

Long-term weight losses associated with prescription of higher physical activity goals. Are higher levels of physical activity protective against weight regain?¹⁻³

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ABSTRACT

Background: High levels of exercise may be necessary for long-term maintenance of weight loss.

Objective: We aimed to determine in a randomized prospective design whether encouraging 2500 kcal physical activity/wk produced greater 30-mo weight losses than did the standard 1000 kcal physical activity/wk prescription.

Design: Overweight adults ($n = 202$) were randomly assigned to either 18 mo of standard behavioral treatment (SBT) with an exercise goal of 1000 kcal/wk or a high physical activity (HPA) treatment with a goal of 2500 kcal/wk. The HPA treatment included all procedures in the SBT plus encouragement to recruit 1–3 exercise partners and small-group counseling with an exercise coach. Participants were followed for 30 mo.

Results: The HPA group achieved significantly greater exercise levels and weight losses than did the SBT group at 12 and 18 mo ($P < 0.01$). Weight losses did not differ significantly at 30 mo: 0.90 ± 8.9 and 2.86 ± 8.6 kg for the SBT and HPA groups, respectively ($P = 0.16$). At 30 mo, average exercise levels no longer differed significantly between groups (1390 and 1696 kcal/wk, respectively; $P > 0.10$). Participants sustaining high exercise levels (>2500 kcal/wk) for 30 mo had significantly ($P < 0.001$) greater 30-mo weight loss than did those exercising less (12 ± 8.8 and 0.8 ± 8.1 kg, respectively).

Conclusions: Although participants in the HPA group sustained the 2500-kcal activity goal during the 18-mo treatment, activity declined once treatment ended, which resulted in no between-group differences in activity or weight loss at 2.5 y. Participants who reported continuing to engage in high levels of exercise maintained a significantly larger weight loss. *Am J Clin Nutr* 2007;85:954–9.

KEY WORDS Adults, long-term weight loss, weight maintenance, physical activity, clinical trial, obesity

INTRODUCTION

Standard physical activity recommendations in weight-control programs have been 1000 kcal/wk, which is approximately equal to the energy expended in walking 30 min/d and which corresponds to the general physical activity recommendations from the Centers for Disease Control and Prevention for health promotion (1). In 2002, the Institute of Medicine released a report recommending 60 min moderate activity/d for weight loss (2), and the 2005 Dietary Guidelines now include a similar goal of 60 min activity/d for weight loss (3). Sixty minutes of

moderate activity corresponds to ≈ 2100 kcal activity/wk, or roughly twice that typically recommended in behavioral weight-control programs (4).

Recognition that more exercise may be necessary for promoting long-term weight control after weight loss has emerged during the past decade. Several weight control studies examining weight loss in participants achieving high or low activity levels have found better long-term weight loss among high exercisers (5–8). Further evidence of the role of high levels of exercise in long-term weight maintenance has been accumulating from a large cross-sectional study of long-term weight maintainers, the National Weight Control Registry (NWCR). Successful weight losers in the NWCR report an activity level of ≈ 2800 kcal/wk, an amount almost 3 times that once recommended during weight loss treatment (9).

The current study was designed to determine, in a randomized prospective design, whether encouraging high levels of physical activity—ie, 2500 kcal/wk—during a behavioral weight-loss program would result in greater short-term (12–18 mo) and long-term (30-mo) weight losses than were seen in a group receiving standard behavior therapy—ie, 1000 kcal/wk. It was hypothesized that participants in the high physical activity (HPA) group would achieve higher levels of physical activity than those in the standard behavior therapy (SBT) group and also that the HPA group would achieve greater short- and long-term weight losses.

