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# CHAPTER 4

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## *BODY COMPOSITION and WEIGHT CONTROL*

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### CHAPTER OVERVIEW

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*MALNUTRITION* has been one of the most pervasive nutritional problems for people in third world countries. In contrast, the major nutrition problems of people in the United States and other industrialized societies are diseases of dietary imbalance, and excess caloric intake. Of the current 10 leading causes of death of Americans, eight relate to improper diet, excessive alcohol consumption, and being overweight. Maintaining suitable weight depends upon energy homeostasis, that is balancing the calories consumed with those expended. The current scientific consensus is that the general health of Americans would be dramatically improved simply by following prudent diet and exercise programs with a goal of maintaining an appropriate body weight. Proper body composition is a major component of health related fitness. It is also the method used to find your desirable weight. Health problems are not only associated with being overweight, but also with being underweight. Eating disorders are a serious, growing problem among college-aged people, especially women.

The purpose of this chapter is to provide basic information regarding the assessment of body composition and the role of diet and exercise on weight control. The major educational outcomes of this chapter are to help you understand:

1. The effect of weight and body composition on health.
2. The scientific methods used to measure and evaluate body composition.
3. The role of nutrition in maintaining good health.
4. The basic nutrients required for good health.
5. The behavioral and exercise methods that enhance the success of a weight control program.
6. The nature of eating disorders.

### WEIGHT AND HEALTH

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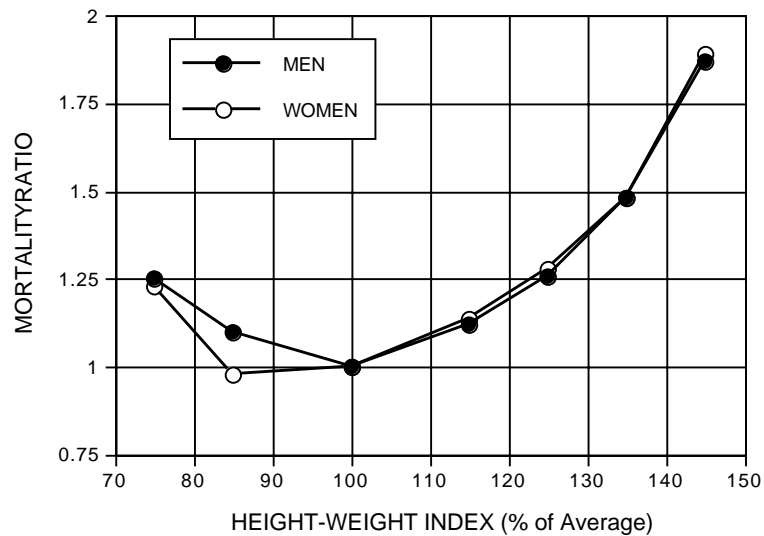
The relationship between weight and mortality is “J” shaped (Figure 4-1). This means that being significantly under or over ideal weight can have serious health consequences. A certain degree of musculature and body fat not only provides protection

from injury and thermal stress, but also enhances good health. Although much of the high mortality associated with being too thin is due to underlying diseases such as cancer, even when this is taken into consideration, being too thin is still not healthy. Excessive weight loss caused by severe diet restriction can be a health hazard and should be avoided. Eating disorders associated with being too thin are a serious health problem. This important topic is addressed at the end of this chapter.

FIGURE 4-1.

All cause mortality ratio for various percentages of average weight. For both men and women, when compared to average weight, the underweight and overweight individuals had the higher mortality ratios. Graph made from published data [14].

*There is a health risk for being either too thin or too heavy.*



About one-third of Americans are overweight to the extent that they suffer from serious health problems [14]. Between the ages of 25 and 50 years, an average American gains about 50 pounds of body weight—about 2 pounds per year. Almost all of this weight gain is body fat. The success rate for the treatment of adulthood obesity is only 25%, lower than the cure rate for most cancers. Overweight people are more likely to lead a sedentary life, and if they decide to start an exercise program, are less likely to be successful [6, 22]. Early intervention with proper diet, exercise, and education are key factors for maintaining an ideal weight.

Many overweight people become diabetic during adulthood. Adult-onset diabetes is a disease primarily of the obese. All obese people are not diabetic, but a subgroup of the obese are particularly at risk. Adults who have “apple shaped” bodies are particularly prone to develop diabetes mellitus. The “apple shape” is due to the accumulation of body fat around the abdomen. This pattern of fat accumulation has more serious health consequences than general adiposity. Just as being overweight can cause diabetes, losing weight can reverse the condition. Often, when people with diabetes lose weight, they are no longer diabetic. This adult form of diabetes is a true “lifestyle” disease.

Overweight people are more likely to be diabetic, hypertensive, and have higher cholesterol levels. Since these are major, independent cardiovascular disease risk factors, some believe that the increased incidence of cardiovascular disease associated with being

overweight is due just to these other cardiovascular disease risk factors. This is not true. Being overweight puts you at a higher risk of heart disease and stroke [10]. Figure 4-2 graphically shows that being overweight increases the risk of cardiovascular disease.

Not only did the data from the Framingham study [10] establish that obesity was a major, independent risk factor for cardiovascular disease, it also showed that gaining weight resulted in a higher risk while losing weight lowered health risk (Figure 4-3). Further, the longer people were overweight, the more serious their risk. It is important to maintain a desirable weight level throughout your entire life. The practice of “yo-yo” dieting, losing weight and then regaining it, is not helpful and can be dangerous.

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**BODY COMPOSITION**

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Body composition is a major component of physical fitness and determined by calculating the percentage of your total weight that is fat tissue. The method most often used to assess percent body fat in the laboratory has been underwater weighing [3, 15]. While the underwater weighing method is very accurate, the dual energy X-ray absorptiometry (DXA) is replacing underwater weighing as the “gold standard.” Figure 4-4 shows the DXA method, which is most commonly used in medical or research settings. The more common field methods presented that you can use are:

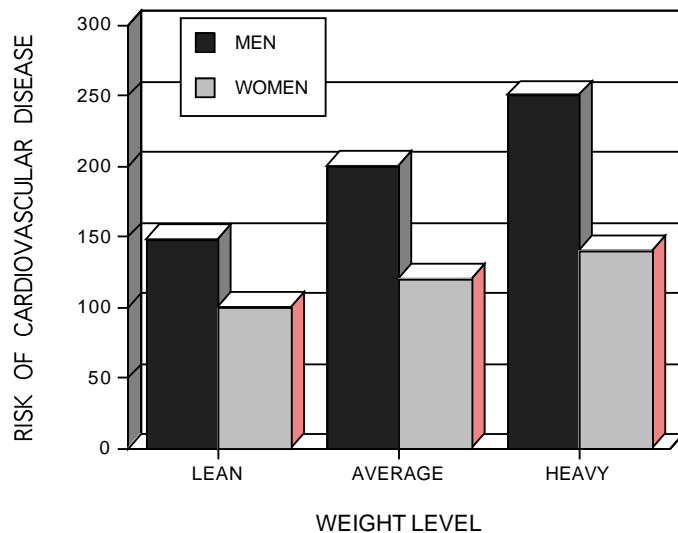
- Body mass index.
- Waist-hip ratio.
- Skinfold fat.

