval walking (IW1) with cycles of 30 s:60 s of high-moderate (5 METs; ~ 6.4 km/h):low-moderate intensities, and 3) 26 min and 20 s of interval walking (IW2) with cycles of 30 s:120 s of high-moderate:low-moderate intensities. Accumulated O_2 uptake during exercise was higher during IW2 (28,232 ± 2,782 mL) compared to IW1 (26,561 ± 2,685 mL; $p = 0.03$) and continuous walking (24,500 ± 2,427 mL; $p = 0.001$), and higher during IW1 than during continuous walking ($p = 0.001$). EPOC over 20 min was higher after IW1 (1,268 ± 117 mL O_2) compared to continuous walking (892 ± 73 mL; $p = 0.04$); the 2 interval walking protocols were not different (IW2: 1,174 ± 178 mL; $p > 0.05$). Exercise enjoyment before, during, and after exercise did not differ among the walking protocols (all $p > 0.05$). Interval walking elicited greater $\dot{V}O_2$ and EPOC in shorter total durations of exercise compared to continuous walking of a similar enjoyment and volume.

Keywords: EPOC, interval walking, aerobic exercise, body fat, affect, adherence

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1. Introduction

Physical inactivity in adults today is a tremendous public health challenge that contributes to excess fat accumulation and an increase in the prevalence and incidence of chronic disease, e.g., type II diabetes, cardiovascular disease, hyperglycemia, and obesity [22]. In 2011, only 52% of U.S. adults met minimum physical activity guidelines [12]. Americans who do not meet the physical activity recommendations often cite lack of time as a major barrier [5]. Interval training, however, has been shown to provide greater or similar benefits to traditional continuous training in a shorter time [5,9,18] and may represent a time-efficient strategy to increase physical activity [16].

Interval training consists of intermittent periods of exercise and recovery at various intensities. Several studies have shown elevated oxygen uptake capacity ($\dot{V}O_{2max}$) and increased muscle glycogen and maximal activity of citrate synthase [8,9] associated with interval training compared to traditional continuous training, regardless of age, sex, or health status [8,9,18,24,31]. In addition, Selfridge [31] noted high intensity interval training to be more effective for increasing maximum

exercise capacity, improving blood pressure, reducing body fat, and raising HDL-C than continuous moderate exercise.

Because traditional high-intensity interval training is performed at high intensities (85-90% $\dot{V}O_{2max}$) it places great strain on the cardiovascular system and may be contraindicated for some adults [10]. Per Stanley and Cumming [34], the structure of an exercise bout can influence the type and duration of elicited exercise related affect responses. Moreover, negative post-exercise affect responses reduces exercise adherence and have been linked to high intensity interval training [27,37,38]. Accordingly, lower intensity interval training protocols have been studied and investigators have shown that they can effectively improve affect [36].

One such form of lower intensity exercise that can be performed using intervals is walking. Walking is a common and practical form of weight-bearing exercise that reduces life-style related risks of chronic diseases and increases positive-activated affect which is linked to increased exercise adherence [15,34]. Traditional interval walking training is a type of interval training that consists of 3-min repeated cycles of high ($\geq 70\%$ peak oxygen uptake, $\dot{V}O_{2peak}$) and low ($\leq 40\%$ $\dot{V}O_{2peak}$) walking intensities [21,23]. Because interval walking training intensities are lower than most traditional interval training

protocols, it may reduce injury risk and improve exercise adherence. To date, interval walking training has been shown to improve body mass index, $\dot{V}O_{2\text{peak}}$, knee extension and flexion strength, and blood pressure when compared to continuous walking [19,21,23,29]. Although intermittent, a modified interval walking training protocol consisting of a 2 min:1 min ratio of low-intensity (40% $\dot{V}O_{2\text{peak}}$) to vigorous-intensity (70% $\dot{V}O_{2\text{peak}}$) exercise was utilized by Campbell et al. [10], who found a reduction in low density lipoprotein.

