CHAPTER 11 Weight Management

Key Questions Addressed

- What are the common weight management concerns for athletes?
- What are the prevalence and significance of overweight and obesity?
- What methods are used to determine weight status?
- Why is body composition important?
- What are the components of energy intake and energy expenditure?
- What methods do athletes use to lose weight?
- What are the weight loss issues for athletes in weight classification sports?
- What happens when weight loss efforts develop into disordered eating patterns?
- How can athletes gain weight healthfully?

You Are the Nutrition Coach

Ian is an 18-year-old gymnast training at a private gym with many other male and female gymnasts. He is competing at an advanced level and is likely to make the next Olympic team. Lately he has been finding some of his balance and strength moves on the rings and parallel bars more difficult. He has gone through a bit of a growth spurt and has gained approximately 5 pounds over the last year. He suspects the weight gain is causing his performance difficulties. He decides to try a weight loss program that will help him lose weight before his next big competition in 6 weeks. He is not sure how many calories to consume and therefore arbitrarily decides to eat 1500 calories per day.

Questions

- Which assessments are required to determine whether Ian needs to lose weight?
- What type of diet and exercise plan would you recommend for Ian?
- What additional concerns do you have for Ian's health and sport performance?

What are the common weight management concerns for athletes?

Almost all athletes are looking for ways to improve sport performance. To gain a performance edge on their competitors, athletes may try to lose weight, gain weight, or modify their body composition. Overall health is also a concern for most athletes; weight modifications may be necessary in some cases if the athlete presents with risk factors such as prehypertension, insulin resistance or prediabetes glucose levels, or lipid abnormalities.

A common reason athletes strive to lose weight is aesthetics. Athletes have similar concerns as the general population about weight and body composition. They are concerned about their appearance and try to meet the ideals of cultural norms. Athletes often perceive additional pressure to maintain or achieve an ideal weight to enhance, improve, or sustain optimal sport performance.

Performance may improve following weight loss in some athletes. For example, a few pounds lost, especially as body fat, may improve speed. If an athlete has less body weight to carry but maintains the same muscle mass and power, speed may improve. Agility may increase as well for similar reasons. Less body fat may help the athlete jump higher or plant and turn with greater speed. Therefore, in some cases, weight loss may improve sport performance. In other cases, attempting to make these changes may lead to an obsession about weight or body composition and result in disordered eating.

Some sports have weight classifications requiring athletes to compete in a specific weight category. These athletes must "make weight" before each event or they will not be able to compete in the event. This places extra pressure on athletes to lose or maintain their body weight, which often involves altering their daily diet, sometimes in a dramatic fashion.

Many athletes want to gain weight or increase lean muscle mass to improve sport performance. As the strength-to-weight ratio increases, more power per pound can be produced, and potentially an athlete can increase speed, decrease time over long distances, and produce more power in explosive sports. Increasing lean mass or overall weight requires nutrition and exercise changes to enhance the ability of the body to develop and maintain additional body mass.

This chapter discusses the various weight management concerns of athletes and ways athletes can alter body weight, if needed. The chapter begins with an introduction of the prevalence and health consequences of overweight and obesity concerns and assessment of weight and body composition. A discussion of energy balance, including intake, needs, and expenditure in athletes and the general population, provides the background necessary for the reader when the topics of weight loss and weight gain in athletes are discussed. A section on issues pertaining to weight-classified sports and eating disorders in athletes is also included in this chapter.

What are the prevalence and significance of overweight and obesity?

Data from the National Health and Nutrition Examination Survey (NHANES) show that there has been a significant rise in the incidence of overweight and obesity.[1,2] Figure 11.1 shows the alarming trends in the rise of overweight and obesity in adult males and females in the United States from 1960 to 2010.[1] Overweight and obesity are determined in these datasets using **body mass index (BMI)** measurements. A BMI of 18.5–24.9 is considered normal weight, ≥25 is considered overweight, and ≥30 is considered obese. The NHANES data show that approximately 69% of adult Americans are overweight or obese, with 35.7% of these being obese.[1] Overweight and obesity in children and adolescents ages 2 to 19 has also been on the rise, with approximately 16.9% of this age population being obese.[2]

body mass index (BMI) An indicator of nutritional status that is derived from height and weight measurements. Body mass index has also been used to provide a rough estimate of body composition even though the index does not account for the weight contributions from fat and muscle.

The prevalence of overweight and obesity in athletes in most competitive sports is relatively low. However, in some sports, such as football, heavyweight wrestling, and boxing, the prevalence of overweight and obesity may be high. As an example, for the past decade there has been a perception that bigger is better in almost all positions in football. Indeed, players are bigger than in years past. This may or may not pose additional health risks to the athlete. If the majority of the weight gain

gaining the performance edge

Overweight and obesity affect nearly two-thirds of the adult American population. Athletes have a much lower prevalence of overweight than the general population. However, athletes participating in some power sports and sports in which a greater body mass is beneficial (e.g., football, heavyweight wrestling, some field events) have a higher incidence of overweight or obesity.

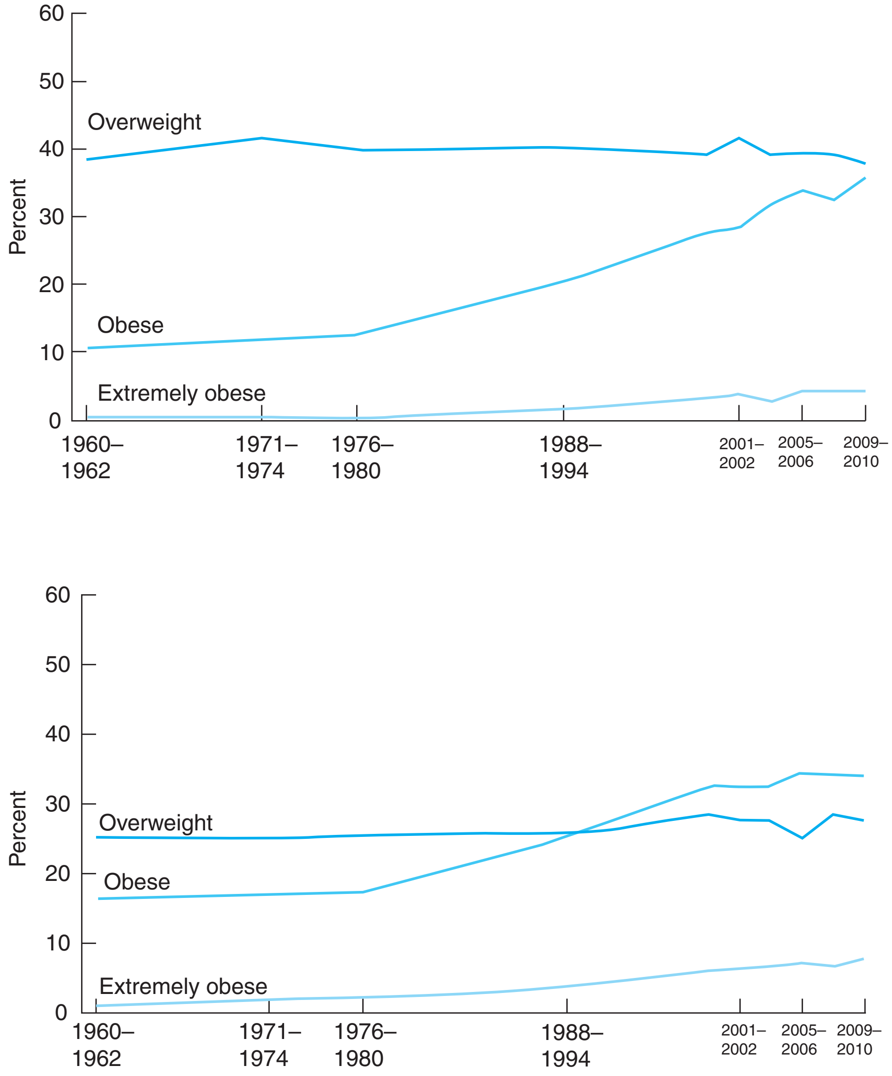


Figure 11.1 Trends in overweight, obesity, and extreme obesity among adults aged 20 to 74 years: United States, 1960–1962 through 2009–2010.

Notes: Age adjusted by the direct method to the 2000 U.S. Census population using age groups 20 to 39, 40 to 59, and 60 to 74. Overweight is a body mass index (BMI) $\geq$ 25 kg/m^2 but, < 30 kg/m^2; obesity is a BMI $\geq$ 30; and extreme obesity is a BMI $\geq$ 40.

Sources: Courtesy of CDC/NCHS, National Health Examination Survey I 1960–1962; National Health and Nutrition Examination Survey (NHANES) I 1971–1974; NHANES II 1976–1980; NHANES III 1988–1994; NHANES 1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, and 2009–2010.

is fat-free mass, then the increase in disease risk is negligible. A study of Division I football players to determine body mass and body composition found the mean BMI of all positions was 29.4 ± 0.6%.[3] Body fat percentages ranged from 15.2–25.4%. Quarterbacks, defensive and offensive backs, and receivers were the leanest and weighed less, whereas the linemen were the heaviest and had the highest body fat percentages. Though the NHANES data are reflective of the U.S. population as a whole, not an athletic population, the trends toward overweight and obesity in the general population are likely to affect the health and performance of athletes, particularly young athletes, in the future.

What are the main health consequences and health risks of overweight and obesity?

The health consequences associated with obesity as a risk factor carry with them significant morbidity and mortality in adults and health problems in children and adolescents. Some of the major health conditions associated with obesity include hypertension, type 2 diabetes, coronary heart disease, stroke, osteoarthritis, respiratory problems, and some types of cancer. There are additional psychological, emotional, and social costs to obese individuals as well. Obese athletes are at risk for developing these health consequences as well. Despite their high activity levels, which offer some preventive effects, obese athletes can develop obesity-related conditions, and professionals working with them should provide screening and education for the athlete just as they would the general population.

BMI and mortality rates have a strong correlation. Individuals in the underweight (<18.5 BMI) and obese (≥30 BMI) categories have increased mortality relative to individuals in the normal weight category.[4] There is relatively low risk in the 18.5–24.9 and even the 25–29.9 BMI categories when there is an absence of concurrent comorbid conditions. Obesity is generally defined as an excess of body fat accumulation. It is the excess adipose tissue that is the cause of the comorbid conditions, not necessarily the excess weight.[5] A person's absolute risk status is based not only on the BMI classification, but also

waist circumference A measure of abdominal girth taken at the narrowest part of the waist as viewed from the front.

on waist circumference measurements, existing disease conditions, and summation of other obesity-associated diseases. Increased risk is found in individuals with cardiovascular disease risk factors and other obesity-associated risk factors, such as osteoarthritis, physical inactivity, hypertension, and gynecological abnormalities. Very high absolute risk status would include individuals with high BMI that already have an existing disease, such as coronary heart disease, atherosclerotic disease, diabetes, or sleep apnea.

