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Training effects of short and long bouts of brisk walking in sedentary women

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ABSTRACT TOP

This study compared the effects of short and long bouts of brisk walking in sedentary women. Forty seven women aged 44.4 ± 6.2 yr (mean ± SD) were randomly assigned to either three 10-min walks per day (short bouts), one 30-min walk per day (long bouts) or no training (control). Brisk walking was done on 5 $d\cdot wk^{-1}$, at 70 to 80% of maximal heart rate, typically at speeds between 1.6 and 1.8 $m\cdot s^{-1}$ (3.5 and 4.0 mph), for 10 wk. Subjects agreed not to make changes to their diet. Twelve short-bout walkers, 12 long-bout walkers, and 10 controls completed the study. Relative to controls, $\dot{V}O_{2max}$ (short-bout, +2.3 ± 0.1 $mL\cdot kg^{-1}\cdot min^{-1}$; long-bout, +2.4 ± 0.1 $mL\cdot kg^{-1}\cdot min^{-1}$; controls, -0.5 ± 0.1 $mL\cdot kg^{-1}\cdot min^{-1}$) and the $\dot{V}O_2$ at a blood lactate concentration of 2 $mmol\cdot L^{-1}$ increased in walkers (both $P < 0.05$), with no difference in response between walking groups. Neither heart rate during standard, submaximal exercise nor resting systolic blood pressure changed in a different way in walkers and controls. The sum of four skinfold thicknesses decreased in both walking groups ($P < 0.05$) but body mass (short-bout, -1.7 ± 1.7 kg; long-bout, -0.9± 2.0 kg; controls, +0.6 ± 0.7 kg) and waist circumference decreased significantly only in short-bout walkers. Changes in anthropometric variables did not differ between short- and long-bout walkers. Thus short bouts of brisk walking resulted in similar improvements in fitness and were at least as effective in decreasing body fatness as long bouts of the same total duration.

The notion that frequent short bouts of moderate intensity physical activity are an effective means of acquiring the health benefits of exercise is enshrined in recent recommendations on physical activity and public health(26,28). Although supporting epidemiological evidence is strong, few experimental studies have compared either fitness or health effects of intermittent and continuous patterns of physical activity.

Walking is a popular form of moderate intensity physical activity which has been linked to a variety of health gains. For example, the amount(27) and pace (24) of regular walking have been associated, respectively, with lower risk of all-cause mortality and coronary attack. Moreover, epidemiological study of the relation between physical fitness and mortality suggests that the greatest public health gains might be achieved from improving the level of physical fitness in the least fit people (6). Walking is eminently suited to this purpose. Men and women walking for exercise typically self-select a speed of about 1.8 $m\cdot s^{-1}$ (≈4 mph), eliciting an oxygen uptake of about 5 METs, (31) sufficient to elicit a training effect in low-fit people in middle-age. Indeed, intervention studies have demonstrated the potential of brisk or fast walking to improve fitness in sedentary men and women (12,20). What is not known, however, is whether short bouts of walking taken at intervals throughout the day can have effects on physical fitness that are comparable with those arising from the longer continuous bouts traditionally prescribed.

The two studies most often cited in support of the comparability of the effects of intermittent and continuous exercise bouts are both in men(9,13), but there is a need for information in women, in whom levels of physical activity are particularly low(22,25,26). There is increasing concern for the impact of this inactivity on the health of women; in Northern Ireland, for example, 56% of women carry excess weight (defined as BMI ≥23.9 $kg \cdot m^{-2}$), with the proportion rising sharply in middle age(22); and women's death rates from coronary heart disease are among the highest in the world (21).

As stated above, brisk walking has been widely reported to improve fitness in sedentary women(2,12,16,20,30,32). There are also reports, moreover, of increased plasma high density lipoprotein cholesterol concentration (12,15) and decreases in body mass or fatness (2,29) on taking up this activity. These studies were, however, all based on continuous periods of walking for 20 min or more and so cannot contribute to a rationale for the efficacy of the accumulation of physical activity in intermittent, short bursts (28). The purpose of this study was to test the hypothesis that similar improvements in endurance fitness($\dot{V}O_{2max}$, $\dot{V}O_2$ at a reference blood lactate concentration, and submaximal heart rate) and similar decreases in body fatness (body mass, sum of four skinfolds, and waist circumference) and systolic blood pressure, can be achieved in sedentary women through several short bouts of brisk walking per day as through one longer, continuous bout.

