The effects of 60 minutes of brisk walking per week, accumulated in two different patterns, on cardiovascular risk

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Abstract

Background. Current ACSM guidelines recommend that adults should exercise for 20–60 min on 3–5 days · week^{-1} (M.L. Pollock, et al., The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Medicine and Science in Sports and Exercise, 30 (6) (1998) 975–991.). For individuals constrained by a busy lifestyle, an exercise prescription that delivers benefits with the minimum investment of time is attractive. The purpose of the present study, therefore, was to examine the effect of instructing sedentary individuals to undertake 20 min of brisk walking, in two different patterns, 3 days per week, on fitness and other cardiovascular disease (CVD) risk factors.

Methods. Forty-eight subjects (31 women) mean ($\pm$SD) age 45.7 $\pm$ 9.4 year were randomly assigned to either one 20-min walk (single bout), two 10-min walks (accumulated bouts) 3 days week^{-1} for 12-week, or no training (control). Oxygen consumption (VO_2), heart rate (HR), and ratings of perceived exertion (RPE) were measured during a 4-stage treadmill test at pre- and post-intervention. Body composition, resting blood pressure and fasting lipoproteins were also assessed. Thirty-two subjects completed the study.

Results. There was a significant difference between single-bout and accumulated-bout walkers in the reduction of HR at stages 2 and 3 of the treadmill test from pre- to post-intervention ($P < 0.05$). There were no differences between groups for changes in VO_2 or RPE from pre- to post-intervention. There were also no changes in body mass, adiposity, blood pressure, waist and hip circumferences, or lipid/lipoproteins.

Conclusion. Brisk walking for 20 min on 3 days of the week fails to alter cardiovascular disease risk factors in previously sedentary adults.

Keywords: Cardiovascular risk; Walking; Exercise; Intermittent; Continuous; Aerobic fitness; Health

Introduction

Walking is the most commonly reported activity in Europe [2]. It requires no special skills or facilities and is achievable by virtually all groups with little injury risk [3]. The favourable effects of walking on both physiological and psychological well being are firmly established [4–7]. As walking is a 'lifestyle' activity it may more easily circumvent frequently cited barriers to exercise, such as lack of time and the belief that one is 'not the sporty type' [8], than other forms of exercise. Indeed, walking has been described as the nearest activity to perfect exercise [4].

Recent recommendations suggest that adults should exercise in a continuous or intermittent fashion (minimum of 10-min bouts) for 20–60 min, 3–5 days per week at 55–90% of maximum heart rate [1]. Much research concerning walking interventions has assessed the effects of training typically 4 or 5 days per week for 30–60 min [7,9–17]. However, to the authors' knowledge, only one study has examined the efficacy of walking at the minimum ACSM

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recommendations, that is, 20 min on 3 days of the week [18]. Given that 'lack of time' is major barrier to exercise [19], an exercise prescription that delivers benefits with minimum time investment is attractive. The delineation of a minimum exercise prescription might also be helpful in motivating individuals to adopt a healthier lifestyle [20].

While Probart et al. [18] reported fitness improvements following 20 min walking 3 days $\cdot$ week^{-1}, their study specifically focussed on women aged 70 years and older. The effects of this walking prescription on aerobic fitness and other markers of cardiovascular risk for young and middle-aged men and women remain to be established. Furthermore, no study has examined whether this minimal walking dose is effective when accumulated in repeated short bouts.

The purpose of the present study, therefore, was to evaluate the effectiveness of instructing sedentary individuals to undertake 20-min brisk walking (in one continuous bout or two 10-min bouts) 3 days per week, on fitness and other cardiovascular disease (CVD) risk factors in previously sedentary adults.

Methods

Subjects

Subjects were staff or students at the University of Ulster, recruited through email, flyers, and posters. Exclusion criteria were: history of cardiovascular or metabolic disease, resting blood pressure (BP) > 140/90 mm Hg, body mass index (BMI) > 30 kg m^{-2}, musculoskeletal condition or injury, taking medications known to interfere with lipid metabolism, or a physically active lifestyle. Being physically active was defined as engaging in more than 20 min of planned exercise per week during the preceding 4-week period. Forty-eight subjects (31 women) mean (±SD) age 45.7 (±9.4) year were randomised on a two to one basis between training and control groups, to either one 20-min walk on 3 days of the week (single bouts; n = 19, 12 women), two 10-min walks on 3 days of the week (accumulated bouts; n = 18, 11 women) or no training (controls; n = 11, 8 women). All subjects gave their written informed consent. The research ethics committee at Queen's University of Belfast approved the study.

