JOURNAL OF WOMEN'S HEALTH
Volume 20, Number 2, 2011

DOI: 10.1089/jwh.2010.2019

Effectiveness of Long and Short Bout Walking on Increasing Physical Activity in Women

Katrina M. Serwe, M.S.,[1] Ann M. Swartz, Ph.D.,[2] Teresa L. Hart, Ph.D.,[2] and Scott J. Strath, Ph.D.[2]

Abstract

Background: The accumulation of physical activity (PA) throughout the day has been suggested as a means to increase PA behavior. It is not known, however, if accumulated PA results in equivalent increases in PA behavior compared with one continuous session. The purpose of this investigation was to compare changes in PA between participants assigned to walk daily in accumulated shorter bouts vs. one continuous session.
Methods: In this 8-week randomized controlled trial, 60 inactive women were randomly assigned to one of the following: (1) control group, (2) 30 minutes a day of walking 5 days a week in one continuous long bout (LB), or (3) three short 10-minute bouts (SB) of walking a day, all at a prescribed heart rate intensity. Walking was assessed by pedometer and self-reported walking log. Before and after measures were taken of average steps/day, resting systolic and diastolic blood pressure (SBP, DBP), resting heart rate (RHR), six-minute walk test (6MWT) distance, height, weight, body mass index (BMI), and hip and waist circumference.
Results: Both walking groups significantly increased PA measured as steps/day compared to controls ($p < 0.001$), and no significant differences were found between LB and SB groups. The LB group demonstrated significant decreases in hip circumference and significant increases in 6MWT distance compared to the control group.
Conclusions: Both walking groups significantly increased PA participation. LB group participants completed more walking at a higher intensity than the SB and control groups, which resulted in significant increases in health benefits.

Introduction

The health benefits accrued from engaging in regular physical activity (PA) are well recognized, and specific to women are a decreased risk for all-cause mortality,[1,2] coronary heart disease (CHD),[3] diabetes,[4] hypertension,[5] breast cancer,[6] and osteoporosis,[7] and an improvement in mental health and quality of life.[8,9] Despite this strong evidence, less than half of female adults in the United States participate in the recommended amount of PA to gain these protective health benefits, and almost a quarter report no leisure time PA.[10]

As part of the effort to encourage the more sedentary members of the population to participate in health-enhancing PA, the American College of Sports Medicine (ACSM) and the Centers for Disease Control and Prevention (CDC) established a minimum recommended PA level that could be easily integrated into a person's daily routine. This recommendation calls for 30 minutes of moderate intensity PA on at least 5 days each week, and the activity may be accumulated in bouts of 10 minutes or longer.[11,12] Although these recommendations are widely promoted, there is still debate about the effectiveness of multiple bouts of PA vs. one continuous bout of PA to promote increases in adherence, overall PA, and health. The current literature base does not provide conclusive evidence whether health benefits are greater for activity performed in multiple bouts throughout the day or for activity performed in one continuous bout during the day. Some studies have found similar health benefits gained from multiple PA bouts vs. one continuous PA bout,[13–16] some have indicated superior health benefits gained from PA in multiple PA bouts,[17,18] and others have indicated superior health benefits gained when activity is performed in one continuous PA bout.[19–21] Although some studies have begun to examine the health benefits of multiple vs. continuous bouts of PA, few have directly examined the effects of activity bouts on adherence to, and participation in, overall regular daily PA.

Armed with the knowledge that walking is the most commonly reported PA, that 46.5% of women report walking for PA,[22] and that the workplace is an effective interventional

[1]Waupun Memorial Hospital, Waupun, Wisconsin.
[2]University of Wisconsin-Milwaukee, Milwaukee, Wisconsin.

structure,[23] the primary purpose of this present study was to determine if a daily walking program of 30 continuous minutes (long bout, LB) or three 10-minute bouts (short bouts, SB) for 8 weeks would cause similar increases in total daily PA participation. A secondary purpose was to determine if LB and SB walking held equal health benefits for women.

Materials and Methods

Study recruitment, participants, and eligibility criteria

Participants were recruited at a single workplace through e-mail and posted fliers and at staff meetings. Participants were premenopausal healthcare workers between the ages of 18 and 50 years. Participants were inactive (i.e., did not engage in $\geq$30 minutes of daily PA either continuous or accumulated on >2 days/week for the past 3 months, per self-report). Inactivity was further assessed by a baseline weeklong measurement of PA through pedometry. Participants who averaged >7500 steps/day, a number found to indicate low active to active lifestyles,[24] were excluded from the study.