METHODS TOP

Design. This was a 10-wk intervention study. Previously sedentary women were randomly allocated to a brisk walking group or to a control group after baseline tests were completed. The protocol was approved by the Ethical Committee of the University of Ulster and each volunteer gave her written consent after a full explanation of the procedures and risks. Measurements were made at baseline and again 10 wk later by the same experienced observer. After baseline testing, women were allocated to one of three groups, i.e., short-bout walking, long-bout walking, or usual life-style (control). All subjects agreed not to change their diet.

Subjects. Forty seven women aged between 31 and 57 yr were recruited by advertisement from the University of Ulster and the local community. None was employed in manual work and none had engaged in regular physical activity (defined as more than one 20-min bout per week) during the preceding 6 months. Exclusion criteria were: history of cardiovascular disease; resting arterial blood pressure >150 mm Hg systolic or >95 mm Hg diastolic; body mass index ≥ 30 $kg \cdot m^{-2}$; diabetes; musculo-skeletal condition or injury; taking any pharmacotherapeutic drug. Thirteen women dropped out because of illness (one control, one long-bout walker), lack of interest (four controls, one short-bout walkers), or time pressures (three short-bout walkers, three long-bout walkers). Dropouts did not differ with respect to age, BMI, or $\dot{V}O_{2max}$ from subjects who completed the study. Data are presented for the 34 women who completed the study (12 short-bout walkers, 12 long-bout walkers, 10 controls).

Exercise tests. After habituation to treadmill walking, subjects undertook two exercise tests. In the first, $\dot{V}O_{2max}$ was determined during an uphill walking test at a constant speed (range 1.6 to 1.7 $m \cdot s^{-1}$), during which the gradient was increased by 2.5% every 3 min until volitional fatigue. Criteria for attainment of $\dot{V}O_{2max}$ were: peak heart rate within 10 $beat \cdot min^{-1}$ of age-predicted maximal value; rating of perceived exertion 19 or 20 (8); increase in $\dot{V}O_2$ between the last two test stages of less than 5%; and a respiratory exchange ratio ≥1.11. In 62 of 68 maximal tests all four criteria were met; three were met in the other six tests.

In the second exercise test, subjects walked (at the speed employed for their maximal test) for 4 min at each of four gradients selected to elicit 50%, 60%, 70%, and 80% of individual $\dot{V}O_{2max}$. At the end of each stage duplicate fingerprick samples were obtained for measurement of capillary blood lactate concentration. The $\dot{V}O_2$ at a reference blood lactate concentration of 2 mmol·L^{-1} was interpolated for each individual as an additional index of endurance fitness (33).

During both exercise tests, $\dot{V}O_2$ and $\dot{V}CO_2$ were measured using an integrated gas analysis system (Oxycon 4, Mijnhardt, Switzerland) and heart rate was measured by short-range telemetry(Sport-Tester PE4000, Polar Electro, Kempele, Finland).

Anthropometry. Height and body mass were determined using standard methods. Skinfold thicknesses were measured at four sites (biceps, triceps, subscapular, and suprailiac) and body circumferences were measured at the waist and hip.

Blood pressures. Duplicate measurements of arterial blood pressures were made by an observer who was blinded to subjects' group assignment using a calibrated mercury-in-glass sphygmomanometer after the subject had rested in the supine position for 10 min.

Brisk walking regimens. Based on the highest heart rate recorded during treadmill walking, a target zone corresponding to 70-80% of maximal heart rate was established for each walker. Walkers were provided with a heart rate monitor (PE4000 Sport-Tester, Polar Electro) and instructed in its use. They were asked to walk briskly, keeping their heart rate within the designated zone, on five days each week, for 30 min·d^{-1}; women in the short-bout group split this into three 10-min sessions at intervals of≥ 4 h; women in the long-bout group were free to select the time of day at which they did their one 30-min bout. Training was performed outdoors on the campus of the University of Ulster.

On one of the five training days each week training was supervised. During these supervised walks, the display of the heart rate monitor was concealed so that subjects' heart rate response to self-paced brisk walking could be determined. Afterward subjects received feedback on the heart rate achieved in an attempt to ensure that they could adopt an appropriate training pace in the event of heart rate monitor malfunction. In practice, monitors proved reliable and were used during almost all training sessions. Walkers recorded the duration of all brisk walks and the heart rates elicited in a training diary which was submitted each week.

