The Role of Physical Activity in Prevention and Treatment of Body Weight Gain in Adults\textsuperscript{1,2}

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ABSTRACT  Overweight and obesity are increasing in prevalence, and this has resulted in a significant public health burden. Therefore, it is important to identify interventions that prevent weight gain and prevent weight regain after weight loss. Energy expended in physical activity has the potential to affect energy balance, and this can potentially affect body weight regulation. There is some evidence that physical activity can minimize weight gain, and it appears that needs to be moderate to vigorous in intensity to significantly affect body weight. Moreover, it appears that improvements in fitness are associated with reductions in risk of weight gain. Physical activity also is associated with improved maintenance of weight loss. Although it appears that interventions targeting physical activity are necessary to affect weight gain and improve long-term weight loss, the impact of these interventions on other components of energy balance should be examined. In addition, although minimal public health recommendations can significantly affect health outcomes, additional research is needed to identify the optimal dose of physical activity to prevent weight gain and improve long-term weight loss.  J. Nutr. 132: 3826S–3829S, 2002.

KEY WORDS:  ● exercise  ● energy expenditure  ● overweight  ● obesity

It is estimated that 50 to 60% of adults in the United States are overweight (1,2), and these estimates indicate that there has been a significant increase in prevalence rates of overweight over the past 10–20 y (1). During this period the total percentage of adults classified as overweight [body mass index (BMI) = 25.0–29.9 kg/m\textsuperscript{2}] has remained relatively stable (32%); however, the absolute number of overweight adults has increased significantly (1). In addition, the percentage of adults classified as obese (BMI $\geq$ 30 kg/m\textsuperscript{2}) has increased from 12% of men and 16% of women in the late 1970s to 20% of men and 25% of women by the early 1990s (1). This increase in the prevalence of overweight and obesity has resulted in a significant public health burden.

Because of the significant health burden of overweight and obesity, interventions to address this epidemic are necessary. Traditionally intervention efforts have focused on treatment, and efforts continue to improve long-term treatment outcomes. The most effective behavioral programs result in an initial weight loss of $\sim$10%; however, maintenance of this magnitude of weight loss has proved to be challenging. Because of the number of chronic conditions (e.g., diabetes, heart disease, cancer etc.) that have been linked to excess body weight (3), efforts to treat this condition remain important.

Although it is important to continue to provide interventions to assist overweight and obese individuals to effectively reduce their body weight, it is equally important to develop interventions to minimize weight gain to prevent the onset of overweight and obesity. Weight gain prevention efforts may be one of the most effective strategies for addressing the overweight and obesity epidemic in the United States; however, far less is known about prevention of weight gain than about weight loss. Therefore, modification to behaviors that affect energy balance (eating and exercise behaviors) may be effective for both prevention of weight gain and treatment for weight loss. It appears that exercise in particular is important both for the prevention of weight gain (4,5) and for improving long-term weight loss (6–9).

Physical activity for prevention of weight gain

Examination of population trends indicates that there may be a link between physical inactivity and increases in body weight. For example, there is a significant increase in the prevalence of obesity as adults move from the third decade of life (20–29 y of age) to the sixth decade of life (50–59 y of age) (1). Moreover, examination of physical activity data from the National Health Interview Survey (NHIS) and the Behavioral Risk Factor Surveillance System (BRFSS) demonstrates that the percentage of adults meeting the minimal public health recommendations for physical activity decreases across this same period of time (10). The data for men are presented in Figure 1, and a similar pattern exists for women.
Thus, as obesity increases from 20 to 60 y of age, there is a corresponding decrease in physical activity, and this may partially contribute to the increase in body weight.