Some health effects associated with interval walking may be attributed to excess post-exercise oxygen consumption (EPOC), defined as the elevated rate of oxygen uptake above the resting value after exercise [30]. In a study conducted by Chan and Burns [13], EPOC values were found to be 43% higher than resting values over a 2-hour period following sprint-interval exercises. According to Børshiem and Bahr [7], EPOC's magnitude depends on exercise duration, intensity, and mode. Therefore, moderate-intensity interval walking that elicits higher $\dot{V}O_2$ during exercise and higher EPOC after exercise may contribute to an increased caloric deficit and positive affect in adults.

Compared to continuous exercise, high-intensity interval exercise has been shown to elicit significantly higher $\dot{V}O_2$ during exercise and EPOC values following exercise, but the ideal exercise and active recovery ratios of interval walking have not been clearly established. Furthermore, the effect of moderate intensity interval walking exercise on $\dot{V}O_2$ during exercise, EPOC, and exercise enjoyment remains unclear. Therefore, the purpose of this study was to compare metabolic (energy expenditure) and enjoyment responses of continuous and interval walking protocols in adults during and immediately following walking. We hypothesized that interval walking would produce higher $\dot{V}O_2$ and similar enjoyment responses during and following exercise compared to continuous walking.

2. Methods

2.1. Study Participants

Ten adults (4 women and 6 men) aged 19-36 volunteered to participate. Each participant completed a medical history and Physical Activity Readiness Questionnaire to screen for health risks that would preclude participation in moderate-intensity exercise. Any person classified as high risk—using American College of Sports Medicine [3] criteria—was excluded from the study. All procedures were approved by the local Institutional Review Board and subjects provided written informed consent prior to participation.

2.2. Experimental Design

Participants reported to the laboratory on 4 separate occasions; all participants were instructed to refrain from caffeine, alcohol, and food consumption for at least 2 h prior to each visit and avoid moderate to vigorous exercise for 24 h prior to each visit. A 24-h history form was used to verify adherence to these guidelines.

The modified Balke-Ware Treadmill Protocol [4] and the International Physical Activity Questionnaire (short form) [14] were administered during the initial visit to evaluate participants' current fitness and physical activity levels, respectively. Because this type of training would be most appropriate for less-fit individuals, participants with a cardiorespiratory fitness level $\geq 70^{\text{th}}$ percentile via the Balke-Ware Treadmill Protocol were excluded from the study. Height (Seca, Gayamills, WI), weight (Tanita BWB-800, Japan), waist and hip circumference (Gulick II Measuring Tape, Gayamills, WI), and percent body fat was estimated via 3-site skinfolds [17] were measured for each participant.

After the initial session, participants returned 2 days later to complete the first of 3 experimental trials. Each subsequent experimental trial was separated by ≥ 48 h. The experimental trials consisted of 3 treatments: 1 continuous walking and 2 interval walking protocols performed on a treadmill (Quinton, Seattle, WA) in a temperate environment ($\sim 22\text{-}23$ °C). Each visit occurred at the same time of day (± 1 h), and the order in which the treatments were performed were counterbalanced with the counterbalanced treatment orders randomly assigned.

MET mins were used to equate total estimated energy expenditure during the treadmill protocols within participants. Additionally, moderate exercise intensities (3–5 METs) [1,2] were chosen to maximize external and ecological validity. The continuous walking protocol consisted of participants walking continuously for 30 min at a low-moderate workload of 3 METs (~ 4.8 km/h) [1,2]. Interval walking protocols consisted of cycled bouts of high-moderate and low-moderate intensities. Each interval walking work bout was set at a high-moderate intensity of 5 METs (6.4 km/h) [1,2] of 'work' and low-moderate intensity of 3 METs (4.8 km/h) of 'active recovery'. The first interval walking protocol (IW1) consisted of a 24 min and 24s bout of walking (19% shorter duration than continuous walking) and work:active recovery bouts of 30 s:60s. The second interval walking protocol (IW2) consisted of work:active recovery bouts of 30s: 120s totaling 26 min and 20 s (11% shorter duration than continuous walking). Each protocol consisted of the same volume of 90 MET min. Figure 1 summarizes the exercise protocols.