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**FIGURE 4-2.**

The 26-year incidence of cardiovascular disease (per 100,000) based upon weight for a given height for the men and women in the Framingham heart study. The subjects were non-smokers who were under 50 years of age, and had normal cholesterol and blood pressure levels. Graph made from published data [10].

*Being overweight increases the risk of cardiovascular disease.*



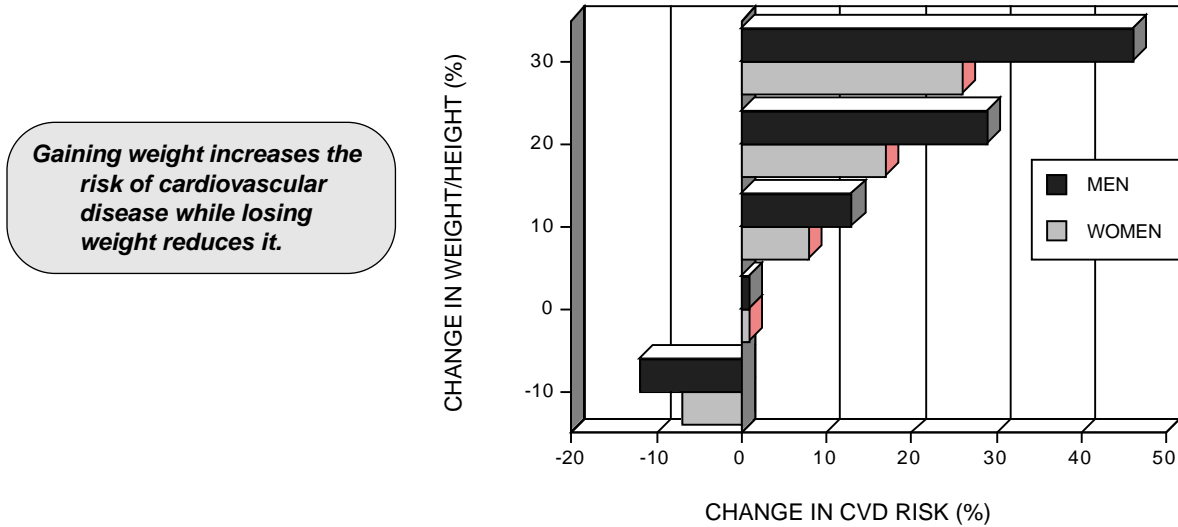
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## BODY COMPOSITION

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**FIGURE 4-3.**

Losing weight decreases the risk of cardiovascular disease (CVD) while gaining weight increases the risk. This provides evidence that the relationship between obesity and cardiovascular disease may be causal. Graph developed from published data [10].



**FIGURE 4-4.**

The DXA system for measuring body composition. Picture courtesy of the LUNAR® Corporation (Madison, WI).



**SOME BASIC DEFINITIONS**

In simple terms, body weight consists of fat weight and fat-free weight, which is largely muscle mass. If percent body fat (%fat) and body weight are known, it is possible to calculate the body's fat weight and fat-free weight components. The equations for making these calculations are:

$$\text{FAT WEIGHT} \quad \text{(EQ 4-1)}$$

$$\text{Fat Weight} = \text{Weight} \times \left( \frac{\% \text{fat}}{100} \right)$$

$$\text{FAT-FREE WEIGHT} \quad \text{(EQ 4-2)}$$

$$\text{Fat-Free Weight} = \text{Weight} - \text{Fat Weight}$$

**Calculation example - Computing Fat and Fat-free Weight.** Assume that the percent body fat of a person is 23% and their weight is 145 pounds. The person's fat weight would be 33.4 pounds with a fat-free weight of 111.65 pounds.

$$\text{Fat Weight} = 145 \times \left( \frac{23}{100} \right) = 33.35 \text{ pounds}$$

$$\text{Fat-Free Weight} = 145 - 33.35 = 111.65 \text{ pounds}$$

Fat tissue consists of subcutaneous fat (fat under the skin) and essential fat consisting of the lipids in the blood and fat that surrounds the internal organs. On the average, the percent body fat of women is about 6-8% higher than that of men. This gender difference is due to essential fat. Although the terms overweight and obesity are often used interchangeably, there are important differences between them. Overweight is the weight that exceeds the "normal" weight defined for an individual by their height and gender. Someone may be lighter than average for particular height due to less muscle, more fat, or a combination. Obesity is the excessive accumulation of fat weight and expressed as an increased percent body fat. The percent body fat levels [15] that define obesity are:

- **Men** - 25%
- **Women** - 32%

**BODY MASS INDEX (BMI)**

Life insurance companies developed height and weight standards based on estimates of mortality risk. The standards represent the statistically optimal weight ranges for the general population. While several height and weight methods have been used, the body mass index (BMI) has become the accepted method. The BMI is the ratio of weight measured in kilograms and height measured in meters and then squared. The steps to follow to calculate BMI are:

1. Convert weight in pounds to weight in kilograms.

$$\text{WEIGHT IN POUNDS TO KILOGRAMS} \quad \text{(EQ 4-3)}$$

$$\text{Weight (kg)} = \text{Weight (lbs)} \times 0.455$$

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## BODY COMPOSITION

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2. Convert height in inches to height in meters.

**HEIGHT IN INCHES TO HEIGHT IN METERS** (EQ 4-4)

$$\text{Height (meters)} = \text{Height (inches)} \times 0.0254$$

3. Calculate BMI with equation 4-5

**BODY MASS INDEX - BMI** (EQ 4-5)

$$\text{BMI} = \left( \frac{\text{Weight in kg}}{\text{Height in Meters} \times \text{Height in Meters}} \right)$$

**Calculation example - Computing BMI.** Assume a person's weight is 142 pounds (64.61 kg) and their height is 5 feet 4 inches or 64 inches (1.63 meters). The person's BMI is 24.3 kg/m<sup>2</sup>.

$$\text{BMI} = \left( \frac{64.61}{1.63 \times 1.63} \right) = 24.3$$

The World Health Organization (WHO) has developed BMI criteria for overweight and obesity. The WHO criteria are:

- Underweight <18.5 kg/m<sup>2</sup>
- Normal weight 18.5 - 24.9 kg/m<sup>2</sup>
- Overweight 25.0-29.9 kg/m<sup>2</sup>
- Obese ≥ 30 kg/m<sup>2</sup>

It is important to assess both body weight (BMI) and percent body fat because they provide two related but different pieces of information about your body composition. Since body weight is easy to measure, once you know your desirable weight for your frame, changes in weight monitor your body composition. The limitation of the BMI can be traced to body weight, which is not only affected by fat mass, but also fat-free mass, consisting of muscle, organs, and skeletal mass. Two individuals of the same height, gender, and age may weigh the same, but have different levels of muscle development and body fat. That is they differ in percent body fat.

