CHAPTER 17

Weight Management: Finding a Healthy Balance

After completing this chapter you should be able to:

- discuss the differences between overweight and obese and their implications for health;
- explain the concept of energy balance in weight management;
- describe the role of exercise and lifestyle modification in maintaining a healthy body weight;
- discuss the consequences of dieting and eating disorders;
- set and evaluate personal goals for maintaining a healthy body weight.

Weight is an issue for all of us. Many people feel obliged to buy diet books, try fad diets and supplements, attempt special programs, and even consider medical procedures, all in the pursuit of attaining an "ideal" body weight. The key to weight management lies not in some vague ideal or perfection but in sensible dietary practices and adequate levels of physical activity.

Despite the efforts of many people, the United States is clearly in a state of nutritional crisis and in need of sound remedies. The statistics are sobering. Collectively, we have grown fatter over the years. Today, more than 50 percent of adults and 30 percent of children are considered overweight or obese, and these statistics continue to increase. Too many children and young adults are facing an epidemic of numerous obesity-related diseases that were unheard of just a generation ago.

We live in an environment where physical activity has been engineered out of day-to-day life, and the food environment has become more "toxic" by the day (Figure 17.1). Eating disorders have also emerged in greater numbers as the social pressure to be thin has increased, especially among adolescents and young adults.

Energy Balance Equation

Human beings come into the world well equipped to regulate what scientists call the **energy balance equation** (Figure 17.2). On one side of the equation is the energy we burn through exercise and other bodily processes (such as digestion and absorption). Kilocalories (kcal) consumed beyond the body's needs are stored as fat. In short, one gains weight when energy input exceeds energy output (Figure 17.2 B) and loses weight when the opposite occurs (Figure 17.2 C). One's weight will remain constant if energy input and output are the same, and one's body is said to be in **energy balance** (Figure 17.2 A).

Although it is more common to hear about people who want to lose weight, there are those who have the desire to put on a few pounds to look better or to "bulk up" for athletic events. Just as weight loss is based on energy balance, so is weight gain. This can be achieved by increasing your food intake while participating in an activity program aimed at developing muscular strength. This increase in mass is due to an increase in functional muscle tissue, not fat.

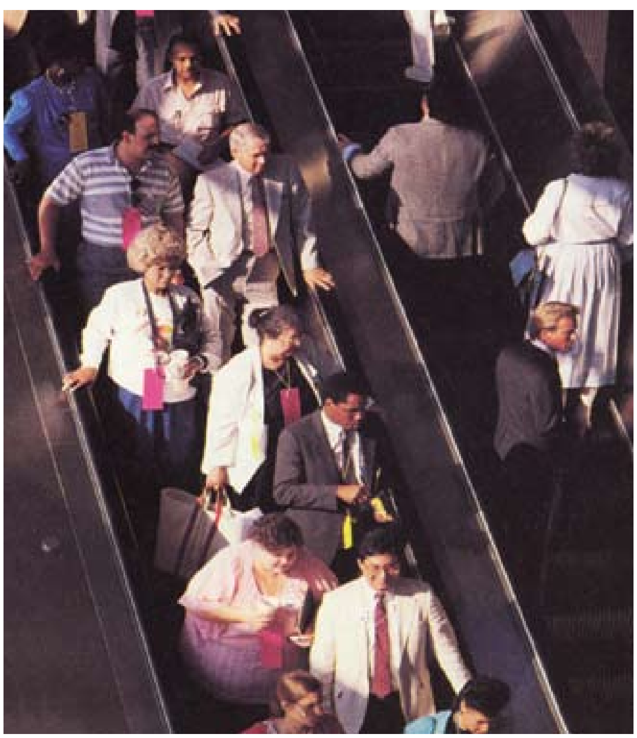

Figure 17.1 Modern conveniences, lower levels of activity, and poor nutritional choices contribute to a myriad of weight and health issues.