Participants were free of cardiovascular, pulmonary, neurological, metabolic, or orthopedic disorders that could interfere with safe walking without an assistive device. Postmenopausal women were excluded to minimize complications of medications, such as hormone replacement therapy (HRT), as well as the effects of menopause on blood pressure. Participants taking medication known to affect blood pressure and pregnant women were also excluded from participation.

Study design

This 8-week randomized controlled trial (RCT) assessed the effect of prescribed LB vs. SB walking on PA levels and related health benefits. This study was approved by the University's institutional review board. At the initial contact meeting, all participants signed a written informed consent and received pedometers along with instruction on how to wear pedometers (i.e., at the midline of the right thigh) and how to complete a walking log. Participants were asked to wear the pedometer for all waking hours for 7 consecutive days to inform study eligibility. After this 1 week of baseline PA assessment via pedometry, participants deemed eligible were randomized to one of three study groups (control, LB, or SB group) and underwent initial preintervention assessments.

Intervention structure

The intervention structure consisted of three groups: group 1, control group; group 2, SB walking group; group 3, LB walking group, with groups 2 and 3 being the intervention groups. The control group was asked to maintain normal PA levels and diet during the 8-week intervention period. Members of both intervention groups were asked to participate in 8 weeks of walking for 30 minutes daily at 60%–70% heart rate reserve (HRR) 5 days/week. Participants monitored walking via pedometry and a walking log and were asked to make no modifications to their diet during the 8 weeks. SB walking group participants completed the walking in three 10-minute bouts 5 days/week. LB walking group participants were asked to complete the prescribed walking in one continuous 30-minute bout 5 days/week. Participants turned in walking logs to a researcher on a weekly basis and received biweekly scripted phone calls for further monitoring of the treatment program conducted by the same researcher. Calls consisted of a brief inquiry as to how the walking program was going and if any pain or injury had been experienced during walking.

One trained field researcher conducted all preintervention and postintervention assessments and interactions with participants. Participants were educated in their respective walking programs at the initial assessment (according to their randomized group assignment). Written directions were issued to participants, and the field researcher reviewed these directions one on one with each participant. All educational materials, assessments, and follow-up calls were scripted to have each participant receive the same information and treatment.

Study measures

All participants completed a general health history and demographic questionnaire at baseline. Additionally, participants underwent measures of body mass (kg) and height (cm) while wearing minimal clothing and no shoes, using a calibrated balance beam scale and stadiometer (Health-OMeter, Inc., Bridgeview, IL).

Physical activity. The primary outcome of this study was PA, which was assessed via steps/day obtained by pedometry. All participants wore an electronic pedometer (Model HJ-720ITC, Omron Healthcare, Bannockburn, IL) for the baseline period and the control and intervention periods. Prior research has shown the Omron pedometer to be valid and reliable for assessing walking behavior in adults.[25] Steps/day detected by the pedometer were recorded in a daily walking log provided to the participant. Participants were instructed to write down the number of steps before, and after each walking session (to derive steps accrued during walking bouts), the number of walking bouts in which they engaged, and the total number of steps accumulated at the end of the day.

Physical activity intensity. At the initial assessment, participants were instructed in proper assessment of PA intensity using a Borg rating of perceived exertion scale (RPE)[26] and a heart rate measure assessed by palpation of the radial artery for 15 seconds. These measures were also reported on participant walking logs for each walking bout to determine if participants were compliant to walking at a designated moderate walking pace (i.e., 60%–70% HRR).

Blood pressure and anthropometrics. Participants underwent measures of resting blood pressure using standardized procedures[27] with a mercury sphygmomanometer and stethoscope. Three measures were taken on the right arm, and the average of the three measures was the reported value. Hip circumference and waist circumference were also assessed using standardized procedures.[26] The waist was measured at the narrowest part of the torso, between the umbilicus and the xiphoid process, directly on the participant's skin. The hip was measured at the widest point, between the waist and gluteal fold, over the participant's clothing.

Functional aerobic capacity. Functional aerobic capacity was measured preassessment and postassessment using a six-minute walk test (6MWT) following standardized procedures of the American Thoracic Society.[28] The course was 30 meters in length, set up in a straight hallway, and 6MWT results were expressed as meters walked. The 6MWT has been shown to have a strong positive correlation with maximal oxygen uptake in healthy and diseased populations.[29]

Statistical analysis

A power analysis was performed to determine the number of participants needed to achieve 80% power using a one-way fixed effects analysis of variance (ANOVA) with three levels. The expected change in PA for this power analysis was based on an expected change of 2770 steps/day, with a standard deviation (SD) of 1700 steps/day.[30] The effect size for the analysis was 0.60. From the power analysis, it was determined that 10 participants were needed for each group, for a total of 30 participants. To adjust for possible study dropouts, 20 participants were recruited for each group, for a total of 60 participants.