### WAIST-HIP RATIO (WHR)

Medical research has shown that people with central, visceral types of obesity are particularly at risk for developing cardiovascular disease, stroke and non-insulin dependent diabetes mellitus. This central visceral obesity is measured by the waist-hip ratio. The measurements used in the waist-hip ratio equation [21] are:

- Waist circumference (waist-C) is measured at the waist horizontally at the umbilicus.
- Hip circumference (Hip-C) is measured at the largest horizontal circumference around the buttocks.

**WAIST-HIP RATIO (WHR)** (EQ 4-6)

$$\text{WHR} = \left( \frac{\text{Waist-C}}{\text{Hip-C}} \right)$$

**TABLE 4-1.** Degree of health risk estimated from the body mass index and waist-hip ratio.

BMI	WAIST-HIP RATIO - MALES			WAIST-HIP RATIO -FEMALES		
	<0.85	0.85-1.0	≥1.0	≤0.70	0.70 - 0.85	>0.85
20 to <25	Very Low	Low	Moderate	Very Low	Low	Moderate
25 to <30	Low	Moderate	High	Low	Moderate	High
30 to <35	Moderate	High	Very High	Moderate	High	Very High
35 to <40	High	Very High	Very High	High	Very High	Very High
≥40	Very High	Very High	Very High	Very High	Very High	Very High

The development of central, visceral obesity is believed to be caused by an alteration in the body’s metabolic system. Several of these endocrine abnormalities are associated with insulin resistance that is believed to be the cause of the increased disease risk. While the BMI has been used to identify overweight individuals, Bray [4] proposed that both BMI and WHR be used to define health risk. Table 4-1 gives health risk estimates.

**MEASURING PERCENT BODY FAT WITH SKINFOLDS**

An accurate and easy method to estimate body composition is to measure the thickness of pinched skin at various parts of the body with a special caliper (Figure 4-5). The total thickness of the subcutaneous fat at these sites can then be related to total body fat by special equations.

Separate sites are used for men and women. The site locations are:

**WOMEN**

- **Arm.** The fold at the middle of the back of the upper right arm midway between the shoulder and elbow.
- **Hip.** A diagonal fold above the crest of the ilium, about in the middle of the right side of the body.
- **Thigh.** A vertical fold on the front of the thigh midway between the hip and knee.

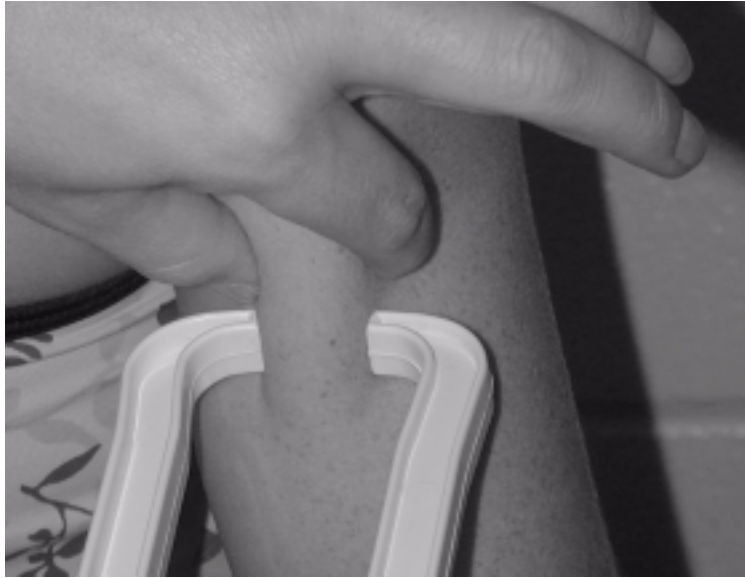
**MEN**

- **Chest.** A diagonal fold taken half way between the nipple and arm.
- **Abdomen.** A vertical fold taken at a lateral distance of approximately 2 cm from the umbilicus.
- **Thigh.** Same location for men and women.

There is an excellent relationship between subcutaneous fat measured with a caliper and percent body fat determined by underwater weighing. Figure 4-6 graphically shows the relationship between the sum of skinfold fat and percent body fat measured by the underwater weighing method [11-13]. This graph shows that the relationship is not perfect, but by knowing your skinfold readings, percent body fat can be accurately measured.

**FIGURE 4-5.**

Caliper used to measure skinfold thickness.



While many different skinfold combinations can be used, we have found that obtaining three measurements provides an accurate estimate of what would be obtained by the underwater weighing method. To insure accuracy, skinfold measurements should be taken by trained individuals. To find percent body fat, you need only to know the sum of the three skinfolds and age. The men's and women's equations are:

**MEN'S PERCENT BODY FAT EQUATION** (EQ 4-8)

$$\text{Percent Body Fat} = (0.275 \times \Sigma \text{Chest, Abdomen, Thigh}) + (0.122 \times \text{Age}) - 2.322$$

**WOMEN'S PERCENT BODY FAT EQUATION** (EQ 4-9)

$$\text{Percent Body Fat} = (0.309 \times \Sigma \text{Arm, Hip, Thigh}) + (0.053 \times \text{Age}) + 3.670$$

**Calculation Example - Estimating Percent Body Fat:** Assume the following data for a man and women.

**Man:** Age 27 years,  $\Sigma$ skinfolds = 54 (Chest skinfold 14 mm, Abdomen 20 mm, and Thigh Skinfold 20 mm)

$$\text{Percent Body Fat} = (0.275 \times 54) + (0.122 \times 27) - 2.322 = 15.8$$

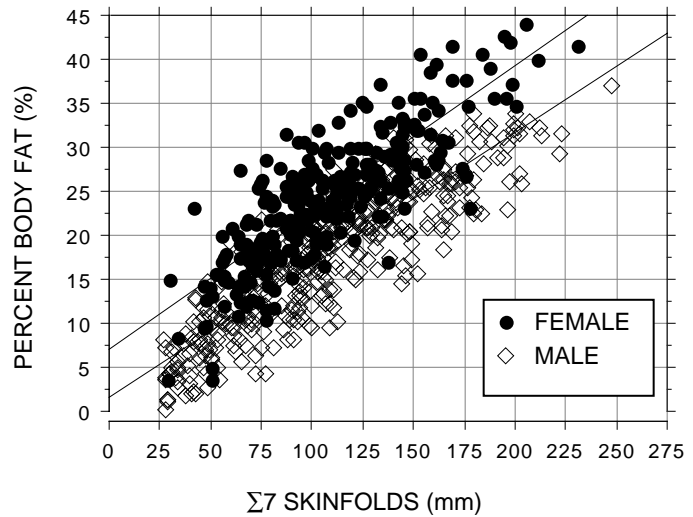
**Woman:** Age 22 years,  $\Sigma$ skinfolds = 55 (Arm skinfold 12 mm, Hip 18 mm, and Thigh Skinfold 25 mm)

$$\text{Percent Body Fat} = (0.309 \times 55) + (0.053 \times 22) + 3.670 = 21.8$$

FIGURE 4-6.