The National Institutes of Health (NIH) and the National Heart, Lung, and Blood Institute published practical guidelines for identification, evaluation, and treatment of overweight and obesity in adults in 2000.[6] This guide includes a treatment algorithm that helps the client and practitioner assess overweight and obesity as well as associated educational tools and treatment options based on the assessment. The treatment algorithm was designed primarily for use in a clinical medical setting. However, this algorithm can be applied to the athletic population to assess and help prevent or treat medical conditions that may be associated with overweight or obesity. The initial assessment can occur during a preseason physical or at other times throughout the athletic season when the need arises. The main steps in assessing, preventing, and treating overweight and obesity, adapting the algorithm for use with athletes, are the following:

1. Measure height, weight, waist circumference, and body composition.
2. Calculate BMI.
3. Determine whether BMI, waist circumference, and body composition are within normal ranges for the athlete.
4. Assess health parameters (e.g., cholesterol and blood pressure).
5. If within normal limits, encourage weight maintenance.
6. If above normal limits, determine athlete's interest in and ability to attempt weight loss; provide education and monitoring of behaviors.
7. Follow up assessments and provide education regularly to determine progress toward goals.

The treatment algorithm is focused on disease risk factors and prevention of disease complications related to obesity. A discussion of BMI and waist circumference measures and their relevance to health and sport performance are presented in the next section.

What methods are used to determine weight status?

The two most commonly used ways to assess weight status are BMI and waist circumference. Both of these measures are used to determine health and health risk and can be used as a starting point when determining a weight that is best for athletic performance. BMI and body fat distribution measures combined with body composition assessments (discussed in the next section) offer sport nutrition professionals helpful information to establish a weight management plan for athletes.

What is body mass index?

The most widely used height for weight index in adults is the BMI. It is a measure of height versus weight using a metric calculation. BMI data were obtained from large general population groups to determine the mid-

Fortifying *Your Nutrition Knowledge*

Calculating Body Mass Index

Metric Calculation Equation

Weight in kilograms ÷ (Height in meters)^2

Height: 74 inches

Weight: 195 pounds

Convert inches to meters:

$74 \text{ inches} \times 2.54 \text{ cm/inch} = 188 \text{ cm} = 1.88 \text{ meters}$

Convert pounds to kilograms:

$195 \text{ lbs} \div 2.2 = 88.6 \text{ kg}$

$88.6 \text{ kg} \div (1.88 \text{ m})^2 = 25.1 \text{ BMI}$

Nonmetric Calculation Equation

$(\text{Weight in pounds} \div [\text{Height in inches}]^2) \times 703$

Height: 74 inches

Weight: 195 pounds

$(195 \div [74 \text{ inches}]^2) \times 703 = .0356 \times 703 = 25.1 \text{ BMI}$

TABLE 11.1 Body Mass Index Classifications

BMI (kg/m²)	Classification
<18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Overweight
30.0–34.9	Obesity class I
35.0–39.9	Obesity class II
≥40	Obesity class III (extreme obesity)

point range of health. BMI is calculated by dividing a person's weight in kilograms by the square of their height in meters. It can also be calculated using body weight in pounds and height in inches (versus kilograms and meters). **Fortifying Your Nutrition Knowledge** presents the calculations for both methods.

Table 11.1 outlines the recommended classifications for BMI adopted by the National Institutes of Health Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults.[7] The BMI is not gender specific and therefore is appropriate for all men and nonpregnant women of all races and ethnic groups. A BMI of 18.5–24.9 is considered normal or healthy for the average population, 25–29.9 is considered overweight, greater than or equal to 30 is considered obese, and greater than or equal to 40 is considered extreme obesity. The BMI should be used to classify overweight and obesity and to estimate relative risk for disease compared to normal weight. Nomogram charts with calculated BMIs for various heights and weights are widely available. This makes BMI an easy and available tool for both health professionals and the public to use to assess their weight and health status.

BMI correlates well with body fatness.[8,9] Evidence supports the use of BMI in risk assessment because it provides a more accurate measure of total body fat than does the assessment of weight alone.[7,10] However, BMI has some limitations when applied to athletes. Individuals with higher muscle mass (like most athletes) may have a BMI above 24.9 because muscle tissue is denser than fat tissue, weighing more when compared with an equal volume of fat tissue, leading to a higher body weight and BMI. Although total body weight in these athletes may be higher, they may be very lean and thus have a lower health risk despite being in the overweight BMI category. Athletes can use BMI for a general idea about their weight status, but body composition measures (the ratio of lean muscle to fat) will provide a better understanding of their overall health status as well as their sport performance needs. BMI can be used as a basic screening tool for athletes. It is a quick and easy way to assess weight; however, it is only one part of a comprehensive assessment to help an athlete determine the best weight for both health and sport performance.

What can measures of body fat distribution tell us?

BMI can be used to predict potential health risks. Other measures of risk assessment also can be employed to obtain a clearer picture of health. Waist circumference measures the degree of weight distribution around the waist. Fat located in the abdominal area is associated with a greater health risk than fat in the gluteal-femoral region. A waist circumference greater than 40 inches (>102 cm) in men and 35 inches in women (>88 cm) is considered high, placing individuals at greater risk for disease.

Waist circumference is measured using a flexible tape at the narrowest part of the waist as viewed from the front while the person is standing. The measure is best conducted against bare skin or tight-fitting clothing. The tape should be snug, but not compress the skin, and should be parallel to the ground all the way around the waist. For individuals who do not have an obvious narrow part of the waist on visual inspection, it is best to measure the waist at the midpoint between the iliac crest and the lower rib. Waist circumference can be an independent predictor of disease risk. However, often waist circumference and BMI are used together to estimate risk status. A high waist circumference measure when BMI is between 25 and 34.9 is associated with an increased disease risk for type 2 diabetes, dyslipidemia, hypertension, and cardiovascular disease.[11,12] **Table 11.2** presents the relative risk of waist circumference combined with BMI levels. At a BMI ≥35, waist circumference measurements have little added predictive power over BMI alone, and it may not be necessary to measure waist circumference in this case. Measuring waist circumference is part of the evaluation guidelines from the NIH and is preferred over waist-to-hip ratio measurement for assessing overweight and obesity. Although waist circumference measures are primarily used to determine health risk, athletes, especially those in heavyweight sports, should have a waist circumference measure as part of an annual sport physical.

TABLE 11.2 Classification of Overweight and Obesity by BMI and Waist Circumference, and Associated Disease Risk*

Underweight, Normal, Overweight, Obesity, and Extreme Obesity	BMI (kg/m^2)	Obesity Class	Men ≤ 102 cm (≤40 in) Women ≤ 88 cm (≤35 in)	Men > 102 cm (>40 in) Women > 88 cm (>35 in)
Underweight	<18.5	—	—	—
Normal+	18.5–24.9	—	—	—
Overweight	25.0–29.9	—	Increased	High
Obesity	30.0–34.9	I	High	Very high
	35.0–39.9	II	Very high	Very high
Extreme obesity	≥ 40	III	Extremely high	Extremely high

* Disease risk for type 2 diabetes, hypertension, and cardiovascular disease.

+ Increased waist circumference can also be a marker for increased risk, even in persons of normal weight.

Source: Reproduced from National Heart, Lung and Blood Institute, National Institutes of Health, U.S. Department of Health and Human Services. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults, Evidence Report, 1998. NIH Publication No. 98-4083.

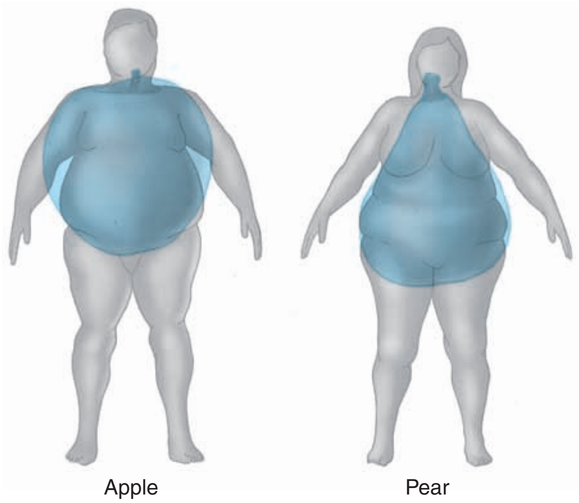


Figure 11.2 Apple vs. pear shape. Android and gynoid fat distribution patterns. Individuals exhibiting android fat distribution have high waist-to-hip ratios and are at greater risk for cardiovascular disease.

Waist-to-hip ratio (WHR) is another fat distribution measure that compares abdominal circumference to hip girth. It gives an indication as to where fat deposition is occurring (i.e., upper body versus lower body). For example, individuals with fat deposition that occurs primarily in the hips are described as having a pear shape (see Figure 11.2). The opposite fat deposition pattern results in a body shape resembling an apple. To determine WHR, the waist measurement is taken as described above for the waist circumference. The hip measurement is taken around the hips and over the buttocks wherever the greatest girth is found. Once the measurements are taken, the WHR is calculated by dividing the waist girth by the hip girth. Females and males with WHRs greater than 0.80 and 0.91, respectively, run a higher risk for cardiovascular disease, diabetes, hypertension, and certain cancers.[13] A low-risk WHR value is less than 0.73 and 0.85 in women and men, respectively.[13]

waist-to-hip ratio (WHR) A comparison of waist girth to hip girth that gives an indication of fat deposition patterns in the body.

Why is body composition important?

Measures of height versus weight and measures of distribution of body fatness in the waist and hip areas are simple, noninvasive, and inexpensive ways to determine appropriate weight and the health risk status of individuals. However, these measures do not provide specific information about the actual quantity of body fat, muscle mass, and other components in the body that make up total body mass. Determining actual body fat, muscle mass, and bone mineral mass percentages (body composition) helps further determine health status and, for athletes, is an excellent way to determine whether weight is optimal for sport performance.

Food for Thought 11.1

Body Mass Index: Calculation and Interpretation

Calculate body mass index and interpret results in relation to health and need for weight loss.

gaining the performance edge

Height, weight, and waist circumference measures are fast, easy, inexpensive, and noninvasive tools that every healthcare provider should use. Calculating BMI or using a nomogram with BMI levels for various heights and weights is simple and gives reliable information quickly about the patient. Waist-only and waist-to-hip circumference measures can give additional information to help assess health risk as well as body fat distribution.

What makes up the composition of the body?

The body is made up of a variety of tissues and substances that contribute to total body mass. **Fat mass (FM)** is the weight of body fat. Body fat is made up of about 10% water and 90% adipose tissue. **Essential body fat** is the fat associated with the internal organs, central nervous system, and bone marrow. Without fat in these areas, the body cannot function properly. In females, some essential body fat is also associated with mammary glands and in the pelvic region. The essential body fat percentage or the minimum level of body fat compatible with health in men is approximately 3–5% and in women is approximately 12–14%.[14] **Nonessential body fat** is found in adipose tissue.

Fat-free mass (FFM) is the weight of all body components except fat and is primarily made up of the skeletal muscles and bone, including minerals, protein, water, and fat-free organ weight. The term FFM is often used interchangeably with **lean body mass (LBM)**; however, LBM includes essential fat and FFM does not. Approximately 70% of the FFM is made up of water. **Bone mineral mass (BMM)** is the weight of the mineral content of bone based on estimations of bone density. Bone consists of approximately 50% water and 50% minerals and protein. Total bone weight is approximately 12–15% of total body weight, but only 3–4% of this is minerals.