Anthropometry

Height and body mass were measured using a stadiometer and scales (Seca model 707; Vodel and Halke; Hambury, Germany), respectively. BMI was calculated by dividing body mass (kg) by height (m^2). Body fat was assessed using bioelectrical impedance analysis (Bodystat 1500. Bodystat Ltd.; Isle of Man, UK) according to standard instructions [21]. Waist and hip measurements were made in compliance with standard procedures [22].

Blood pressure

Resting blood pressure (BP) was recorded as the mean of duplicate measurements, taken at least 2 min apart, using a validated automated device (Omron 705CP; Omron Matsusaka Co. Ltd., Japan) after the subject had rested in a supine position for 5 min.

Treadmill test

In order to assess the physiological response to submaximal exercise, an identical treadmill test was conducted at pre- and post-intervention. Subjects walked on a motorised treadmill (HP Cosmos Pulsar; Nussdorf, Germany) at a suitable speed determined beforehand in a habituation session. Subjects walked for 4 min at each of four gradients selected to elicit 40%, 50%, 60% and 70% of maximum heart rate (HR) reserve (percentage of the difference between resting and maximum HR added to resting HR) at baseline. They were encouraged to complete all four stages but the test was stopped if HR reached 85% of age predicted (220 age) maximum. Respiratory gases were measured using a gas analysis system (Quinton Metabolic Cart; Seattle, USA). The mean VO_2 of the 16-min test was computed. HR was measured by short-range telemetry (Accurex Plus, Polar Electro; Kempele, Finland). The mean HR during the last minute of each gradient was subsequently determined. Ratings of Perceived Exertion (RPE) using the Borg 15-grade scale [23] were obtained during the last minute of each stage and averaged. Recommended instructions for using the RPE scale were read to each subject prior to all treadmill tests [21].

Blood sampling procedures

Following a 10-h fast, a 10-ml blood sample was taken by venepuncture with the subject in a seated position. Subjects were instructed to avoid strenuous physical activity on the previous day. Blood samples were collected in serum tubes, allowed to clot for 1 h, then separated and stored at −20°C. All samples were analysed in the same batch at the Institute of Clinical Science at Queen's University Belfast. Whole blood was analysed immediately upon collection for haemoglobin and haematocrit to monitor changes in plasma volume [24]. Female subjects were asked to complete a menstrual phase diary to ensure that baseline and post-training blood samples were taken at the same phase of the menstrual cycle. Samples were taken prior to the treadmill tests, and all post-training blood samples were taken on day 3 after the last walking session.

Analytical procedures

Total cholesterol, HDL cholesterol and triglycerides were measured by enzyme assay (Sigma Diagnostics; Dorset, UK) using a Cobas FARA bioanalyser (Roche Products Ltd, Herts, UK). The concentration of LDL cholesterol was calculated using the Friedewald formula [25].

Brisk walking programmes

Participants were instructed to 'walk briskly' throughout the 12-week walking programme and were permitted to use the treadmills at the university free of charge. Subjects were advised to perform all walking bouts on treadmills. Walkers recorded the duration, speed, distance and RPE of all walks in a training diary. During one session each week walking was supervised and HR and walking speed monitored continuously. Subjects were instructed maintain their usual dietary habits throughout the study.

Statistical analysis

Physiological data and treadmill test responses were analysed using a two-way ANOVA with repeated measures, one factor between subjects (single-bout vs. accumulated-bout vs. control) and the second factor within subjects (pre- vs. post-intervention). As all possible comparisons between groups were planned, the multiple comparison problem was ignored and Fisher's Least-Significant Differences (LSD) post hoc [26] tests were used to identify significant differences in responses between groups Independent *t* tests were used to compare group differences in walking programme characteristics and compliance. Statistical significance was established at $P < 0.05$.