The relationship between the sum of seven skinfolds of men and women and percent body fat measured by the underwater weighing method. For the same level of skinfold fat, women have a higher percent body fat level. This is due to the difference in essential fat that is measured by the underwater weighing method, but not the skinfold method.

*Percent body fat can be accurately predicted from skinfold thickness.*



An important advantage of the skinfold method is that it measures body fat directly. The reduction of this type of fat is the goal of a weight loss program. You can monitor this change by simply pinching yourself. If your pinch thickness is small, you do not need to lose weight.

**INTERPRETING BODY COMPOSITION**

There is no single, ideal percent body fat for everyone. The level for good health differs from that desired for appearance, or athletic performance. Highly trained endurance athletes (e.g., distance runners) have very low levels of body fat. The average percent body fat of world class distance runners is about 5% for men and ranges from 12 to 15% for women. This is an unrealistically low level for most who are not exercising to the level of these athletes. World class athletes run from 10 to 15 miles each day of the week. At this mileage, they expend over 1,000 kilocalories a day just from exercise. Physically active people (i.e., high exercise caloric expenditure) are lean.

The percent body fat of men and women differ. On the average, the percent body fat of women is about 5 to 8% higher than men. This difference is due to “essential fat,” the fat that surrounds the internal organs of the body. This is a normal biological gender difference. Even considering this gender difference, there is no exact, “ideal” percent body fat standard. A more realistic approach is to use percent body fat ranges. Table 4-2 and Figure 4-7 include standards for evaluating the body composition of men and women, and the interpretation of the standards [3, 11, 12].

## BODY COMPOSITION

**TABLE 4-2.** Percent body fat standards for men and women.

BODY COMPOSITION STANDARD	AGE GROUP IN YEARS WOMEN				AGE GROUP IN YEARS MEN			
	≤ 30	30-39	40-49	≥50	≤ 30	30-39	40-49	≥50
High Body Fat	>32%	>33%	>34%	>35%	>28%	>29%	>30%	>31%
Moderately High Body Fat	26-32	27-33	28-34	29-35	22-28	23-29	24-30	25-31
Optimal Range	15-25	16-26	17-27	18-28	11-21	12-22	13-23	14-24
Low Body Fat	12-14	13-15	14-16	15-17	6-10	7-11	8-12	9-13
Very Low Body Fat	≤11%	≤12%	≤13%	≤14%	≤5%	≤6%	≤7%	≤8%

**FIGURE 4-7.** Standards for interpreting percent body fat levels for men and women.

STANDARD	INTERPRETATION OF THE STANDARD
<b>HIGH</b>	Percent fat at this level indicates the person is seriously overweight to a degree that this can have adverse health consequences. The person should be encouraged to lose weight through diet and exercise. Maintaining weight at this level for a long period of time places the person at risk of hypertension, heart disease, and diabetes. A long-term weight loss and exercise program should be initiated.
<b>MODERATELY HIGH</b>	It is likely that the person is significantly overweight, but it could be high due in part to measurement inaccuracies. It would be wise to carefully monitor people in this category and encourage them not to gain additional weight. People in this category may want to have their body composition assessed by the underwater weighing method.
<b>OPTIMAL RANGE</b>	It would be highly desirable to maintain body composition at this level.
<b>LOW</b>	This is also acceptable, but there is no reason to seek a lower percent body fat level. Loss of additional body weight could have health consequences.
<b>VERY LOW</b>	Percent fat level at this range should only be reached by high-level endurance athletes who are in training. Being this thin may carry its own additional mortality. Individuals, especially females, this low are at risk of having an eating disorder such as anorexia nervosa.

### OTHER BODY COMPOSITION METHODS

The skinfold method is the most popular method used to evaluate body composition, but several other computer-controlled devices are available. Two of the more popular methods use infrared and bioelectrical impedance technology. Unfortunately, these methods are not much more accurate than using just height and weight and are less accurate than the skinfold method.

Many commercial fitness facilities use these electronic devices to market their fitness program. You need to view these results with caution because of their potential inaccuracy. A major danger is they will overestimate the percent body fat of someone who is at a desirable body composition. If the affected person is too concerned about their weight, he or she may attempt unnecessarily to lose additional weight. A loss of weight when at a suitable body composition (i.e., optimal level) can have adverse health consequences.

## ENERGY HOMEOSTASIS — REGULATING DIET AND EXERCISE

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Losing or gaining weight is largely due to the inability of maintaining energy homeostasis—a balance between caloric intake and caloric expenditure. A small imbalance can alter body composition and weight substantially over an extended period. Since a pound of fat tissue yields about 3,500 kilocalories, a small caloric imbalance can produce substantial weight gain or loss over time. The following daily caloric imbalances would produce:

- $\pm 250$  kcal/day =  $\pm 0.5$  pounds per week, or about  $\pm 2$  pounds per month.
- $\pm 500$  kcal/day =  $\pm 1.0$  pounds per week, or about  $\pm 4$  pounds per month.
- $\pm 750$  kcal/day =  $\pm 1.5$  pounds per week, or about  $\pm 6$  pounds per month.
- $\pm 1000$  kcal/day =  $\pm 2.0$  pounds per week, or about  $\pm 8$  pounds per month.

### DETERMINING YOUR DESIRED WEIGHT

Establishing a “desirable weight” provides a goal for weight loss. If you know your percent body fat and body weight, desired weight can be easily calculated. Your desired weight is the weight for a desired percent body fat based on your body build. The first step is to calculate fat-free weight. The fat-free equation was presented in the beginning of this chapter (EQ 4-2). Desired weight is calculated from fat-free weight and the desired percent body fat. The equation for desired weight is:

**DESIRED WEIGHT** (EQ 4-10)

$$\text{Desired Weight} = \left[ \frac{\text{Fat-Free Weight}}{1 - \left( \frac{\text{Desired \% fat}}{100} \right)} \right]$$

**Calculation Example - Computing Desired Weight.** Assume that the weight of a person is 165 pounds and their body fat is 32%. The person’s fat weight is 52.8 pounds and their fat-free weight is 112.2 pounds. Further assume the person would like to be at 25% body fat. Their desired weight (i.e., weight at 25% body fat) would be 149.6 pounds. The person would need to lose about 15 pounds of fat weight to be at 25% body fat.

$$\text{Desired Weight} = \left[ \frac{112.2}{1 - \left( \frac{25}{100} \right)} \right] = 149.6$$

Lab 7.3 (Appendix B) is designed to help you estimate your desired weight. The method cannot only be used to establish an intelligent weight loss goal (if desirable); it also can be used to monitor changes in body composition. If fat-free weight does not change, fluctuations in body weight represent changes in body fat. Often when sedentary individuals start an exercise program, fat-free weight increases while losing fat weight. So even if you do not see drastic changes on the scale, you may notice body composition changes.

After exercising for several weeks, you may find that your clothes are not as tight. This is due to lowering your percent body fat. When using exercise to lower your body weight, it is a good idea to periodically check your percent body fat. Some will build muscle mass with exercise. Gaining fat-free weight increases your desired weight.

