# Effects of Intermittent Exercise and Use of Home Exercise Equipment on Adherence, Weight Loss, and Fitness in Overweight Women

## A Randomized Trial

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**Context** Enhancing participation in long-term exercise may translate into improved long-term weight loss in overweight adults.

**Objectives** To compare the effects of intermittent with traditional continuous exercise on weight loss, adherence, and fitness, and to examine the effect of combining intermittent exercise with that using home exercise equipment.

**Design** Randomized trial from September 1996 through September 1998.

**Setting and Participants** A total of 148 sedentary, overweight (mean [SD] body mass index, 32.8 [4.0] kg/m$^2$) women (mean [SD] age, 36.7 [5.6] years) in a university-based weight control program.

**Interventions** Eighteen-month behavioral weight control program with 3 groups: long-bout exercise (LB), multiple short-bout exercise (SB), or multiple short-bout exercise with home exercise equipment (SBEQ) using a treadmill.

**Main Outcome Measures** Body weight, body composition, cardiorespiratory fitness, and exercise adherence.

**Results** Of 148 subjects, 115 (78%) completed the 18-month program. At 18 months, mean (SD) weight loss was significantly greater in subjects in the SBEQ group compared with subjects in the SB group (−7.4 [7.8] kg vs −3.7 [6.6] kg; $P<.05$). Mean (SD) weight loss for subjects in the LB group (−5.8 [7.1] kg) was not significantly different than for subjects in the SB or SBEQ groups. Subjects in the SBEQ group maintained a higher level of exercise than subjects in both the SB and LB groups ($P<.05$) at 13 to 18 months of treatment. All groups showed an increase in cardiorespiratory fitness from baseline to 18 months, with no difference between groups. Mean (SD) weight loss at 18 months was significantly greater in individuals exercising more than 200 min/wk throughout the intervention (−13.1 [8.0] kg) compared with individuals exercising 150 to 200 min/wk (−8.5 [5.8] kg) or less than 150 min/wk (−3.5 [6.5] kg) ($P<.05$).

**Conclusions** Compared with the LB group, subjects in the SB group did not experience improved long-term weight loss, exercise participation, or cardiorespiratory fitness. Access to home exercise equipment facilitated the maintenance of SB, which may improve long-term weight loss. A dose-response relationship exists between amount of exercise and long-term weight loss in overweight adult women.

*JAMA. 1999;282:1554-1560* www.jama.com

A SIGNIFICANT HEALTH RISK ACcompanies a body mass index (BMI) in excess of 25 kg/m$^2$,[1] and more than 50% of adults in the United States are overweight by this criterion.[2,3] Despite the short-term effectiveness of behavioral interventions for treating obesity,[1] many individuals regain significant weight within a 1-year period.[4,5] Exercise enhances short-term weight loss when combined with dietary modification and is one of the best predictors of long-term maintenance of weight loss.[6] However, exercise adherence in overweight adults is less than desirable.[7]

Public health guidelines recommend the accumulation of physical activity,[8] which may be easier to achieve, given the time constraints of many sedentary individuals. Recent evidence suggests that exercise accumulation combined with dietary modification may be effective at improving short-term exercise adherence and weight loss in overweight adults.[9] However, the long-term implications of multiple short bouts of exercise on these parameters in overweight adults have not been examined. Cross-sectional and laboratory-based studies have suggested that providing access to exercise equipment may improve exercise participation[10,11] by making exercise more convenient. However, we are unaware of any randomized clinical trials that have examined the effectiveness of home exercise equipment on exercise adherence rates.

This study was designed to examine whether exercise performed in multiple short bouts compared with exercise performed in 1 long bout would improve weight loss in overweight women after 18 months and to deter mine whether overweight women us-

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ing home exercise equipment during short bouts of exercise would show improved weight loss after 18 months. Secondary outcomes included exercise participation and cardiorespiratory fitness.

## METHODS

### Subjects

Adult women were recruited for this study through advertisements in local newspapers. Subjects were 25 to 45 years old, had body weights 20% to 75% higher than ideal body weight,[12] and were sedentary (reported exercising <20 min/d on <3 d/wk for the previous 6 months). Women were excluded if they had medical conditions that would limit their ability to participate in this study; were taking medication that would affect body weight, other metabolic parameters, or both; had personal commitments that would limit optimal participation; or were pregnant within the previous 3 months, currently pregnant, or planned on becoming pregnant in the following 18 months. Subjects provided written consent from their personal physicians prior to participating in this study. Subjects' written informed consent was obtained, and all procedures were approved by the institutional review board at the University of Pittsburgh.