Percent body fat (%BF) is the percentage of total body weight that is fat mass. The %BF is the number that most athletes and their coaches and trainers use to determine whether the athlete is at an optimal body composition. This combined with BMI will give a better picture of overall health and ability to perform in the sport.

The World Health Organization (WHO) and the NIH have not yet determined body composition recommendations for the average population. These organizations have not made these recommendations primarily because there are many techniques used to determine body composition, thereby making it difficult to compare results and make recommendations. In addition, some methods are costly, are time consuming, may lack reliability, and are not readily available to the public or the average medical provider. As previously discussed, BMI and waist circumference measures are available, easy, and inexpensive, making these assessments appropriate for the general population. For athletes, body composition remains the preferred assessment (versus BMI and waist circumference) because it is a better method for determining the quantities of both FFM and FM.

Body composition varies greatly between individuals. It is influenced by a myriad of factors, including genetics, gender, age, disease, diet, and activity level. Young individuals tend to have higher resting metabolic rates, are more active, and as a result are lean. As puberty approaches, the males begin to build more muscle mass and the females more fat mass because of increasing sex hormone levels. In adulthood, job and family responsibilities tend to replace regular exercise, sports participation, or recreational activities, and the result over time is muscle mass decreases and fat mass increases. In older individuals, the continued decreased activity level and onset of certain chronic diseases, such as osteoarthritis, can compound muscle loss and fat accumulation. For these reasons and based on genetics and response to training, athletes in the same sport and with the same training regimen will have varied body composition measures.

What are the methods for measuring body composition?

Body composition can be measured in a variety of ways. Some methods are quick and relatively inexpensive to complete, whereas others are time consuming, highly technical, and costly. The accuracy of the various body composition measurements is also highly variable. In fact, even the most accurate techniques have measurement errors in the 2–3% range.

fat mass (FM) The portion of body composition that is fat. Fat mass includes both fat stored in the fat cells and essential body fat.

essential body fat Fats found within the body that are essential to the normal structure and function of the body.

nonessential body fat Fat found in adipose tissue. Nonessential body fat is also called "storage fat."

fat-free mass (FFM) The weight of all body substances except fat. Fat-free mass is primarily made up of skeletal muscles and bone and includes minerals, protein, water, and fat-free organ weight.

lean body mass (LBM) The portion of a body's makeup that consists of fat-free mass plus the essential fats that comprise those tissues.

bone mineral mass (BMM) The weight of the mineral content of bone.

percent body fat (%BF) The amount of fat mass found on the body expressed as a percentage of total body weight.

Figure 11.3 Underwater weighing. During underwater weighing, the subject must exhale completely, submerge without taking a breath, and remain motionless until the water is still and the scale is steady.

This section addresses the commonly used body composition measurement tools used in the field and laboratory, which include underwater weighing (UWW), air displacement plethysmography, bioelectrical impedence analysis, skinfold measurement, dual-energy X-ray absorptiometry (DEXA), and others.

The gold standard (or criterion) methods of determining body composition are underwater weighing (i.e., densitometry) and DEXA. These techniques are considered accurate, and their validity and reliability have been established in the research literature. UWW and DEXA are used to help validate other methods of body composition.

What is underwater weighing?

Underwater weighing, or hydrostatic weighing, is an assessment of body composition based on the determination of body density or densitometry. To determine the density of the body, the athlete is first weighed on land and is then submerged in a tank of water to determine his or her underwater weight (see Figure 11.3). The basic premise of this technique is that fat-free mass sinks and fat floats; therefore, the more the body weighs in the water, the less fat within the body. Most of the error associated with this method arises from the assumptions made when converting body density to percent body fat. Although fat density from one person to the next is fairly consistent, assumptions about fat-free mass can decrease accuracy because it is assumed that all of the component tissues making up fat-free mass exist in the same percentages from person to person. This assumption is flawed because, for example, an osteoporotic female would have less dense bones than normal, and her skeletal weight would therefore make up a lower percentage of her FFM than assumed. Fortunately, the induced error is relatively small under most circumstances, which is why underwater weighing is still considered the standard for body composition assessment. In addition, researchers have developed conversion equations for various subpopulations to account for known differences in FFM to increase the accuracy of this technique. Under ideal measurement conditions and applying the appropriate conversion formula, the standard error of measurement is approximately ±2.5%.[13]

underwater weighing The gold standard of body composition determination that involves weighing a person while he or she is totally immersed in water.

The disadvantages of underwater weighing are that it has to be conducted in a laboratory because the water tank is not mobile; the protocol is fairly complex, so obtaining all the data needed requires some technical expertise; and many people do not like getting into a small tank of deep water, much less totally submerging themselves for several seconds while their underwater weight is measured. Finally, the test requires the person being measured to follow some very specific directions that some populations, especially children, can find difficult.

What is air displacement plethysmography?

A newer method of body composition analysis that is similar to UWW but enables determination of body density based on air displacement rather than water is **air displacement plethysmography**. Just as in UWW, once body volume is known, the density of the body can be calculated and used to determine percent body fat. The commercially available machine that uses air displacement plethysmography is called the BOD POD. The BOD POD is an egg-shaped container in which the person sits (see Figure 11.4).

The accuracy of air displacement plethysmography is similar to underwater weighing. It is prone to many of the same assumption

air displacement plethysmography A technique that measures the volume of air displaced by an object or body. In body composition assessment, air displacement plethysmography is used to determine the volume of the body so that the density of the body can be determined.


Courtesy of COSMED USA, Inc.

Figure 11.4 BOD POD. By using air displacement, the BOD POD provides an alternative to underwater weighing that is easier, cheaper, and of similar accuracy.


© Photodisc

Figure 11.5 DEXA (dual-energy X-ray absorptiometry). The two-dimensional image produced from a DEXA scan can be used to assess body composition.

errors as UWW because once body density is calculated assumptions have to be made to convert to percent body fat. The advantages to this method over UWW are that subject participation in the measurement is minimal, the subject stays dry, and the fear of going underwater is removed. It is relatively simple to use, and obtaining the measurement is quick. Also, the BOD POD is easier to maintain than the water tank used for UWW and is smaller, lighter, and more portable. The disadvantage is that the BOD POD is expensive and well above the budget of many facilities.

dual-energy X-ray absorptiometry (DEXA) A method of body composition assessment that involves scanning the body using radiography technology to distinguish between fat and lean body tissue.

What is dual-energy X-ray absorptiometry?

Dual-energy X-ray absorptiometry (DEXA) has been used for measuring bone mineral density for research and health assessment for many years. It is commonly used to assess risk for osteoporosis and can measure bone mineral density (BMD) by region in the body. In addition to assessing BMD, DEXA also can be used for body composition determination. During assessment, the individual is placed in a supine position on a table in the DEXA machine, and the DEXA scanner passes over the entire length of the body (see Figure 11.5). Just as with any X-ray technology, the various body tissues absorb or reflect the X-rays to varying degrees, allowing for differentiation between tissue types. The X-ray information is analyzed by computer software that differentiates between the various tissue types and calculates body fat percentage. Unlike UWW and the BOD POD, which are based on a two-component model of body composition (FM and FFM), the DEXA provides a three-component look at body composition (FM, bone mass, and lean body mass). Most studies have concluded that DEXA is accurate and correlates well with results from UWW.[15,16]

DEXA's advantages are that it is the only method that provides regional as well as whole body composition measures; it requires minimal cooperation from the participant, thus expanding its use to all ages and levels of health; it is easy to operate; and it is relatively fast (it takes 15 to 20 minutes). The limiting factors in using DEXA are that the machine is large, costly, and not mobile. As a result, these machines are usually found only in research institutions or clinical settings.

What is bioelectrical impedance analysis?

Bioelectrical impedance analysis (BIA) has become a popular way to assess body composition. A variety of BIA machines are available to the general population for home use, and more sophisticated machines are available for clinical and research

bioelectrical impedance analysis (BIA) A body composition assessment technique that measures the resistance to flow of an insensible electric current through the body; percent body fat is then calculated from these impedance measurements.

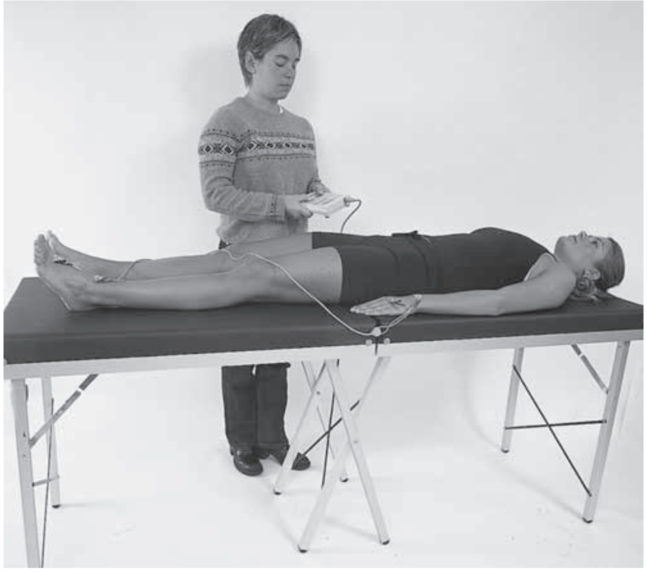


Figure 11.6 Bioelectrical impedance analysis (BIA). The measured resistance to a small electrical current passed through the body is used to estimate body composition.

settings. During BIA in a lab, the person lies flat on a nonconducting surface. Electrodes are placed on two different parts of the body, usually one on the foot and one on the hand on the same side of the body (see Figure 11.6). An insensible electrical current is passed between the electrodes, and the resistance to the flow of the electricity is measured. Because the physical properties of fat make it an insulator, the greater the resistance to flow (i.e., impedance) of the electric current, the higher the percent body fat. Computer software then uses prediction equations based on gender and age to convert the impedance measures to percent body fat.

The accuracy of BIA depends on which prediction equations are used and whether certain premeasurement conditions are met. Of particular concern are any preassessment activities that might affect hydration level.[17] An athlete who is overhydrated prior to BIA assessment is likely to have a higher calculated body fat percentage, and a dehydrated athlete is likely to have a lower calculated body fat percentage than if the measures were taken in a normal hydrated state.[17] To obtain accurate measures, subjects should avoid alcohol consumption within 48 hours of testing; avoid moderate or vigorous physical activity within 12 hours of assessment; abstain from eating within 4 hours of the test; avoid ingestion of any substances that have diuretic effects, including caffeine, prior to assessment; and empty the bladder immediately before the test. When the appropriate prediction equation is applied and measurement conditions are met, the standard of error for BIA can be fairly small (±5%).[18]

The handheld or foot bathroom scale types of BIA do not provide as accurate of a measure as the typical laboratory devices. However, they can be used in combination with body weight to assess changes in mass over time. Athletes making dietary and exercise changes to alter body composition (either to gain FFM or to lose FM) may use these scales as an adjunct to weight measures alone. They can plot changes in %BF and weight over time to determine the trend in changes in these two parameters. For better success with assessing trends in using the handheld or foot scales, measurements should be done weekly on the same day and at the same time of day, before exercise, and with the same average amount of hydration.

What is a skinfold assessment?