### THE ROLE OF EXERCISE ON WEIGHT CONTROL

Properly designed aerobic exercise helps you maintain body weight and lose excessive body fat. The American College of Sports Medicine in its 1990 position paper [1] on exercise for health and fitness states:

...Although there is variability in the human response to body composition change with exercise, total body mass and fat weight are generally reduced with endurance training programs while fat-free weight remains constant or increases slightly...

Weight loss programs using dietary manipulation that result in a more dramatic decrease in total body mass show reductions in both fat weight and fat-free weight. When these programs are conducted with exercise training, fat-free weight loss is more modest than in programs using diet alone. Programs that are conducted at least 3 days per week, of at least 20 minutes duration, and of sufficient intensity to expend approximately 300 kcal per exercise session (75-kilogram person) are suggested as a threshold level for total body mass and fat weight loss. An expenditure of 200 kcal per session has also been shown to be useful in weight reduction if the exercise frequency is at least 4 days per week. If the primary purpose of the training program is for weight loss, then regimens of greater frequency and duration of training and low to moderate intensity are recommended. (pp. 268-269)

The reduced caloric expenditure caused by modern technological advances is a major reason for the creeping obesity of industrial societies. Work once done by human power is now being done by machines. The effect of this reduction in caloric expenditure can be illustrated with some simple examples.

**Worker vs. sedentary executive.** Assume a worker walks around the shop at work for 8 hours a day and expends an average of 3.5 kilocalories per minute (exercise intensity of about 3 METs) while the sedentary executive expends only 2 kilocalories per minute (about 2 METs) at his desk. This represents a difference of 720 kilocalories per day ( $8 \times 60 \times (3.5 - 2.0) = 720$ ). At 5 days per week, 48 work-weeks per year, this is over 170,000 kilocalories, which translates to nearly 50 pounds of fat. Small changes in activity without reduction in caloric intake can quickly lead to weight gain.

**The former athlete.** The training regimes followed by competitive athletes tend to be very physically demanding, leading to the development of muscle mass and a low level of body fat. What happens to an athlete after he or she retires from competition? To illustrate the problem, assume that during his active competitive years a male athlete's weight was 100 kilograms and his percent body fat was 15%. His body composition would be 85 kilograms of fat-free weight and 15 kilograms of fat weight. At the conclusion of his athletic career, he reduces activity and desires to reach his "normal" weight of 80 kilograms. Since he reduces his physical activity he must reduce caloric consumption as well. To maintain the desirable body composition of 15%, he would have to reduce to 12 kilograms of fat weight and 68 kilograms of lean body weight, or lose 3 kilograms of fat and 17

kilograms of muscle tissue. Fat-free weight is about 70% water, which contains no calories. The dry weight of fat-free mass has an energy equivalent of about 4,000 kilocalories per kilogram. Adipose tissue is only 20% water and has an energy equivalent of 9,000 kilocalories per kilogram. The 17 kilograms of fat-free weight represent 20,400 kilocalories and the 9 kilograms of fat contain 21,600 kilocalories. The total energy loss required for the athlete to reduce to a “normal weight” of 80 kilograms while maintaining 15% body fat would be 42,000 kilocalories. This additional reduction in diet must be accomplished at the same time that caloric expenditure must be reduced because the ex-athlete is less active. Unfortunately the ex-athlete is used to eating a lot. This combined reduction regimen is often too difficult and helps explain the reason many competitive athletes have weight problems during their post-competitive years.

### **THE INFLUENCE OF AGING ON WEIGHT CONTROL**

As people age, their daily caloric expenditure usually decreases because basal metabolism slows and they tend to exercise less. Basal metabolism is the energy expended at a resting state. Although the rate is low, usually only about 75 kilocalories per hour, the total energy consumption from basal metabolism is high because most people sleep or are sedentary for over 12 hours per day.

Another problem associated with aging is that it is difficult to change lifelong eating habits. Maintaining the same diet while basal metabolism slows leads to an energy imbalance and an increase in body fat. Typically, increased body fat leads to less physical activity. It also serves as an insulator. These factors further reduce daily caloric requirements. Scientists have shown that there is a loss of muscle associated with aging, which further reduces caloric expenditure. All these factors increase your risk of obesity and underscore the importance of maintaining the proper caloric balance at all stages of life. Illustrated next is the potential influence of aging on energy homeostasis.

***Aging and reduced basal metabolism.*** Assume a person has been in weight balance, but over the years their basal metabolic rate drops 10%. The metabolic rate during 8 hours of sleep is 75 kilocalories per hour and 100 kilocalories per hour during 5 hours of sedentary activities. The total daily caloric expenditure due to basal metabolism would be 1,100 kilocalories, i.e.,  $[(8 \times 75) + (5 \times 100)] = 1,100$ . A 10% reduction due to aging would mean that 110 fewer kilocalories per day would be expended. This is a reduction of about 40,150 kilocalories per year. If you did not reduce your diet accordingly, you would gain almost 11.5 pounds of fat weight.

### **INFLUENCE OF BODY COMPOSITION ON WEIGHT CONTROL**

A high level of body fat further increases the risk of obesity. For a given body weight, a person with a higher percent body fat requires fewer calories than someone who has a lower level of fat. The next example illustrates this.

***Caloric differences for percent fat levels.*** Assume two people both weigh 70 kilograms (154 pounds), but one person is 10% body fat while the other is 35%. Their body composition would be: 7 kilograms of fat weight and 63 kilograms of fat-free weight for the person with 10% body fat; and 24.5 kilograms of fat weight and 45.5 kilograms of fat-free weight for the other. The metabolic rate for the fat-free weight component of body weight is about 40 kilocalories per kilogram per day (kcal/kg/day), while the metabolic rate for fat is much lower, about 4 kcal/kg/day. Thus, the basal caloric requirements for the two would be:

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## WEIGHT LOSS METHODS

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**10% Body Fat Person** =  $(63 \times 40) + (7 \times 4) = 2,548$  Kcal per day

**35% Body Fat Person** =  $(45.5 \times 40) + (24.5 \times 4) = 1,918$  Kcal per day.

Individuals with higher levels of body fat are typically less active. If we assume that the leaner person's physical activity averages 175 kilocalories daily as compared to 95 kilocalories per day for the 35% person, the total caloric estimates would be: 10% body fat person—2,723 kilocalories (2,548 + 175); and 35% body fat person—2,013 kilocalories (1,918 + 95). The difference is 710 kilocalories per day. That is, the 35% person would have to consume 26% fewer calories than the leaner person just to maintain his obese state. If they ate the same (i.e., 2,723 kilocalories per day), the fatter person could theoretically gain over 6 pounds a month while the thinner person would not gain an ounce.

High levels of percent body fat not only adversely affect daily caloric expenditure, but also activity habits. Individuals with high levels of body fat exercise less than their more active counterparts. A major problem of adult exercise programs is that most who start will quit within six months. Body composition is a major determinant of one's exercise habits. Individuals with a high percent body fat are not only more likely to be sedentary, they are more likely to drop out of a program once they start [6]. A major public health objective is to find ways to help overweight people exercise and lead an active lifestyle [17].