Analytical procedures. Lactate concentration was determined on fresh samples of nonhemolyzed, nonprecipitated whole blood (Analox GM7). On each day the analyzer was calibrated before use with two standards (designated values 3.0 and 5.0 mmol·L^{-1}). Precision was evaluated by analyzing ten aliquots of the same venous blood sample (coefficients of variation ≤ 3.6%). Accuracy was ensured using two quality control sera. Sera were aliquoted at the start of the study and frozen at -20°C. One aliquot of each was thawed and assayed on each test occasion. Coefficients of variation across all test occasions (baseline and post-training) were 3.2% and 1.4%, respectively, for sera with designated lactate concentrations of 1.6 and 2.8 mmol·L^{-1}.

Statistical analysis. Changes over time were adopted as a summary measure of the response over time for each subject(7,23). Mean changes were then compared using one-way (factorial) ANOVA, with Tukey *post-hoc* tests to identify significant differences in response between groups. The Bonferroni adjustment was employed to reduce the likelihood of Type I error. The outcome variables tested were: indices of endurance fitness, i.e., $\dot{V}O_{2max}$,$\dot{V}O_2$ at a blood lactate concentration of 2 mmol·L^{-1} and heart rate during standardized submaximal treadmill walking; indices of fatness, i.e., body mass, sum of four skinfold thicknesses, and waist circumference; and resting systolic blood pressure. Tests were considered statistically significant at the 5% level and results are presented as mean± SD.

RESULTS TOP

Table 1 presents some physical and physiological characteristics of the subjects at baseline. There were no significant differences between groups for any variable.

	Controls $N = 10$	Short-Bout Walkers $N = 12$	Long-Bout Walkers $N = 12$
Age (yr)	47.3 ± 4.1	44.8 ± 8.4	48.0 ± 5.5
Body mass index ($kg \cdot m^{-2}$)	26.5 ± 4.6	25.1 ± 3.4	25.8 ± 2.9
Body mass (kg)	72.5 ± 13.8	66.5 ± 9.7	66.7 ± 8.3
Σ 4 skinfold thicknesses (mm)	66.9 ± 23.4	72.4 ± 20.8	66.8 ± 22.5
Waist circumference (cm)	82.3 ± 8.5	78.2 ± 7.1	76.8 ± 6.9
Systolic blood pressure (mm Hg)	128.6 ± 13.3	125.5 ± 10.8	124.2 ± 11.1
$\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	25.0 ± 4.1	27.8 ± 2.9	28.1 ± 3.0
$\dot{V}O_2$ at blood lactate of 2 $mmol \cdot L^{-1}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	19.1 ± 3.4	18.9 ± 2.5	19.3 ± 1.7

No significant differences between groups ($P > 0.05$).

TABLE 1. Some physical characteristics at baseline for sedentary controls and for women who subsequently walked briskly for 30 $min \cdot d^{-1}$ in three 10-min bouts (short-bout walkers) and for women who walked briskly for 30 $min \cdot d^{-1}$ in one continuous bout (long-bout walkers). Mean± SD.