2.3. Calculations

Prior to each exercise trial, baseline oxygen uptake ($\dot{V}O_2$) and respiratory quotient (RQ) were measured using a metabolic cart (TrueOne 2400, Parvo Medics, Sandy, UT) during a 20-min supine rest period. Both baseline $\dot{V}O_2$ and RQ were recorded continuously, averaged every 30 s, and calculated as the average of the final 5 min [35]. In addition, pre-exercise enjoyment [7-point exercise enjoyment scale ranging from 1 (not at all) to 7 (extremely)] [33] was captured following the initial 5 min of the 20-min supine rest period. During each walking protocol, continuously measured $\dot{V}O_2$, RQ, and heart rate (HR; Polar, Lake Success, NY) were averaged. These measurements, rating of perceived exertion (RPE; using the 6-20 Borg scale) [6], and enjoyment during exercise were measured at 6 time points, evenly distributed amongst each protocol (Continuous walking: 5 min, 10

min, 15 min, 20 min, 25 min, 30 min; IW1: 4 min 4 s, 8 min 8 s, 12 min 12 s, 16 min 16 s, 20 min 20 s, 24 min 24 s; IW2: 4 min 23 s, 8 min 46 s, 13 min 9 s, 17 min 32 s, 21 min 55 s, 26 min 18 s). Exercising $\dot{V}O_2$ was calculated as $\dot{V}O_2$ during walking minus $\dot{V}O_2$ at baseline. Post exercise $\dot{V}O_2$, RQ, and HR were measured and averaged every 5 min and enjoyment and overall RPE (How hard did you work during the previous exercise session?) were measured during the initial 5 min of a 20-min supine rest period [26]. Accumulated exercising $\dot{V}O_2$ and EPOC were calculated as the area under the $\dot{V}O_2$ curve via the trapezium rule by adding the areas under the graph between each pair of consecutive observations [20]. Utilizing RQ, total-, fat- and carbohydrate-accumulated caloric expenditure, and relative substrate contributions were calculated [11].

2.4. Statistical Analyses

Repeated measures analysis of variance (ANOVA) was used to test for mean differences between experimental treatments in baseline $\dot{V}O_2$, RQ, HR, and exercise enjoyment; $\dot{V}O_2$ accumulated during and post-exercise; caloric expenditure; and HR, RPE, and enjoyment during and post-exercise. Five-min cumulative EPOC values were analyzed between treatments using a two-way repeated measures ANOVA (treatment \times time). Bonferroni post-hoc comparisons were used, when applicable, to determine individual differences between treatments. All data were analyzed using SPSS v. 22 (Statistical Package for the Social Sciences; Armonk, NY) and $\alpha = 0.05$ was used for all hypothesis tests.

3. Results

The physical characteristics of the study participants ($n = 10$) are displayed in Table 1. For each exercise protocol, participant mean baseline physiological and psychological values are illustrated in Table 2. Participants began the exercise protocols in similar resting states as evidenced by similar baseline $\dot{V}O_2$, HR, RQ, and exercise enjoyment values.

Table 1. Descriptive characteristics of participants (men: $n = 6$; women: $n = 4$)

Variable	Mean \pm SD
Age (y)	24 \pm 5
Height (cm)	171.0 \pm 6.9
Body mass (kg)	77.3 \pm 21.8
Waist circumference (cm)	78.1 \pm 12.2
Hip circumference (cm)	99.3 \pm 12.0
% body fat	13.0 \pm 8.3

Table 2. Mean \pm SD baseline values for exercise trials ($n = 10$)

Variable	CW	IW1	IW2
$\dot{V}O_2$ (mL min^{-1})	222.2 \pm 17.0	218.8 \pm 14.0	219.0 \pm 18.0
$\dot{V}O_2$ (mL kg^{-1} min^{-1})	2.9 \pm 0.1	2.9 \pm 0.2	2.9 \pm 0.2
HR (beats min^{-1})	63.0 \pm 3.0	66.0 \pm 3.0	63.0 \pm 2.0
RQ	0.85 \pm 0.01	0.88 \pm 0.01	0.85 \pm 0.02
Exercise enjoyment	5.0 \pm 0.3	5.0 \pm 0.3	5.0 \pm 0.2

$\dot{V}O_2$ = oxygen uptake; HR = heart rate; RQ = respiratory quotient. There were no differences among treatments ($p > 0.05$) for any variables.