### Intervention

Subjects were randomly assigned to 1 of 3 groups. All subjects were prescribed a similar volume of exercise. The 3 groups differed in the way the exercise was prescribed (number of exercise sessions per week, duration of exercise sessions, and the availability of home exercise equipment). The exercise in all groups was home-based, and subjects were instructed to choose a mode of exercise similar to brisk walking.

**Long-Bout Exercise Group.** Forty-nine subjects were instructed to exercise 5 d/wk; duration progressed from 20 min/d during weeks 1 through 4, to 30 min/d during weeks 5 through 8, to 40 min/d for the duration of this study. Participants performed the exercise in 1 long bout.

**Short-Bout Exercise Group.** Fifty-one subjects in this group were instructed to exercise 5 d/wk, and duration of the exercise progressed from 20 min/d to 40 min/d by the ninth week of the program. However, rather than exercising continuously for the prescribed duration, subjects were instructed to divide the exercise into multiple 10-minute bouts that were performed at convenient times throughout the day. Therefore, subjects were instructed to progress from 2 to 4 exercise bouts per day by week 9.

**Short-Bout Plus Exercise Equipment Group.** The exercise prescription was identical to the exercise prescribed for the short-bout group in terms of days per week, duration per day, and number of bouts of exercise. The 48 subjects in this group were also provided with motorized home treadmills that were delivered to subjects' homes and maintained by the investigators during the 18-month intervention.

### Common Treatment Components

All subjects participated in an 18-month behavioral weight-loss program that had components common to all participants. Subjects attended weekly group treatment meetings during months 1 through 6, biweekly meetings during months 7 through 12, and monthly meetings during months 13 through 18. These group meetings focused on behavioral strategies for modifying eating and exercise behaviors and were led by nutritionists, exercise physiologists, and behavioral therapists. When a subject missed a group meeting, she was contacted in an attempt to schedule a makeup session.

All groups were instructed to reduce both daily energy and fat intake. Subjects weighing at least 90 kg at baseline were prescribed an intake of 6276 kJ/d, whereas subjects weighing less than 90 kg at baseline were prescribed an intake of 5021 kJ/d. This prescribed energy intake would create a 2092- to 4184-kJ deficit per day (0.45-0.9 kg weight loss per week)[13] and does not go below the minimal recommended energy intake of 5021 kJ/d.[13] Subjects were prescribed a fat intake goal of 20% of total energy intake. Both the energy and fat intake prescribed have been shown to promote significant weight loss in a previous study.[9] Subjects were instructed to record their dietary intake in a daily food diary, which were reviewed on a weekly basis by the interventionists, who provided dietary feedback.

### Assessments

Weight was assessed at baseline and 6, 12, and 18 months to the nearest 0.11 kg using a calibrated balance-beam scale. Height was assessed using a calibrated stadiometer on subjects standing upright and not wearing shoes.

Body composition was assessed at baseline, 6 months, and 18 months using a dual-energy x-ray absorptiometer. A urine pregnancy test was performed immediately prior to a total body scan. The mode of the baseline scan was made according to the recommendations outlined in the operator's manual. Scans at 6 months and 18 months were performed at the scanning mode that was used at baseline.

Girth measurements of the waist and hip[14] were performed at baseline, 6 months, and 18 months and were assessed using a tape measure. Two measurements were taken at each site. The average of these 2 measurements was used for data analysis.

Cardiorespiratory fitness was assessed at baseline, 6 months, and 18 months using a submaximal graded exercise test on a cycle ergometer.[13] Initial work rate was 150 kg $\times$ min$^{-1}$ and increased by the same at 3-minute intervals until the subject achieved 80% of age-predicted maximal heart rate.[13] Heart rate was assessed using a 12-lead electrocardiogram,[15] and oxygen consumption ($\dot{V}O_2$) was also assessed. A linear relationship exists between heart rate and $\dot{V}O_2$ in overweight adults.[16] Therefore, linear regression, incorporating the heart rate and $\dot{V}O_2$ collected at each minute of exercise and at the point of termination, was used to assess the relationship between heart rate and $\dot{V}O_2$ for the prediction of peak $\dot{V}O_2$ (predicted $\dot{V}O_{2peak}$).

Dietary intake was assessed at baseline, 6 months, and 18 months using the Block Food Frequency Questionnaire.[17]

Subjects recorded the exercise they performed in a log that was collected by the investigators at each scheduled visit and used to compute the amount of weekly exercise performed by each participant.

Triaxial accelerometers were used to verify the weekly exercise logs during months 1 through 6. Subjects were assigned to wear the device for a randomly selected 1-week period within the initial 6 months of treatment. Minute-by-minute data were collected, and a computer program developed in our laboratory was used to identify activity periods that were consistent with the exercise prescription. These results were compared with the exercise log completed during the same week that the device was worn.