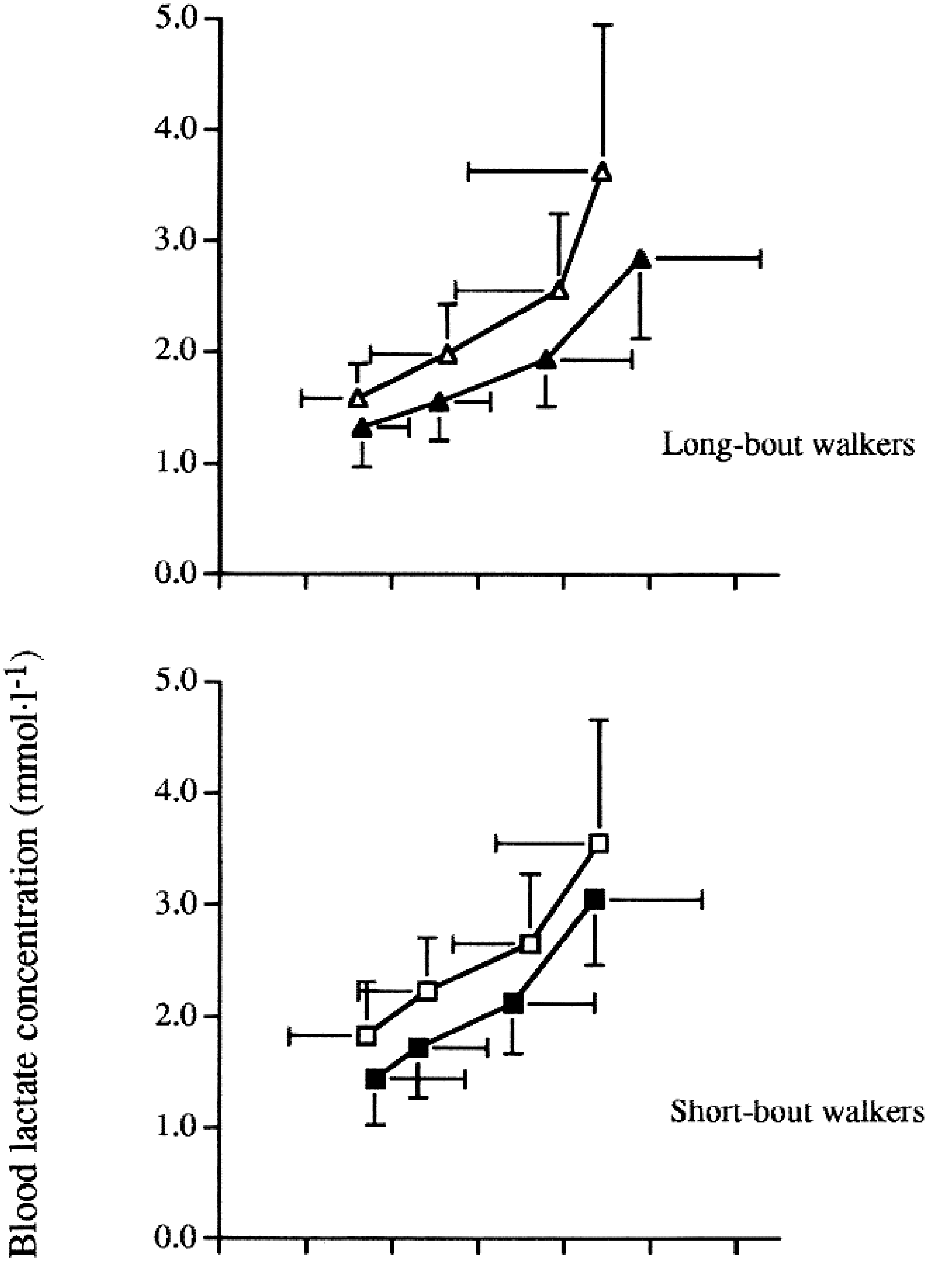
Short-bout walkers completed 128 ± 14 sessions (range 114-150), 85± 2% of the 150 prescribed. Long-bout walkers completed 44 ± 3(range 39-50) sessions, 88 ± 2% of the 50 prescribed. Total brisk walking time did not differ between groups (short-bout walkers 1298 ± 114 min; long-bout walkers 1316 ± 111 min, $P > 0.05$). Average heart rate during supervised brisk walking did not differ significantly between groups: short-bout walkers 131 ± 7 $beat \cdot min^{-1}$, long-bout walkers 136 ± 10 $beat \cdot min^{-1}$, 73% and 75% of maximal heart rate, respectively. Brisk walking speed was typically between 1.6 and 1.8 $m \cdot s^{-1}$ (3.5 and 4.0 mph).

Table 2 shows changes in the variables of interest for the three groups over the 10-wk observation period. Indices of endurance fitness remained essentially unchanged in controls but were increased in walkers. Specifically, $\dot{V}O_{2max}$ and $\dot{V}O_2$ at a blood lactate concentration of 2 $mmol \cdot L^{-1}$ (Fig. 1) increased significantly relative to controls in short-bout walkers and in long-bout walkers. Neither of these variables changed in a different way in short- and long-bout walkers. Decreases in heart rate during standard, submaximal exercise (Fig. 2) were not significantly different from the response of controls.