Body composition can be estimated by measuring subcutaneous fat. The thickness of the layer of fat directly underneath the skin is measured using **skinfold calipers**. During skinfold measurement, the tester pinches a fold of skin between the thumb and index finger. While holding the fold, the thickness of the fold is measured by placing the skinfold calipers perpendicular to and about a half an inch below the pinching fingers. The spring tension in the caliper jaws slightly presses in on the fold, and the skinfold thickness is measured in millimeters. Figure 11.7 shows the skinfold calipers being used to measure the thickness of the triceps skinfold. Measurements are taken at several anatomical locations on the body. **Table 11.3** lists the common skinfold sites and their anatomical locations.

After the skinfold measurements are taken, prediction equations can be applied to determine the overall percentage of body fat. The accuracy of skinfold assessment depends on many factors. First, not all fat is deposited under the skin. In fact, up to 50% or more of the body's

skinfold calipers An instrument used to measure the thickness of skinfolds in millimeters.

gaining the performance edge

Monitoring body composition in athletes provides a standard of measure that more accurately reflects body fatness than BMI or waist circumference measures. Periodic assessment of body composition, using the same mode of testing and following standardized protocols, will provide an ongoing way for athletes to assess their body composition over the course of a season and thus help them evaluate whether weight loss or gain is needed.

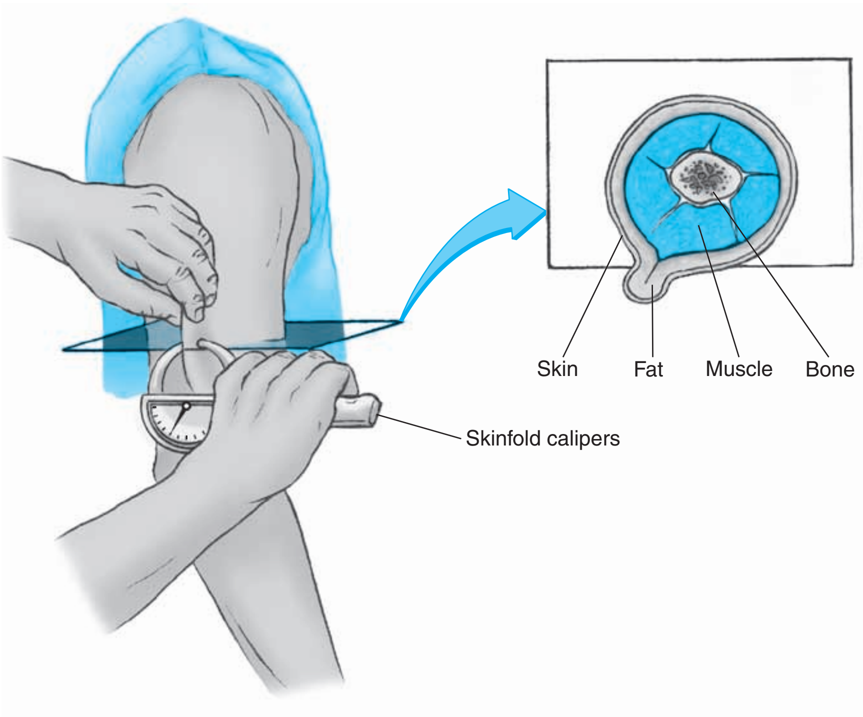


Figure 11.7 Skinfold measurements. A significant amount of the body's fat stores lies just beneath the skin, so, when done correctly, skinfold measurements can provide an indication of body fatness. An inexperienced or careless measurer, however, can easily make large errors. Skinfold measurements usually work better for monitoring malnutrition than for identifying overweight and obesity. They also are widely used in large population studies.

fat can be found in areas other than subcutaneously. As a result, an assumption has to be made that subcutaneous fat levels are accurate indicators of overall body fat. Many formulas have been used to improve the accuracy of subcutaneous measures as they relate to total body fat. In addition, technical errors in the skinfold measurement can decrease accuracy. Learning to take skinfold measurements requires proper instruction, education, and substantial practice. Pinching poorly shaped skinfolds, taking measurements at the wrong locations, placing the calipers incorrectly on the fold, and so on can all affect measurement accuracy. If experienced testers follow the standardized measurement techniques and apply the correct prediction equations, then skinfold assessment can accurately predict %BF to within 3–4% of UWW.[19]

As has been discussed, many methods can be used to assess body composition in athletes. Selection of the method used will depend on what equipment and staff are available and its cost. Regardless of the method selected, the athlete should use the same body composition method in subsequent reevaluations. This reduces data variability caused by methodological differences

TABLE 11.3 Common Sites for Skinfold Measurements

Skinfold Site	Direction of Fold	Anatomical Location
Abdominal	Vertical	2 centimeters to the right of the umbilicus
Biceps	Vertical	Anterior midline of upper arm over the mid-belly of bicep muscle, 1 centimeter above the level of the triceps skinfold
Triceps	Vertical	Posterior midline of upper arm halfway between acromion process and olecranon process
Chest or pectoral	Diagonal	Men: half the distance between anterior axillary fold and nipple Women: one-third the distance between anterior axillary fold and nipple
Medial calf	Vertical	Midline of the medial aspect of calf muscle at the level of greatest girth
Midaxillary	Vertical	Midaxillary line at the level of the xiphoid process of sternum
Subscapular	Diagonal	1–2 centimeters below inferior angle of scapula
Suprailiac	Diagonal	Anterior axillary line just superior to iliac crest
Thigh	Vertical	Anterior midline of thigh halfway between inguinal crease and proximal edge of patella

Source: Data from American College of Sport Medicine. Health-related physical fitness testing and interpretation. In: Thompson WR, Gordon NF, Pescatello LS, eds. *ACSM's Guidelines for Exercise Testing and Prescription.* 8th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2010.

between body composition protocols and makes it easier to follow actual changes that may be occurring in body composition over time. Generally, a lower body fat percentage and higher lean mass are optimal for athletes. However, the ideal body composition for each athlete can be very different. Therefore, coaches and nutrition professionals should be careful not to set a single body composition level that an entire team or group of athletes should attain. Rather, body composition levels should be developed based on the individual athlete, their genetics, the physical demands of their sport, their performance goals, and their overall health.

How does body composition affect sport performance?

There are basic body composition levels identified for health of the general population but no set standards or ideals for athletes in specific sports or athletes as a group. When considering weight management and body composition issues, each athlete and his or her support staff must look at both the actual value of body fatness and lean body mass and determine whether changes in weight or body composition are warranted for that *individual athlete*. Assessment data can be compared to any published data for the specific sport, and additional considerations of the athlete's current sport performance, goals, diet, exercise patterns, and health should be made to determine whether body composition is in the ideal range.

Although the WHO and NIH have yet to set body composition standards for the general population, others have suggested healthy body fat ranges of 10–20% for men and 20–30% for women.[20] These general recommendations may not reflect sport performance norms for athletes. Athletes often assume there is an ideal weight or body composition that is best for their sport and thus for them personally. Suggesting ideal body composition or body fat percentages by sport assumes that there is a known optimal combination of fat mass and fat-free mass that is best for sport performance in a particular sport or activity. However, "ideal" is difficult to define from athlete to athlete because there are so many individual considerations that contribute to body composition. Genetics, natural physique differences, and muscle and fat distribution are just a few things to consider. Sport performance is determined by a myriad of factors, only one of which is the makeup of FM and FFM in athletes.

The body composition levels required for maintaining health tend to be more lenient than those required for optimal performance in many sports. Therefore, body composition recommendations for athletes have been determined by taking the average body weights and fat percentages from large groups of elite athletes in various sports. Manore and Thompson did an extensive review of body fat percentages in male and female athletes in a large variety of sports.[21] They found variations in the ranges of body fat percentage in athletes within the same sport and of the same gender. These body fat percentages ranged from approximately 5–19% for male athletes and 7–20% for female athletes. These levels, and those from other research studies of body composition in athletes, can be healthy for some athletes but also could be quite low for other athletes and should not necessarily be considered ideal for a specific sport.

Different sports have different typical body composition levels. For example, sports such as gymnastics, track, and others in which the athlete must work against his or her own body weight to perform in competition tend to benefit from low body fat percentages. In these sports, excess body fat merely weighs the athlete down and does not provide any benefit in regard to force or energy production. In other words, fat weight in these athletes is considered "dead weight." At the other extreme are athletes performing in events where weight may be advantageous. For example, football linemen and sumo wrestlers benefit from the extra fat weight. Increased body weight in these athletes improves their stability, helps them to hold their ground, and/or helps them move lighter opponents out of the way. Another example where fat can be beneficial is for an athlete participating in long-distance cold water swimming; increased levels of body fat help the athlete float, decreasing drag and providing thermal insulation from the cold water. In these cases, excess body fat can enhance sport performance but is not good for cardiovascular health.[22]

There are many sports that fall somewhere in between the extremes in regard to body fat requirements. In some sports, body height is more important than body fat (e.g., basketball). In other sports, moderate levels of body fat can be beneficial as long as it is not at the expense of speed (e.g., rugby, hockey). Despite the fact that body fat levels vary from sport to sport, with all other sport-related requirements (e.g., skills, height)

TABLE 11.4 Considerations and Information Needed When Setting Body Weight or Body Composition Goals for Athletes

1. The goal is to find the weight that is best for the athlete, not necessarily the lowest possible weight.
2. Assess genetics, resting metabolic rate (RMR), body composition, and activity level.
3. Calculate BMI.
4. Measure waist circumference.
5. Measure body composition.
6. Assess current eating habits.
7. Determine changes in dietary intake and exercise patterns that may naturally produce weight and body composition changes.
8. Assess training regimen—strength, cardiovascular, stretching, time, and intensity.
9. Review data on typical body composition for sport and assess whether this is reasonable for the athlete.
10. Determine whether modifying body composition or weight poses a risk (e.g., for injury, for an eating disorder) to the athlete.
11. Assess the athlete's attitude toward nutrition and behavior change.

being equal, *excess* body fat is generally a disadvantage for athletes.

Many athletes closely monitor their body weight as if it is a good indicator of fat levels or body composition. Nothing could be further from the truth. Two athletes can weigh the same on a scale and even be the exact same height but have vastly different FM and FFM percentages. As a result, athletes who train regularly should not only track body weight but also have body composition measured routinely, especially if they are planning to either increase or decrease weight. Assessing body composition along with body weight can help the athlete determine which component of body mass is changing and thus whether the program is working. For example, if an athlete loses body weight, it could be resulting from either a decrease in muscle mass or a decrease in body fat. A decrease in muscle mass is not beneficial because of its negative impact on metabolism, strength, and power, thus indicating a change is needed in either the athlete's training regimen or his or her daily diet. Alternatively, an athlete aiming to lose weight on a particular diet and exercise program may not see a change in total body weight as measured by a scale. The failure to see a body weight loss does not necessarily mean the program is not working because muscle mass could have increased and balanced out any weight loss caused by decreased fat levels. Obviously, tracking changes in body composition over time is preferable and more informative than monitoring changes in body weight alone. Table 11.4 provides a list of considerations and information that should be collected to help determine an optimal body weight and body composition for individual athletes and their sport.

Food for Thought 11.2

Body Composition: Methods and Calculations

Define various body composition measurement tools, and calculate fat mass and fat-free mass based on body fat percentage.

What are the components of energy intake and energy expenditure?