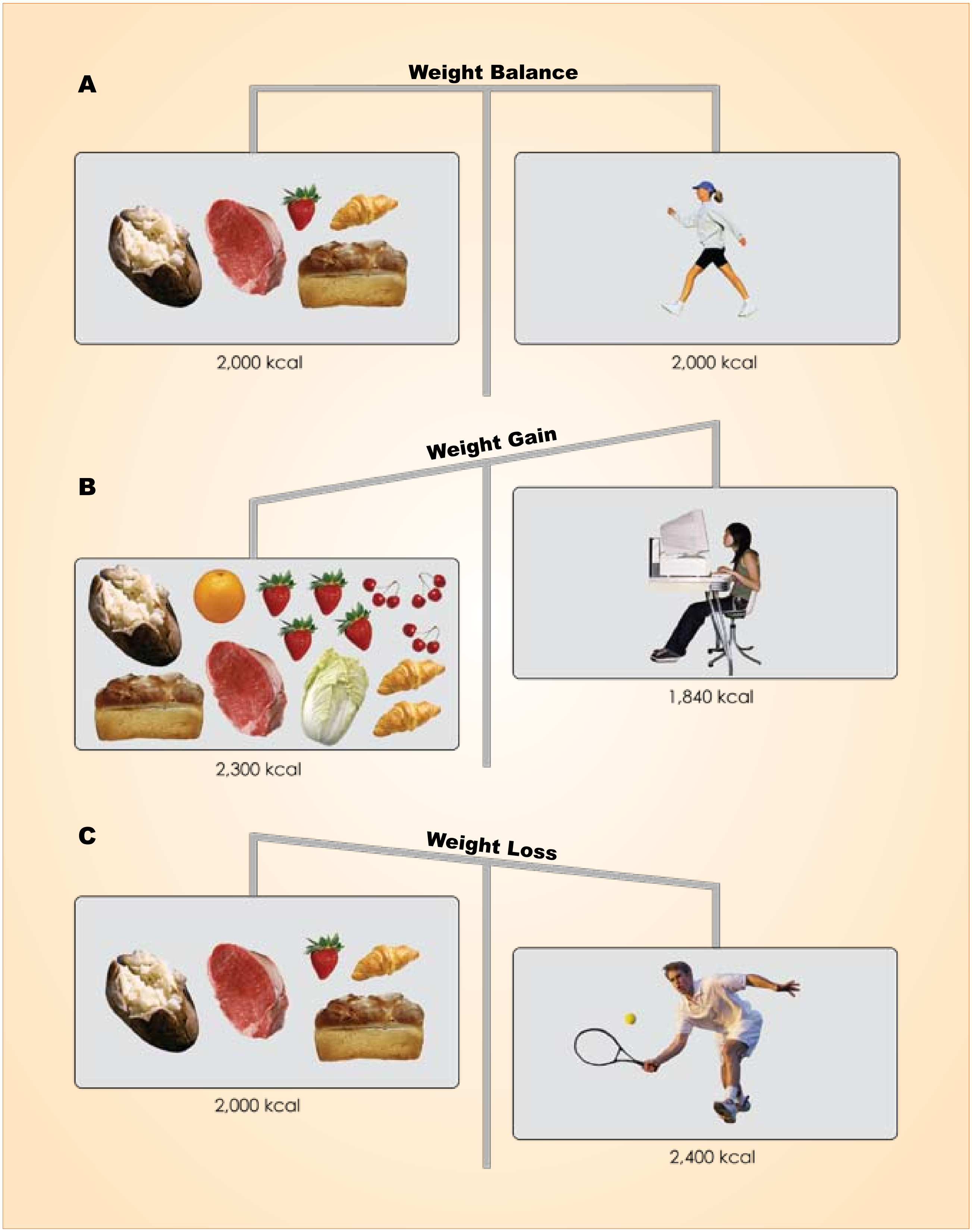

Figure 17.2 The energy balance equation. **A.** Energy input equals energy output. **B.** Energy input exceeds energy output. **C.** Energy output exceeds energy input.