Results

Fourteen subjects dropped out of the study due to: time pressures with work/study (2 single-bout walkers, 3 accumulated-bout walkers); personal circumstances (1 single-bout walker, 2 accumulated-bout walkers, 1 control); lack of interest (1 accumulated-bout walker); starting medication (1 accumulated-bout walker); moving job (1 accumulated-bout walker); and starting a personal exercise programme (2 control). Because the study sought to examine the physiological effects of the exercise prescription, as opposed to whether the prescription was behaviourally/ecologically valid, the intention-to-treat principle was not employed. Compliance was defined as completing at least 60% of prescribed sessions [7] and, as a result, two subjects were excluded (1 single-bout walker, 1 accumulated-bout walker). Data are therefore presented for 32 subjects (17 women) who completed the study. Subjects completed 90.4 (±10.6)% of the single bouts (range 76.4–97.3) and 82.1 (+10.0)% of the accumulated bouts (range 67.6–100) prescribed.

Changes in HR from pre- to post-intervention are shown in Fig. 1. For two of subjects (1 single-bout walker, 1 accumulated-bout walker), heart rate data from the post-intervention treadmill test were unavailable so data are presented for 30 subjects. There was a significant Time × Group interaction for changes in HR at stages 2 and 3 of the treadmill test ($P < 0.05$). Furthermore, post hoc tests revealed a significantly greater reduction in HR in single-bout walkers than accumulated-bout walkers at stages 2 and 3 of the treadmill test ($P < 0.05$). The effects of training upon VO_2 and RPE responses to fixed submaximal exercise are shown in Table 1. There was a significant Time × Group interaction for changes RPE from pre- to post-intervention ($P < 0.05$). The RPE of single- and accumulated-bout walkers decreased from 12.7 to 10.8 and 13.4 to 11.9, respectively, whereas the control group increased from 12.4 to 12.8.

Table 2 shows the physiological characteristics and lipid and lipoprotein variables of the subjects at pre- and post-intervention. There were no significant changes in body mass, body fat, waist and hip circumferences, blood pressure, total cholesterol, triglycerides (TG), HDL or LDL cholesterol in single-bout walkers, accumulated-bout walkers or controls.

Exercise intensity, walking speed, and RPE for both walking programmes are shown in Table 3. There were no significant differences between the two walking groups for any of these programme characteristics.

Discussion

The novel aspect of the present investigation is that it is the first to examine the effect of 20 min brisk walking, 3 days per week, for 12 weeks, on cardiovascular risk in men and women <60 years. Additionally, it is the first to examine the efficacy of this walking dose when accrued in an accumulated manner. However, it appears that this exercise prescription is insufficient to evoke improvements in cardiovascular risk in previously sedentary adults.

Using a similar exercise prescription to the present study, it has previously been shown that 22 min of cycling 3 days per week at 75% HR_{max} increased aerobic capacity by $8.7\ ml \cdot kg^{-1}\ min^{-1}$ [27]. Also, 30 min of running 3 days per week at 85–90% HR_{max} increased aerobic capacity by $5.8\ ml \cdot kg^{-1} \cdot min^{-1}$ [28]. In light of this information, it is possible that greater intensities than those employed in the present study are required to enhance fitness parameters when exercising for 20 min, 3 $days \cdot week^{-1}$. Possibly walking up an incline would increase the intensity sufficiently to elicit a greater training effect. However, there is limited scope for uphill walking to be integrated into 'lifestyle' activity. Consequently, while there is evidence to suggest it is possible to attain significant improvements in fitness with a minimal investment in time, advocating 20 min of brisk walking on 3 days per week may not be sufficient.

There was a significantly greater reduction in HR from pre- to post-intervention in single-bout walkers than in accumulated-bout walkers at stages 2 and 3 of the treadmill test. The finding is supported by the greater reduction in oxygen uptake during the submaximal test in single-bout