Data analyses were completed in SPSS version 15 or SPSS graduate pack version 16 for Windows (SPSS, Inc., Chicago, IL). All variables were checked for normality by examining frequency distributions before analysis; nonnormal data were log transformed for inferential analysis. For participants who did not complete the intervention, intent-to-treat analysis was employed, using the last observation carried forward method. For all analyses, alpha was set at 0.05, and tests were 2-tailed.

Descriptive statistics were calculated for all variables. Groups were analyzed for differences using a one-way ANOVA to detect any differences in baseline variables: PA, systolic blood pressure (SBP), diastolic blood pressure (DBP), 6MWT distance, height, weight, body mass index (BMI), hip circumference, waist circumference. The primary outcome variable, change in PA, was analyzed with a one-way ANOVA examining change in average steps/day from baseline to week 8 for walking groups compared to the control group. Scheffé *post hoc* testing was completed to determine significant pairwise differences where necessary. Additionally, changes from pretest to posttest measures of health-related variables (i.e., SBP, DBP, resting heart rate, 6MWT, weight, height, BMI hip and waist circumference) were completed using a one-way ANOVA with Scheffé *post hoc* pairwise testing.

Independent samples t tests were used to assess compliance between walking groups, as measured by completing 80% of prescribed walking bouts (as assessed by walking logs). Participants were classified as compliant or noncompliant to the walking program based on the percentage of walking bouts completed. Compliance was defined as a participant who completed $\geq$80% of the prescribed walking bouts. This definition was based on past research findings indicating health benefits in response to PA for programs in which participants completed $\geq$80% of the prescribed program but not for programs with participants completing $<$80%.[13,18,19,31–33]

Intensity of walking was calculated by averaging reported heart rates for weeks 4 and 8 of the study while performing prescribed walking bouts. Participants were categorized as in-range, below range, or above range for reported walking heart rates (i.e., 60%–70% HRR). A paired t test was used to compare average heart rate at week 4 to average heart rate at week 8.

Results

Participant characteristics

Table 1 presents characteristics for all participants. There were no significant differences between the three experimental groups on any of the demographics or variables of interest at baseline. Of the 60 women enrolled, 53 completed the study; there were no significant PA or health differences between any characteristics of those who dropped out compared to those who completed the program (data not shown).

Table 1. Characteristics of All Participants

Variable and group	*Control Before (n = 20)*	*Control After*	*LB Before (n = 20)*	*LB After*	*SB Before (n = 20)*	*SB After*
Age (years)	36.3 ± 8.1	36.9 ± 8.1	37.1 ± 7.2	37.1 ± 7.2	38.2 ± 7.3	38.5 ± 7.3
Height (cm)	164.5 ± 5.2	164.5 ± 5.2	163.1 ± 5.8	163.1 ± 5.8	165.5 ± 6.1	165.5 ± 6.1
Weight (kg)	76.0 ± 24.2	79.9 ± 32.6	74.6 ± 19.0	73.2 ± 16.3	85.7 ± 26.7	85.4 ± 27.1
Body mass index (kg/m^2)	28.0 ± 8.9	29.8 ± 11.3	28.2 ± 8.1	27.6 ± 6.7	31.1 ± 8.9	30.9 ± 9.0
Hip circumference (cm)	106.3 ± 20.3	105.8 ± 22.1	107.4 ± 12.9	104.8 ± 13.2***	114.0 ± 19.1	112.6 ± 18.5*
Waist circumference (cm)	87.2 ± 17.3	87.6 ± 19.5	85.6 ± 12.0	85.0 ± 11.7	95.9 ± 20.9	95.2 ± 20.0
Systolic blood pressure (mm Hg)	120.9 ± 9.2	120.8 ± 9.2	115.1 ± 10.5	115.6 ± 11.8	117.7 ± 12.1	113.3 ± 11.4*
Diastolic blood pressure (mm Hg)	72.7 ± 7.2	73.5 ± 6.4	73.4 ± 8.1	68.8 ± 5.3*	73.2 ± 8.7	67.7 ± 5.5**
Resting heart rate (beats/min)	72.7 ± 9.5	72.9 ± 9.0	68.4 ± 10.9	68.6 ± 7.2	65.8 ± 6.0	64.8 ± 5.0
6 minute walk test distance (m)	1753.9 ± 300.3	1759.5 ± 324.1	1751.0 ± 152.3	1830.5 ± 174.3**	1722.7 ± 252.2	1764.3 ± 232.5*
Steps/day	5542 ± 1439	5910 ± 1514	5203 ± 1545	8171 ± 2434***	5379 ± 1064	7788 ± 2474***
Prescribed walking sessions completed (%)	N/A	N/A	N/A	80.2 ± 26	N/A	68.9 ± 31

Values are mean ± standard deviation (SD).