Leisure-time physical activity (LTPA) was assessed at baseline, 6 months, and 18 months using the Paffenbarger Questionnaire.[18]

### Statistical Analysis

Data were analyzed using SPSS version 8.0 software (SPSS Inc, Chicago, Ill). Based on descriptive data, skewed data were log transformed prior to analysis. Comparison of baseline data was performed using a 1-way analysis of variance (ANOVA). The a priori hypotheses were examined using a 2-factor (group × time) repeated measures ANOVA, and additional analyses were performed using 1-way ANOVA and Duncan post hoc analysis. A $\chi^2$ test was used to assess distribution patterns for subjects who dropped out and attainment of intervention goals,[19] and these results were confirmed using Fisher exact tests.[19] Statistical significance was defined as $P \leq .05$. All data were analyzed using an intent-to-treat analysis unless otherwise specified. For missing data, we assumed that there was a return to baseline values for weight, body composition, fitness, dietary intake, and LTPA or that there was no exercise performed (exercise logs).

A power analysis based on weight loss at 18 months (the primary hypothesis) was conducted prior to recruitment. This analysis indicated that 50 subjects per group would provide statistical power of 70% to detect an effect size of 0.63 for differences in weight loss at 18 months between groups.

## RESULTS

At baseline, there were no significant differences between groups (TABLE 1). Overall, 115 subjects (78% of 148 subjects randomized) completed 18 months of treatment, with no significant difference in attrition rates between the groups ($P = .12$). Reasons for not completing the study are shown in FIGURE 1. There was no significant difference in attendance at the behavioral group sessions among the intervention groups across the 18 months of treatment. The mean (SD) percentage of sessions attended was 67.1% (23.3%) for the LB group, 70.9% (24.1%) for the SB group, and 71.7% (21.9%) for the SBEQ group.

**Table 1.** Baseline Characteristics of Subjects Randomly Assigned to Treatment and of Those Completing the Study*

| Variable and Group | LB Group | SB Group | SBEQ Group | Total |
|---|---|---|---|---|
| No. | | | | |
| Subjects randomly assigned | 49 | 51 | 48 | 148 |
| Subjects completing treatment | 37 | 36 | 42 | 115 |
| Age, y | | | | |
| Subjects randomly assigned | 37.3 (6.0) | 35.8 (4.9) | 37.0 (5.7) | 36.7 (5.6) |
| Subjects completing treatment | 37.2 (6.2) | 36.7 (4.6) | 37.5 (5.5) | 37.1 (5.4) |
| Weight, kg | | | | |
| Subjects randomly assigned | 90.0 (11.6) | 91.6 (10.2) | 88.3 (12.0) | 90.0 (11.3) |
| Subjects completing treatment | 89.2 (11.7) | 90.3 (9.0) | 87.5 (11.6) | 88.9 (10.9) |
| Body mass index, kg/m$^2$ | | | | |
| Subjects randomly assigned | 32.9 (3.8) | 33.2 (4.0) | 32.2 (4.3) | 32.8 (4.0) |
| Subjects completing treatment | 32.8 (3.9) | 32.4 (3.1) | 32.1 (4.3) | 32.4 (3.8) |

*LB indicates long bouts of exercise; SB, short bouts of exercise; and SBEQ, short bouts of exercise plus use of home exercise equipment. All data are presented as mean (SD).

### Change in Body Weight

When the 3 treatment groups were included in the model, there was a significant group × time interaction for change in body weight ($P < .01$) (FIGURE 2). There was no significant difference between the LB and SB groups for mean (SD) weight loss at either 6 months (LB, −8.2 [5.5] kg; SB, −7.5 [5.4] kg) or 18 months (LB, −5.8 [7.1] kg; SB, −3.7 [6.6] kg). Weight loss at 6 months was not significantly different between the SBEQ (−9.3 [5.6] kg) and SB (−7.5 [5.4] kg) groups ($P = .11$). However, weight loss at 18 months was significantly greater in the SBEQ group (−7.4 [7.8] kg) compared with the SB group (−3.7 [6.6] kg) ($P < .05$). Post hoc analysis showed no significant difference in weight loss at 6 or 18 months between the LB and SBEQ groups. In analyses using only the 115 subjects who completed 18 months of treatment, there were no significant difference in weight loss at 6 months among the groups (LB, −10.2 [4.2] kg; SB, −9.3 [4.5] kg; SBEQ, −10.2 [5.2] kg; $P = .63$). Weight regained during months 6 to 18 did not differ between the LB (2.6 [5.5] kg) and SB (4.1 [5.6] kg) groups. However, there was significantly less weight regain in the SBEQ group (1.8 [4.7] kg) compared with the SB group ($P = .05$) but no significant difference between the SBEQ and LB groups.

