



# Research DIGEST

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## The Importance of Physical Activity for Losing Weight, Maintaining Weight, and Preventing Weight Gain

### Brief Summary

Physical activity is an important component of interventions to prevent weight gain and to enhance weight loss. Physical activity is also critically important for maintaining weight. Physical activity can also positively impact other health-related outcomes. Therefore, physical activity is recommended in intervention programs for the prevention and treatment of overweight and obesity in adults.

The prevalence of Americans who are overweight or obese is the source of significant public health problems in the United States, and many other countries around the world are experiencing the same problems. Determination of whether a person is overweight or obese is typically based on body mass index (BMI). BMI is used to categorize an individual as normal weight (BMI = 18.5 -24.9 kg/m<sup>2</sup>), overweight (BMI = 25 -29.9 kg/m<sup>2</sup>), or obese (BMI of 30 kg/m<sup>2</sup> or greater). Population-based trends show steady increases in the prevalence of overweight and obesity over the past several decades. Population-based data<sup>1</sup> show that 68.8% of adults in the United States are either overweight or obese. Severe obesity is defined by a BMI >35.0 kg/m<sup>2</sup> and the prevalence of severe obesity in the United States is 15.4%, which is of great concern. The prevalence of overweight and obesity are public health concerns because of their association with numerous chronic diseases and health-related conditions.<sup>2</sup>



*Physical activity contributes to improvements in  
body weight regulation and also has independent effects  
on other health-related outcomes.*

Thus, interventions are needed to prevent excessive weight gain, reduce body weight in those who are overweight and obese, and sustain weight loss. Medical weight management methods include pharmacotherapy and bariatric surgery, but even with these interventions the cornerstone of successful long-term weight management is grounded in lifestyle approaches, with physical activity as a key component.

## Energy Balance

The delicate balance between energy (calorie) intake and energy (calorie) expenditure, typically referred to as energy balance, is central to body weight regulation for adults. Given that physical activity participation in the United States and many other parts of the world is low,<sup>3</sup> incidence of overweight and obesity over the past several decades has increased. Thus, physical activity has been recommended as a key lifestyle behavior to both prevent and treat overweight and obesity in adults.<sup>2</sup>

On the surface, the concept of energy balance appears simple. To prevent weight gain, energy (or caloric) intake cannot exceed energy (or caloric) expenditure. To lose weight, the energy intake must be less than the energy expenditure. This approach to energy balance reflects a “static” perspective of how energy intake and energy expenditure interact. For example, in a static model of energy balance, when energy expenditure is altered it is assumed that energy intake will remain constant unless intentionally modified; likewise, when energy intake is altered the assumption is that energy expenditure will remain constant unless intentionally modified.

However, research is emerging to suggest that energy intake and energy expenditure do not function in isolation as suggested in a static model of energy balance, but rather that unique, and sometimes unanticipated, interactions occur between energy intake and energy expenditure. For example, in response to a single bout of approximately 40 minutes of exercise performed at 70% to 75% of age-predicted maximal heart rate, 58% of subjects reduced energy intake compared to a non-exercise control condition, whereas 42% increased energy intake following exercise compared to a control condition.<sup>4</sup> Thus, in some individuals the energy expended through exercise may be counteracted due to a subsequent increase in energy intake, reducing the effectiveness of physical activity to alter body weight.

The three main components that contribute to total energy expenditure are resting energy expenditure, thermic effect of food, and physical activity.<sup>5</sup> Resting energy expenditure is the amount of energy required to sustain basic physiological processes and the thermic effect of food is the amount of