The short-term weight losses during the 18-mo treatment phase of this study were reported previously (10). The subjects randomly assigned to the HPA treatment (2500 kcal/wk) reported performing a significantly higher level of exercise at 6, 12, and 18 mo than did those in the SBT group. Weight losses were

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also significantly ($P < 0.05$) greater in the HPA group than in the SBT group at 12 and 18 mo, which indicated that recommending higher levels of physical activity during treatment can improve weight losses in the short term. This report focuses on the long-term follow-up of physical activity and weight outcomes 30 mo after randomization, or 1 y after the 18-mo treatment program ended.

SUBJECTS AND METHODS

Subjects

A total of 202 subjects were recruited evenly between the University of Minnesota School of Public Health (Minneapolis, MN) and the Miriam Hospital (Brown University Medical School, Providence, RI) through advertisements in local newspapers. Participants were 25–50 y old, 14–32 kg overweight according to actuarial norms, and free of serious medical or psychological disorders. Participants were randomly assigned to the SBT or HPA group. Both treatments involved behavior therapy for obesity conducted in small groups (eg, 10–20 participants) that met weekly during the first 6 mo, biweekly during months 7–12, and monthly during months 13–18. Groups were led by nutritionists, exercise physiologists, or psychologists. Dietary goals were identical in the 2 treatments: 1000 or 1500 kcal/d, depending on initial body weight with $\leq 20\%$ of calories from fat.

The difference between the 2 treatments was the prescribed physical activity goal. SBT involved recommendations to initiate a regular physical activity program, gradually building up to an energy expenditure (EE) of 1000 kcal/wk (eg, walking for 30 min/d). The HPA group's exercise goal was 2.5 times that of the SBT group, or an EE equivalent to 2500 kcal/wk (eg, walking 75 min/d). Several strategies were used to promote adherence to the higher exercise goals. HPA group participants were encouraged to invite 1–3 social support partners to participate with them, were assigned an exercise coach, and were given small monetary incentives for achieving 2500 kcal of exercise in a given week. Exercise coaches met with participants as an adjunct to regular standard behavioral treatment for 15–20 min in small groups. Participants in the HPA group were encouraged to reach the 2500-kcal exercise goal by month 6 of the program.

There was no treatment contact with participants after the 18-mo program. All participants were recontacted at month 30 (1 y after the end of the treatment program) and asked to come to the clinic for final assessments. Participants were paid \$50 for completing the 30-mo assessment.

Dependent measures

The primary dependent measure was change in body weight, as measured in the clinic with the use of a calibrated scale (Detecto, Webb City, MS) at baseline, 6, 12, 18, and 30 mo while the subject wore light street clothes and no shoes. Height was measured with a wall-mounted stadiometer (Perspective, Portage, MI). Physical activity was measured by using a self-report format of the Paffenbarger activity questionnaire (11) to provide an estimate of total EE (in kcal) during the previous week. Dietary intake, used to estimate daily energy intake (EI), was measured by using the Block food-frequency questionnaire (12) at each assessment and was analyzed by using DIETARY

ANALYSIS SYSTEM software (version 4.01; National Cancer Institute, Bethesda, MD).

Statistical analysis

The primary comparisons of interest were between treatment groups at 30 mo. Statistical analyses were performed with SPSS software (version 13; SPSS Inc, Chicago, IL). Continuous dependent variables (ie, weight, total EE, and total EI) were analyzed by using general linear modeling procedures for repeated measurements. For intention-to-treat analyses, participants for whom data were missing at any timepoint were assumed not to have lost any weight, and an approach of carrying the baseline forward was used. EE was not normally distributed, and the data were log transformed before analysis. Between-group comparisons of baseline characteristics, weight change, or change in calories (exercise or diet) at specific endpoints was analyzed by using analysis of variance. Analyses of exercise subgroups controlled for baseline weight and sex.

RESULTS

The participants ($n = 202$) had a mean (\pm SD) age of 42.2 ± 6.4 y; 58% were female, 43% were college graduates, 80% were white, and the average baseline body mass index (BMI; in kg/m^2) was 31.7 ± 2.6 (range: 26–44). There were no significant between-group differences in baseline characteristics (10). At 30 mo, retention of study participants as a proportion of those randomly assigned was 79% (74 of 93) in the SBT group and 77% (84 of 109) in the HPA group. Examination of the baseline characteristics of study completers ($n = 158$) and study dropouts ($n = 44$) at 30 mo found no significant differences in body weight, BMI, sex, EI, or EE.