An individual is in energy balance when energy intake is equal to energy expenditure. When an individual is in energy balance, weight remains stable. Positive energy balance occurs when energy intake is greater than energy expenditure, leading to weight gain. Negative energy balance is the opposite—when energy expenditure is greater than energy intake, causing weight loss. Maintaining energy balance is essential for the maintenance of lean tissue mass, immune and reproductive function, and optimal athletic performance.[23] When trying to lose weight, athletes must achieve negative energy balance. However, the right balance must be struck, where the calorie intake deficit or the increase in energy expenditure through training is not so great that it compromises sport performance. This section will cover energy balance, including assessing energy expenditure as well as the multiple components of energy intake and energy expenditure.

energy balance A state in which energy intake is equal to energy expenditure.

positive energy balance A state in which the total daily calories consumed are greater than the total daily calories expended. A positive energy balance will result in weight gain.

negative energy balance A state in which the total daily calories consumed are less than the total daily calories expended. A negative energy balance will result in weight loss.

What influences energy intake?

Energy intake is simply calories consumed in the form of the macronutrients (carbohydrates, fats, and proteins) and alcohol. As discussed in earlier chapters, carbohydrates and proteins contain 4 kcal/g and fats contain 9 kcal/g. Alcohol contains 7 kcal/g but does not provide any appreciable nutrients, vitamins, or minerals. Energy intake is usually higher in athletes versus nonathletes because of their higher energy expenditures. Food records, 24-hour dietary recalls, and dietary history interviews are used to determine an athlete's energy intake.

Physiological, environmental, social, and emotional factors all regulate food consumption. These include both internal and external cues for eating. Internally, hunger and satiation provide signals for intake (see Figure 11.8). External factors include environmental stimuli such as smell, sight, and taste of food as well as the influence of the eating environment.

Internally, **hunger** prompts eating through physical cues such as gurgling or growling of the stomach. These are physiological signs that the body is depleted of energy and needs fuel. **Satiation** is the feeling of fullness that accompanies food intake and signals the time to end a meal. **Satiety** refers to the feeling of fullness that maintains after a meal and helps determine the intervals between meals. The composition of the diet can influence hunger, satiation, and satiety. Protein has an increased satiety effect compared to fat and carbohydrates. The fiber content of a meal or food can enhance satiety by slowing gastric emptying. Total energy content can affect satiation and satiety as well. Energy-dense diets (those high in fat and low in fiber) tend to delay satiation and may encourage overeating. When any type of food is eaten, the stomach and intestines become enlarged and distended; this internal action has a satiation effect.

Appetite often is confused with hunger, and therefore a distinction between the two is important in discussions of dietary intake and attempts to lose weight. Appetite is a psychological or emotional desire for food, whereas hunger is driven by a physiological need or drive for food. A number of factors stimulate appetite. External factors such as the smell of fresh baked bread or the anticipation of the taste of a favorite dessert can stimulate appetite. Social influences such as the time of day, social circumstances, and social events all affect appetite. Cultural influences of family and friends, foods that have special meaning, and traditions around food all can influence the desire to eat regardless of physiological hunger. Stress or other emotions can also encourage or discourage food intake that is not related to a physiological need for food.

Hunger A physical cue such as gurgling or growling of the stomach that prompts an individual to eat.

Satiation The feeling of fullness that accompanies food intake and signals the time to end a meal.

Satiety The feeling of fullness that maintains after a meal and helps determine intervals between meals.

Appetite A psychological or emotional desire for food.

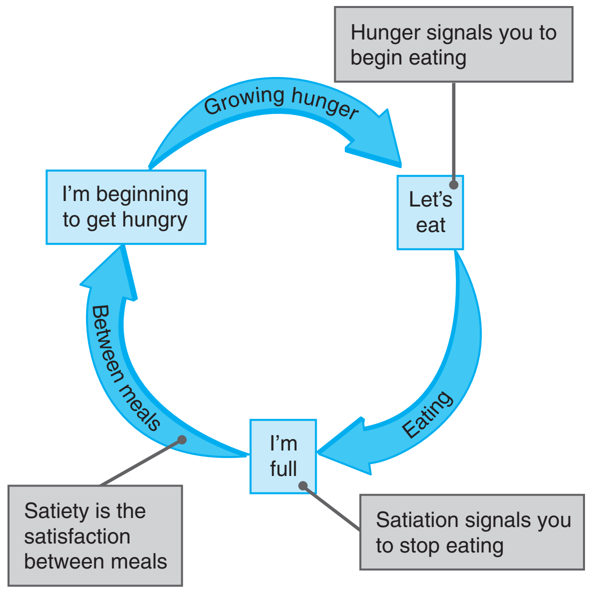


Figure 11.8 Hunger, satiation, and satiety. Hunger helps initiate eating. Satiation brings eating to a halt. Satiety is the state of nonhunger that determines the amount of time until eating begins again.

What are the components of energy expenditure?

Three main components make up the total amount of energy expended each day. These components include the resting metabolic rate (RMR), the thermic effect of food (TEF), and the thermic effect of activity (TEA). Our body expends energy to maintain basic physiological functions (e.g., circulation, respiration, cellular functions), to allow for muscular activity, to process nutrients consumed, and, to a lesser degree, to help with temperature control. Energy expenditure increases during physical trauma, growth periods, fevers, and in extreme hot or cold environments and during exercise. Figure 11.9 illustrates the primary components of energy expenditure.

What is resting metabolic rate?

Figure 11.9 demonstrates that the largest portion of calorie expenditure is attributable to fueling basic physiologic functions. The body is constantly building and tearing down cells to continue functions for life. This portion of total energy expenditure is termed basal metabolic rate (BMR) or resting metabolic rate (RMR). RMR and BMR are often used interchangeably. However, RMR is usually slightly higher than BMR because RMR is assessed several hours after a meal or physical activity and BMR is assessed while the individual is in a totally rested state (no exercise for 12 to 18 hours and after an overnight sleep). RMR reflects a more practical measure. The functions included in RMR are the respiratory process, circulation, heartbeat, muscle functions, nervous functions, temperature regulation, and all of the organ functions that are very metabolically active. It is estimated that 60–75% of the total energy expenditure daily is RMR.[24]

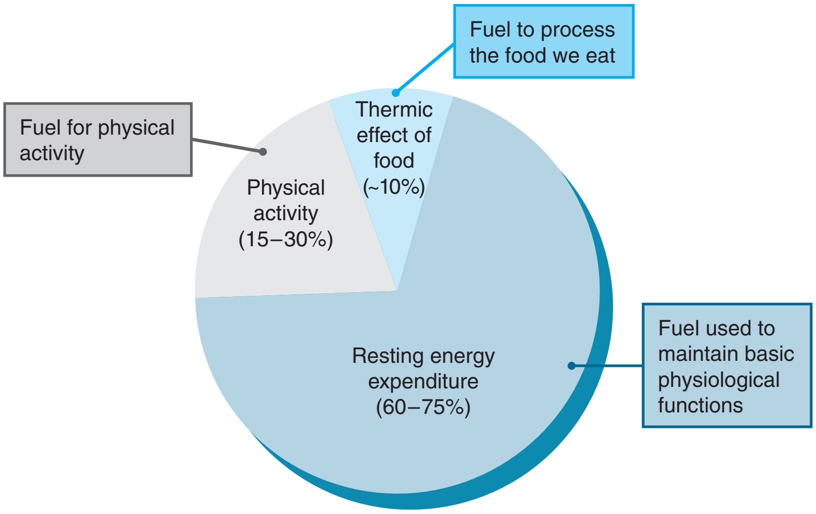


Figure 11.9 Major components of energy expenditure. The majority of daily energy expenditure is used to maintain physiological functions. Energy expended by athletes during physical activity and exercise is significant and could equal or exceed the energy needed for maintaining resting energy expenditure. The thermic effect of food is the energy required to digest, absorb, transport, metabolize, and store food.

Many factors can influence RMR. Individuals with higher body weight or larger surface area have a higher RMR. Those with increased lean body mass have a higher RMR because muscle tissue is more metabolically active than fat tissue. Caffeine intake and smoking increase RMR, as does hot or cold ambient temperature. Rapid growth and some medical conditions can increase or decrease RMR. Each individual's RMR remains relatively consistent over time, but significant differences in RMR can be found when comparing different individuals.

Actual total daily energy expenditure can be assessed in several ways. Many are used in research or hospital settings and are available only to research participants or hospitalized patients. These measures include direct calorimetry using a whole body calorimeter; indirect calorimetry, which measures oxygen consumed and carbon dioxide produced; and doubly labeled water that measures isotope excretion rates. These methods are costly to administer and not widely available to the public. Because these methods are not quick and easy to use in the athletic training room, on the field, or in a sports professional's office, other methods to estimate energy expenditure must be used.

Regression or prediction equations are the most commonly used practical method to help determine energy expenditure and thus energy requirements. Table 11.5 presents four calculation methods that can be applied in clinical and training settings to provide an estimation of daily energy requirements. One consideration when using prediction equations to estimate energy needs of athletes is how the equations were developed. Most prediction equations used the general population, both obese and nonobese, and did not use athletes in their studies that resulted in the development of the equations. Each equation can be applied to athletes, but the sports nutrition professional must be aware that these are prediction equations, meaning just that—they predict or estimate energy expenditure. Practitioners working with athletes should use their clinical and sport knowledge and expertise along with the equations to determine baseline energy needs for athletes.[25] Here is an example of how two different equations applied to the same athlete produce different results:

Male athlete, 180 pounds, 5′11″, 24 years old, high-intensity training 1 to 1.5 hours/day

WHO equation:

$$\text{REE} = 15.3 \times 81.8 + 679 = \mathbf{1930}$$

Harris-Benedict equation:

$$\text{REE} = 66.5 + (13.7 \times 81.8) + (5 \times 180.3) - (6.8 \times 24) = \mathbf{2251}$$

TABLE 11.5 Calculating Energy Needs

Harris-Benedict Equation Method

Adult Males	*Adult Females*
Resting energy expenditure = 66.5 + 13.7 (Weight in kg) + 5.0 (Height in cm) − 6.8 (Age)	Resting energy expenditure = 655 + 9.6 (Weight in kg) + 1.8 (Height in cm) – 4.7 (Age)

Source: Data from Harris J, Benedict F. *A Biometric Study of Basal Metabolism in Man*. Washington, DC: Carnegie Institute of Washington; 1919.

Dietary Reference Intakes (DRI) Method: Estimated Energy Requirements for Adults

Males	*Females*
662 – 9.53 (age) + PA × (15.91 × [Weight in kg] + 539.6 × [Height in meters])	354 – 6.91(age) + PA × (9.36 × [Weight in kg] + 726 × [Height in meters])
PA (physical activity):	PA (physical activity):
Sedentary = 1.0	Sedentary = 1.0
Low active = 1.11	Low active = 1.12
Active = 1.25	Active = 1.27
Very active = 1.48	Very active = 1.45

Source: Data from Institute of Medicine. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients).* Food and Nutrition Board. Washington, DC: National Academies Press; 2005.