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## WEIGHT LOSS METHODS

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The most successful method for weight loss is a combination of both diet and exercise. Losing weight and keeping it off is difficult. The adult success rate is less than 15%, lower than the cure rate for most forms of cancer. Chances for success can be enhanced by following some sound behavioral diet tips and exercise procedures.

### BEHAVIORAL DIET TIPS

Psychologists have discovered several behaviors that improve chances of success. Behavioral patterns can be easily followed and incorporated into your daily life. Listed next are some proven behavioral diet practices.<sup>1</sup>

- **Monitor your weight.** Keep a daily log of your body weight. Display it in a prominent place and graph the changes. Do not concern yourself with minor changes (i.e., 1 or 2 pounds), look at the general trend over time. Weight loss should be slow and progressive, no more than 2 pounds per week.
- **Reward yourself.** Give yourself a reward when you reach an important goal. Sorry, food is not a suitable reward. Find something else you really enjoy. It might be buying new clothes to fit your new shape.
- **Be careful when hungry.** Do not do your grocery shopping when you are hungry. Wait until you have eaten. When possible, prepare meals when you are not hungry. Pack your lunch after you have eaten, not before.
- **Control your eating environment.** There are many simple things you can do to reduce caloric intake. Some examples are:

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1. Taken from: DeBakey, Gotto, Scott, & Foreyt, 1984) and "The Help Your Heart Eating Plan," Diet Modification Clinic, The Methodist Hospital, Baylor College of Medicine, Houston, Texas, not dated.

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## WEIGHT LOSS METHODS

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- Always eat in one place, such as at the table.
- Join the dirty plate club. Leave some food on your plate.
- Eat slowly and chew everything well.
- Avoid second helpings.
- Use a smaller plate and spread the food out on the plate.
- Store all food out of sight and in opaque containers.
- Do not carry change for use in vending machines.

## EXERCISE FOR WEIGHT CONTROL

When exercising for weight loss, it is important to participate in exercise that leads to a high caloric expenditure. The best type of exercise for weight loss is aerobic exercise done at a relatively low comfortable intensity, frequently, and for a long duration. Provided next is a discussion of the factors related to exercise adherence and behavioral tips that can help enhance exercise adherence.

### Exercise Adherence

Many people start exercise programs, but most quit. It is estimated that only about 10% of all adult Americans exercise vigorously and frequently enough to meet the levels recommended in the position statement of the American College of Sports Medicine [1]. A major problem with adults who initiate any type of exercise program is that only about 30 to 40% of them will continue their programs, while 60-70% quit. The drop-out rate from high quality supervised exercise programs is about 50%. There are several factors that increase the chances of dropping out of an exercise program [4, 22]. These are:

- **Smoking history.** Smokers are more likely to drop out of exercise programs than non-smokers.
- **Education.** Individuals with higher education levels are more likely to participate in health-related exercise programs.
- **Body weight and body composition.** The overweight and obese are less likely to stay with a fitness program. The obese respond better to moderate activity such as walking, but even with gentle walking programs, 60-70% will stop within 6-12 months [5].
- **Fitness level.** Individuals with low aerobic capacities are less likely to continue an exercise program.
- **Exercise history.** Individuals with an exercise history are more likely to continue an exercise program [5]. These individuals tend to have a more favorable body composition and aerobic fitness profile.
- **Self motivation.** The psychological trait of self-motivation [5, 6] is related to exercise adherence. Individuals who score high on this inventory are more likely to continue an exercise program.

### Self-Motivation

Research [5] shows that the more negative traits one has (e.g., overweight, low fitness, etc.), the more likely the person will not become a regular exerciser. The topics of body composition, aerobic fitness, and exercise habits are fully discussed in other sections of this book. The psychological trait of self-motivation has been shown to be an important predictor of exercise adherence [6, 7].

Self-motivation reflects willpower or self-regulatory skills such as effective goal settings, self-monitoring of progress, and self-reinforcement. These factors are believed to be

important for maintaining a desirable level of physical activity and the ability to change behavior. Successful endurance athletes score high on self-motivation. This psychological trait [5] discriminated between those who continue in exercise programs and those who drop out in a wide variety of settings such as athletic conditioning, adult fitness, preventive medicine, cardiac rehabilitation, commercial spas, corporate fitness, and self-supervised programs<sup>2</sup>.

Self-motivation [6] is measured with a paper-pencil test consisting of several positively and negatively worded statements scored on a 5-point scale ranging from “Extremely uncharacteristic of me” to “Extremely characteristic of me.” Some examples of the statements are:

- I’m not very good at committing myself to do things.
- I get discouraged easily.
- I can persist in spite of failure.

The self-motivation scale has been administered to over 2,000 University of Houston students for the purpose of developing normative standards. There is very little difference in self-motivation of male and female college students. Table 4-3 gives these standards.

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**TABLE 4-3.**

Normative standards developed on University of Houston Students for self-motivation.

<b>SELF-MOTIVATION LEVEL</b>	<b>WOMEN</b>	<b>MEN</b>
High	150	149
Above Average	140	140
Average	129	127
Below Average	116	113
Low	103	101

The value of understanding your self-motivation is to help you find the type of exercise program that best fits your psychological profile. Starting and successfully continuing an exercise program will likely be easier for someone who scores high on the self-motivation scale. Those who score high on self-motivation are more likely to be able to exercise on their own in a self-supervised setting. In contrast, those who score low on the self-motivation scale are less likely to be successful in a self-supervised exercise program. Dishman [5] maintains that individuals lacking self-motivation can negate the behavioral forces by seeking programs with strong social support or reinforcement in settings requiring low-frequency, low-intensity activity.

#### **Behavioral Exercise Tips**

One reason that many people quit their exercise program is that they are not exercising properly. The following suggestions should be helpful.

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2. Self-supervised exercise involves starting, continuing, and monitoring exercise on your own. Examples of this are people who are seen regularly walking or jogging in their neighborhood.

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## WEIGHT LOSS - DIET OR EXERCISE?