*Significant prepost difference, $p < 0.05$; **Significant prepost difference, $p < 0.01$; ***Significant prepost difference, $p < 0.001$.

LB, long bout of 30 minutes continuous walking 5 days/week for the 8 weeks of the study; NA, not available; SB, short bout of these 10-minute walks 1/day 5 days/week for the 8 weeks of the study.

Of the 7 who did not complete the study, 1 was from the control group, 3 were from the SB group, and 3 were from the LB group.

Changes in physical activity participation

There was a significant difference between groups on change in steps after 8 weeks ($F = 10.471$, $p < 0.001$). *Post hoc* testing showed that participants in both LB and SB walking groups had significantly more steps at 8 weeks than participants in the control group. The LB group took an average of 2261 steps/day and the SB group took an average of 1878 steps/day more than the control group during week 8 ($p < 0.001$ and $p = 0.005$, respectively). However, there were no significant differences in week 8 average steps/day between the LB and SB groups. Figure 1 shows the preintervention and postintervention mean steps/day for the LB, SB, and control groups.

Changes in PA participation: Analysis with program compliance

Program compliance was calculated as the percentage of total prescribed sessions completed. Mean compliance for the LB group was 80% (SD 26%); mean compliance for the SB group was 69% (SD 31%). Differences in compliance rates between the LB and SB groups were not statistically significant ($p = 0.239$). In the LB group, 12 participants completed ≥80% of the walking program, qualifying them as compliant with an average of 3716 more steps/day than the control group at week 8. In the SB group, 8 participants completed ≥80% of the walking program, thus qualifying them as compliant to the program with an average of 2205 more steps/day than the control group at week 8. Table 2 shows differences in steps/day between those who were compliant, by group.

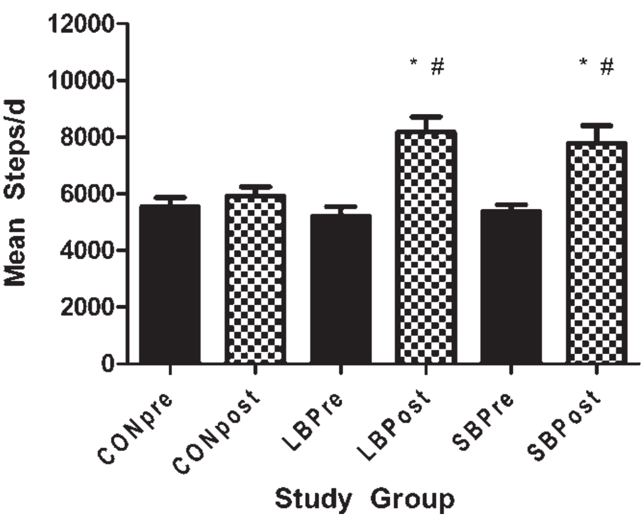

FIG. 1. Mean steps/day preintervention (Pre) and postintervention (Post) for the control (CON), long bout (LB), and short bout (SB) groups. *Significantly different from preintervention ($p < 0.05$); [#]Significantly different from control group preintervention ($p < 0.05$).

TABLE 2. PAIRWISE COMPARISONS FOR MEAN STEPS/DAY FOR THOSE WHO WERE COMPLIANT ($N = 20$)

Group comparisons	*Mean*	*SE*	p *value*
LB-SB	1511.2*	569.6	0.040
LB-CON	3716.3*	464.5	<0.001
SB-CON	2205.1*	516.7	0.001

*Significant at the $p < 0.05$ level.
CON, control; SE, standard error.

Adherence to prescribed intensity

During week 8 of the walking program, 51.6% of the participants were in the recommended heart rate range of 60%–70% HRR, 38.7% of participants averaging below the recommended range and 9.7% of participants averaging above the recommended heart rate range. Average heart rate from week 4 of the intervention was not significantly different from the week 8 average heart rate ($t = -0.481$, $p = 0.636$). Week 4 and week 8 heart rate averages were positively correlated ($r = 0.564$, $p = 0.015$). The LB group followed recommended heart rate ranges with greater consistency than did the SB group (Table 3).