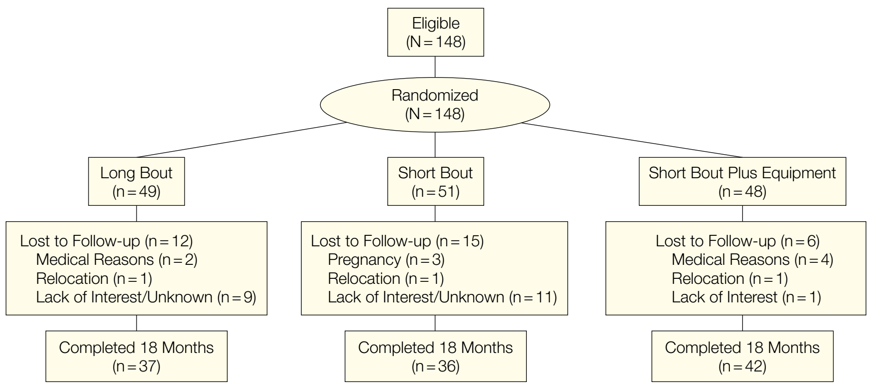
### Change in Body Composition

There were significant changes in percentage of body fat, fat mass, and lean body mass over time ($P < .001$), but no change in bone mineral content (TABLE 2). In addition, there was a significant group × time interaction when all groups were included in the analysis. When the a priori hypothesis comparing the LB and SB groups was examined, there was no significant difference for measures of body composition. However, changes in percentage of body fat and fat mass were greater in the SBEQ group compared with the SB group, and no difference for lean body mass or bone mineral content. Comparison of the LB and SBEQ groups revealed no differences. Despite changes over time for waist girth and waist-to-hip ratio

($P<.001$), there were no differences in the pattern of change (Table 2).

**Figure 1.** Participant Flow




### Exercise Participation

The duration of exercise for weeks 1 through 4 was significantly greater in the SB compared with both LB and SBEQ groups ($P<.05$) (FIGURE 3). There were no significant differences among groups for weeks 5 through 8, weeks 9 through 24, or months 7 through 12. However, exercise duration was greater in SBEQ compared with both LB and SB groups for months 13 through 18 ($P<.05$). After duration (mean [SD]) peaked during weeks 9 through 24, all groups showed a decrease during months 7 through 12 (LB, −41.7 [72.5] min/wk; SB, −31.2 [104.0] min/wk; SBEQ, −45.8 [74.0] min/wk) with no significant differences among groups. However, the decrease in duration of exercise during months 13 through 18 was significantly greater in the SB group (−68.7 [95.1] min/wk) compared with the SBEQ group (−31.6 [58.7] min/wk) ($P<.05$); the LB group (−42.2 [73.7] min/wk) did not differ significantly from either the SB or SBEQ groups ($P>.09$).

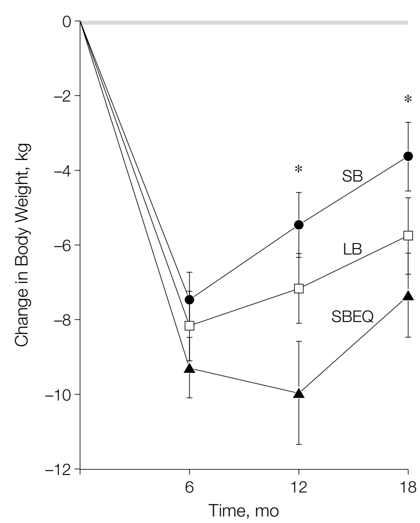
A similar percentage of subjects in each group (LB, 73.5%; SB, 78.4%; SBEQ, 75.0%) achieved a level of exercise of at least 150 min/wk[8] during weeks 5 through 24; 47.2%, 62.5%, and 72.2% maintained this level during months 7 through 12 in the LB, SB, and SBEQ groups, respectively ($P = .09$). Of those subjects achieving at least 150 min/wk of exercise during both weeks 5 through 24 and months 7 through 12, 70.6%, 64.0%, and 73.1% maintained this level during months 13 through 18 in the LB, SB, and SBEQ groups, respectively (not significant; $P = .77$). There was also no difference between groups (LB, 24.5%; SB, 31.4%; SBEQ, 39.6%) for the number of subjects achieving at least 150 min/wk of exercise at all 3 time intervals (weeks 5-24, months 7-12, months 13-18).