Energy Needs of the Body

Of the total energy you require on a daily basis, the highest proportion is used for basal metabolism. Your basal metabolism, or **basal metabolic rate (BMR)**, is defined as the minimum amount of energy the body requires to carry on all vital functions at rest (including blood circulation, respiration, and brain activity). Thus, your basal metabolism will vary throughout your life. As a general rule, your BMR is relatively high at birth and continues to increase until the age of two, after which it will gradually decline as your life progresses (except for a rise at puberty). Other variables also affect your BMR, such as body composition (muscular bodies have higher BMRs), physical fitness (fit people have higher BMRs), sex (the BMRs of men are approximately 5 percent higher than those of women), sleep (BMRs are 10 percent lower during sleep), pregnancy (a 20 percent increase in BMR), and body temperature (a one degree rise in body temperature – for example, when you have a fever – increases BMR about 7 percent). Among all these factors, age is probably the most significant because many people fail to recognize their changing metabolic needs, and do not adjust their food intake to reflect these changes. Many people put on extra pounds as they grow older for this very reason.

To calculate your BMR, use the formula presented in the box below (*Calculate Your Basal Metabolic Rate*).

Total Energy Expenditure

Total energy expenditure (TEE) (kcal/day) = BMR (~60 percent of TEE) + the thermic effect of food (TEF) (energy used in digestion and absorption after a meal) + the thermic effect of activity (energy used during physical activity) + nonexercise activity thermogenesis (NEAT) (energy used when someone is fidgeting, for example).

Exercise and Weight Management

When you exercise, the body's needs for energy increase significantly beyond basal metabolic needs. The amount of extra energy or kilocalories required depends upon the volume of exercise (how long you exercise or the quantity of exercise performed), the intensity of exercise (the rate of exercise per unit of time), and the type of exercise performed (Table 17.1). It must be stressed, however, that exercise on its own can be a slow way to lose weight. For example, if you are a woman weighing 121 pounds (55 kg), you would have to walk over two hours or cross-country ski for over one hour to burn off the kilocalories consumed in a single vanilla milkshake (Figure 17.3, Table 17.1). But combined with controlled eating patterns involving energy reduction, your chances for success are greatly enhanced. Exercise is a great

Calculate Your Basal Metabolic Rate

Your basal metabolic rate (BMR) reflects the amount of energy in kilocalories (kcal) needed to maintain basic body functions such as breathing and blood circulation. Use the simple equation below to help you determine your approximate BMR. NOTE: a woman's BMR is approximately 5 percent lower than that of a man the same age.

BMR per day = 1 kcal x body weight (kg) x 24

Example: 70-kg man

BMR per day = 1 kcal x 70 x 24
= 1,680 kcal

This individual needs approximately 1,680 kcal to maintain his body at rest. Of course, any additional activity above this level raises energy requirements accordingly.

[NOTE: 1 kg = 2.2 lb]