Resting Energy Expenditure (REE) Calculations and Activity Factors

Gender and Age (years)	*Equation (BW in kilograms)*	*Activity Factor*
Males, 10 to 18 years old	REE = (17.5 × BW) + 651	1.6–2.4
Males, 19 to 30 years old	REE = (15.3 × BW) + 679	1.6–2.4
Males, 31 to 60 years old	REE = (11.6 × BW) + 879	1.6–2.4
Females, 10 to 18 years old	REE = (12.2 × BW) + 749	1.6–2.4
Females, 19 to 30 years old	REE = (14.7 × BW) + 496	1.6–2.4
Females, 31 to 60 years old	REE = (8.7 × BW) + 829	1.6–2.4

Source: Data from World Health Organization. Energy and Protein Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Technical Report Series 724. Geneva, Switzerland: World Health Organization; 1985.

Cunningham Equation

Males and Females

RMR = 500 + 22 FFM (kg)

Source: Data from Cunningham JJ. A reanalysis of the factors influencing basal metabolic rate in normal adults. *Am J Clin Nutr.* 1980;33:2372–2374.

The WHO and Harris-Benedict equations predict *resting* energy expenditure for 24 hours. To arrive at estimates of 24-hour total energy expenditure, the REE must be multiplied by an activity factor to account for the thermic effect of exercise or activity.[26] Activity factors range from 1.2 if confined to bed rest, low activity 1.3, average activity 1.5–1.75, and highly active 2.0.[27] The WHO equation listed in Table 11.5 uses activity factors of 1.6–2.4, which may be a better estimate of the thermic effect of activity for athletes.

To complete the example for the 180-pound male athlete with high-intensity training, an activity factor of 2.0 is applied:

WHO equation:

REE = 1930 × 2.0 = 3860

Harris-Benedict equation:

REE = 2251 × 2.0 = 4502

Both equations are applied correctly but result in more than a 600-calorie estimate difference. This is a good example of why sports nutrition professionals must use their expertise and experience in determining athletes' needs. Providing a range of calories, calculating two or three different ways, and using clinical judgment based on the diet and exercise information from the athlete can help determine the best calorie-level range for each individual athlete.

What is the thermic effect of activity?

In the average population, RMR is the highest percentage of total daily energy expenditure. In athletes, the energy expended through exercise can actually meet or exceed estimated RMR rates. The thermic effect of activity (TEA) includes the energy costs for skeletal muscle contraction and relaxation as well as the costs to maintain posture and position. Table 11.6 lists the energy costs of various daily and sport activities. For example, a male triathlete weighing 60 kilograms who bikes for 4 hours (average speed 18 mph) and runs (7:30 minute per mile) for 1 hour could expend 3690 calories during one training day.

What is the thermic effect of food?

The thermic effect of food (TEF) is the increase in energy expenditure associated with food consumption. The digestion and absorption processes of food intake require energy, as does the metabolism and eventual storage of nutrients throughout the body. The TEF is

thermic effect of activity (TEA) The amount of energy required to meet the energy demands of any physical activity.

thermic effect of food (TEF) The increase in energy expenditure associated with food consumption.

TABLE 11.6 Energy Expenditure of Sport Activities

			Kcal/hr at Different Body Weights				
Description	Kcal/hr/kg	Kcal/hr/lb	50 kg 110 lb	57 kg 125 lb	68 kg 150 lb	80 kg 175 lb	91 kg 200 lb
Aerobics							
Light	3.0	1.36	150	170	205	239	273
Moderate	5.0	2.27	250	284	341	398	455
Heavy	8.0	3.64	400	455	545	636	727
Bicycling							
Leisurely, < 10 mph	4.0	1.82	200	227	273	318	364
Light, 10–11.9 mph	6.0	2.73	300	341	409	477	545
Moderate, 12–13.9 mph	8.0	3.64	400	455	545	636	727
Fast, 14–15.9 mph	10.0	4.55	500	568	682	795	909
Racing, 16–19 mph	12.0	5.45	600	682	818	955	1091
BMX or mountain	8.5	3.86	425	483	580	676	773
Daily activities							
Sleeping	1.2	0.55	60	68	82	95	109
Studying, reading, writing	1.8	0.82	90	102	123	143	164
Cooking, food preparation	2.5	1.14	125	142	170	199	227
Home activities							
House painting, outside	4.0	1.82	200	227	273	318	364
General gardening	5.0	2.27	250	284	341	398	455
Shoveling snow	6.0	2.73	300	341	409	477	545
Running							
Jogging	7.0	3.18	350	398	477	557	636

(continued)

TABLE 11.6 Energy Expenditure of Sport Activities *(Continued)*

Description	Kcal/hr/kg	Kcal/hr/lb	Kcal/hr at Different Body Weights: 50 kg 110 lb	57 kg 125 lb	68 kg 150 lb	80 kg 175 lb	91 kg 200 lb
(continued)							
Running, 5 mph	8.0	3.64	400	455	545	636	727
Running, 6 mph	10.0	4.55	500	568	682	795	909
Running, 7 mph	11.5	5.23	575	653	784	915	1045
Running, 8 mph	13.5	6.14	675	767	920	1074	1227
Running, 9 mph	15.0	6.82	750	852	1023	1193	1364
Running, 10 mph	16.0	7.27	800	909	1091	1273	1455
Sports							
Frisbee, ultimate	3.5	1.59	175	199	239	278	318
Hacky sack	4.0	1.82	200	227	273	318	364
Wind surfing	4.2	1.91	210	239	286	334	382
Golf	4.5	2.05	225	256	307	358	409
Skateboarding	5.0	2.27	250	284	341	398	455
Rollerblading	7.0	3.18	350	398	477	557	636
Soccer	7.0	3.18	350	398	477	557	636
Field hockey	8.0	3.64	400	455	545	636	727
Swimming, slow to moderate laps	8.0	3.64	400	455	545	636	727
Skiing downhill, moderate effort	6.0	2.73	300	341	409	477	545
Skiing cross country, moderate effort	8.0	3.64	400	455	545	636	727
Tennis, doubles	6.0	2.73	300	341	409	477	545
Tennis, singles	8.0	3.64	400	455	545	636	727
Walking							
Strolling, < 2 mph, level	2.0	0.91	100	114	136	159	182
Moderate pace, ~3 mph, level	3.5	1.59	175	199	239	278	318
Brisk pace, ~3.5 mph, level	4.0	1.82	200	227	273	318	364
Very brisk pace, ~4.5 mph, level	4.5	2.05	225	256	307	358	409
Moderate pace, ~3 mph, uphill	6.0	2.73	300	341	409	477	545

Source: Adapted from Nieman DC. *Exercise Testing and Prescription.* 4th ed. Mountain View, CA: Mayfield Publishing; 1999.

estimated to account for approximately 10% of total daily energy expenditure when a mixed diet is consumed.[28] For example, an athlete who consumes 3000 calories per day will expend approximately 300 calories (10% TEF) to metabolize the food. Simply eating calories contributes to the daily total energy expenditure.

Variance in the type of macronutrient consumption may affect TEF. Protein and carbohydrates have slightly higher TEF because they require more calories to be converted into storage forms (i.e., fat and glycogen) than fat. Conversely, fat consumed in the diet takes little energy to digest and then store as fat in the body. It appears that consuming a diet that contains a higher percentage of carbohydrates and protein and a lower percentage of fat may be beneficial in producing weight loss. However, regardless of the TEF, the most important reason that reducing intake of dietary fat can produce a calorie deficit resulting in weight loss is because fat is more calorically dense than carbohydrates or protein.

gaining the performance edge

Athletes may have a high total energy expenditure because of a higher RMR and the high energy costs of training. RMR is increased in most athletes because they have higher levels of lean body mass, which is highly metabolically active tissue. The energy costs of training and daily activity (TEA) could be as high or even higher than RMR, resulting in very high total energy expenditure daily.

What methods do athletes use to lose weight?

Weight loss methods for athletes contain similar components as weight loss plans for nonathletes. There must be a calorie deficit through reduced calorie intake, increased exercise, or a combination of both. Weight loss should occur slowly, at a rate of approximately 1 to 2 pounds per week and should include goal setting and a monitoring system to encourage continued progress toward the weight and fat loss goals. Weight loss programs specific to competitive athletes should maintain a good balance of macronutrients for sport training (emphasizing adequate carbohydrate for glycogen use and replenishment and protein for lean tissue maintenance) and contain adequate energy and nutrients to continue to train and improve sport performance. If weight loss (fat loss) is desired, it should start early, before the athlete starts the competitive season.[23]

This section of the chapter covers calculating calorie needs, calorie deficit, macronutrient composition, meal planning, exercise, goal setting, and monitoring to help athletes lose weight.

How are weight and body composition goals for athletes determined?

After it has been determined that weight or body fat loss is indicated for an athlete, a goal weight or body fat percentage should be determined. Sports nutrition professionals should help athletes avoid choosing an arbitrary goal weight and use individual weight and body composition data to determine the best weight and body composition for each athlete individually.

Body mass index can be used initially to determine weight goals. In using a BMI nomogram or online calculator, athletes plug their height and weight into the chart to determine their current BMI. Next, they can choose a weight on the chart that is one or more points below their current BMI or one that may correspond with a BMI in the normal range. The choice of a BMI goal weight depends greatly on current BMI, level of overweight or obesity, weight history and/or history of recent weight gain, level of exercise, and commitment to a long-term weight management plan. The weight goal chosen also should fall within the general guideline of not losing more than 1–2 pounds per week and, as discussed earlier in the chapter, should fall within the goal of a 5–10% loss of current body weight.

In many instances, athletes should use weight and body composition data to determine appropriate weight (fat) loss goals. Athletes attempting to lose weight should have both BMI and body composition measured before starting a weight loss program. Once %BF is determined, a calculation can be completed to determine optimal body weight based on desired body fat level. For example, a 20-year-old college male middle-distance runner had a BOD POD measurement of 11% body fat. He is 5′10″ and weighs 160 pounds (BMI = 23). Typically, college middle-distance runners have 6–9% BF. He and his sports dietitian determine that 8% body fat is a good goal for him based on his BMI and current percentage of body fat. His weight loss goal can be calculated using the following formulas:

FM = %BF × Body weight (lbs or kg)
FFM = Body weight − FM
Desired body weight = FFM ÷ (1 − [Desired %BF])
Calculate FM: 0.11 × 160 = 17.6
Calculate FFM: 160 − 17.6 = 142.4
Desired Body Weight: 142.4 ÷ (1 − 0.08) = 154.8

This example shows that a modest weight loss of approximately 5 pounds (primarily fat loss) could be enough for this athlete to achieve a 3% drop in his body fat percentage and a reduction to a BMI of 22. Once the goal weight and body composition are determined, athletes can consult with their sports dietitian to determine the energy intake that will produce this loss.

How are energy needs for weight loss determined?

To lose weight, energy expenditure must be greater than energy intake. When exercise and activity are equal to energy intake, weight maintenance occurs. If dietary intake is greater than energy expenditure, weight gain occurs. To achieve negative energy balance for weight loss, athletes can decrease food intake, modify exercise and activity levels, or both, creating a total energy deficit.

The first step in estimating an athlete's calorie needs is to use one of the equations listed in Table 11.5. This establishes an estimate of the athlete's baseline energy expenditure and a starting point for determining the number of calories the athlete should reduce to produce weight loss. Once this baseline is established, calorie intake recommendations should decrease this number by 250–1000 calories per day.