Among the 115 subjects who completed 18 months of treatment, both the SB and SBEQ groups exercised for a longer duration per session than prescribed, whereas the LB group exercised for a longer duration (minutes/session) than both the SB and SBEQ groups (TABLE 3). Both the SB and SBEQ groups exercised for more sessions per week than the LB group.

Across the entire 18 months of treatment, there was no significant difference between the LB (74.3% [28.1%]) and SB (75.9% [26.4%]) groups for the percentage (mean [SD]) of exercise sessions in which walking was the selected activity. However, the SBEQ group reported selecting walking for exercise more often (93.7% [10.8%]) than the LB group ($P<.05$), but there was no difference between the SB and SBEQ groups across the 18-month period. As expected, the SBEQ group reported using a treadmill for exercise (41.6% [31.7%]) more than both the LB (8.1% [20.5%]) and SB (10.7% [19.5%]) groups during the 18-month period ($P<.05$).

The triaxial accelerometer was worn by 111 of the 115 individuals who completed the intervention; 3 individuals in the LB group and 1 individual in the SB group did not wear the device properly, refused to wear it, or both. There was no difference between the accelerometer data and self-reported data, respectively, for the total amount of exercise completed per week (mean [SD]) by the LB (130.0 [66.7] vs 154.5 [69.4] min/wk), SB (189.9 [94.5] vs 185.5 [141.9] min/wk), and SBEQ (198.5 [131.7] vs 181.7 [96.6] min/wk) groups. In addition, wearing the accelerometer did not increase exercise participation compared with the other weeks when the exercise prescription was identical (174.5 [106.4] min/wk vs 197.8 [86.9] min/wk, respectively) ($P<.01$). This pattern was similar between treatment groups.

**Figure 2.** Changes in Weight




Changes in weight loss among treatment groups across 18 months of treatment (mean [SEM]). Asterisk indicates that data for the short-bout exercise (SB) group and multiple short-bout exercise plus home exercise equipment (SBEQ) group were significantly different ($P<.05$) at the same time period. LB indicates long-bout exercise. Error bars indicate standard error of the mean.

### Leisure-Time Physical Activity

Analysis of LTPA revealed no significant group or group × time interaction. However, there was a significant time effect ($P<.001$) for LTPA that increased significantly from 0 to 18 months in the LB (2251.0 [2108.7] to 6378.1 [5816.2] kJ/wk), SB (2680.7 [2262.7] to 5777.3 [4916.2] kJ/wk), and SBEQ (2723.8 [3333.0] to 6199.9 [5432.9] kJ/wk) groups.

## Changes in Energy Intake

All groups significantly decreased total energy intake and the percentage of energy consumed as fat ($P<.001$). However, the nonsignificant group × time interaction indicates that the change in energy intake measured at 0, 6, and 18 months was similar among the LB (7308.6 [3197.4] to 5446.3 [2572.3] to 5874.8 [2946.4] kJ/d), SB (8169.7 [4719.6] to 5714.5 [2249.3] to 6716.6 [4491.1] kJ/d), and SBEQ (8003.6 [4960.1] to 6144.2 [4777.3] to 6178.5 [4448.4] kJ/d) groups. Similar results were shown for percentage of energy consumed as fat for the LB (37.9% [6.7%] to 31.7% [8.9%] to 33.6% [8.8%]), SB (35.3% [7.1%] to 28.8% [8.5%] to 32.3% [8.2%]), and SBEQ (35.1% [6.7%] to 30.9% [8.6%] to 32.9% [7.4%]) groups.

## Changes in Fitness

Increases in predicted $\dot{V}O_{2peak}$ (mL × kg$^{-1}$ × min$^{-1}$) from 0 to 6 months were 18.9% (22.3%) in the LB group, 9.5% (15.7%) in the SB group, and 16.0% (14.4%) in the SBEQ group. All groups significantly increased cardiorespiratory fitness compared with baseline within the initial 6 months of treatment ($P<.05$). The magnitude of this increase was significantly different between the LB and SB groups ($P<.05$). Predicted $\dot{V}O_{2peak}$ remained significantly ($P<.05$) increased at 18 months compared with 0 months (LB, 9.9% [22.7%]; SB, 6.3% [13.1%]; SBEQ, 11.5% [17.1%]; $P\leq.007$), with no difference between groups.