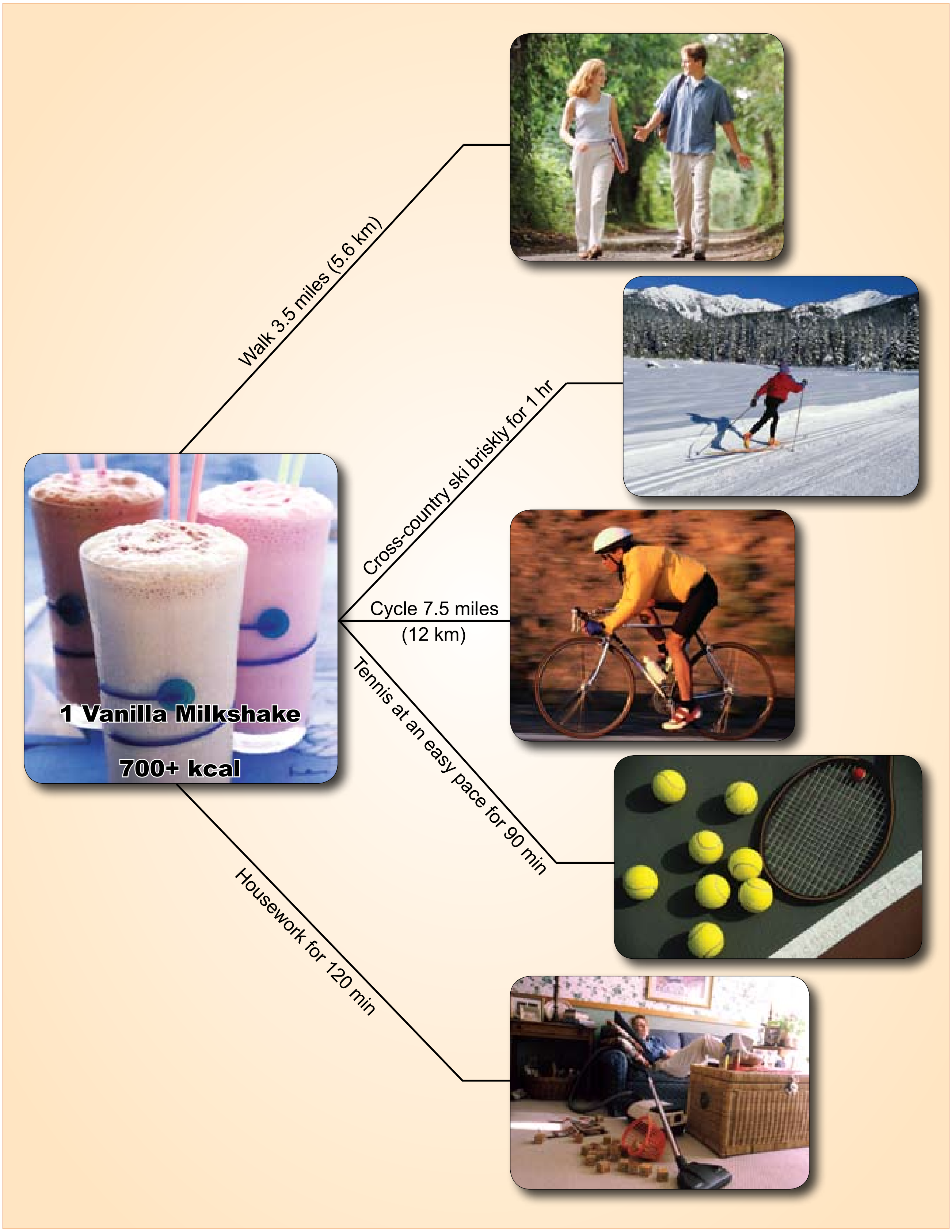

Figure 17.3 Using food energy. How much activity would it take to burn off the kilocalories from a single shake?

Table 17.1 Approximate kilocalories expended for male (154 lb) and female (121 lb) participants in sporting and recreational activities lasting an hour.

Activity	Male (154 lb)	Female (121 lb)	Kcal/hour/lb
Sporting Activity			
Basketball	581.0	456.5	3.8
Cycling (racing)	714.0	561.0	4.6
Ice hockey	875.0	687.5	5.7
Running 8 min/mile	868.0	682.0	5.6
7 min/mile	959.0	753.5	6.2
6 min/mile	1050.0	825.0	6.8
Cross-country skiing	679.0	533.5	4.4
Soccer	546.0	429.0	3.5
Squash	889.0	698.5	5.8
Swimming breaststroke	686.0	539.0	4.5
Tennis (singles)	462.0	363.0	3.0
Weight training	294.0	231.0	1.9
Leisure Activity			
Cycling 6 miles/hour	266.0	209.0	1.7
10 miles/hour	413.0	324.5	2.7
Canoeing	182.0	143.0	1.2
Dancing	350.0	275.0	2.3
Golfing	357.0	280.5	2.3
Hiking	385.0	302.5	2.5
Jogging (11 min/mile)	553.0	434.5	3.6
Rowing ergometer	735.0	577.5	4.8
Walking	329.0	258.5	2.1

way to maintain the weight that is lost, and it also helps keep metabolism higher.