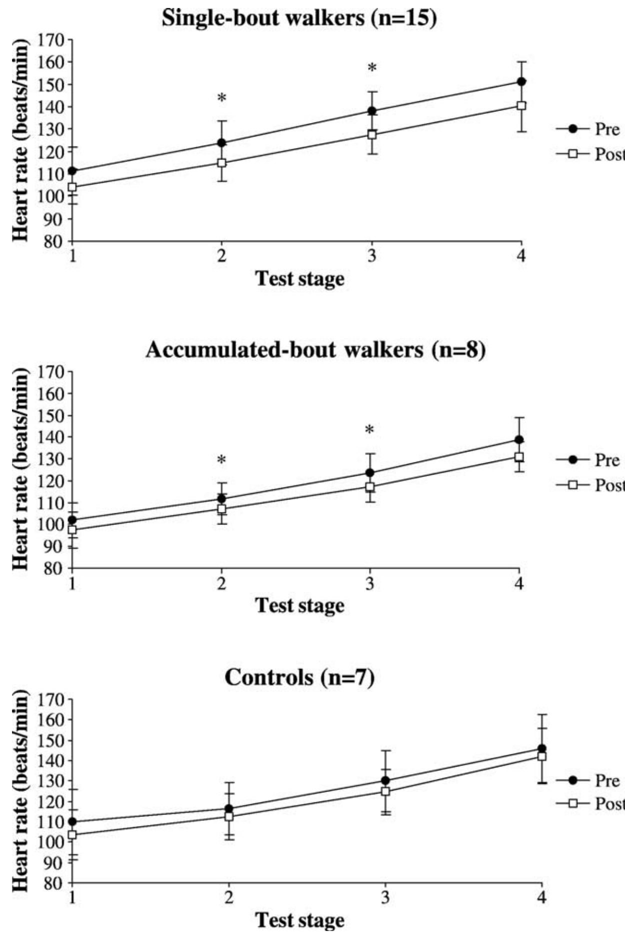

Fig. 1. Heart rate response to treadmill test at pre- and post-intervention. Values are mean ± SD. * Significant difference between single-bout and accumulated-bout walkers in reduction in HR at stage 2 and 3 from pre- to post-intervention ($P < 0.05$).

walkers than in accumulated-bout walkers, although the difference was not significant. Thus, a somewhat increased mechanical efficiency in the single-bout walkers may explain a minor part of the heart rate decrease after training [29]. Together, these results imply that the single-bout walkers experienced a greater effect on aerobic fitness than the accumulated-bout walkers. However, these findings are merely suggestive and merit further investigation.

Table 1
Oxygen consumption (VO_2) ratings of perceived exertion (RPE) during the submaximal treadmill test

	Pre	Post
Mean $VO_2 (ml \cdot kg^{-1} \cdot min^{-1})$		
Single-bout	19.3 (3.6)	17.8 (2.9)
Accumulated-bout	17.6 (2.2)	16.6 (1.9)
Control	19.6 (2.4)	19.2 (2.8)
Mean RPE		
Single-bout	12.7 (1.8)	10.8 (2.0)*
Accumulated-bout	13.4 (1.2)	11.9 (1.5)*
Control	12.4 (0.9)	12.8 (0.9)*

Mean (SD).
* Significant Group × Time interaction ($P < 0.01$).

There were no significant changes in TG, total, HDL, or LDL cholesterol in the present study. These results are in agreement with other intervention studies that have failed to evoke favourable changes in lipid parameters. A quantitative analysis of blood lipid adaptations to exercise revealed that the threshold for adaptations occur at training volumes of 1200 to 2200 kcal/week [30]. It is likely that the energy cost of the walking sessions in the present study was approximately 370 kcal per week [31] and therefore unlikely to alter lipid profiles. Additionally, the lack of change in body weight or body fat in both our walking groups may have contributed to the failure to evoke favourable changes in HDL-C [32].

The lack of body mass change is also consistent with other walking studies using normal weight subjects [9,32–34]. During the 12-week programme, it is estimated that subjects expended approximately 4464 kcal while walking [31], and therefore, theoretically should have incurred a weight loss of approximately 0.6 kg [21]. A compensatory increase in food intake in response to increased energy expenditure during walking sessions [35], or a reduction in leisure-time activity has been proposed as a reason for this [32]. Additionally, the walking programme included the

Table 2
Effects of training on body composition, blood pressure, lipid and lipoprotein concentrations