	Controls $N = 10$	Short-Bout Walkers $N = 12$	Long-Bout Walkers $N = 12$
Body mass (kg)	+0.6 ± 0.7	−1.7 ± 1.7†	−0.9 ± 2.0
Σ4 skinfold thicknesses (mm)	+2.6 ± 2.8	−3.3 ± 3.5†	−2.8 ± 3.8†
Waist circumference (cm)	+0.6 ± 1.0	−3.0 ± 2.4†	−1.8 ± 2.4
Systolic blood pressure (mm Hg)	−2.0 ± 6.9	−7.4 ± 7.3	−4.6 ± 5.9
$\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	−0.5 ± 0.1	+2.3 ± 0.1†	+2.4 ± 0.1†
VO_2 at blood lactate of 2 $mmol \cdot L^{-1}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	−2.1 ± 6.6	+2.6 ± 2.1†	+3.5 ± 1.7†

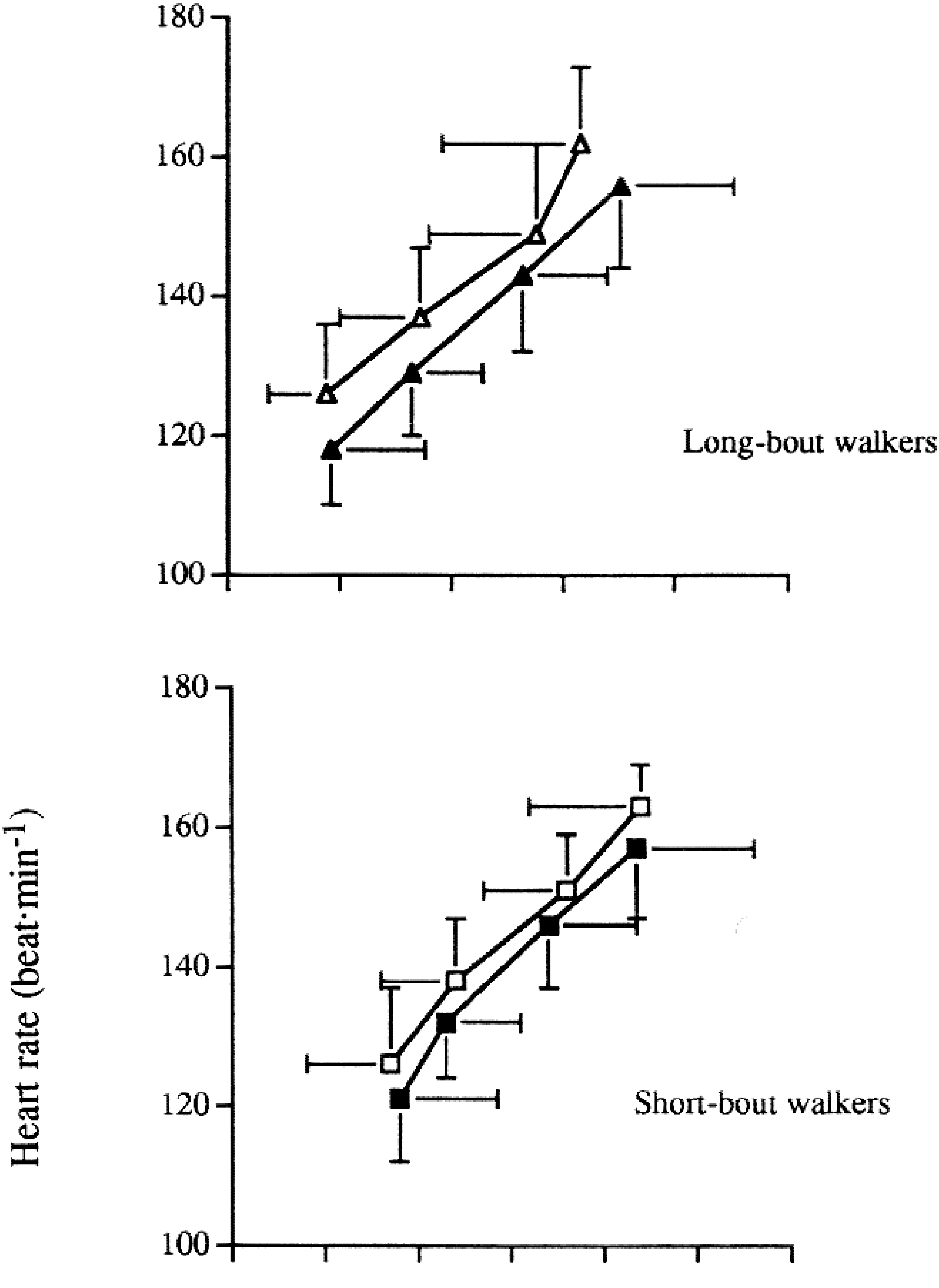
† Change from baseline significantly different from change in controls, $P < 0.05$.