energy above resting energy expenditure that is required to process and digest the foods that are consumed. Both resting energy expenditure and the thermic effect of food are relatively stable, changing only in response to chronic and significant changes in weight, physical activity, or eating patterns. Within the components of total energy expenditure, the more variable component is physical activity, including both lifestyle (walking up stairs, carrying groceries, etc.) and structured periods of activity (basketball, swimming, yoga, etc.).<sup>5</sup> However, it has been suggested that physical activity may also influence other components of energy expenditure, namely resting energy expenditure, which can further affect total energy expenditure. There appears to be an acute increase in resting energy expenditure in response to physical activity, and chronic physical activity participation may be associated with a higher resting energy expenditure.<sup>6</sup> This may be important for overweight and obese individuals because resting energy expenditure tends to decrease in the presence of weight loss, which can decrease total energy expenditure and possibly affect weight loss and weight loss maintenance. However, even when physical activity is included as a component of the intervention, resting energy expenditure has been shown to decline in response to significant weight loss.<sup>7</sup> Still, this decrease is less than when weight loss is achieved through methods that do not include physical activity. Thus, it is unlikely that physical activity results in increased resting energy expenditure during periods of significant weight loss.





## Association between Physical Activity and Weight Gain or Obesity

Prospective cohort studies have examined the association between weight and baseline physical activity, physical activity at follow-up, and the change in physical activity from baseline to follow-up. In a nationally representative sample of men and women, it was shown that the current level of self-reported physical activity was not predictive of change in weight over a period of two years.<sup>8</sup> Similar findings were reported in which baseline energy expenditure was not predictive of weight change over a follow-up period of four years.<sup>9</sup>

In contrast, an inverse association between BMI and physical activity at moderate-to-vigorous intensity ( $>3 \text{ MET} \cdot \text{min}^{-1}$ ) consistently for a period of  $>10$  minutes has been reported that is predictive of weight change.<sup>10</sup> A MET is a metabolic equivalent, with 1 MET equivalent to the energy expenditure under resting conditions. Thus, for example, an activity that has an energy expenditure of 3 METs would result in an energy expenditure that is three times the energy expenditure experienced under resting conditions. These findings showed that individuals with higher BMIs were engaging in physical activity less frequently, for a shorter duration and at a lower intensity, compared to individuals with lower BMIs. This appears to contribute to lower energy expenditure from physical activity as BMI increases, but does not necessarily imply that low physical activity contributes to higher BMI. Support for physical activity in preventing weight gain and obesity also comes from the Nurses' Health Study,<sup>11</sup> which

reported that for each hour per day of brisk walking there was a 24% reduction in the risk of becoming obese over a period of six years. Di Pietro et al.<sup>12</sup> estimated that weight gain would occur in men who had a decrease in their physical activity level over a period of five years, with modest weight loss occurring in men who increased their activity from low to moderate or low to high.

A significant body of literature indicates that sedentary behavior, rather than engagement in physical activity, may also be associated with weight gain and the onset of overweight or obesity.<sup>13</sup> For example, the Nurses' Health Study has reported a 23% increase in the risk of becoming obese for each two-hour per day increase in television viewing time.<sup>11</sup> Ball and colleagues<sup>14</sup> have also reported that a higher level of sedentary time, defined as time spent sitting, was associated with a decrease in the likelihood of weight maintenance and an increase in the likelihood of weight gain over a period of four years in young women.

## Weight Loss from Physical Activity Interventions without Diet Restrictions

While physical activity has been recommended as a key behavior within interventions that target overweight and obesity,<sup>2</sup> the effect on weight loss appears to be modest when physical activity is not coupled with a reduction in energy intake. The U.S. Department of Health and Human Services' 2008 *Physical Activity Guidelines for Americans*<sup>15</sup> concluded that physical activity equivalent to 180 to 270 minutes per week resulted in weight loss of 0.5 to 3.0 kg.



