Seasonal Fluctuation

Body weight and body fat fluctuate from season to season and year to year. Typically, lean body weight (body weight minus fat weight) does not change as rapidly. Lean body weight consists mainly of muscles, bones, and organs. Thus, seasonal changes in body weight result from differences in the amount of fat being stored in adipose tissue. Total body fat storage often is higher during winter months, when subcutaneous fat serves as insulation against the cold. In summer, weight and fat often decline in response to an increase in energy expenditure and a decrease in appetite (stimulated in part by the increase in daylight).

ACTIVITY AND WEIGHT CONTROL

The only way to remove stored fat is to burn it off. By now, you know that exercise increases caloric expenditure and that energy expenditure is related to both the intensity and the duration of activity. As exercise becomes more intense, the duration of participation must necessarily become shorter. Although we may be able to expend as many as 125 calories in a fast mile (1.6 km) run, we can walk briskly or jog at a comfortable pace for 3 miles (4.8 km) and triple the caloric expenditure without becoming exhausted. This notion explains why we recommend moderate activity instead of high-intensity effort for weight control. The relationship of exercise to caloric expenditure also helps explain why the benefits grow with improved fitness. More fitness allows more activity, and therefore more control over your weight.

The effects of exercise do not stop when the exercise ceases. The excess postexercise oxygen consumption (EPOC), the amount that exceeds the resting level after exercise, indicates a prolonged postexercise elevation in caloric expenditure. Caloric expenditure can remain elevated for 30 minutes or more after vigorous exercise. Long-duration effort such as a distance run will elevate oxygen consumption and body temperature and call forth hormones to mobilize energy and increase metabolism. When the exercise stops, caloric expenditure remains elevated above resting levels during the recovery period. The EPOC is often neglected when the caloric benefits of exercise are tabulated.

Exercise Versus Dieting

Some people believe that dieting is better than exercise for controlling weight. They point out, quite correctly, that it is easier to reduce caloric intake by refusing a piece of cake (250 cal) than it is to burn off the cake after eating it, which would require jogging more than 2 miles (3.2 km) at 110 calories per mile. But let's examine the question of whether dieting is a better method of weight control. The answer has been available for over 35 years, and the answer is no.

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Oscai and Holloszy (1969) compared the effects of dieting and exercise on the body composition of laboratory rats. They controlled the experiment so that both groups lost the same amount of weight. Following 18 weeks of either food restriction (dieting) or swimming (exercise), they performed carcass analysis. The analysis indicated that exercise was a more effective way to lose fat (78% of the total weight loss for the exercising group versus 62% for the dieting group). Furthermore, the study provided vivid evidence of the protein-conserving effects of exercise, 5 percent protein loss for exercisers versus 11 percent for dieters. The amount of water lost through caloric restriction was 16 percent for exercisers versus 26 percent for dieters. A control group of sedentary, freely eating animals gained weight during the study. Their weight gain consisted of 87 percent fat and 10 percent water.

■ The combination of exercise and dieting burns more fat and retains more lean tissue than dieting alone.

Exercise and dieting combine to provide a positive attack on both causes of overweight: inadequate caloric expenditure and excess caloric intake.

The results of the previous animal study have been confirmed in a number of human studies. A famous study at the University of Minnesota, "The Semi-Starvation Study" confirmed that initial weight loss in sedentary dieters is due primarily to water loss, with loss of lean muscle and fat contributing to later weight loss when the dietary restrictions are extreme. Water loss, a common occurrence among dieters, accounts for the early success of most fad diets and the eventual failure of the overall goal, fat loss.

A study involving 16 obese patients compared a period of 6 months of dieting with a similar period of dieting and exercise. The exercise group achieved greater fat loss, and the exercise produced other benefits, including a lower resting heart rate and improved heart rate recovery after exercise (Kenrick, Ball, and Canary 1972). And when 25 women created a deficit of 500 calories per day by dieting, exercise, or a combination of the two, all the women lost the same amount of weight, but those in the dieting group lost less fat and more lean tissue. The authors of the study (Zuti and Golding 1976) recommended that those interested in losing weight combine dieting and exercise to ensure greater fat loss and conservation of lean tissue. A study of 24 obese women confirms the superiority of diet and exercise for the reduction of adipose tissue and preservation of lean tissue (skeletal muscle), as compared with diet alone (Ross, Pedwell, and Rissanen 1995).