This general guideline allows for a modest change in energy intake that will most likely not affect daily energy levels or the athlete's ability to recover from workouts. This large range of 250–1000 calories allows the athlete and the sports nutrition professional to have flexibility in calorie reduction levels based on the athlete's weight, current dietary intake, and goal rate of weight loss. Athletes must be reminded not to dramatically decrease calorie intake because it can negatively affect sport performance. The calorie recommendations for weight loss should always be compared to actual current intake and evaluated for necessary adjustments. For example, an athlete's total energy needs may be calculated at 3500 calories, which would translate into a weight loss recommendation of about 3000 calories per day. However, if the athlete is currently consuming 4000 calories, then suggesting a decrease in caloric intake merely to the originally calculated 3500 estimate may initiate some weight loss and appear less drastic to the athlete.

Combining a dietary reduction in calories with increased caloric expenditure is most likely to produce weight loss results for athletes. Obtaining a daily deficit of 250–1000 calories by changing only diet or exercise by itself may be challenging. Cutting calories too low often leads to hunger and discomfort. Most athletes cannot tolerate being hungry and thus have trouble adhering to the strict weight loss diet. In addition, very low calorie diets can result in the body going into a protective mode, thus lowering basal metabolic rate making further weight loss and long-term weight management difficult. Conversely, creating the calorie deficit solely from physical activity and exercise can lead to overtraining and injury. A combination of a reduction of 250–500 dietary calories and a deficit of 250–500 calories produced from increased exercise and physical activity can produce a weight loss of approximately 1–2 pounds per week.

What dietary changes are necessary for athletes to lose weight?

Dietary changes to reduce caloric intake are necessary for athletes to lose weight. Athletes need to concentrate on matching the macronutrient intake recommended for weight loss to that required for continuing sport activities. Portion control, regardless of macronutrient composition of the diet, is important in helping athletes reduce calories. Eating regular meals to avoid becoming ravenous as well as proper meal planning also play an important role in any healthful weight reduction nutrition plan for athletes.

How does the macronutrient composition of the diet affect weight loss for athletes?

When weight loss diets are objectively studied, it appears that, regardless of macronutrient composition, if calories are reduced, then weight loss occurs. Macronutrient intake in athletes is of great importance in regard to sport performance. Carbohydrates, fat, and protein all perform essential functions within the body related to overall health, energy production, and sport performance. Therefore, when modifying an athlete's total daily intake, consider the relative importance of the various macronutrients.

Carbohydrates are the primary macronutrient that athletes need to perform well in sport and exercise activities. Carbohydrates are essential fuel for the working muscles during exercise and are valuable to muscles after exercise to replenish muscle glycogen stores. Many popular diets recommend severe restriction in carbohydrates, including those foods that contain valuable nutrients (fruits, vegetables, whole grain breads, milk, and yogurt); these plans are recipes for performance disaster, often depleting an athlete's body of carbohydrates as well as essential vitamins and minerals. It can be beneficial to reduce some carbohydrates in the diet if the sources of carbohydrates do not provide nutritional value; for example, reducing foods that contain high amounts of added sugars (candy, cookies, soda, etc.) will reduce overall calories consumed without reducing the nutrient density in the athlete's diet. Substituting higher-fiber foods such as grains, fruits, and vegetables for some of these calorie-dense foods can increase feelings of fullness and satiety so that athletes may consume fewer calories throughout the day.

Protein is important in any athlete's diet for maintaining muscle mass, building and repairing tissues, and providing satiety. Consuming adequate amounts of protein to maintain these functions is critical, especially when athletes are making lifestyle changes for weight loss. Maintenance of muscle mass can help keep the resting metabolic rate elevated, aiding in the weight loss effort and improving the likelihood of weight loss maintenance. Athletes who consume at least the minimum amount of protein recommended for their sport activities should obtain enough protein to maintain protein's necessary functions in the body. Protein intakes at the high

end of the recommended ranges may be appropriate for some athletes to produce better satiety levels. Athletes should be encouraged to choose lean, low-fat protein sources that will contribute fewer total calories than high-fat options.

Fat is an essential component of a healthful athlete's diet; however, intake should be moderated while trying to lose weight. Fat contains more than twice the amount of calories per gram as carbohydrates or protein. Therefore, a reduction in fat can help produce a calorie deficit for weight loss because it is more calorie dense. It should be emphasized that athletes are not encouraged to eliminate fat from the diet; a modest decrease in total fat intake to a level of approximately 20% of total calories will allow for the consumption of essential fatty acids without the contribution of excessive calories.

A weight loss plan that produces a reduction in calories, regardless of the macronutrient composition, should lead to weight loss. For all athletes, the macronutrient composition of the reduced-calorie diet should match their individual needs to produce weight loss while maintaining quality sport performance. Athletes should be educated on the detrimental effects of some popular diet plans that dramatically decrease or eliminate certain macronutrients, while encouraging the excessive intake of other macronutrients. For athletes aiming to lose weight, balance, variety, and moderation should remain the mantras of healthy eating to ensure that all nutrient needs are being met.

How can athletes plan meals to meet weight loss and body composition goals?

If possible, athletes should attempt initial dietary changes for weight loss in the off-season. This allows the athlete to focus on moderating eating behaviors without the concern of how these changes might affect sport performance. Off-season modifications also allow time for the dietary changes to become a habit that the athlete can then follow throughout the season.

The emphasis of dietary changes should be on how athletes can decrease calorie intake without compromising sport performance. Meal skipping to reduce calories is not recommended because the lack of fuel prior to or after training can decrease exercise performance. However, consuming smaller meals and/or snacks frequently throughout the day will keep the body fueled while moderating calorie intake.

A small reduction in the size of portions eaten at each meal or snack can produce a calorie deficit for weight loss. This deficit can occur even without any change in the types of foods eaten. Because serving sizes in restaurants and in food packages have become enormous, individuals mistakenly assume that one item or one meal served is a "normal" serving size. For example, a serving size from the MyPlate food guidance system for a bagel is half of a 2-ounce bagel. A 2-ounce bagel (two servings of grains) contains approximately 150 calories. A 6-ounce plain bagel, typical of many gourmet bagel and coffee shops, counts as six servings of grains and contains approximately 450 calories. This phenomenon of large servings of carbohydrate-rich foods has mistakenly led people to believe that carbohydrates cause weight gain. In actuality, it is the large number of calories consumed, which is often underestimated, that is contributing to weight gain. In the example of the 2- and 6-ounce bagels, the larger bagel has an additional 300 calories! Therefore, a reduction in portions, regardless of

Training Table 11.1: Portion Control Tips

- Choose low-calorie, nutrient-dense foods such as vegetables, fruits, and whole grains.
- Serve smaller portions than usual on meal and snack plates.
- Purchase preportioned meals, entrée, and snacks and read labels to determine how many servings are in each package. Purchase more economical sizes of foods and package them into single serving sizes immediately once home from the grocery store.
- Use the MyPlate food guidance system serving sizes as a guide for portions consumed.
- Weigh or measure cooked food for a week to gain an understanding of appropriate serving sizes.
- At restaurants, plan ahead to take home leftovers. Remove bread and chips from the table and focus on enjoying the meal. Ask the wait staff to bring a take-out box when the entrée is served. Place half of the meal into the take-out box before starting the meal.
- Order off the appetizer or lunch menu. Many appetizers when combined with a salad or soup can make a meal.

the food item, can produce the necessary calorie deficit for weight loss. The portion control tips shown in **Training Table 11.1** can help athletes reduce total calorie intake.

Eating three to five times per day or approximately every 3 to 4 hours will sustain metabolism and energy levels. This schedule of eating can prevent athletes from becoming too hungry and subsequently overeating when a meal is finally consumed. Eating based on physical needs for food (hunger) helps the athlete fuel up when energy levels are low and provides regular intake of calories without overconsumption.

Consuming carbohydrate calories from sports beverages may be indicated for athletes during high-intensity workouts or during training or competition sessions lasting more than an hour. Some athletes avoid sports drinks during long-duration training or competition events for fear that the calories in these products will prevent weight loss; however, this concern is not valid. Sports beverages have multiple benefits, including enhanced endurance and sport performance, as well as the prevention of dehydration and electrolyte imbalances. Emphasis should be placed on helping the athlete improve performance by using these products. Sports nutrition professionals can weave these calories into an athlete's training diet, thereby providing the performance benefit of sports beverages while keeping on track for weight loss.

After exercise, athletes trying to lose weight must consume a postexercise meal or snack. Many athletes find the elimination of the postexercise meal or snack an easy way to decrease calorie intake. However, by neglecting to replenish the body, the athlete will feel sluggish, fatigued, and sore during subsequent workouts. Therefore, athletes should consume moderate amounts of nutrient-dense grains, vegetables, fruits, low-fat dairy products, and lean protein sources after exercise while limiting calorie-dense high-fat and high-sugar foods.

A sample meal plan for weight loss is listed in **Training Table 11.2**. Notice that substitutions of

Training Table 11.2: Sample Meal Plan for Weight Loss

2500 Calories	2000 Calories
Breakfast	*Breakfast*
1 cup dry cereal	1 cup dry cereal
1/4 cup raisins	1/4 cup raisins
1 cup 2% milk	2 tbsp slivered almonds
1 cup orange juice	1 cup skim milk
	1 small orange
Lunch	*Lunch*
1 small whole grain pita sandwich	1 small whole grain pita sandwich
3 oz deli meat	3 oz deli meat
Tomato slices, sprouts, lettuce	Tomato slices, sprouts, lettuce
1 tbsp mayonnaise	1 tbsp low-fat mayonnaise
1 bag potato chips	1 bag baked chips
12 oz soda	10 baby carrots
	12 oz water
Snack	*Snack*
Frozen yogurt with chocolate sprinkles	2 graham cracker sheets
Dinner	*Dinner*
1 1/2 cups pasta	1 cup whole wheat pasta
1 cup tomato/vegetable spaghetti sauce	1 cup tomato/vegetable spaghetti sauce
3 small meatballs (5 oz)	2 small meatballs (3 oz)
1 cup cooked broccoli	1 cup cooked broccoli
1 cup 2% milk	1 cup skim milk
Snack	*Snack*
1 cup low-fat yogurt	1 cup low-fat yogurt
1 large banana	1 small banana

lower-fat, higher-fiber foods created the 500-calorie decrease. This method of modification retains the athlete's basic dietary pattern while selecting foods that have lower levels of calories.

How do exercise and physical activity influence weight loss for athletes?

Most athletes engage in more exercise than is recommended for the overall population in regard to health, prevention of weight gain, and to aid in weight loss. The updated physical activity recommendations for adults from the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) state that to promote and maintain health, adults need the following amounts of activity:

- A minimum of 30 minutes of moderate intensity aerobic physical activity on 5 days each week *or* 20 minutes of vigorous intensity aerobic physical activity on 3 days each week.
- A combination of these two aerobic intensity levels of exercise is acceptable.
- In addition to the aerobic activity, adults should perform activities that maintain muscular strength and endurance a minimum of 2 days per week.[29]

This amount of exercise may be challenging for nonathletes to achieve in 1 week, but athletes could easily attain this amount of physical exercise in only 2 or 3 days of training. The updated guidelines are outlined for the adult population to maintain health, prevent chronic disease, and prevent weight gain.