This report also concluded that in studies reporting a lack of a significant reduction in body weight, physical activity was consistently less than 150 minutes per week. These modest effects of physical activity on weight loss have regularly been reported throughout the scientific literature.<sup>16–21</sup> However, the amount of weight loss reportedly increases as the dose of physical activity increases. For example, the most recent Position Stand of the American College of Sports Medicine (ACSM) concluded that physical activity of >150 minutes per week results in 2 to 3 kg of weight loss, with weight loss of 5 to 7.5 kg occurring with 225 to 420 minutes per week of physical activity, respectively.<sup>16</sup>

## Physical Activity Combined with Reductions in Energy Intake

A more common approach to weight loss is for physical activity to be combined with reduction in energy intake.<sup>2</sup> When compared with energy restriction alone, the addition of physical activity improves weight loss by 2 to 3 kg.<sup>16,18,21,22</sup> The inclusion of physical activity improves weight loss by 20% to 25% compared to energy restriction alone.<sup>22,23</sup> This effect of physical activity, when combined with a reduction in energy intake, has been well documented in the scientific literature. However, the additional weight loss achieved with physical activity appears to occur only when the restriction in energy intake is modest (500 to 700 kilocalories per day [kcal/day], with kcal = calorie), with little or no additional weight loss observed with the addition of physical activity when the restriction in energy intake is of a greater magnitude.<sup>16</sup> This may suggest the need to combine physical activity with a reasonable and modest reduction in energy intake to maximize the influence of physical activity on weight change.



## Association between Physical Activity and Long-Term Weight Loss

Physical activity appears to become more important when attempting to maximize long-term weight loss and prevent weight regain, and a growing body of literature supports this perspective. An early study reported that 90% of formerly obese women who maintained weight loss exercised regularly, whereas 34% of obese women who successfully lost weight but subsequently were unable to maintain their weight loss did not exercise regularly.<sup>24</sup>

Data from the National Weight Control Registry (NWCR) has also provided substantial cross-sectional evidence as well as prospective evidence to support the importance of physical activity for sustaining substantial long-term weight loss. The NWCR consists of adults who report having lost at least 13.6 kg (30 lbs) and maintaining this weight loss for at least 1 year.<sup>25</sup> Initial reports from the NWCR showed that individuals in this registry self-reported expenditure of approximately 2,800 kcal per week through physical activity.<sup>25</sup> Prospective observational data from the NWCR have also shown that individuals who regained weight over a period of one year in the registry had greater decreases in self-reported physical activity when compared to those who were able to maintain their weight loss over this same period of time.<sup>26</sup> Moreover, the NWCR has shown that to sustain significant weight loss, previously obese adults need to engage in more physical activity when compared to non-obese individuals who are now at a similar level of absolute body weight.<sup>27</sup>

The suggestion that relatively high levels of physical activity may be important for maintaining long-term weight loss and preventing weight gain has been demonstrated by other investigators.<sup>25,28,29</sup> Data from intervention studies have also contributed to the understanding of the dose of physical activity that may improve long-term weight loss and minimize weight regain. There is a growing body of scientific literature to support that a self-reported physical activity ranging from approximately 275 to 300 minutes per week is important for enhancing long-term weight loss and preventing weight regain.<sup>30–32</sup> More current, unpublished, data from the Physical Activity and Weight Management Research Center at the University of Pittsburgh has shown that overweight and obese adults who achieve a weight loss of >10% of their initial body weight after 6 months of a behavioral intervention, and who also sustained this magnitude of weight loss at 18 months, engaged in approximately 269 min/week of objectively measured moderate-to-vigorous intensity physical activity, with the activity accumulated across bouts that were ≥10 minutes in duration.

While the vast majority of evidence supports the importance of physical activity for improving long-term weight loss and prevention of weight regain through behavioral intervention programs, there is evidence that physical activity is also important for long-term weight loss when the weight loss is induced with other medical approaches. For example, physical activity appears to enhance the magnitude of weight loss that can be achieved with weight loss medication.<sup>33</sup> Thus, while there are currently limited medications approved solely for weight loss, these data appear to suggest that physical activity should be recommended as an important behavior for individuals who are also prescribed medication to induce weight loss.