If you doubt the importance of exercise to such a program geared at weight loss, consider this. Not only does regular exercise (especially endurance type) strengthen the heart, improve endurance, provide a means of managing stress, and help prevent osteoporosis, it also burns energy and keeps your metabolism using food for energy rather than storing kilocalories.

As described earlier, a higher amount of fat-free mass (muscle) and a higher level of physical fitness are associated with higher metabolism. These can both be achieved by engaging in regular physical exercise. Individuals with elevated or normal metabolic rates are less likely to become overweight. When your metabolism is more active, you can eat more without necessarily gaining weight, and your body will burn more energy even when you are not exercising. Weight management becomes much easier with a lifestyle that includes regular exercise.

Body Composition

The human physique includes three interrelated aspects of the body: size, structure, and composition. **Size** refers to the volume, mass, length, and surface area of the body, while body **structure** refers to how certain aspects such as the skeleton, muscle, and fat are arranged or distributed throughout the body. **Body composition** refers to the amount of body constituents, such as fat, muscle, bone, and organs, and is regarded as one of the major components of physical fitness.

The composition of the human body can be divided into many components. However, a two-component model dividing the body into lean body mass and fat mass, or total body fat, is the most common.

Lean Body Mass

Perhaps the most important component of the body is **lean body mass (LBM)**. It refers to the "nonfat" or "fat-free" component of the human body and generally consists of skeletal muscle, bone, and water. LBM can be calculated by using the following simple formula:

LBM = TBM – TBF

By subtracting the **total body fat (TBF)** from **total body mass (TBM)** we arrive at lean body mass. TBF is calculated by multiplying TBM, or weight, by percent body fat (see calculation in next section) divided by 100. For example, if a subject weighs 150 pounds and has 10 percent body fat, he has 15 pounds (150 pounds x 10/100 = 15 pounds) of TBF. If TBF is known, LBM can be calculated. In our example, this works out to an LBM of 135 pounds (150 pounds – 15 pounds). Individuals with high amounts of lean body mass normally have higher rates of metabolism.

Note that the terms "lean body mass" and "fat-free mass" are often used interchangeably; however, they are not exactly the same thing. Lean body mass refers to all the lean mass in the body, as described previously; it is measured indirectly, by such instruments as skinfold calipers and underwater weighing. Fat-free mass can really only be measured on a cadaver – that is, when all the fat-free mass can be separated from any fat mass.

Lean body mass may represent a biological lower limit beyond which a person's body mass cannot be reduced without impairing health. In women, excessive leanness may increase the chances of developing amenorrhea (absent menstruation). Amenorrhea should be viewed as a red flag, and women with amenorrhea should discuss their condition with a knowledgeable sports physician.

The reproductive system can be compromised in situations where an athlete does not consume enough energy to support her body's metabolism and exercise needs, leading to a decrease in estrogen production. The body will try to conserve kilocalories and shift metabolism down, which in turn shuts down the reproductive system's production of estrogen. Estrogen plays an important role in maintaining bone health, and thus females with low levels of estrogen are at a greater risk of developing osteoporosis. Both amenorrhea and disordered eating can lead to osteoporosis. This trio of complications, known as the female athlete triad, will be discussed in more detail later in this chapter.

Fat Mass

Fat mass, or **total body fat**, can be divided further into two types of fat. **Storage fat (SF)** is fat that accumulates as adipose tissue (fat cells). This fat serves as an energy reserve (should the body be subjected to starvation) and also serves to protect internal organs by cushioning them. The main storage site for SF is beneath the skin surface; this fat is thus often referred to as subcutaneous fat. The average man has about 12 percent of body weight as SF, while the average woman has about 15 percent of body weight as SF. Individuals require some fat to exist; however, excess fat is associated with numerous health problems.

The second type of fat is **essential fat (EF)**, which is the fat that is required for normal physiological functioning. Some of this fat is present in the bone marrow, heart, lungs, liver, spleen, kidneys, intestines, muscle, and the lipidrich tissues of the central nervous system. To maintain normal health and metabolism, men require a minimum essential body fat of 3 percent, while the minimum essential body fat for women is 12 percent. Not surprisingly, this sex-specific essential fat is located in the mammary glands and pelvic region and is involved in hormone-related functions and pregnancy.