Table 3. Mean \pm SD bioenergetic outcome measures during exercise ($n=10$)

Variable	CW	IW1	IW2
RQ	0.86 \pm 0.01	0.87 \pm 0.01	0.85 \pm 0.01
% Fat	46.3 \pm 3.9	43.0 \pm 3.5	50.3 \pm 4.2
% Carbohydrate	53.8 \pm 0.3	57.0 \pm 3.5	49.7 \pm 4.2
Total kcal min^{-1}	4.0 \pm 0.4	5.3 \pm 0.5*	5.2 \pm 0.5*
Fat kcal min^{-1}	1.8 \pm 0.2	2.3 \pm 0.3*	2.7 \pm 0.4*
Carbohydrate kcal min^{-1}	2.2 \pm 0.2	3.1 \pm 0.4*	2.6 \pm 0.3

CW = continuous walking; IW1 = interval walking protocol 1; IW2 = interval walking protocol 2; RQ = respiratory quotient, averaged over the entire exercise period. *, Significantly different from the continuous walking protocol ($p < 0.05$).

Table 4. Mean \pm SD bioenergetic outcome measures post-exercise ($n=10$)

Variable	CW	IW1	IW2
RQ	0.92 \pm 0.01	0.95 \pm 0.02	0.99 \pm 0.08
% Fat	23.9 \pm 4.3	19.6 \pm 4.5	30.3 \pm 4.5
% Carbohydrate	76.0 \pm 4.3	80.9 \pm 4.5	69.7 \pm 4.5
Total kcal min^{-1}	0.22 \pm 0.02	0.32 \pm 0.03*	0.29 \pm 0.04
Fat kcal min^{-1}	0.05 \pm 0.01	0.06 \pm 0.02	0.09 \pm 0.03
Carbohydrate kcal min^{-1}	0.17 \pm 0.02	0.26 \pm 0.03*	0.20 \pm 0.02

CW = continuous walking; IW1 = interval walking protocol 1; IW2 = interval walking protocol 2; RQ = respiratory quotient, averaged over the entire post-exercise period. *, Significantly different from the continuous walking protocol ($p < 0.05$).

The various walking protocols did result in differences in bioenergetics markers during and after exercise ($p < 0.05$) (Table 3 and Table 4). Lower total- and fat-caloric expenditures per minute were produced by continuous walking (4.0 \pm 0.4 kcal min^{-1} ; 1.8 \pm 0.2 kcal min^{-1}) than IW1 (5.3 \pm 0.5 kcal min^{-1} ; $p < 0.001$; 2.3 \pm 0.3 kcal min^{-1} ; $p = 0.01$) and IW2 (5.2 \pm 0.5 kcal min^{-1} ; $p < 0.001$ 2.7 \pm 0.4 kcal min^{-1} ; $p = 0.04$) during exercise. IW1 amassed higher carbohydrate-caloric expenditure per minute during (3.1 \pm 0.4 kcal min^{-1}) and following (0.26 \pm 0.03 kcal min^{-1}) exercise compared to continuous walking (2.2 \pm 0.2 kcal min^{-1} ; $p = 0.04$) (0.17 \pm 0.02 kcal min^{-1} ; $p = 0.02$). Additionally, following exercise, IW1 elicited higher total-caloric expenditure per minute (0.32 \pm 0.03 kcal min^{-1}) than continuous walking (0.22 \pm 0.02 kcal min^{-1} ; $p = 0.04$); IW2 was similar to the other protocols (0.29 \pm 0.04 kcal min^{-1}). Fat-expenditure per minute did not differ among the protocols after exercise ($p > 0.05$).