From baseline to 30 mo, weight losses in the SBT and HPA groups were 0.90 ± 8.9 and 2.86 ± 8.6 kg, respectively. These weight changes correspond to a loss of 1% and 3% of initial body weight in the SBT and HPA groups, respectively, and these losses did not differ significantly by treatment. Moreover, no significant differences between groups were seen in weight regain from 18 to 30 mo: the SBT group regained 5.3 ± 7.0 kg, and the HPA group regained 5.9 ± 5.9 kg. At 30 mo, assuming no weight loss for those missing at follow-up, 26% of those randomly assigned achieved a total weight loss of $\geq 5\%$; 12% achieved a total weight loss of $\geq 10\%$, and there was no significant difference by treatment.

The pattern of weight loss over time in those with data at all timepoints (ie, 0, 6, 12, 18, and 30 mo) is shown in **Figure 1**. Repeated-measures analysis of variance (ANOVA) found a significant time effect ($P = 0.001$), but the treatment \times time interaction was not significant ($P = 0.21$). The repeated-measures ANOVA using an intent-to-treat approach, assuming no weight change from baseline for those with missing data, found the same pattern of significance.

Table 1 shows baseline and 30-mo means for dietary and exercise variables by treatment condition. For those with dietary data at baseline and 30 mo ($n = 150$), repeated-measures ANOVA found a significant time effect ($P < 0.001$), but the treatment \times time interaction was not significant; the 2 groups reported similar reductions in average daily EI over time (SBT group: 338 ± 822 kcal; HPA group: 378 ± 917 kcal) and in daily macronutrient intake over time. At baseline, both treatment