Data from the National Health and Nutrition Examination Survey I follow-up study, 1971–1975 to 1982–1984, provide evidence that low levels of physical activity may be linked to weight gain in both men and women (5). Odds ratios for weight gain were based on the reference group being those individuals that reported high levels of recreational physical activity at both assessment periods (1971–1975 and 1982–1984). For men, the relative odds of gaining 8.1–13.0 kg increased to 2.0 and 3.9 for those reporting moderate or low levels of physical activity at both assessments, respectively. For women, the relative odds of gaining >13.0 kg increased to 3.4 if moderate activity was reported at both assessments, and further increased to 7.1 if low levels of activity were reported at both assessment periods. The risk of significant weight gain was lower in individuals who increased their level of physical activity compared to those who decreased their level of physical activity. These results support the hypothesis that recreational physical activity may have an impact on significant weight gain. Moreover, these findings appear to indicate that there may be a dose-response relationship, with higher levels of exercise being more effective than both moderate and low levels of exercise for prevention of weight gain. Of interest is the association between body weight and change in body weight with nonrecreational physical activity was inconsistent. This may be a result of either the intensity or the duration of the activity that is performed, or the interpretation by individuals regarding details of this activity. For example, many household activities (e.g., cleaning) can vary in intensity and duration. Thus, although it may take 2 h to clean a house, the amount of time that the individual is actually active may be <2 h and the intensity may also be reduced if labor-saving devices are being used.

The Pound of Prevention Study (4) examined various strategies to prevent weight gain in a community sample of adults. Analysis of data collected across a 3-y period revealed that physical activity was predictive of change in body weight (4). Analysis of data for women showed that an increase in either moderate intensity (i.e., walking and home maintenance activities such as gardening and snow shoveling), high intensity (i.e., running/jogging, biking, swimming, exercise classes) or occupational activity was prospectively associated with a lower body weight. Body weight at follow-up was lower by 0.10 kg for each additional moderate intensity exercise session/wk and by 0.15 kg for each high intensity exercise session/wk. In men each additional high intensity exercise session/wk resulted in body weight being lower by 0.54 kg. These data further support the role of physical activity in the prevention of weight gain in adults and provide some evidence that the amount of activity necessary for prevention of weight gain may differ between men and women. In addition, higher intensity activity (e.g., running/jogging, biking, swimming) may be more beneficial than less intense activities for prevention of weight gain, particularly in men.

Results from additional studies support the use of physical activity to prevent weight gain (11–13). For example, the Stanford Five-City Project conducted baseline assessments in five northern California cities between 1980 and 1982, with follow-up occurring every other year until 1989. Results revealed that both men and women who increased their level of physical activity gained less weight during this period than individuals who maintained or reduced their level of physical activity (11). Thus, these results support the hypothesis that participation in adequate levels of physical activity will be protective for weight gain.

It may be important that physical activity be sufficient intensity and/or duration to result in significant improvements in cardiorespiratory fitness to effectively attenuate weight gain in adults. DiPietro et al. (14) examined data from the Aerobics Center Longitudinal Study, which is a database of men and women who received at least three medical examinations between 1970 and 1994. Results of this study showed that a 1-min improvement in time on a treadmill during a graded exercise test resulted in 0.6 kg less weight gain in both men and women. Moreover, the odds of gaining ≥5 kg was reduced by 14% in men and 9% in women for every 1-min improvement in fitness, with the odds of gaining ≥10 kg reduced by 21% in both genders with this same improvement in fitness.

Physical activity for prevention of weight regain

Physical activity has also been shown to play a significant role in improving weight loss in overweight and obese adults. Although the combination of changes in both eating and exercise behaviors is the most effective behavioral treatment for weight loss (3), physical activity may be especially important for preventing or minimizing weight regain after initial weight loss (6–9).

To more effectively implement physical activity interventions to prevent weight regain, it is important to establish the optimal dose of physical activity that is most effective. The minimal level of physical activity that will improve health is 150 min/wk (10,15). However, it is unclear whether this level of physical activity will also be effective for preventing weight regain. There is an increasing body of literature suggesting that levels of physical activity greater than the minimal public health recommendation is required for preventing weight regain in overweight and obese adults (6–9). For example, data collected on individuals in the National Weight Control Registry that have maintained a weight loss of ~30 kg for ~6 y report participating in ~2500–3500 kcal/wk of leisure-time physical activity (6). This would be the equivalent of engaging in ~3.5–5.0 miles of brisk walking every day of the week.