Bariatric surgery is also an increasingly popular method used to facilitate weight loss, and it appears that patients who undergo bariatric surgery gain significant benefits from physical activity. For example, greater weight loss has been reported in bariatric surgery patients who reported participation in >150 minutes per week of physical activity, compared to patients participating in <150 minutes per week.<sup>34</sup> Additional studies have also reported greater weight loss 6 to 24 months post-bariatric surgery with the inclusion of physical activity.<sup>34–36</sup> However, it has been reported that prior to bariatric surgery these patients are relatively inactive,<sup>37</sup> and the vast majority of these patients remain inactive following bariatric surgery.<sup>38</sup> Thus, there is a need to effectively increase physical activity participation in patients who have undergone bariatric surgery to improve long-term weight loss success and to realize the additional health-related benefits of engaging in physical activity.

## Alternative Forms of Physical Activity

### Resistance Exercise

The majority of weight gain prevention and weight loss studies focused on total physical activity or aerobic forms of physical activity, such as walking. Resistance exercise is an alternative form of activity attributed to affecting body weight or body fatness.<sup>16</sup> However, evidence from intervention studies suggests that resistance training has a modest effect on body weight and body fatness.<sup>16, 39</sup> Moreover, while resistance exercise can result in an increase in lean mass<sup>40–43</sup> and reduced percent body fat, limited data support that resistance exercise significantly reduces absolute fat mass. While the effect on total body fatness is modest, resistance exercise may result in a decrease in subcutaneous abdominal fatness.<sup>44</sup> However, limited data support the idea that resistance exercise is superior to other forms of physical activity to reduce body weight or body fatness.



### Aquatic Exercise

Overweight and obese adults may have functional limitations that result in difficulty performing traditional weight-bearing activities.<sup>45</sup> Aquatic exercise is a commonly recommended alternative due to the potential therapeutic qualities of water, which include reducing the weight and stress placed on the body. However, limited data support the idea that aquatic exercise is superior to traditional forms of physical activity for overweight and obese adults. Within the context of a comprehensive intervention that included a recommendation to reduce dietary intake, the weight loss achieved with aquatic exercise was similar to the weight loss achieved with land-based activity such as brisk walking.<sup>46</sup> However, water-based activity may pose unique barriers including access to a pool, comfort of the participant in water, and body image factors related to clothing for the water. Thus, rather than recommending aquatic exercise broadly for overweight and obese adults, the decision to engage in water-based rather than land-based activity should be determined by clinical need and the participant's preference.

### Lifestyle Activity

The daily energy expenditure other than from structured exercise, eating, or sleeping has been referred to as non-exercise activity thermogenesis (NEAT).<sup>47</sup> NEAT may contribute to increases in total energy expenditure and therefore may be an intervention target for the prevention and treatment of obesity. A common recommendation to boost NEAT is to add unstructured periods of walking, often prescribed as increasing steps taken throughout the day, which can be measured by a pedometer. While this strategy should theoretically result in increased energy expenditure, its impact on body weight regulation is modest. Interventions that have promoted increased steps by providing pedometers have shown a mean increase of 2,100 steps per day and a reduction of

BMI by 0.38 units,<sup>16</sup> which is equivalent to approximately 2 to 4 pounds. Chan et al.<sup>48</sup> reported an association between increased steps on a pedometer and reduction in waist circumference; however, this association was not related to change in BMI.

While the effect of such an intervention strategy on weight loss appears modest, it may be sufficient in preventing weight gain. It has been suggested that the positive energy balance that contributes to weight gain may be as little as 50 to 100 kcal per day.<sup>49</sup> Thus, assuming energy intake remains stable, an additional 2,000 to 3,000 steps walked per day may be sufficient to offset gradual weight gain.

## Weight Loss Variability in Response to Physical Activity

Despite consistent findings reported in the scientific literature on the influence of physical activity on body weight regulation, evidence also suggests inter-individual variability in weight loss in response to physical activity.<sup>50</sup> For example, in response to four months of controlled exercise, weight loss ranged from approximately 3.0 to 12.0 kg.<sup>51</sup> The variability in weight change may be a result of a variety of factors that influence energy balance.