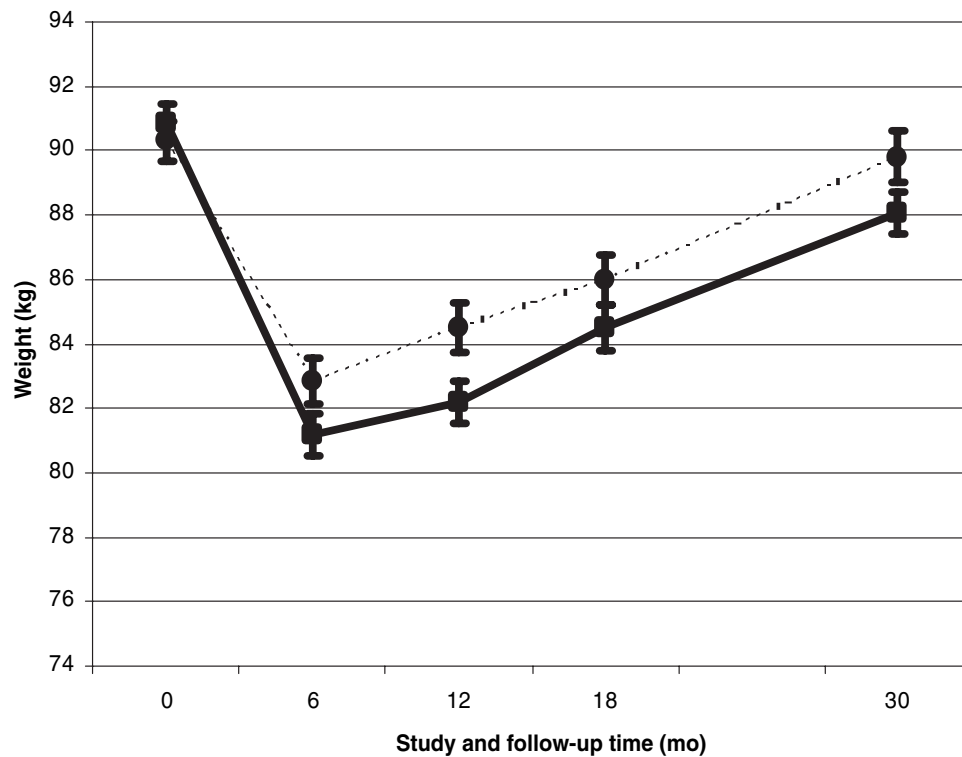


FIGURE 1. Weight by randomized group. ●, Standard behavior treatment group ($n = 66$); ■, high physical activity group ($n = 75$). Time effect, $P < 0.001$; treatment \times time interaction, $P = 0.21$ (repeated-measures ANOVA).

groups reported EEs of ≈ 1200 to 1300 kcal/wk. Although physical activity increased during treatment and was significantly higher in the HPA group than in the SBT group at 6, 12, and 18 mo (10), by 30 mo, exercise levels did not differ significantly between treatment groups. Repeated-measures ANOVA of the exercise data found a significant time effect ($P = 0.04$) but no

significant difference in the treatment \times time interaction ($P = 0.15$).

Association between amount of exercise at 30 mo and weight loss

Because the treatment groups did not differ in physical activity at 30 mo, data from both treatment groups were combined to examine the associations between magnitude of physical activity and long-term weight loss. Participants were grouped by the amount of EE at 30 mo. Half (49%) of the participants were exercising <1000 kcal/wk ($n = 37$ SBT, 40 HPA); 29% were exercising 1000 – 2500 kcal/wk ($n = 22$ SBT, 24 HPA); and 22% were exercising >2500 kcal/wk ($n = 15$ SBT, 20 HPA). Significant main effects of exercise group ($P = 0.003$) and sex ($P = 0.04$) on total weight loss were found, but the exercise group \times sex interaction was not significant ($P = 0.29$). Weight losses from baseline to 30 mo were significantly greater in men (4.2 ± 7.1 kg) than in women (0.29 ± 9.5 kg). In addition, weight losses from baseline to 30 mo were significantly greater in those who reported >2500 kcal exercise/wk at month 30, and the differences between the other 2 groups (ie, weight losses of 0.4 ± 8.3 , 0.6 ± 8.4 , and 7.0 ± 8.7 kg for those with <1000 , 1000 – 2500 , and >2500 kcal activity/wk at month 30, respectively) were not significant. Weight losses by activity group and sex \times activity group are presented in **Figure 2**. In addition, no differences in weight regain between 18 and 30 mo were observed in those with reported activity <1000 kcal/wk or between 1000 and 2500 kcal/wk; however, those with activity levels >2500 kcal/wk at 30 mo regained only 2.9 kg, whereas those with activity <1000 kcal/wk and between 1000 and 2500 kcal/wk regained >6 kg ($P < 0.05$).

TABLE 1
Behavioral outcomes by treatment group¹

	Baseline	30 mo	P^2
Energy intake (kcal/d)			
SBT	2082 ± 120 (74) ³	1710 ± 813 (67)	<0.001
HPA	2146 ± 1028 (84)	1780 ± 1030 (82)	
Protein (g/d)			
SBT	85 ± 47 (74)	77 ± 38 (67)	0.09
HPA	87 ± 36 (84)	82 ± 47 (82)	
Fat (g/d)			
SBT	84 ± 47 (74)	66 ± 36 (67)	<0.001
HPA	87 ± 50 (84)	69 ± 55 (82)	
Carbohydrate (g/d)			
SBT	239 ± 149 (74)	198 ± 100 (67)	<0.001
HPA	244 ± 115 (84)	204 ± 108 (82)	
Energy expenditure (kcal/wk)			
SBT	1273 ± 1144 (74)	1380 ± 1191 (73)	<0.05
HPA	1243 ± 1403 (84)	1696 ± 1552 (84)	

¹ SBT, standard behavioral therapy; HPA, high physical activity. Groups did not differ significantly at baseline.