The findings from the National Weight Control Registry are supported by Schoeller et al. (7) and Jakicic et al. (9). Schoeller et al. (7) followed women for a period of 1 y after initial weight loss, a threshold of 80 min/d of moderate intensity physical activity or 35 min of vigorous intensity physical activity was related to reductions in weight gain in this sample. Jakicic et al. (9) reported that greater levels of physical activity had minimal impact on 6-mo weight loss in women that were reducing energy intake. However, the impact of exercise appeared to be more effective for prevention of weight regain. It was reported that women engaging in ~280 min/wk of at least moderate intensity physical activity (i.e., brisk walking) throughout the 18-mo study reduced their body weight by 13 ± 8.0 kg,

![FIGURE 1 Participation in >150 min/wk of physical activity across age groups in men based on the National Health Interview Survey (NHIS) and the Behavioral Risk Factor Surveillance Survey (BRFSS) [see US Department of Health and Human Services (10)].](https://academic.oup.com/jn/article-abstract/132/12/3826S/4712105)
whereas exercising <200 min/wk or <150 min/wk resulted in weight loss of 8.5 ± 5.8 and 3.5 ± 6.5 kg, respectively.

Results of these studies suggest that physical activity levels greater than the minimal level that is currently recommended to improve health may be necessary to prevent weight regain after a period of weight loss. However, data from randomized clinical trials are needed to confirm these findings. Therefore, these data do not suggest that the current physical activity recommendations are ineffective in overweight and obese adults; rather, these individuals can realize significant improvements in health and fitness by increasing participation in moderate intensity physical activity to at least 150 min/wk (10,15). When this level has been successfully achieved, additional weight control benefits may be realized by increasing activity participation above this minimal recommended level.

The impact of physical activity on components of energy balance

Maintaining energy balance is the key to weight maintenance and prevention of weight regain after initial weight loss. The components of energy balance include both energy expenditure and energy intake, and it is important to understand the impact and influence of physical activity on each of these components. This may provide important information to understand the mechanisms by which physical activity exerts an effective impact on body weight regulation.

The largest component of energy expenditure is the resting component. Resting energy expenditure (REE) is ~75% of total energy expenditure for most individuals (16). REE is positively correlated with both total body mass and fat-free mass (17,18), and individuals with greater body mass or fat-free mass typically have a higher REE compared to that of individuals with lower body mass and fat-free mass. Certain forms of physical activity have been shown to affect fat-free mass, and it may be hypothesized that the increase in fat-free mass will ultimately lead to an increase in REE. Although the magnitude of this increase in REE can vary, even a minimal increase in REE can affect energy balance and changes in body weight. However, during weight loss absolute REE tends to decrease, and neither resistance nor aerobic forms of exercise have been shown to prevent the decrease in absolute REE that is typically observed (19–21). Therefore, it is unlikely that physical activity prevents initial weight gain or weight regain solely through the impact on REE.

The most variable component of energy expenditure is the energy expended in various forms of physical activity. This physical activity component consists of activities of daily living and other lifestyle activities, leisure-time and recreational activity and other forms of structured exercise. It is estimated that physical activity accounts for ~20–30% of total daily energy expenditure (16), but this can vary between individuals based on activity behaviors. For example, those who are physically active in their occupation (e.g., construction worker) may have a greater level of energy expenditure in physical activity than those who are seated at a desk most of the day (e.g., secretary). However, even an individual with a relatively sedentary occupation can participate in leisure-time and structured forms of physical activity to enhance total daily energy expenditure. Therefore, all forms of physical activity can affect energy balance, and it is important to engage in sufficient amounts of physical activity to affect body weight.

Although it is apparent that an adequate amount of physical activity is necessary to effectively manage body weight, physical activity may be part of a constellation of behaviors that are important for successfully controlling body weight. For example, there is evidence that individuals who are successful at prevention of weight gain engage in sufficient amounts of physical activity and also make changes in their eating behaviors. Data from the Pound of Prevention study indicate that an increase in physical activity significantly contributes to protection from weight gain (4). However, this study also reports that dietary fat intake was predictive of increases in body weight (4). In addition, close examination of the data from the National Weight Control Registry shows that individuals successful at long-term weight loss engage in high levels of physical activity and engage in healthful eating behaviors (6). Although physical activity is part of a cluster of behaviors that are important for body weight management, it has not been clearly shown that physical activity causes a change in dietary behaviors (22).