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- **Start slowly and steadily progress.** A major problem is you may start exercising too hard. Exercising at a high intensity is uncomfortable and increases the risk of injury. Start with a walking program. As your fitness improves, move to a walk-jog program, and then possibly advance to a jogging program.
- **Do not use high intensity exercise.** Research has shown that people do not enjoy high intensity exercise programs (i.e.,  $\geq 70\%$  VO<sub>2</sub>max) and are more likely to quit if exercise is too intense. It is not necessary, for example, to jog up stairs or hills. This may be fine for the aspiring athlete, but not for most of us who are trying to maintain aerobic fitness and keep our weight down. Exercise at an intensity that will allow you to continue for longer durations. You can increase your duration to about 45 minutes per exercise session. For many, this may be a walking program, which is fine and a recommendation of the American Medical Association [16].
- **Exercise regularly.** The minimum is 3 days per week, but if weight loss is your major objective, progress to 4 and even 7 days per week. The medical recommendation is to aerobically exercise daily [16]. Build up slowly and keep the intensity down. High intensity exercise for more than 3 days per week increases the risk of injury.
- **Find an enjoyable exercise mode.** Many modes of aerobic exercise can be used for caloric expenditure. It is important to find an enjoyable exercise mode and exercise in a pleasant environment. We use examples of walking and jogging extensively in this book because they are easy to do. You only need a place to walk or jog. Often this can be your neighborhood. If, for example, you enjoy swimming, cycling, or playing a certain sport and have access to such facilities, participate regularly. These are excellent exercise modes for caloric expenditure. One of the authors of this text (A.S.J) became a rower because he moved to a lake and the Texas climate allows him to row all year.
- **Walk instead of ride.** It is possible to increase your caloric expenditure in your daily life. Start by walking where possible. For example, walk the stairs, do not ride the elevator. Do not drive your car a short distance, walk. This can have a dramatic long-term effect. To illustrate, suppose you walk when possible and expend another 100 kilocalories per day, which represents a walking distance of about 1 to 1.5 miles. If everything else remained constant, you would expend an additional 700 kilocalories per week, about 3,000 per month, or about 36,000 kilocalories per year. This translates to about 10 pounds of body fat, much more than the average weight gained per year by most people. A little daily walking would help retard the “inner tube” middle that advancing age can bring.

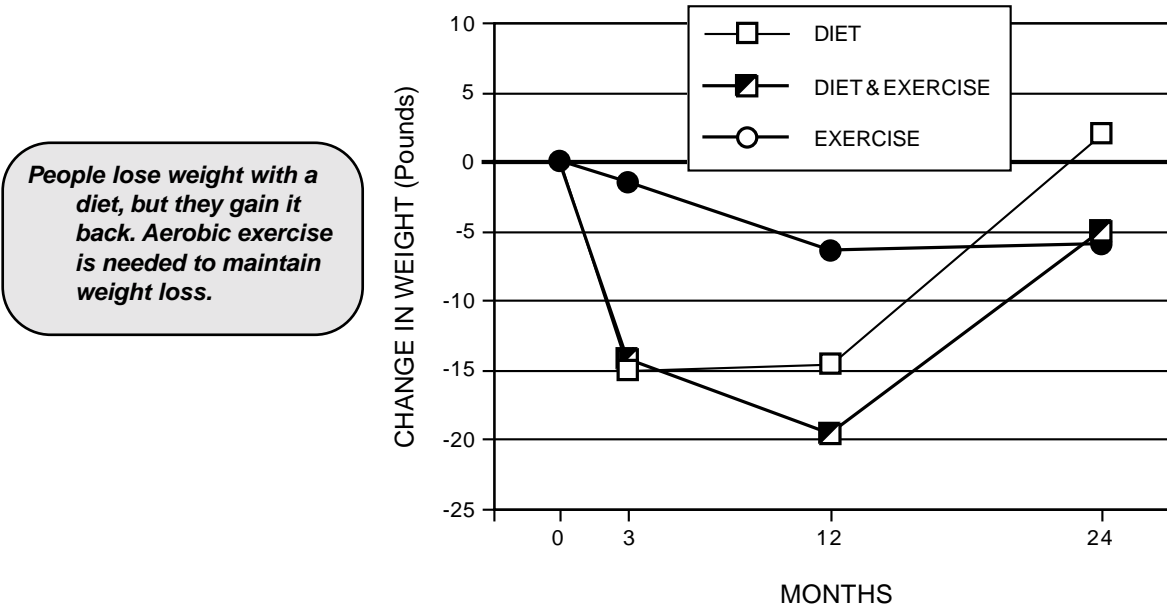
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## WEIGHT LOSS - DIET OR EXERCISE?

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While you may be presently at an acceptable weight level, public health data suggest that 30-40% of us will have a weight problem and will want to lose weight. If you want to lose weight, what is the best method, diet or exercise? Most of us learn weight loss methods through the mass media. While some advertisements market exercise equipment which is usually not effective for weight loss, most ads market diet plans. A diet book is generally listed among the top selling books in the United States. The mass media bombards the public daily about various diet programs. Many include testimonials given by individuals who have lost weight. But are these diets successful?

FIGURE 4-8. The 24-month influence of diet and exercise on weight loss.



Research [20] from the Behavioral Medicine Research Center at Baylor College of Medicine (Houston, TX) answered this question. Diets do lead to weight loss, but the advertisements do not tell the whole story. In a carefully conducted two-year experimental study, Baylor scientists compared the weight loss of three groups: 1) diet only; 2) exercise only; and 3) diet and exercise. The 127 men and women who participated in the study were at least 30 pounds overweight when they started. Figure 4-8 gives the results of the study. During the first three months the exercise group lost very little while the two diet groups showed dramatic weight losses. Between three and 12 months the diet-only group leveled off and then during the next 12 months gained all the weight back and even slightly exceeded their start point. The exercise-only group progressively lost weight over the first 12 months and maintained the weight loss for the next 12 months. Finally, the diet-and-exercise group lost the most weight during the first 12 months, but their weight rebounded in the final 12 months to the level reached by the exercise-only group.

These data give a more complete answer to the value of diet weight loss programs. You can lose weight, but over a period of time the weight will be back to the start point. Diet researchers hear stories daily from patients who have been on many popular diets. They lose weight, but gain it back and typically exceed their start point; “yo yo” weight loss is a health risk.

While the exercise program produced a smaller weight loss at 12 months, the subjects maintained the loss. The current accepted theory among weight-loss scientists is that diet alone is not effective because people will regain the lost weight. Sound weight-loss programs must include an aerobic exercise program.

There are no magical results as suggested in diet and exercise ads, losing weight and maintaining weight loss typically means you must change your lifestyle and increase caloric expenditure. This is difficult for some people. Dr. Rod Dishman, a leading scientist on the topic of exercise motivation observed that many people would rather have their jaws wired shut to prevent eating than start an exercise program. Exercise levels needed for weight control are not excessive. The public health statement<sup>3</sup> on physical activity covered in Chapter 3 provides sound weight-control advice. Exercise moderately, but exercise. It is one key to good health and weight control.

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## EATING DISORDERS

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Eating disorders,<sup>4</sup> anorexia nervosa, bulimia nervosa, and binge-eating disorder,<sup>5</sup> are extremely complex problems that are historically documented. Cases of self-inflicted starvation and weight loss were noted as early as the 4th century when it was recorded that pale, thin, fasting women died of the regimen [8]. Biological, family, and cultural factors are associated with eating disorders. The incidence of these disorders appears to be on the rise and corresponds to societal pressure for women to be thin.

Eating disorders are much more prevalent among young women than men. It is estimated that about 90% of individuals with eating disorders are women [8]. Anorexia nervosa begins in early to late adolescence with the greatest risk for onset between the ages of 14 and 18 years. The average age of onset for bulimia is 17-19 years. It is estimated that about 1% of young women are anorexic. The prevalence of bulimia nervosa is approximately 1-3%. It has been estimated that from 4-19% of young women engage in significant levels of bulimic behavior.