² Significant effect for time; nonsignificant effect for group and group \times time interaction as determined by repeated-measures ANOVA.

³ $\bar{x} \pm SD$; n in parentheses (all such values).

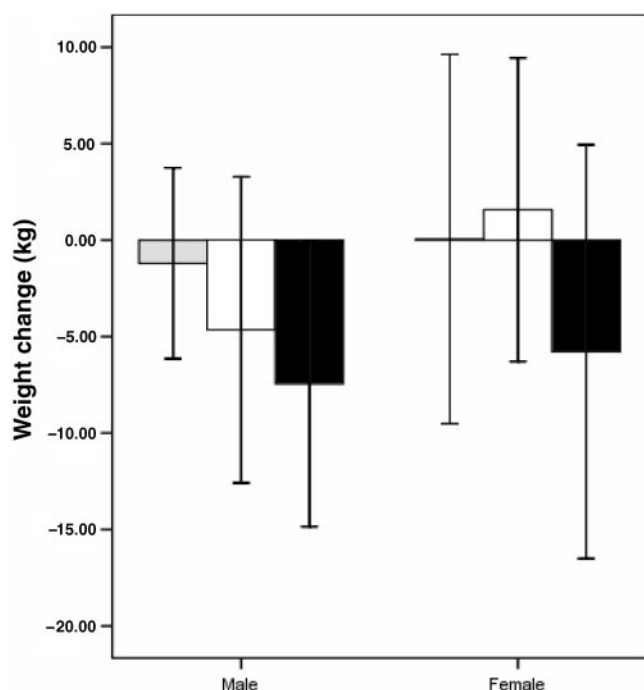


FIGURE 2. Weight changes by exercise level at 30 mo. \square , < 1000 kcal activity/wk ($n = 26$ M, 51 F); \square , $1000-2500$ kcal activity/wk ($n = 16$ M, 29 F); \blacksquare , >2500 kcal activity/wk ($n = 22$ M, 13 F). Main effect of sex, $P = 0.04$; main effect of exercise group, $P = 0.003$; sex \times exercise group interaction, $P = 0.29$ (NS). Error bars are ± 1 SD.

Is consistently high exercise protective against weight regain?

To examine the effect on weight maintenance of consistently exercising at a high level, post hoc analyses were conducted in a selected “high-adherence” exercise group. High adherence was defined as achieving and sustaining the goal of 2500 kcal activity/wk. This analysis was undertaken to explore whether those reporting high levels of activity at all follow-ups were protected against weight regain. Thus, participants were classified as achieving or not achieving ≥ 2500 kcal exercise/wk on the basis of their responses on the Paffenbarger activity questionnaire (11) at follow-up assessments (eg, 12, 18, and 30 mo). Participants who achieved this goal at all follow-ups were considered the high-adherence sample ($n = 13$; 3 SBT, 10 HPA; 3 F, 10 M) and were compared with other participants ($n = 141$). A comparison of this group sustaining high exercise with other participants with respect to weight and other behavioral factors related to weight loss is shown in **Table 2**. Weight losses over time are shown in **Figure 3**. Total weight losses at 30 mo were significantly greater in the group exercising at 2500 kcal (controlling for baseline weight and sex) compared with the average weight loss achieved by other participants (12 ± 8.8 and 0.8 ± 8.1 kg, respectively; $P < 0.001$). These participants achieved high levels of physical activity, lost significantly more initial weight than did other participants, and regained 3.1 ± 5.6 kg, whereas other participants regained 5.9 ± 6.4 kg ($P = 0.13$). An examination of weight regain as a percentage of initial weight lost found that 62% of participants reporting high adherence to exercise maintained $\geq 75\%$ of their initial weight loss. Only 24% of those reporting less consistent exercise maintained 75% of their initial weight loss. Table 2 shows that high exercisers reported not only the