TABLE 2. Changes in amount and distribution of body fat, blood pressure, and indices of fitness (post-training minus baseline) for sedentary controls, for women who walked briskly for 30 $min \cdot d^{-1}$ in three 10-min bouts (short-bout walkers), and for women who walked briskly for 30 $min \cdot d^{-1}$ in one continuous bout (long-bout walkers). Mean± SD.



Blood lactate concentration (mmol·l-1)
5.0
4.0
3.0
2.0
1.0
0.0
Long-bout walkers
5.0
4.0
3.0
2.0
1.0
0.0
Short-bout walkers

Figure 1-Blood lactate concentrations during submaximal treadmill walking at baseline (open symbols) and 10 wk later (post-training, solid symbols) for controls (*N* = 10), short-bout walkers(*N* = 12) and long-bout walkers (*N* = 12). Mean ± SD.



180
160
140
120
100
Long-bout walkers
180
160
140
120
100
Short-bout walkers
Heart rate (beat·min-1)

Figure 2-Heart rate during submaximal treadmill walking at baseline(open symbols) and 10 wk later (post-training, solid symbols) for controls(*N* = 10), short-bout walkers (*N* = 12), and long-bout walkers (*N* = 12). Mean ± SD.

Although women in both walking groups exhibited a decrease in body mass, only for short-bout walkers did this differ significantly from the small increase seen in controls (Table 2). Skinfold thicknesses decreased in both groups of walkers relative to controls who showed an increase. Waist circumference decreased in short-bout walkers relative to controls. Changes over time did not differ significantly between short- and long-bout walkers for these anthropometric measurements.

The decrease in systolic blood pressure in walkers did not differ significantly from the decrease observed in controls.

DISCUSSION TOP

This study confirmed the potential of brisk walking to stimulate improvements in both $\dot{V}O_{2max}$ and in the blood lactate response to standard submaximal exercise in previously sedentary middle-aged women. The major new finding was that these indices of fitness improved to a similar degree through three short brisk walks per day as through one longer walk when exercise intensity and duration were held constant. Improvements in $\dot{V}O_{2max}$ of about 2.5 $mL \cdot kg^{-1} \cdot min^{-1}$ (≈8%) were observed for both short- and long-bout walkers after only 10 wk of training. Although modest, these improvements are clearly worthwhile for these women with lower than average $\dot{V}O_{2max}$ values (22). They are sufficient, for example, to confer a level of fitness approaching that associated with a low risk of cardiovascular and all-cause mortality (≈ 9 METs) (6) and equivalent to an increase of more than 0.22 $m \cdot s^{-1}$ (≈0.5 mph) in comfortable walking speed(3).

Our finding that the increases in $\dot{V}O_{2max}$ were very similar for short- and long-bout training regimens contrasts with that of deBusk et al.(9) for sedentary men who followed an 8-wk program of jogging. They found an increase in $\dot{V}O_{2max}$ for long-bout joggers(4.6 $mL \cdot kg^{-1} \cdot min^{-1}$ or 13.9%) which was nearly twice as high as that for short-bout joggers (2.4 $mL \cdot kg^{-1} \cdot min^{-1}$ or 7.6%). One explanation for the disparity in findings could be that the long-bout joggers exercised above their target heart rate range (65-75% peak treadmill heart rate) for 33% of training time compared with 17% for the short-bout group(9). By contrast, in our study neither group of walkers spent more than 9% of any session above the target heart rate range, so the training stimulus might have been more strictly comparable between groups. The tendency for long-bout joggers to spend more of their training time above target heart rates than long-bout walkers may, of course, reflect an practical problem. In untrained people, heart rate rises progressively during exercise. During 30-min sessions walkers monitoring their heart rate may slow their pace and oppose this rise, but joggers with low $\dot{V}O_{2max}$ values (33 $mL \cdot kg^{-1} min^{-1}$ in the study of DeBusk et al.(9)) may not be able to do this without changing their gait to walking.

Our findings agree with those of deBusk et al. (9) in that the decrease in heart rate during submaximal exercise was similar in short- and long-bout groups. We measured another response during submaximal exercise, the $\dot{V}O_2$ at a reference blood lactate concentration, as a simple but sensitive measure of training-induced changes in endurance(33). This index increased in a similar manner for both groups of walkers and proportionally more than $\dot{V}O_{2max}$ (Table 2), suggesting an improvement in endurance capability from multiple short bouts of walking as well as from fewer longer bouts.