## Exercise and Weight Loss

Based on self-reported exercise at each of the 6-month intervals (weeks 5-24, months 7-12, months 13-18), subjects were divided into 1 of the following groups: (1) averaging less than 150 minutes of exercise per week at all of the 6-month intervals (EX<150), (2) averaging at least 150 minutes of exercise per week at all of the 6-month intervals but not more than 200 minutes per week of exercise at all of the 6-month intervals (EX≥150), or (3) averaging at least 200 minutes per week at all of the 6-month intervals (EX≥200). There was a significant group × time interaction ($P<.001$) for self-reported exercise and a significant ($P<.001$) decrease in both the EX<150 (0-6 months, 182.7 [81.2]; 7-12 months, 129.5 [75.5]; and 13-18 months, 52.3 [62.3] min/wk) and EX≥150 (0-6 months, 233.3 [62.2];

**Table 2.** Changes in Body Composition Parameters Between the Intervention Groups*

| Variable and Assessment Period | LB Group (n = 49) | SB Group (n = 51) | SBEQ Group (n = 48) | *P* Values, Group × Time Effect: LB vs SB | SB vs SBEQ | LB vs SBEQ |
|---|---|---|---|---|---|---|
| Body mass index, kg/m$^2$ | | | | | | |
| Baseline | 32.9 (3.8) | 33.2 (4.0) | 32.2 (4.3) | .48 | <.01 | .30 |
| 6 mo | 29.9 (4.4) | 30.5 (4.7) | 28.8 (4.6) | | | |
| 12 mo | 30.3 (5.0) | 31.2 (4.6) | 28.9 (4.9) | | | |
| 18 mo | 30.8 (5.1) | 31.9 (4.6) | 29.5 (5.1) | | | |
| Percent body fat | | | | | | |
| Baseline | 44.9 (4.3) | 44.5 (4.6) | 43.5 (5.3) | .14 | <.01 | .43 |
| 6 mo | 40.6 (5.5) | 40.3 (6.4) | 38.7 (6.6) | | | |
| 18 mo | 42.0 (5.9) | 42.9 (5.8) | 39.4 (7.5) | | | |
| Fat mass, kg | | | | | | |
| Baseline | 40.2 (7.7) | 40.5 (7.8) | 38.4 (8.9) | .17 | <.01 | .45 |
| 6 mo | 33.3 (8.5) | 34.1 (9.6) | 30.9 (9.3) | | | |
| 18 mo | 35.7 (9.7) | 37.8 (9.1) | 32.4 (11.0) | | | |
| Lean body mass, kg | | | | | | |
| Baseline | 46.2 (5.3) | 47.3 (3.8) | 46.4 (4.9) | .45 | .79 | .19 |
| 6 mo | 45.2 (5.3) | 46.6 (4.2) | 44.9 (5.3) | | | |
| 18 mo | 45.4 (5.4) | 46.6 (3.6) | 45.4 (5.5) | | | |
| Bone mineral content, g | | | | | | |
| Baseline | 2578 (338) | 2585 (249) | 2567 (333) | .51 | .08 | .42 |
| 6 mo | 2604 (337) | 2579 (265) | 2619 (329) | | | |
| 18 mo | 2585 (346) | 2582 (254) | 2560 (315) | | | |
| Waist girth, cm | | | | | | |
| Baseline | 101.0 (10.3) | 101.8 (11.3) | 100.0 (12.4) | .38 | .05 | .54 |
| 6 mo | 93.7 (11.5) | 94.9 (12.6) | 91.9 (13.0) | | | |
| 18 mo | 95.6 (13.0) | 98.2 (12.8) | 92.8 (12.8) | | | |
| Waist-to-hip ratio | | | | | | |
| Baseline | 0.86 (0.07) | 0.86 (0.07) | 0.87 (0.08) | .50 | .09 | .43 |
| 6 mo | 0.84 (0.07) | 0.85 (0.07) | 0.86 (0.07) | | | |
| 18 mo | 0.84 (0.07) | 0.85 (0.08) | 0.84 (0.10) | | | |

*LB indicates long bouts of excercise; SB, short bouts of exersise; and SBEQ, short bouts of exercise plus use of home exercise equipment. All data are presented as mean (SD).

7-12 months, 209.3 [39.0]; and 13-18 months, 188.0 [35.6] min/wk) groups. Compared with both the EX<150 and EX≥150 groups, exercise in the EX≥200 group was significantly greater (*P*<.05) and remained unchanged across time (0-6 months, 291.4 [69.3]; 7-12 months, 282.6 [65.9]; and 13-18 months, 281.0 [70.8] min/wk). Following 18 months, there was no significant difference in estimated energy used (kJ/wk) during LPTA between the EX≥150 (9025 [5238] kJ/wk) and EX≥200 (11 004 [5318] kJ/wk) groups, and both groups used significantly more energy than the EX<150 group (5515 [5284] kJ/wk) (*P*<.05).