Anorexics and bulimics tend to judge their self-worth in terms of shape and weight. Examples of some of these distorted views [8] are:

- To be fat is to be a failure, unattractive, and unhappy.
- To be thin is to be successful, attractive, and happy.
- To exert self-control by keeping their weight down is a sign of strength and discipline.

The causes of anorexia nervosa and bulimia nervosa are complex and not well understood. In American society, women associate thinness with beauty. Advertisements in the mass media constantly reinforce this notion. The intelligent application of body composition assessment and education can help people establish desirable, intelligent weight goals. The healthy body weight for a well-muscled woman is often higher than what is the social norm. It is our judgment that placing too much emphasis on being thin adds to

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3. Every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.

4. This section was written with the assistance of John Foreyt, Ph.D. and Carlos Poston II, Ph.D., from the Nutrition Research Center, Baylor College of Medicine, Houston, Texas.

5. Binge-eating is a less well defined eating disorder. Binge eating is a behavioral trait of bulimia nervosa, and places one at risk for bulimia nervosa. The focus on this chapter will be on anorexia nervosa and bulimia nervosa.

the problem. The following incident witnessed by one of the author's daughters at her high school underscores the problem.

Many Texas high school drill teams and cheerleader squads have weight limits based on height. These standards do not consider the amount of weight that is body fat and muscle mass. A well-muscled young woman may exceed the standard, but not have a high percent body fat. Weight loss for this person would be the loss of muscle mass—an undesirable effect. A young woman exceeded the weight limit set for the high school cheerleader squad. The faculty advisor told her to lose weight. At this high school, cheerleaders train by lifting weights. Weight lifting not only increases strength, but also increases fat-free weight. Not only did she not lose weight, she gained more weight in the form of muscle mass. This complicated her problem further.

A major theme of this text is the positive effect of exercise and weight control on health. A serious note of caution is now in order. Being too concerned about exercise and weight control can manifest itself into serious problems. While exercise is a very positive behavior for most, it can become very destructive for the anorexic or bulimic. Exercise can become compulsive and used as a weight reduction strategy by those who should not lose weight. The body composition standards presented in this text reflect realistic, healthy levels.

### **ANOREXIA NERVOSA**

The central characteristic of anorexia nervosa is “drive for thinness.” Persons with anorexia strive to lose weight beyond the point of social desirability, attractiveness, and good health. Individuals with this disorder are highly motivated to adhere to socially derived notions of beauty and femininity, which in our society has become thinness [8]. Mass advertising with female models constantly reinforce this notion. The recognized characteristics used to diagnose anorexia nervosa [2, 8] are:

- Refusal to maintain body weight at or above a minimally normal weight for one's age and height.
- Denial of the seriousness of their current low weight.
- Intense fear of gaining weight or becoming fat, though underweight.
- Amenorrhea, or the absence of at least three consecutive menstrual cycles in post-menarcheal females.

Anorexia nervosa has potentially lethal consequences. This disorder has a 20% mortality rate, the highest of any psychological disorders.

### **BULIMIA NERVOSA**

The essential characteristic of bulimia nervosa is an excessive intake of food, usually high in calories, in a relatively short period. Although this varies considerably, as many as 30,000 calories may be consumed during a binge. This binge eating is accompanied by recurrent methods to prevent weight gain such as vomiting or using laxatives. The bulimic needs psychological counseling to develop self-esteem and overcome serious body image concerns. Unlike the anorexic, the bulimic may not experience serious weight loss; many maintain a normal weight. Bulimia nervosa is characterized [2, 8] by:

- Recurrent episodes of binge eating that includes eating a large amount of food within a discrete period of time (e.g., 2-hour period); and a sense of lack of control over eating. Bulimics feel they cannot stop or control what or how much they eat.

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## SUMMARY

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- Recurrent inappropriate compensatory behavior designed to prevent weight gain. These may include self-induced vomiting, misuses of laxatives, fasting, or excessive exercise.
- The binge eating and inappropriate compensatory behaviors occur regularly, at least twice a week, for an extended time period, i.e., three months.
- The bulimics self-evaluation is unduly influenced by body shape and weight.

### EATING DISORDER SCALE

Many different psychological inventories are available to help identify those at risk of developing eating disorders. While these paper and pencil tests provide useful information, the diagnosis of eating disorders can only be made by professionals after intensive evaluation. The scale consists of several statements that relate to food, eating habits, and body size. The student responds on a 5-point scale ranging from “always” to “never” the degree that the statement is applicable to them. Some examples of the statements are:

- Other people think that I am too thin.
- I like my stomach to be empty

Table 4-4 provides normative data of the eating disorder scale administered to over 2,000 University of Houston college students [9]. A high score on this scale represents a tendency to exhibit eating disorder behaviors. It does not mean the person has an eating disorder, only that the score is high in relation to the way other college students responded on the scale. Female students were found to score significantly higher on the scale than male students.

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**TABLE 4-4.**

Normative eating disorder standards developed on University of Houston Students.

RISK LEVEL	WOMEN	MEN
High	58	54
Above Average	49	44
Average	41	35
Below Average	33	27
Low	26	23

The diagnosis of an eating disorder can only be confirmed through a comprehensive assessment by a competent professional. Most colleges and universities have services available to students who want more comprehensive information. If concerned, you are encouraged to contact the University Counseling Center to seek additional information.

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## SUMMARY

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Body composition, the components of fat and fat-free body mass, is a major component of health-related physical fitness. The best method of determining percent body fat is through underwater weighing. The body mass index (BMI) provides a means of assessing body composition from height and weight. The ratio of waist and hip circumferences measures central or visceral fat. This fat component is a strong predictor of degenerative diseases such as stroke, heart disease, and diabetes. The skinfold test is an easy method of

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## STUDY QUESTIONS

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measuring body composition. By knowing skinfold thickness, it is possible to estimate percent body fat accurately. The most scientifically sound method of determining your most desirable body weight for your build is from percent body fat.

Being overly concerned about your body weight can be a problem. The eating disorders of anorexia nervosa and bulimia nervosa are on the rise. These are most prevalent among young women and associated with societal pressure for women to be thin. Eating disorders are complex health problems and those with these disorders need to seek professional help.

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## STUDY QUESTIONS

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1. What is the body mass index and what is a desirable value?
2. Why is the ratio of waist and hip circumference important?
3. What is percent body fat and how can it be determined?
4. What are the optimal percent body fat ranges for men and women?
5. What are the skinfold sites used to measure percent body fat for men and women?
6. What changes in the American diet are needed to promote health?
7. How many calories are in one pound of fat?
8. What are sound guidelines to follow to lose weight with exercise?
9. How can you alter your dietary behavior to help lose weight?
10. When dieting, how much weight should be lost each week?
11. What are the factors that increase your chances of being able to exercise on a regular basis?
12. What is the psychological trait of self-motivation and how can it be used to enhance your chances of continuing an exercise program once you start?
13. What are the major eating disorders and what group of people are most likely to have them?

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