Measuring Body Fat

There are many ways to assess total body fat, and most involve an *indirect* method. The *direct* method is simply to grind tissue and measure the amount of fat through **chemical analysis**. Obviously, this is impractical for living organisms, and this method is generally used only on cadavers.

The most common indirect method involves measuring skinfold thickness with **skinfold calipers**. This indirect method requires some technical expertise but is relatively inexpensive. The measurements obtained can be used to predict or estimate total body fat based on the assumption that subcutaneous fat is directly related to total body fat. To perform this technique, the skin is pulled away from muscle and pinched between two flattened prongs of the fat calipers, which exert a constant tension. The accuracy of skinfold measurement is about ±3.98 percent when performed correctly by an experienced individual. By measuring skinfolds at a number of sites and comparing results to tables or using mathematical formulas, a percentage of body fat can be predicted.

A second indirect method of determining percent body fat is to use **hydrostatic weighing**, or underwater weighing (Figure 17.4 A). This is a more accurate means of measuring body composition and the standard for other indirect techniques. It is based on Archimedes' principle of water displacement. According to this principle, when an object is submerged in water, there is a buoyant force equal to the weight of the water displaced. Since bone and muscle have a greater density than water, an individual with a high percentage of fat-free mass will weigh more in the water than an individual with a high percentage of body fat. To use hydrostatic weighing, one must first determine body density by measuring (a) body weight on land, (b) underwater body weight, (c) water density at the temperature used for the test, and (d) residual lung volume (the amount of air left in the lungs after a forceful expiration). It is important to measure residual lung volume because if it is not accounted for, body fat will be overestimated. Once body density has been determined, equations (e.g., the Siri equation) can be used to calculate **percent body fat**.

Another method of measuring body fat is the **Bod Pod** (also known as air-displacement plethysmography), a somewhat expensive but

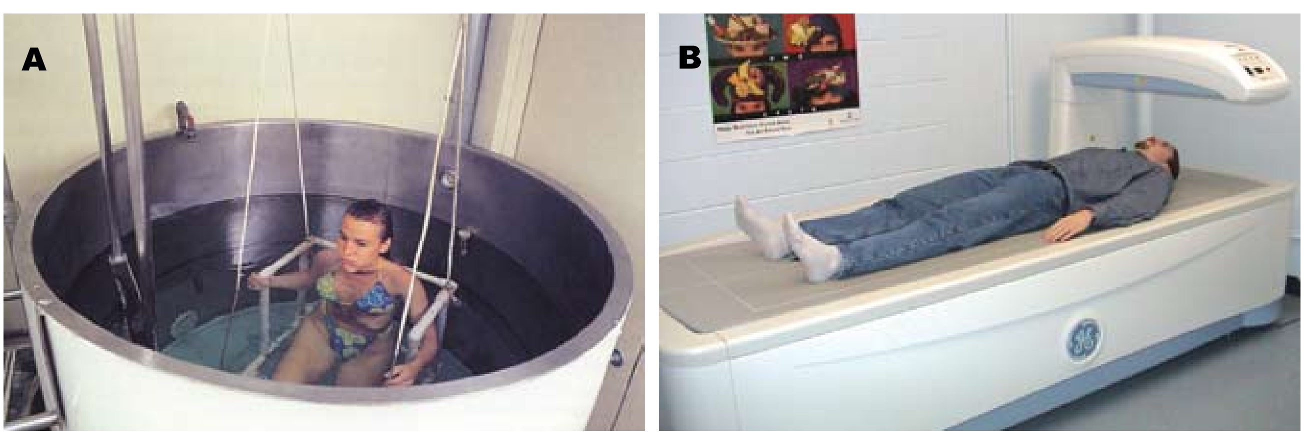

Figure 17.4 Research methods for establishing percent body fat. **A.** Hydrostatic weighing. **B.** Dual energy x-ray absorptiometry (DEXA).