TABLE 2

Comparison of consistently high exercisers with all others on weight and behavioral variables

	Baseline	30 mo	<i>P</i>
Weight (kg)			
>2500 ($n = 13$)	96.3 \pm 7.8 ¹	84.3 \pm 8.4	0.03 ²
Others ($n = 141$)	90.1 \pm 10.1	89.2 \pm 12.7	< 0.001 ³
Energy intake (kcal/d)			
>2500 ($n = 13$)	2542 \pm 930	1710 \pm 813	0.03 ³
Others ($n = 133$)	2042 \pm 1075	1747 \pm 967	
Protein (g/d)			
>2500 ($n = 13$)	92 \pm 24	79 \pm 30	NS
Others ($n = 133$)	84 \pm 43	80 \pm 44	
Fat (g/d)			
>2500 ($n = 13$)	96 \pm 33	58 \pm 24	0.05 ³
Others ($n = 133$)	83 \pm 48	69 \pm 49	
Carbohydrate (g/d)			
>2500	277 \pm 95	211 \pm 90	0.001 ⁴
Others	235 \pm 135	199 \pm 106	
Energy expenditure (kcal/wk)			
>2500	1776 \pm 1411	4490 \pm 1337	0.003 ³
Others	1188 \pm 1234	1227 \pm 1005	

¹ $\bar{x} \pm$ SD (all such values).

² Groups differed significantly at baseline.

³ Significant group \times time interaction (repeated-measures ANOVA).

⁴ Significant main effect for time (repeated-measures ANOVA); non-significant group effect.

maintenance of a substantially larger increase in exercise per week at 30 mo than did other participants (2713 ± 1804 and 78 ± 1489 kcal, respectively) but also greater decreases in dietary intake (828 ± 791 and 315 ± 869 kcal/d)—in particular, significantly greater changes in fat intake ($P < 0.05$).

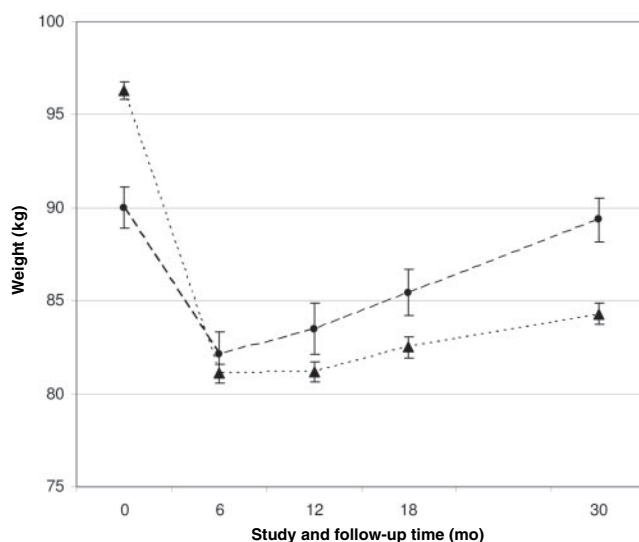


FIGURE 3. Weight for consistently high exercisers (\blacktriangle ; $n = 13$) compared with all other participants (\bullet ; $n = 128$). Treatment \times time interaction, $P = 0.001$; time effect, $P = 0.001$ (repeated-measures ANOVA). Mean weight losses differed significantly ($P = 0.001$) at 6, 12, 18, and 30 mo after control for baseline weight and sex.

DISCUSSION

This study examined the hypothesis that participants randomly assigned to a behavioral weight-loss program that prescribes 2500 kcal physical activity/wk would have better weight loss and maintenance than would participants randomly assigned to a program with the standard exercise prescription of 1000 kcal/wk. Although this hypothesis was supported through 18 mo (10), by 30 mo, weight losses did not differ significantly between the groups. Participants in the HPA lost 3% of initial body weight from baseline to 30 mo, whereas participants in the SBT group lost 1%.