The interval walking protocols (IW1: 136.3 \pm 13.5 kcal; IW2: 143.2 \pm 14.0 kcal) elicited higher cumulative total-accumulated caloric expenditures (exercise + 20-min EPOC) than the continuous walking protocol (124.0 \pm 12.0 kcal) (IW1: $p < 0.001$; IW2: $p = 0.002$) (Figure 2). IW1 and IW2 produced similar accumulated caloric expenditures ($p = 0.09$). Cumulative fat-accumulated caloric energy expenditure differed between protocols ($p = 0.03$), with IW2 (71.6 \pm 9.7 kcal) producing higher cumulative fat-accumulated caloric expenditure than IW1 (56.8 \pm 6.5 kcal; $p < 0.05$). Continuous walking's cumulative fat-accumulated caloric expenditure (57.1 \pm 7.6 kcal) was similar to the other protocols (both $p > 0.05$). Additionally, the various walking protocols did not result in differences in cumulative carbohydrate-accumulated caloric expenditure (CW: 67.7 \pm 7.7 kcal; IW1: 79.5 \pm 9.3 kcal; IW2: 71.6 \pm 7.7 kcal; $p = 0.06$).

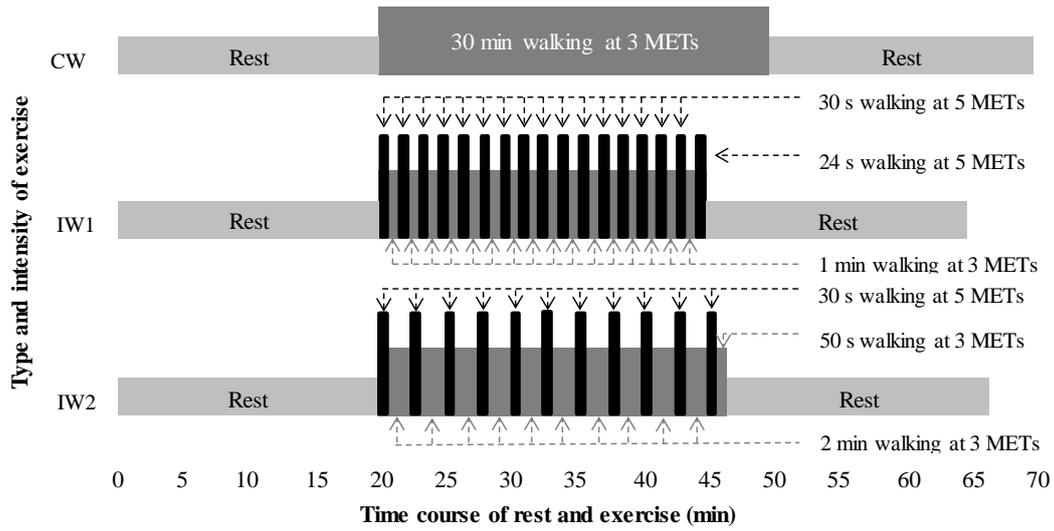


Figure 1. Overview of walking protocols. CW = continuous walking; IW1 = interval walking protocol 1; and IW2 = interval walking protocol 2

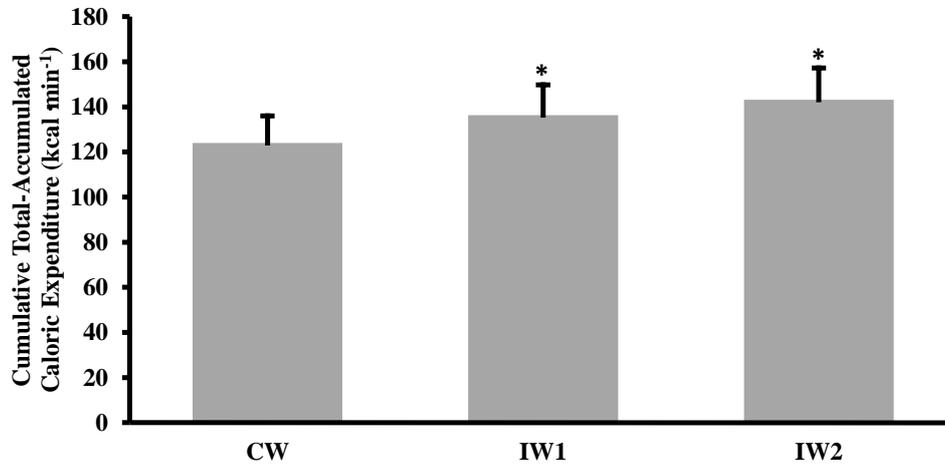


Figure 2. Mean \pm SD cumulative total-accumulated caloric expenditure values during exercise for continuous and interval walking protocols (n=10). CW = continuous walking; IW1 = interval walking protocol 1; and IW2 = interval walking protocol 2. * Significantly different from CW (IW1: $p < 0.001$; IW2: $p = 0.002$)