These studies clearly indicate the need for activity in a program of weight control. Dieting or caloric restriction can lead to loss of weight, but a loss of protein (lean tissue) and water accompanies the weight loss. When the body loses lean tissue, it becomes less able to burn calories and eventually gains more fat weight. Dietary weight loss leads to a disproportionate decline in the metabolic rate and almost certain future weight gain (Leibel, Rosenbaum, and Hirsch 1995). A complication in the loss of lean tissue is a possible resetting

Metabolic Rate

Exercise has an added benefit in relation to weight control and diet. In one study, several weeks of severe caloric restriction imposed by dieting led to the usual loss of lean tissue and a decrease in metabolic rate. The drop in metabolic rate makes it difficult for dieters to maintain a lower body weight because the more efficient body burns 10 to 15 percent fewer calories daily. On the bright side, however, just 2 weeks of exercise restored the metabolic rate to predicted levels. Moreover, the exercise reduced the loss of protein and increased the use of fat as the source of energy (Móle et al. 1989).

of the metabolic thermostat, making weight gain likely with even less caloric intake. Four decades of research show that weight loss with exercise maximizes the removal of fat, minimizes the loss of protein, and helps maintain the metabolic rate. Exercise and dieting combine to provide a positive attack on both causes of overweight: inadequate caloric expenditure and excess caloric intake.

Exercise and Appetite

In the past, the use of activity to achieve energy balance and weight control received criticism. Detractors argued that exercise would increase the appetite as the body attempted to keep pace with energy needs. Many assume that the desire for food signifies a real need for nourishment, but it doesn't. Appetite is a psychological desire that is influenced by several factors. The control center for food intake, the **appestat**, is located in the hypothalamus, an area of the brain that functions like a thermostat to turn on eating behavior and then turn it off when the desire or hunger has been satisfied. Unfortunately, it takes many minutes for the food that you eat to reach the bloodstream, where the appestat can see that you've satisfied the need. You may tuck away several hundred extra calories before the appestat gets the message.

Physiological factors such as low blood sugar, hormones, hours of daylight, cold temperatures, hunger pangs from an empty stomach, and unfilled fat cells can stimulate the appestat. Physical activity also stimulates eating behavior, but the increased caloric intake serves only to maintain body weight. Sedentary people take in more calories than they need. More exercise means more food intake, but the appetite doesn't keep pace with energy output. Regular activity seems to help the appestat adjust caloric intake to energy needs. The appestat is rather imprecise at a low level of energy expenditure, but for regularly active people, appetite control is much more related to energy requirements (Mayer and Bullen 1974). An exercise study with obese women cycling at 50 percent of $\dot{V}O_2$max found that 25 of 28 participants ate less during the 12-week program and continued to eat less during a 10-week follow-up (Vailodash 2000). At the high end of the activity scale, where endurance athletes and workers burn 4,000 to 6,000 calories daily in running, cycling, swimming, or work, the appetite usually underestimates energy needs (Ruby, Schoeller, and Sharkey 2001). Conversely, when a sedentary routine is imposed on otherwise active men, no reduction in energy intake occurs, leading to a positive energy balance (Stubbs et al. 2004).

Psychological factors such as the smell, sight, or taste of food can evoke the desire to eat. Habit and emotional factors also condition eating behavior. Television and screen activities are often associated with eating. Sedentary habits often lead to snacking. Have you ever noticed the snack jars on the desks of office workers? While sitting at your computer, have you ever gotten the urge to eat? We eat to celebrate, to prolong feelings of excitement. Appetite is a complex phenomenon, subject to many influences, reflecting more than the need for nourishment. The appestat frequently overestimates energy needs. Weight