The failure to achieve greater long-term weight loss in the HPA group at 30 mo likely relates to the failure to maintain higher levels of physical activity 1 y after treatment ended. Although participants randomly assigned to the HPA group were able to sustain their higher exercise during treatment, once the 18 mo treatment ended, their exercise levels dropped. Strategies are needed to help participants maintain high levels of activity over the long-term. Lengthening weight-loss treatment has been shown to improve adherence to prescribed behaviors and to result in better overall weight losses (13–15). The current study included an 18-mo treatment protocol, but even longer periods of treatment in a chronic care model may be necessary to sustain the behaviors necessary for long-term weight regulation. Physical activity maintenance has been promoted through lower-intensity strategies such as mailings and periodic phone calls (16); thus, extending the treatment via print, phone, or e-mail contacts may have helped to maintain the difference between treatment conditions in physical activity and weight loss in the current study. It is also possible that sustaining the long-term behavior changes that are needed for behaviors such as physical activity will require changes to the larger social and environmental context in which these behaviors occur (17).


Higher levels of physical activity were associated in the current study with better long-term weight losses in both men and women, which confirms several earlier studies that reported significant associations between activity levels and weight-loss maintenance (5, 7, 18). It is interesting that overall weight loss from baseline to month 30 and weight regain from month 18 to month 30 did not differ between participants who reported <1000 kcal activity/wk and those reporting 1000–2500 kcal activity/wk at 30 mo. Only exercise expenditures > 2500 kcal/wk were substantially better at promoting long-term weight loss. Specifically, 2.5 y after baseline, participants reporting >2500 kcal activity/wk lost an average of 7 kg from baseline weight, whereas the other 2 groups had average weight losses of < 1 kg. Moreover, those exercising > 2500 kcal/wk regained only 3 kg from month 18 to month 30, whereas those exercising < 250 kcal/wk lost >6 kg. These data suggest that there may be a threshold for physical activity and support the recent Institute of Medicine recommendations (2) for higher levels of physical activity for weight loss maintenance.

Extension of this dose-response analysis to those persons who reported consistently high levels of exercise at every follow-up assessment found an even larger total weight loss (12%) in comparison with all other participants (1%). However, those participants reported not only high physical activity levels but also significant decreases in EI and dietary fat intake. Thus, their successful weight loss probably relates to combined changes in diet and activity, which is consistent with the findings from the

National Weight Control Registry, in which participants who are most successful at long-term maintenance of weight loss are maintaining high levels of exercise and following a diet low in calories and fat (19).

Perhaps of greatest interest and concern is the finding that none of the levels of activity attained in this study were effective in totally preventing weight regain. Examination of the most successful participants—those reporting >2500 kcal activity/wk at 6, 12, 18, and 30 mo—found that weight regain was still evident. It should be noted that only 13 participants achieved those consistently high levels of activity. On average, these consistently high exercisers regained 2 kg during the year of follow-up, and only 4 participants maintained their entire weight loss throughout the year. However, the overall weight loss of 12% in these participants is notable and would result in important improvements in health. Furthermore, their regain is less than that in participants with lower levels of activity or less consistent activity. The goal of behavioral programs may thus have to be increasing the magnitude of weight loss achieved during treatment, with acceptance that, even with high activity levels, some weight regain is going to occur.

The study has several major strengths, including the randomized design, multicenter intervention, objective weight data at all follow-up points, long-term treatment and follow-up, and study retention. Limitations include the self-reporting of the behavioral measures. It is not possible to determine consistency of exercise during the entire follow-up period by using any self-reported measure of physical activity. Most self-reported measures and even interviewer-administered recalls capture the activity of the previous week, which may or may not have been typical of weeks between the assessment visits. In addition, we did not consider differences in body composition that could result from different exercise levels.