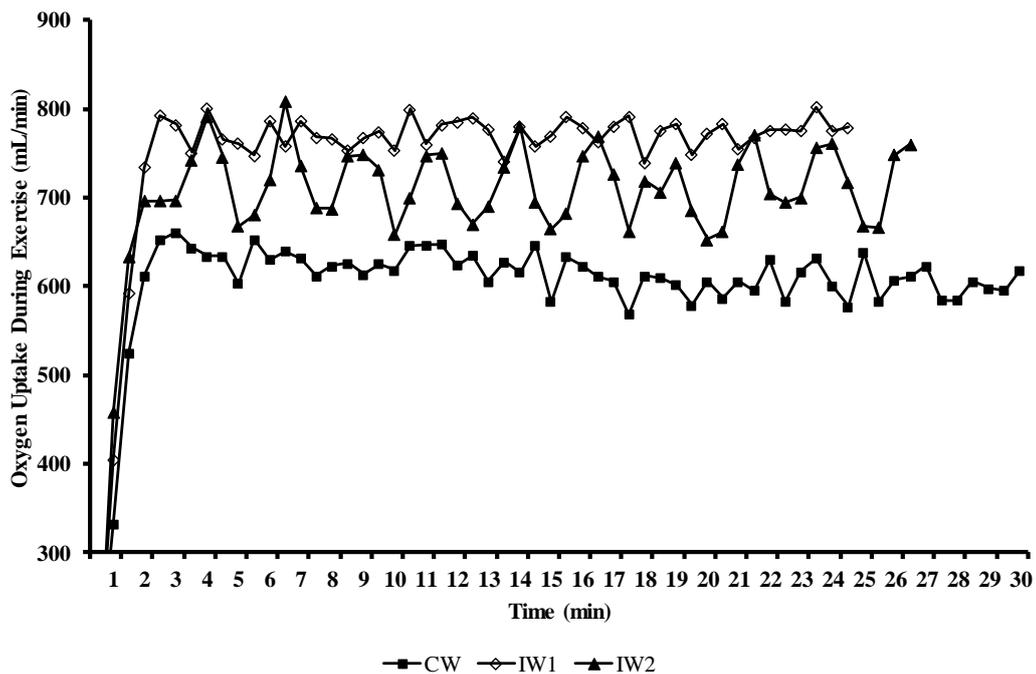


Figure 3. Oxygen uptake (mL/min) during exercise for continuous and interval walking protocols (n=10). CW = continuous walking; IW1 = interval walking protocol 1; and IW2 = interval walking protocol 2