Strategies for improving physical activity participation

It appears that physical activity does play a significant role in management of body weight. However, although the importance of physical activity is well known, strategies for improving participation in physical activity are desperately needed. As described earlier, as physical activity decreases, weight has a tendency to increase. This is especially troublesome because the prevalence of physical inactivity in both children and adults is extremely high (10). Therefore, it is important to consider strategies to enhance physical activity participation in underactive and inactive individuals because this may have a significant impact on the overweight and obesity rates.

Environmental changes. It has been suggested that many individuals living in developed countries are exposed to a “toxic environment” that affects physical activity behaviors, and this ultimately leads to overweight and obesity (23). The “toxic environment” can affect energy expenditure by reducing opportunities for physical activity and increasing opportunities for sedentary behaviors. Therefore, it has been suggested that modifications to the environment may have a significant affect on behaviors that may have an impact on body weight.

When considering the potential changes that can be made to the environment that will affect physical activity, it may be important that these changes result in an increase in the convenience of opportunities for physical activity. When provided with an option to engage in a sedentary or active behavior, it has been shown that providing physical activity options that were proximal to the individual resulted in a higher selection of the physical activity behavior compared to when the activity option was more distal (24). When applied to environmental systems such as communities and neighborhoods, these results may suggest that the availability of sidewalks, parks and other physical activity amenities are important considerations. For example, Sallis et al. (25) showed that individuals living in close proximity to physical activity options report higher levels of physical activity than that of individuals living in areas with a low density of physical activity options. Although these findings are encouraging, the direction of this relationship is unknown. In addition, extensive research is needed to examine whether modifications to communities such as, for example, building sidewalks, bike trails and parks lead to an increase in physical activity in individuals living in those communities.

Critical moments for intervention. If the reduction in energy expenditure is linked to weight gain, it is important to understand why this might occur. As suggested earlier, weight increases and physical activity decrease between 20 and 60 y of age (1,5). These changes may be a result of life transitions that are occurring during this period. For example, this may be a time when employment status changes, families start and so
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forth. It has been suggested that it may be important to intervene in health-related behaviors when life events begin to change, as is typical in early adulthood (26). In addition, it may be important to identify key periods when children and adolescents show signs of reducing physical activity (10). Therefore, interventions targeting physical activity that focus on specific life events or life periods may be especially important for prevention of weight gain.

Lifestyle approaches to physical activity. To improve or maintain adequate amounts of physical activity to control body weight, alternative approaches to traditional structured exercise may be effective. Recent literature suggests that it may be advantageous to use a lifestyle approach to changing physical activity behaviors (27,28). These lifestyle approaches incorporated behavioral skills training into the intervention to promote adoption and maintenance of physical activity. For example, Dunn et al. (28) individualized activity recommendations based on stage of readiness for change and used small-group interactions along with behavioral skills training such as problem solving. Thus, including behavioral strategies that assist participants to incorporate moderate intensity physical activity into their lifestyles appears to be beneficial.

It has also been suggested that lifestyle forms of physical activity (gardening, house cleaning etc.) may be effective for managing body weight (27). To date these studies have included information regarding the activity that was prescribed, but have failed to provide information regarding specific activities that participants have selected and actually performed. However, it has been well documented that dividing 30–40 min of exercise into multiple 10-min bouts of exercise may facilitate initial adoption of activity in previously sedentary adults (9,29). Therefore, alternative approaches to promoting physical activity should be considered, and these may have a significant impact on body weight regulation.

Summary

In summary, it appears that the prevalence of obesity is increasing in both adult men and women. Because of this increase over the past few decades it is important to focus not only on the treatment of obesity but also on the prevention of obesity. Data from population-based surveys and longitudinal observational studies indicate that exercise may be an important strategy for prevention of weight gain. Moreover, there is a growing body of literature to support the importance of physical activity for improving long-term weight loss. Currently, minimal public health guidelines recommend 150 min of moderate intensity physical activity per wk. It is important to develop effective intervention strategies for promoting the adoption and maintenance of this minimal level of physical activity. Moreover, it is important to examine whether this level of physical activity is effective for preventing weight gain and enhancing long-term weight loss.

LITERATURE CITED