One explanation is that biological factors influence the magnitude of weight loss observed in response to physical activity. For example, with a similar amount of physical activity and the same energy intake, pairs of identical male twins tend to lose a similar amount of weight.<sup>52</sup> However, when comparing the response between one pair of twins and another pair who are of similar weight, the variability in weight loss increases. This suggests that individuals with very similar physiological and metabolic characteristics will respond to physical activity in a similar

manner; however, individuals with different physiological and metabolic characteristics may have a different weight loss response. This may help explain why weight loss varies among individuals who engage in similar amounts of physical activity.

As indicated earlier, it also appears that some individuals will tend to eat more and some will tend to eat less in response to physical activity,<sup>4</sup> which has been confirmed in more than one study.<sup>53</sup> Physical activity may influence hunger and satiety, with this varying among individuals, which may explain why some individuals lose more weight than others when engaging in similar amounts of physical activity.

## Is Fitness an Important Clinical Outcome for Overweight or Obese Adults?

Due to the high prevalence of overweight and obesity in adults, prevention of weight gain and sustained weight loss is important. Thus, the primary role of physical activity within the context of body weight regulation is to increase energy expenditure, which will contribute to weight loss or prevention of weight gain. However, physical activity has benefits aside from weight control for the overweight or obese adult, namely improvements in cardiorespiratory fitness. For example, physical activity interventions without concurrent reduction in energy intake have improved cardiorespiratory fitness, with more activity typically resulting in a greater improvement in cardiorespiratory fitness.<sup>19</sup> Moreover, fitness improves with physical activity in overweight and obese adults regardless of whether the intervention results in significant weight loss.<sup>54</sup> However, fitness does not appear to improve when the weight loss is achieved solely by reducing energy intake (calories) without the inclusion of physical activity as part of the intervention.<sup>55</sup>





Higher levels of cardiorespiratory fitness are associated with more desirable health-related outcomes. For example, cross-sectional evidence supports the idea that higher cardiorespiratory fitness is associated with a lower relative risk of age-adjusted cardiovascular disease death and all-cause mortality.<sup>56</sup> Moreover, increasing fitness has been shown to lower risk of mortality.<sup>57</sup> Therefore, physical activity interventions are important because of the resulting improvements in fitness.

Of interest to the overweight or obese adult is the finding that fitness is inversely associated with the relative risk for all-cause mortality even in the presence of an individual carrying excess body weight.<sup>56</sup> Moreover, this association is present regardless of whether excess body weight is expressed with BMI<sup>58–61</sup> or other measures of body composition.<sup>62,63</sup> However, some studies suggest that both low fitness levels and excess body fatness contribute to mortality. For example, it has been reported that while fitness reduces the risk of all-cause mortality, fatness increases the risk of all-cause mortality.<sup>64,65</sup> A recent review also concluded that selective risk factors for cardiovascular disease and diabetes are influenced by both body fatness and cardiorespiratory fitness.<sup>66</sup> However, fitness is important for improving glucose control in adults with type 2 diabetes, with greater fitness change over a four-year period associated with greater improvement in HbA1c. This relationship remained after controlling for change in weight and the use of medications.<sup>67</sup> Thus, interventions for overweight and obese adults should include physical activity at a dose sufficient to result in improvements in cardiorespiratory fitness because of the independent effect of fitness on mortality and additional health-related factors.



## Summary

Physical activity is an important component of interventions to prevent weight gain and to enhance weight loss. Physical activity results in an average weight loss of 0.5 to 3.0 kg, with the magnitude of weight loss improving as the amount of physical activity increases. Moreover, the addition of physical activity can increase weight loss by 20% to 25% compared to diet restriction alone. Physical activity has also been consistently associated with improved long-term weight loss and prevention of weight regain. Physical activity also enhances weight loss achieved through the use of prescribed weight loss medication or with bariatric surgery. However, the amount of weight that is lost with physical activity varies and may be influenced by a variety of biological, metabolic, and behavioral factors. Regardless, physical activity contributes to improvements in body weight regulation and also has independent effects on other health-related outcomes. Therefore, physical activity is recommended in intervention programs for the prevention and treatment of overweight and obesity in adults.

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