In addition to the study of deBusk et al. (9), two studies have compared the effectiveness of training regimens based on short and long bouts of exercise. Ebisu et al. (13) studied 51 young adult men and, like us, found similar improvements in $\dot{V}O_{2max}$ for subjects who split their training distance into three bouts per day as for subjects who covered a similar mileage in one continuous bout. These authors do not report the typical length of short bouts, however, but this was probably closer to 20 min than to the 10 min employed in the present study. Our findings may therefore be more pertinent in defining minimal desirable standards of physical activity.

In a more recent study, obese women followed two different training regimens, both aerobic exercise, mainly walking that were very similar to those we employed (19). After 20 wk, predicted $\dot{V}O_{2max}$ was increased by a similar amount in short- and long-bout groups, i.e., 5.0% and 5.6%, respectively-somewhat smaller increases than found here. The short-bout group, however, exercised on more days than did long-bout group and for a greater total duration, so it is possible that short-bout walkers may not have gained equivalent improvements in fitness per unit of training time.

The improvements in fitness with brisk walking may confer health benefits, including, for example, a decrease in the risk of developing hypertension(5). Mean decreases in blood pressure with brisk walking, although not statistically significant, were 5.4 and 2.6 mm Hg greater (short- and long-bout, respectively) than the decrease observed for controls. The decrease shown by short-bout walkers might be interpreted as clinically important. Small increases in systolic pressure in normotensives, even in the range 120-129 mm Hg, are associated with a three-fold increase in the risk of developing hypertension (5). Probably because of the greater potential for blood pressure reduction in individuals with above optimal values, all nine walkers with high normal systolic blood pressure >130 mm Hg (six short-bout, three long-bout) showed a decrease with walking.

From the public health point of view the potential of walking to influence weight regulation is also of interest. Despite its theoretical potential, evidence of weight/fat loss with walking in normal-weight women is equivocal(12,14,16,30). Our subjects showed only modest changes in body mass with 2.5 h of brisk walking per week-a gross weekly exercise energy expenditure of ≈2.8 MJ (1). Both groups experienced loss of body mass, but only short-bout walkers showed a loss that was significant relative to controls. A trend for greater decrease in body mass in short-bout walkers was also found among the obese women studied by Jakicic et al. ($P < 0.07$), but, as well as doing more walking, their short-bout walkers showed a somewhat greater decrease in energy intake (19). Consequently, available evidence does not permit a conclusion on the loss of body mass through short-bout as compared with long-bout patterns of walking.

Body mass changes do not necessarily reflect changes in fatness, however. In our study significant and similar decreases in skinfold thicknesses were observed for both groups of walkers. This supports the suggestion that total exercise energy expenditure is a major predictor of change in fat mass with exercise training (4). The decreases in waist circumference in short-bout walkers could indicate a potential for alteration of the distribution of body fat, with associated benefits in the long term for cardiovascular risk (34). Decreases in visceral fat, for which waist circumference may be a simple anthropometric proxy, have been reported to be proportional to metabolic improvements (lipid profile, insulin response to glucose challenge) associated with exercise training(11).

The increases in body mass and fatness observed for sedentary controls over the course of our study (Table 2) should be noted, as these contribute to the difference in response between controls and walkers. Such increases have been reported previously(2,12), but the reasons are unknown. Seasonal fluctuations (18) are unlikely explanations, at least for the studies from our laboratory because both were conducted during the Spring/Summer. It is conceivable that controls tend to decrease their physical activity on instructions from researchers to maintain a previously inactive lifestyle, but we have no evidence.

In England and in Northern Ireland, as in the United States, physical inactivity is widespread among women(22,25,26), and policies to redress this are under active consideration (10,26). A recent review of randomized controlled trials concluded that the promotion of physical activity is most effective for moderate exercise that does not depend on attendance at a facility and can easily be accommodated into an existing lifestyle (17). Walking is the activity most likely to fulfill these criteria, perhaps especially for women, many of whom perceive themselves to be not the sporty type (25).

Our study shows that repeated short bouts of brisk walking, a pattern easily incorporated into daily living, can improve physical fitness and help with weight regulation in women exposed to the health hazards of a sedentary lifestyle.

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