Taken together, the short- and long-term data have important implications for behavioral weight control programs. The short-term data (10) suggest that behavioral weight control programs can extend weight losses to 18 mo by increasing the exercise recommendations to ≥ 60 min/d and providing the support that participants need to achieve this goal. The long-term data suggest that few participants will continue to follow these recommendations once treatment ends. However, those who continue with a high level of activity (>2500 kcal/wk) and a low-fat diet will achieve the best long-term outcomes. 

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RRW and RWJ were responsible for the study design; NES and DFT were responsible for data collection; DFT was responsible for writing the manuscript; and all authors contributed to data analysis, interpretation, and manuscript revision. None of the authors had a financial or personal conflict of interest.

REFERENCES

1. Pate R, Pratt M, Blair S, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 1995;273:402–7.
2. Institute of Medicine. Dietary reference intakes for energy, carbohydrates, fiber, fat, protein and amino acids (macronutrients): a report of the Panel on Macronutrients, Subcommittees on Upper Reference Levels of Nutrients and Interpretation and Uses of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Washington, DC: National Academies Press, 2002.
3. US Department of Health and Human Services and US Department of



- Agriculture. Dietary guidelines for Americans. 6th ed. Washington, DC: US Government Printing Office, 2005.
4. Wing RR. Behavioral approaches to the treatment of obesity. In: Bray G, Bouchard C, James W, eds. Handbook on obesity. New York, NY: Marcel Dekker; 1998:855–73.
 5. Schoeller D, Shay K, Kushner R. How much physical activity is needed to minimize weight gain in previously obese women? *Am J Clin Nutr* 1997;66:551–6.
 6. Jeffery RW, Wing RR, Thorson C, Burton LR. Use of personal trainers and financial incentives to increase exercise in a behavioral weight-loss program. *J Consult Clin Psychol* 1998;66:777–83.
 7. Jakicic JM, Winters C, Lang W, Wing RR. Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss, and fitness in overweight women: a randomized trial. *JAMA* 1999;282:1554–60.
 8. Jakicic JM, Marcus BH, Gallagher KI, Napolitano M, Lang W. Effect of exercise duration and intensity on weight loss in overweight, sedentary women: a randomized trial. *JAMA* 2003;290:1323–30.
 9. Klem M, Wing RR, McGuire M, Seagle H, Hill J. A descriptive study of individuals successful at long-term maintenance of substantial weight loss. *Am J Clin Nutr* 1997;66:239–46.
 10. Jeffery RW, Wing RR, Sherwood NE, Tate DF. Physical activity and weight loss: does prescribing higher physical activity goals improve outcome? *Am J Clin Nutr* 2003;78:684–9.
 11. Paffenbarger RS Jr, Wing AL, Hyde RT. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol* 1978;108:161–75.
 12. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol* 1990;43:1327–35.
 13. Perri MG, Nezu AM, Patti ET, McCann KL. Effect of length of treatment on weight loss. *J Consult Clin Psychol* 1989;57:450–2.
 14. Perri MG, Sears S, Clark J. Strategies for improving maintenance of weight loss: toward a continuous care model of obesity management. *Diabetes Care* 1994;16:200–10.
 15. Perri M, Corsica J. Improving the maintenance of weight lost in behavioral treatment of obesity. In: Wadden T, Stunkard A, eds. Handbook of obesity treatment. New York, NY: Guilford Press, 2002:357–82.
 16. Castro C, King A, Brassington G. Telephone versus mail interventions for maintenance of physical activity in older adults. *Health Psychol* 2001;20:438–44.
 17. Saelens BE, Sallis JF, Black JB, Chen D. Neighborhood-based differences in physical activity: an environment scale evaluation. *Am J Public Health* 2003;93:1552–8.
 18. Ewbank P, Darga L, Lucas C. Physical activity as a predictor of weight maintenance in previously obese subjects. *Obes Res* 1995;3:257–63.
 19. McGuire M, Wing RR, Klem M, Hill J. Behavioral strategies of individuals who have maintained long-term weight loss. *Obes Res* 1999;7:334–41.