Changes in health indices

Significant differences in health outcome variables were found for measures of DBP ($F = 3.880$, $p = 0.026$), hip circumference ($F = 4.112$, $p = 0.021$), and 6MWT ($F = 6.1150$, $p = 0.014$). The SB group had significantly decreased DBP ($p = 0.044$) compared to the control group; the LB group had significantly decreased hip circumference ($p = 0.021$) compared to the control group. The LB group also significantly increased 6MWT distance compared to the control group ($p = 0.004$). No significant intervention effects were detected for measures of SBP, resting heart rate, weight, BMI, or waist circumference.

Discussion

This study compared the effect of accumulated short bouts vs. one continuous session of walking to increase PA levels in previously inactive women. The primary findings from this study showed that both SB and LB walking prescriptions caused significantly increased PA participation compared to the control group. After randomization to walking groups, 67% of the LB group and 47% of the SB group were meeting

TABLE 3. PERCENT ADHERENCE TO PRESCRIBED HEART RATE RANGE

	Heart rate in-range	*Heart rate low*	*Heart rate high*
All LB group participants	67%	20%	13%
All SB group participants	38%	56%	6%
LB group compliant participants[a]	70%	20%	10%
SB group compliant participants	38%	63%	0%

[a]Compliant participants, participants who completed ≥80% of the prescribed walking bouts.

PA recommendations after 8 weeks of the intervention. This value is higher than those reported by others (20%–30%) in nonsupervised settings.[34]

Change in steps/day between the LB and SB walking groups was not statistically significant when all participants were included in the analyses (i.e., using intent-to-treat analysis). LB group participants were taking an average of 8171 steps/day by the end of the intervention period, demonstrating an increase of 57% over baseline values, and SB groups were taking an average of 7788 steps/day by the end of the intervention period, demonstrating an increase of 45% over baseline values. The step difference could be because the LB group walked at a higher intensity than the SB group, as indicated by average exercise heart rate measures assessed at weeks 4 and 8 of the study. It is possible that the LB group participants were walking faster and thus taking more steps during the 30 minutes of daily walking. Furthermore, SB group participants reported the third walk of the day was the hardest to complete and was frequently skipped. Ten minutes less of walking per day on a few days of the week could also account for step differences between the LB and SB groups. Previous studies involving LB and SB walking prescriptions have not found as large a discrepancy in PA between LB and SB walking. Most studies have found similar rates of PA between LB and SB walkers, as assessed by completion of prescribed bouts or estimated energy expenditure.[13,14,16–19,21,35] However these studies did not examine steps/day, as assessed by an objective method of PA; furthermore, only two of these studies allowed participants to complete walking in an unsupervised setting.[17,18] Of the studies published in the literature examining LB and SB walking, to our knowledge, no other has used a pedometer to help track activity. Previous studies have tracked activity using logs with minutes or number of prescribed bouts completed.[13–21,32,36] The use of a pedometer increases the accuracy of self-report and provides a measure to compare self-reported minutes of walking against recorded steps, as it has been shown that 30 minutes of walking correlates with approximately 3000–4000 steps/day.[24]

This study is unique in that the primary outcome variable was PA level as assessed by steps/day. Previous studies examining LB and SB walking have focused solely on the resulting health benefits of the program. To our knowledge, no study has been conducted to examine the effects of LB and SB walking on PA participation as a primary outcome variable. Two walking studies have been conducted that examined bout and nonbout walking and compared LB and SB groups to determine if adherence rates were significantly different.[13,17] Of these, one study had supervised walking sessions on an indoor track and found similar adherence rates between the two types of walking groups.[13] The second study had participants involved in unsupervised walking at the location of their choice.[17] This study was a 6-week crossover design that compared LB and SB walking and found when averaging the bout and nonbout results of the crossover design, that there was a slightly higher adherence rate for the LB walking, at 91%, than SB walking, at 88%; this difference was not statistically significant.[17] Previous studies examining LB and SB walking conducted in a supervised session found overall adherence rates ranging from 83%[36] to 85%.[18] Results from the current study were similar, with no significant differences found between LB and SB group adherence rates (i.e., completing $\geq$80% of prescribed walking bouts). Similar studies conducted in a semicontrolled manner with some supervised sessions and some unsupervised sessions have had adherence rates ranging from 82% to 90%.[19,32] The current study results, with a group mean LB compliance rate of 80%, are similar to others reported in the literature. However, the group mean compliance rate of 69% for the SB group was lower than that of similar studies. The lower compliance in the SB group could be due to certain social or cultural factors, including the need to change clothing to perform the walking bout, the need to shower after a walking bout, sweating, or the need to apply makeup or style hair. This may also result in a lower intensity to avoid such issues, especially in the final walking bout, and may be easier to accomplish with just one bout (i.e., the LB group). Alternatively, the difference in compliance to the prescription between the LB and SB groups may be because of the need to fit one bout vs. three bouts of PA into the day. These issues may influence compliance and introduce bias into the study and should be considered when prescribing three 10-minute bouts in this population. Additionally, 12 of the 20 (60%) LB group participants completed >80% of their prescribed walking sessions, whereas only 8 of the 20 (40%) SB participants completed their prescribed walking sessions. Overall, these data suggest that women who are prescribed one 30-minute bout of walking may meet PA recommendations more often than those prescribed three 10-minute bouts.