	Single-bout		Accumulated-bout		Control	
	Pre	Post	Pre	Post	Pre	Post
Body mass (kg)	74.2 (14.3)	74.4 (14.4)	74.6 (12.0)	75.2 (11.7)	70.8 (9.8)	71.9 (9.7)
Body fat (%)	26.9 (7.6)	26.6 (7.8)	28.0 (5.9)	29.4 (4.9)	28.5 (7.3)	28.9 (7.0)
Waist girth (cm)	84.3 (12.3)	84.0 (12.5)	90.7 (10.4)	90.1 (9.6)	84.1 (9.3)	83.7 (9.3)
Hip girth (cm)	100.9 (7.5)	102.5 (7.5)	102.3 (5.7)	103.7 (5.5)	101.6 (3.4)	101.8 (2.7)
SBP (mm Hg)	117.9 (12.0)	118.6 (11.1)	121.7 (11.2)	117.2 (11.0)	117.5 (18.1)	114.3 (17.2)
DBP (mm Hg)	74.0 (9.8)	73.8 (7.7)	75.4 (6.6)	72.6 (6.7)	73.1 (10.6)	69.6 (10.9)
Total Chol ($mmol \cdot l^{-1}$)	5.4 (0.9)	5.8 (1.2)	5.8 (1.0)	5.8 (0.8)	5.8 (1.2)	5.0 (0.5)
TG ($mmol \cdot l^{-1}$)	1.1 (0.7)	1.2 (0.6)	1.1 (0.5)	1.2 (0.4)	1.1 (0.6)	1.0 (0.3)
HDL ($mmol \cdot l^{-1}$)	1.2 (0.4)	1.5 (0.6)	1.3 (0.4)	1.4 (0.6)	1.6 (0.6)	1.4 (0.5)
LDL ($mmol \cdot l^{-1}$)	3.7 (0.9)	3.8 (1.0)	4.0 (1.1)	3.8 (1.0)	3.7 (1.1)	3.1 (0.5)

Mean (SD).

Christmas holiday period when individuals traditionally gain weight [36,37]. It may therefore be of individual significance that the body mass of those in the single and accumulated-bout groups increased by only 0.2 and 0.6 kg, respectively, compared to a 1.1-kg increase in the control group. It has been suggested that physical activity plays more of a role in preventing significant weight gain, rather than in promoting weight loss [38]. However, as energy intake was not recorded in the present study these explanations are merely speculative.

No significant changes were recorded in BP, in agreement with results of studies employing greater walking volumes [9,13]. As the subjects in the present study were normotensive at baseline it was unlikely that significant decreases in BP would occur. In walking studies which have used individuals with BP <129/84 mm Hg, the majority have reported non-significant changes in systolic BP or diastolic BP [7,9,10,13,34,39–41]. Exercise training generally results in BP lowering following exercise which is greater in hypertensive patients than in normotensive subjects [42].

Adherence to the walking prescription was high, with subjects completing 90.4% (10.6) and 82.1% (10.0) of sessions in the single- and accumulated-bout groups, respectively. A point of note, however, is that 44% of the accumulated-bout walkers dropped out of the study compared with only 16% of the single-bout walkers. This is not to suggest that accumulating short bouts of physical activity may be less convenient than previously postulated [7,13,43,44]. For the present study, it was a requisite that all walking sessions be performed on a treadmill. It is thus possible that time pressure to gain access to the available treadmills deterred subjects from completing the programme, particularly for the accumulated-bout walkers for whom twice as many visits were required. The authors accept that walking on a treadmill does not comply with the notion of 'lifestyle' activity. However, as the exercise prescription in the present study was much less than previously investigated, it was felt that detailed description of the training sessions and confirmation of exercise intensity was necessary. Treadmill walking and weekly supervision within the controlled laboratory environment facilitated this.

Table 3
Characteristics of the walking programmes

	Single-bout	Accumulated-bout
Intensity (% HR_{max})	73.1 (8.7)	72.1 (7.7)
RPE	12.3 (0.8)	12.4 (1.4)
Speed ($m \cdot s^{-1}$)	1.8 (0.3)	1.8 (0.2)

Mean (SD).

The present study has several strengths. When obtaining blood samples, menstrual cycle phase, plasma volume shifts and the effect of the last exercise bout were controlled for. One session per week was supervised, therefore exercise duration and intensity were regularly recorded. As all sessions were performed on treadmills, there was direct measurement of walking speed throughout the training programme. Lastly, adherence to the walking programmes was high.

There are some limitations worthy of comment. The drop out rate was high (37%) and weakens the power of the study. The impact that the compulsory use of treadmills may have had on attrition rates has been discussed earlier. It is recommended that this exercise prescription be repeated in free-living conditions for longer duration and with greater subject numbers, so that both attrition rates and physiologic effects can be elucidated further.

In conclusion, the results of this study suggest that brisk walking for one continuous 20 min bout or two 10 min bouts, on 3 days per week for 12 weeks, fails to improve cardiovascular risk in previously sedentary adults. In pursuit of the minimum exercise prescription to improve cardiovascular risk, research should focus on brisk walking programmes of greater total duration than 60 min per week.

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