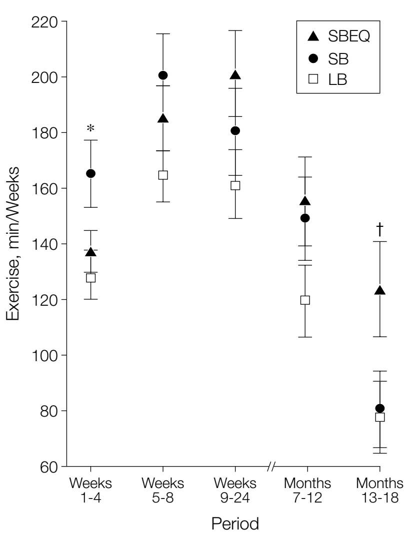
There was a significant group × time interaction (*P*<.001) for weight loss, suggesting that the pattern of weight loss across the groups was significantly different (FIGURE 4). Weight loss at 18 months was significantly greater in the EX≥200 group (−13.1 [8.0] kg) compared with both the EX<150 (−3.5 [6.5] kg) and EX≥150 (−8.5 [5.8] kg) groups (*P*<.05). There was no effect of randomized group assignment (LB, SB, SBEQ) on these results.

## COMMENT

It has been suggested that a minimum of 150 minutes of moderate-intensity physical activity accumulated throughout the week can improve health.[8] We have previously shown that prescribing exercise in multiple short bouts per day increases exercise participation in overweight women during a 20-week period.[9] Despite other studies that show the efficacy of short bouts of exercise,[20,21] to our knowledge, no other studies have examined whether this strategy increases long-term exercise participation or weight loss. As has been done in recent physical activity intervention studies,[22] we used a home-based activity program with a strong behavioral component to compare continuous (LB) and intermittent (SB) exercise. Initial results showed statistically significant higher levels of exercise in the SB compared with the LB group. However, compared with the LB group, the SB group did not statistically increase the minutes of exercise per week after the first 4 weeks, nor did it increase the number of individuals averaging a minimum of 150 min/wk of exercise throughout the entire 18-month intervention. Therefore, the use of short bouts of exercise performed multiple times throughout the day may not increase long-term exercise adherence beyond what can be achieved with traditional long bouts of exercise coupled with a strong behavioral program. Moreover, there was no significant difference in weight loss following 18 months of treatment when the SB group was compared with the LB group.

Our study also showed that multiple short-bout exercise with home exercise equipment improves long-term weight loss and fat loss compared with short bouts. This may be a result of the SBEQ group showing less decline in exercise participation during the final 6 months of treatment (months 13-18) compared with the SB group. Therefore, the incorporation of short bouts of exercise may be most effective when participants have access to home exercise equipment. Having access to exercise equipment may make exercise more convenient,[10,11] which may facilitate the adoption of multiple short bouts of exercise. However, because long-

**Figure 3.** Changes in Exercise Participation



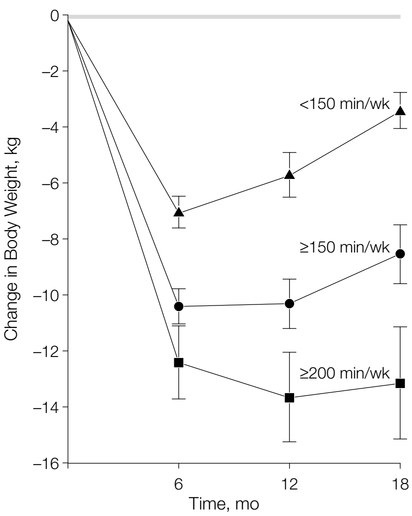

Changes in exercise participation among treatment groups across 18 months of treatment (mean [SEM]). Single asterisk indicates data for the short-bout exercise (SB) group were significantly different (*P*<.05) compared with the long-bout exercise (LB) group and the multiple short-bout exercise plus home exercise equipment (SBEQ) group at the same time period. Dagger indicates that the SBEQ group data were significantly different (*P*<.05) compared with the LB and SB group data at the same time period. Error bars indicate standard error of the mean.