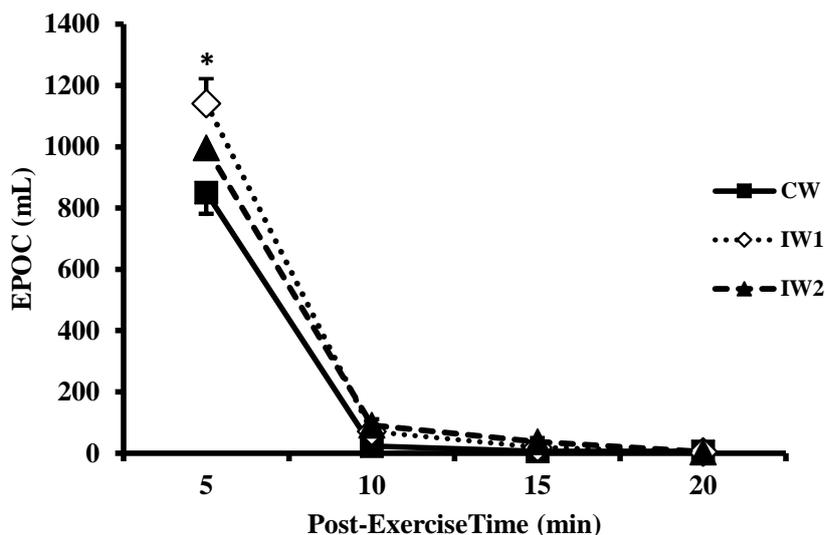


Figure 4. Mean \pm SD cumulative 5-min EPOC values during the 20-min recovery period following continuous and interval walking equivalent to 90 MET-min ($n=10$). CW = continuous walking; IW1 = interval walking protocol 1; and IW2 = interval walking protocol 2. * Significantly different from CW ($p = 0.04$)

During-exercise oxygen uptakes (mL min^{-1}) for each exercise protocol are shown in Figure 3. Accumulated O_2 above baseline uptake during IW2 ($28,232 \pm 2,782$ mL) was higher than both continuous walking ($24,500 \pm 2,427$ mL; $p = 0.001$) and IW1 ($26,561 \pm 2,685$ mL; $p = 0.03$). Similarly, accumulated O_2 uptake above baseline was higher during IW1 than continuous walking ($p = 0.001$).

IW1 resulted in higher accumulated 20-min EPOC than continuous walking ($1,268 \pm 117$ mL vs. 892 ± 73 mL; $p < 0.05$), but EPOC after IW2 ($1,174 \pm 178$ mL) was not different than the other protocols.

Figure 4 shows the EPOC following each exercise bout. IW1 elicited a higher EPOC in the first 5 min relative to continuous walking ($p = 0.04$), but it was not different from IW2. After the first 5 minutes, EPOC for all treatments declined rapidly, reaching near baseline $\dot{V}\text{O}_2$ at 10 min post exercise.

Average HR during IW1 was higher than that observed during continuous walking (108 ± 3 vs. 103 ± 3 beats min^{-1} , respectively; $p = 0.02$), but HR during IW2 (103 ± 2 beats min^{-1}) was not different from the other treatments (both $p > 0.05$). Although average HR during IW1 was higher than during continuous walking, this did not translate into a higher average RPE during exercise (9 ± 1 vs. 8 ± 1 for IW1 and continuous walking, respectively; $p = 0.77$) or during exercise enjoyment (5 ± 0.3 vs. 5 ± 0.3 ; $p = 1.0$), nor was average RPE and exercise enjoyment different than either of the other treatments during IW2 (RPE: 8 ± 1 ; $p = 0.77$; exercise enjoyment: 5.0 ± 0.3 ; $p = 0.34$). Additionally, despite the higher average HR during IW1, RPE and exercise enjoyment were not different after the first 5 min of the 20-min post-exercise period (RPE: continuous walking: 9 ± 1 ; IW1: 9 ± 1 ; IW2: 9 ± 1 ; $p = 0.50$; exercise enjoyment: continuous walking: 5 ± 0.3 ; IW1: 5 ± 0.4 ; IW2: 5 ± 0.3 ; $p = 0.50$).

4. Discussion

This is the first study investigating both metabolic and enjoyment responses of continuous and interval walking

of similar volume before, during, and following exercise. In support of our hypothesis, the primary findings were that the interval walking protocols—despite being comprised of shorter durations than continuous walking (IW1: 19% shorter duration; IW2: 11% shorter duration)—resulted in greater accumulated O_2 uptake during exercise (IW1: 8%; IW2: 13%) and greater EPOC (IW1: 30%; IW2: 24%). It should be noted that though the differences among walking protocols were statistically significant, they were small. However, it is also important to note that small differences, when repeated often, can accumulate into substantial total differences over time.