The LB group achieved statistically significant health benefits of a decrease in hip circumference and increase in 6MWT distance compared to the control group, whereas the SB group showed a significant decrease in DBP compared to the control group. These differences are of note considering the current study was designed to be of equal volume and intensity between the SB and LB walking groups for equal comparison of health benefits. LB group members participated in significantly more walking sessions with greater consistency in following heart rate ranges than did their SB group counterparts. The increased volume and intensity of walking may have affected the health benefits gained. Despite the lower compliance rate to walking prescriptions and the lower increase in steps/day, the SB group appeared to achieve improvements in health outcomes. On examination of the within-group pre/post changes in health outcomes, there were similar results between LB and SB groups. Both the LB and SB groups significantly improved DBP, hip circumference, and 6MWT; the SB group also significantly improved SBP outcomes from preintervention to postintervention. The control group showed no changes in health outcomes from preintervention to postintervention. This suggests the increase in steps resulting from three 10-minute walking sessions (or less) can improve health.

There were several strengths to this study. This was an RCT, which allowed comparison of results of multiple intervention groups to a control group. There was moderate to high compliance to the prescribed walking program. PA was assessed using an objective assessment device, which strengthens the quality of the data. This study was not without limitations, however. Because of the strict randomization protocol, participants had no choice in group assignment, which may have affected compliance and removed the notion of self-selecting how to obtain daily PA. In addition, there is limited generalizability because participants were Midwestern women all of the same socioeconomic background and similar culture.

Using a self-report log to record daily pedometer steps is also a limitation and, therefore, may have affected the number of steps reported by the participants. Finally, using one non-blinded field researcher may have potentially contaminated the data or introduced measurement bias.

Conclusions

When providing a PA prescription to an individual, national recommendations state that all individuals should strive to accumulate 30 minutes or more of a moderate intensity on 5 days/week and that this recommendation can be achieved through the accumulation of 10-minute bouts of activity performed throughout the day.[11,12] This study shows that individuals will respond differently to each recommendation, despite equal volume and equal intensity prescriptions. Those who engage in one LB session increased their PA level (as measured by steps/day) more than those who engaged in three SB sessions throughout the day. In addition, those walking in one LB session demonstrated significant decreases in hip circumference and increased 6MWT distance at posttesting compared to the control group. Those walking in accumulated SB sessions demonstrated significant changes in DBP compared to the control group. Both groups showed significant improvements in steps/day as well as health outcomes from preintervention to postintervention. The study was designed to have equal volume and intensity of walking in the SB and LB groups. However, the LB group completed significantly more walking, as measured in average steps/day, and followed heart rate recommendations more accurately than the SB group. Results indicate both LB and SB walking are beneficial to prescribe, with 67% of LB participants and 47% of SB participants increasing activity levels to meet national PA recommendations; however, LB walking may cause the greatest increase in PA and resultant health benefits. Future research is needed to verify these results in other subsets of the population.

Acknowledgments

We thank all the women who participated in this study. This work was supported by funding from a College of Health Sciences Research Award and from a Career Development Award from the National Institute on Aging (K01AG025962).

Disclosure Statement

No competing financial interests exist

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Address correspondence to:
Scott J. Strath, Ph.D.
Department of Human Movement Sciences
The University of Wisconsin-Milwaukee
Enderis Hall, Room 449
Milwaukee, WI 53201-0413

E-mail: sstrath@uwm.edu