**Table 3.** Differences in Exercise Participation Between Groups*

| Variable and Time Period | LB Group (n = 37) | SB Group (n = 36) | SBEQ Group (n = 42) | *P* Value: Group | *P* Value: Time | *P* Value: Group × Time |
|---|---|---|---|---|---|---|
| Minutes/session | | | | | | |
| Week 1-4 | 25.3 (5.6) [20] | 16.5 (5.3) [10] | 14.2 (4.7) [10] | | | |
| Week 5-8 | 31.9 (6.1) [30] | 16.5 (7.7) [10] | 14.3 (4.8) [10] | | | |
| Week 9-24 | 36.9 (9.1) [40] | 15.4 (6.6) [10] | 15.6 (7.0) [10] | <.001 | <.001 | <.001 |
| Month 7-12 | 34.2 (13.3) [40] | 20.6 (20.3) [10] | 17.9 (9.4) [10] | | | |
| Month 13-18 | 24.3 (19.9) [40] | 15.3 (12.9) [10] | 17.2 (13.0) [10] | | | |
| Sessions/week | | | | | | |
| Week 1-4 | 5.2 (1.6) [5] | 10.8 (2.2) [10] | 10.3 (2.5) [10] | | | |
| Week 5-8 | 5.3 (2.0) [5] | 13.8 (3.6) [15] | 13.6 (4.2) [15] | | | |
| Week 9-24 | 5.0 (1.9) [5] | 13.6 (5.2) [20] | 13.7 (6.4) [20] | <.001 | <.001 | <.001 |
| Month 7-12 | 4.4 (2.3) [5] | 10.6 (5.8) [20] | 9.7 (5.8) [20] | | | |
| Month 13-18 | 2.8 (2.3) [5] | 5.8 (5.7) [20] | 6.6 (5.3) [20] | | | |
| Days/week | | | | | | |
| Week 1-4 | 4.6 (1.0) [5] | 5.7 (0.7) [5] | 5.7 (0.8) [5] | | | |
| Week 5-8 | 4.6 (0.9) [5] | 5.6 (1.0) [5] | 5.6 (1.3) [5] | | | |
| Week 9-24 | 4.3 (1.1) [5] | 5.1 (1.4) [5] | 5.2 (1.7) [5] | <.001 | <.001 | .79 |
| Month 7-12 | 3.7 (1.5) [5] | 4.6 (1.7) [5] | 4.5 (1.8) [5] | | | |
| Month 13-18 | 2.5 (2.0) [5] | 3.0 (2.4) [5] | 3.7 (2.4) [5] | | | |

*LB indicates long bouts of exercise; SB, short bouts of exercise; and SBEQ, short bouts of exercise plus use of home exercise equipment. Data are self-reported, presented as mean (SD). Numbers in brackets indicate prescribed duration in minutes per session, sessions per week, or days per week.

**Figure 4.** Dose Response of Exercise on Weight Loss




Dose response of exercise on weight loss across 18 months of treatment (mean [SEM]). For time, group, and group × time, all $P<.001$. Error bars indicate standard error of the mean.

bout exercise was not combined with exercise equipment, the effectiveness of this exercise intervention in overweight women remains unclear.

Despite differences in exercise participation between the groups, additional factors such as dietary intake and attendance at group meetings also could have contributed to differences in weight loss. While recognizing the difficulty of assessing dietary intake in a free-living environment using questionnaires,[23] we observed no difference in dietary intake between the intervention groups at any time point. In addition, we observed no difference between groups for the number of behavioral sessions that were attended.

Although short-bout exercise was not significantly better than long-bout exercise with regard to weight loss, exercise participation, or fitness, this study suggests that long-term results obtained with short bouts were as beneficial as those obtained with long bouts in overweight women. Therefore, short bouts can be used as an option for incorporating exercise into one's lifestyle. Dunn et al[22] have shown that lifestyle physical activity is as effective as structured exercise for improving fitness in adults. These nontraditional methods of prescribing exercise should be considered when traditional methods of exercise prove to be ineffective at increasing participation.

Our study also demonstrated that achieving a minimum of 150 min/wk of exercise throughout the 18-month program enhanced weight loss compared with not maintaining this minimal level of exercise. However, achieving higher levels of exercise resulted in even greater weight loss at 18 months. These results indicate that overweight individuals can achieve relatively high levels of exercise per week. Moreover, the amount of exercise necessary for enhancing long-term weight loss may be greater than the minimum cited in public health recommendations,[8] which supports the findings of Klem et al[24] and Schoeller et al.[25]

In summary, this study showed that dietary modification combined with exercise performed in short bouts does not improve long-term weight loss compared with exercise performed in longer bouts. However, the addition of a home treadmill to the multiple short-bout exercise intervention (SBEQ) minimized reductions in long-term exercise participation and improved long-term weight loss. This study has also demonstrated that either continuous (LB) or intermittent exercise (SB, SBEQ) can significantly improve cardiorespiratory fitness, which is consistent with previous findings.[9,20] These results indicate that there are a number of options for effectively incorporating exercise into a behavioral weight loss program, and these should be considered when developing behavioral intervention strategies for increasing long-term weight loss and exercise participation in overweight adult women.

**Funding/Support:** This study was supported by the National Institutes of Health with a F.I.R.S.T. Award to Dr Jakicic (grant No. HL56127) and by grant No. DK46204 to support the Obesity/Nutrition Research Center at the University of Pittsburgh.

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