Interestingly, the more intense, moderate intensity interval walking protocols produced similar exercise enjoyment and RPE as continuous walking. These findings are similar to a previous field experiment conducted by our laboratory (unpublished observations) that investigated the self-reported enjoyment responses of 3 self-selected intensity walking protocols [1 continuous walking protocol at a low-moderate intensity (RPE-12) and 2 interval walking protocols with work bouts set at 30s high-moderate (RPE-13): 60 s low-moderate and 30s high-moderate: 120s low-moderate intensities] of constant duration (20 min) in adult females. As with the current findings, we found no enjoyment or RPE differences between the continuous and interval walking protocols.

Previous affect research has found high intensity interval training to produce negative feeling responses in comparison to continuous training during and after exercise [28]. Conversely, greater positive affect is evident after acute bouts of moderate intensity exercise [33,36]. Since the highest intensity used during the intervals in the present study was only moderate, it may explain why the interval protocols resulted in similar enjoyment ratings as the continuous exercise that was performed at a lower intensity. In addition, similar enjoyment among treatments could be attributed to the fact that participants were healthy and of similar physical fitness levels. This notion could explain why even though exercise intensity was moderate, perceived exertion was equivalent to what is considered a very light intensity (RPE ≤ 9) [3].

Similar to previous high intensity interval training exercise ratios (30 s) [16,38], our interval walking protocols elicited greater $\dot{V}O_2$ [22] than continuous exercise. EPOCs following 30 s of high-moderate intensity work bouts of walking could account for the higher accumulated $\dot{V}O_2$ during the exercise portion of the interval walking protocols. It was unexpected that lowering the work-to-rest ratio from 1:2 (IW1: 30 s/60 s) to 1:4 (IW2: 30 s/120 s) would elicit significantly greater energy expenditure, where the duration (and number) of 5-MET exercise bouts was 35% lower than IW1 of the same work volume. Since exercise HR was similar between interval protocols, the 7% longer total duration associated with IW2 likely contributed to the increased $\dot{V}O_2$.

EPOC is comprised of rapid and slow components. These results support the notion that exercise intensity may be of more importance than duration in terms of influencing EPOC [7]. It may be that higher EPOC following interval walking was because of greater disturbance to homeostasis; thus, during the rapid component of EPOC, greater restoration of both phosphocreatine and oxygen stores in the muscle was necessary. Similarly, elevated levels of epinephrine or norepinephrine following interval walking may account for the greater EPOC. In contrast to the fast component, there was little slow-component of EPOC in any of the treatments as evidenced by a rapid decline in $\dot{V}O_2$ to near baseline following the initial 5 min post-exercise period.

The interval protocols elicited 9% (IW1) and 13% (IW2) greater cumulative total-accumulated caloric expenditures than continuous walking. Additionally, per minute, total-accumulated caloric expenditure was greater during the interval walking protocols than continuous walking and may be more effective in expending calories when time available for physical activity is limited. Moreover, cumulative fat-accumulated caloric expenditure during IW2 was similar to continuous walking and 20% greater than IW1. This finding is comparable to those who have noted greater fat oxidation following interval exercises of high intensities (Chan and Burns 2013). Although IW2 was of greater duration than IW1, it was less intense and may be a more suitable form of interval walking for fat oxidation in sedentary adults.

Walking is the most commonly preferred form of physical activity of adults that meet the physical activity guidelines [32]. The moderate intensity interval walking protocols resulted in similar enjoyment and RPE as the longer duration continuous walking, so it is just as well tolerated and thereby may result in greater adherence. Furthermore, higher exercising $\dot{V}O_2$ and EPOC associated with interval walking in the present study provide rationale for prescribing its use as a suitable substitute for conventional continuous walking.

5. Conclusion

In summary, findings from this study demonstrate that interval walking of various moderate intensities significantly elevates $\dot{V}O_2$ during and after exercise compared to continuous walking of the same work volume. The ideal dose of exercise and active recovery for lower intensity interval walking has not been clearly established. Therefore,

further research should determine if moderate-intensity interval walking of various work-to-rest ratios have similar effects in sedentary and/or obese adults who cannot attain high levels of exercise intensity using traditional interval training in both laboratory as well as in field settings. Practitioners may find the results especially relevant for clinical populations for whom walking exercise is prescribed and who desire increased caloric expenditure despite a small time committable to exercise.

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