To lose weight, additional exercise and physical activity are needed, along with dietary reductions in calories. The updated ACSM and AHA guidelines further delineate that to lose weight or to maintain a significant weight loss, as much as 60 to 90 minutes of physical activity 5 days per week may be necessary. Typically, athletes who are training for competition are going to get that amount of exercise in 1 week. So, for athletes to benefit from exercise to lose weight, they may need to alter their training routine and try to get more activity as part of their daily routine. Activities such as walking to class or work, using the stairs instead of elevators, yard work, active housework, and getting off the bus one stop early and walking could produce modest calorie burning that, when combined with sport training, could help produce weight loss. Making sure they are getting the right amount of aerobic and strength training in each week can also help athletes achieve weight loss. Aerobic exercise (e.g., cycling, running, swimming, aerobic dance) increases energy expenditure. Exercising at higher intensities or for longer durations can produce higher energy expenditure. Changing the type of aerobic workout performed can also help the body burn more calories per workout. Anaerobic exercise (e.g., resistance training, sprint training) increases and helps maintain lean body mass, which is the most metabolically active tissue in the body. This raises and helps sustain RMR during weight loss and weight management. Table 11.6 describes the amount of calories burned in many sport activities.

Similar to dietary modifications, athletes should attempt changes in exercise and physical activity during the off-season. Athletes are not necessarily focused on competitive performance in the off-season and therefore may be more willing to spend additional time on activities that may produce weight loss. Athletes should be encouraged to make gradual increases in workout intensity or duration to avoid overuse injuries.

How does goal setting help athletes lose weight?

It is difficult sometimes for athletes to make the necessary changes to achieve weight loss and main-

Fortifying *Your Nutrition Knowledge*

Exercise Is Medicine

ACSM and the American Medical Association launched "Exercise Is Medicine" in November 2007. It is a program designed to "encourage America's patients to incorporate physical activity and exercise into their daily routine." In addition, the program calls on doctors to prescribe exercise to their patients.

The program's website, www.exerciseis-medicine.org, provides educational information for physicians to use in their practice and information for patients, the media, and policy makers, as well as links to supporting organizations.

tain the weight loss over time. Assessing readiness to change is one way that nutrition professionals and athletes work together to make dietary changes. Once the athlete is ready to make changes in dietary behaviors, the athlete and nutrition professional should set goals and a establish a method to measure the progress toward those goals for weight loss. The following section provides a brief overview of goal setting as it relates to athletes attempting to lose weight.

What types of goals should athletes set for weight loss?

The NIH recommends initially losing 5–10% of current body weight over a period of 3 to 6 months. It then recommends maintaining that lost weight for 3 to 6 months before attempting further weight loss. If the athlete is able to maintain the initial weight loss, and it is deemed appropriate to lose additional weight, then a goal of an additional 5–10% of current body weight is recommended. Using this recommendation, an athlete weighing 220 pounds would have a goal of losing 11–22 pounds in the first 3 to 6 months. If the weight loss is successfully maintained, then a reevaluation of weight and sport performance goals is appropriate. A total deficit of 500–1000 calories per day should produce this amount of weight loss gradually over the recommended time period. Weekly weight loss should not exceed 2 pounds per week. Rapid weight loss can contribute to muscle mass loss, fluid/electrolyte imbalances, and possibly cardiovascular complications. Therefore, if weight loss occurs too quickly, an increase in calorie intake or a decrease in physical activity may be indicated to slow the progression. Slow, gradual weight loss is safer for overall health, is more likely to target the loss of body fat versus muscle mass, is less likely to negatively affect sport performance, and has been shown to have a greater success rate long term.

Setting a weight loss goal is essential to any weight loss plan, but goals for how to accomplish the weight loss are also needed. Goals should be developed that are short term, or "process oriented," and long term, or "outcome oriented." Short-term goals help the individual design a specific plan for dietary, exercise, or behavior changes needed to meet the long-term weight loss goal. These might include eating a high-fiber breakfast cereal every day for the next 7 days or spending an additional 15 minutes on strength training at practice twice per week. Long-term goals might include a weight loss goal or a body composition goal, such as a reduction in body fat percentage. Once a short-term goal has been maintained for several weeks, a different goal can be established to further progress toward the long-term goal.

Other goals, such as those that focus on changes in sport performance, may motivate athletes to continue healthful eating behaviors. A goal of achieving a personal best in a sprint or long-distance event may motivate the competitive runner to continue with healthy eating behaviors. Realizing improvements in sport performance typically keeps athletes motivated, especially if weight loss is slow. Similarly, using both body composition and weight as measures of success is beneficial to the athlete. Because dietary and physical activity recommendations for weight loss produce slow, gradual weight loss, it may be difficult for athletes to stay motivated when the scale does not show big losses. However, if body composition changes occur, the athlete can be confident that improvements are being made, despite slower weight loss. By setting both short- and long-term goals based on physical health or improving sport performance, the athlete establishes several ways to monitor success besides body weight.

How do athletes monitor progress toward goals?

Monitoring of goals and progress toward those goals is essential for continued weight loss success. Self-monitoring helps athletes identify the behavior they are attempting to change, track progress toward their goals, and regularly review the behavior and adjust as needed. Food diaries are helpful monitoring tools. Monitoring food intake by recording foods and portion sizes helps athletes become more conscious of food intake as well as the types of foods eaten. Athletes are often surprised at how often they eat without realizing it and how much is consumed at meals. Noting the level of hunger and satiation before and after eating can also add value to the

gaining the performance edge

Healthful weight loss programs for the general population and for athletes include a combination of diet and exercise changes to induce weight loss. A calorie deficit is essential to any weight loss plan. Athletes trying to produce a calorie deficit need to be careful to eat enough calories to continue optimal sport performance, while allowing for gradual weight loss. Weight loss should be attempted during the non-competitive season, when possible.

food diary process. Athletes with already full exercise schedules might monitor intensity level of exercise or ability to train longer or harder once modest weight loss is achieved.

Monitoring weight or body composition is another useful tool for weight management success. Weighing once each week and plotting the progress over time can help individuals see gradual progress toward the long-term weight loss goal. Daily weighing is not recommended because it can become obsessive, and daily fluctuations in weight can occur regardless of food eaten or how much exercise is completed, leading to a false impression of weight loss or gain. Ideally, weight should be measured only once per week, on the same day of the week, and at the same time of day, to achieve consistency. Body composition measurements should be taken monthly or quarterly to evaluate progress. Evaluation of the effectiveness of an athlete's weight loss plan should include regular weight or body composition information as well as other measures of sport performance, energy levels, and satisfaction with the diet and exercise plan.

Evaluation of sport performance is another measure of success or failure of the weight loss plan. If sport performance declines, it could mean calorie intake is too low to sustain training levels and replenishment of glycogen stores. If sport performance is maintained or improves, the athlete is likely on the right track for weight loss success.

What are the summary recommendations for athletes regarding weight loss?

Successful weight loss practices for athletes include a combination of dietary, exercise, and behavior changes that can be maintained for a lifetime. Meal planning that encourages healthful eating at regular intervals while being mindful of portion sizes can provide the appropriate amount of calories and nutrients to maintain sport performance and allow for gradual weight loss. Exercise and physical activity levels are generally high in athletes, but slight modifications in the amount, type, or intensity of exercise can help produce a calorie deficit to achieve weight loss. Table 11.7 provides a summary of recommendations for athletes trying to lose weight.

Food for Thought 11.3

Weight Loss Guidelines: Losing Weight Without Sacrificing Performance

Define appropriate weight loss guidelines for athletes.

What are the weight loss issues for athletes in weight classification sports?

Weight classifications are typically found in sports such as wrestling, martial arts, crew (rowing), boxing, and horse racing (jockey). Athletes participating in these sports often try to perform in a weight class lower than their typical body weight to potentially gain a competitive edge over their competition. Athletes in these sports often struggle with their weight during the season and potentially use drastic weight loss measures to achieve their weight class goals.

Rapid weight loss prior to weighing in before an event, or **weight cutting**, is common for these athletes. Cutting weight is a practice

weight cutting The practice of losing weight, usually in preparation for a competitive event in hopes of making a lower weight class and thus improving performance.

TABLE 11.7 Weight Loss Recommendations for Athletes

Determine Energy Needs
- Measure height, weight, waist circumference, and body composition.
- Calculate athlete's estimated daily energy needs.
- Determine calorie deficit appropriate for individual athlete to lose weight.
- Calorie deficit of 250–1000 calories per day via diet and/or exercise.

Dietary Modifications
- Emphasize healthful eating patterns and foods, not a "diet."
- Eat more often to fuel activities and avoid extreme hunger.
- Enjoy small amounts of favorite foods occasionally.
- Exercise portion control.
- Choose nutrient-dense foods with more fiber for better nutrient intake and satiety.
- Choose lower-fat foods.

Set and Monitor Goals
- Attempt weight loss during the noncompetitive part of sport season.
- Aim for a loss of 5–10% of current body weight.
- Lose at a rate of no more than an average of 1–2 pounds per week.
- Monitor weight weekly.
- Measure body composition monthly.
- Assess training and sport performance level.

Fortifying
Your Nutrition Knowledge

Should Athletes Go on a "Diet"?

There seems to be an endless parade of diet plans promoting weight loss. These popular diets are often the first thing individuals try when aiming to lose weight. Unfortunately, most of these plans either are deficient in the nutrients required by athletes or do not promote long-term weight loss success, causing an athlete's performance to suffer and body weight to fluctuate over time. Athletes should be educated on how to decipher between a well-balanced, credible approach to weight loss and a quick-fix "fad" diet.

Diet books are a main source of popular diet information for consumers. It seems that every year several "revolutionary" new diet books are published that claim to be the best new weight loss method.[27] From low carbohydrate to high protein to wheat free to getting in the "zone," there seems to be no end to the number of weight loss diets available. One thing that all of these plans have in common is that they are low-calorie diets.

If fewer calories are consumed than expended, weight loss will occur over time. Therefore, in most cases, people who follow a popular diet plan lose weight. The problem is that weight loss is usually not sustained over time with these diets. Individuals may have success when "on" the diet but return to an equivalent or higher prediet body weight once they go "off" the plan. Athletes should be encouraged to avoid fad diets. Fad diets are too low in energy, do not provide enough nutrition for recovery needs, and will only decrease sport performance in the long run. Therefore, athletes should look for a diet and exercise regimen that they can continue long term and develop into a habit.

The main differences among popular diet programs are the macronutrient composition and the way foods are eaten or combined. Some plans suggest that a certain macronutrient composition is the key to weight loss success. Several current popular diets recommend lowered carbohydrate intake with subsequent higher fat and/or protein intake. Other plans suggest the opposite—low fat and high complex carbohydrates. Still others tout the benefits of a precise ratio of carbohydrates, protein, and fat eaten at every meal. In addition, some diets recommend a certain eating style, the combination of foods, or the avoidance of certain foods altogether. Athletes should look for weight loss plans that maintain a balance in macronutrients, allowing all foods to fit into a healthy diet, with a focus on portion control of all foods.

Being a good consumer of health and dieting information will improve an athlete's chances of success in weight management. Athletes can look for a number of cues to determine whether a diet is a fad or has potential for long-term weight loss success. A credible diet should:

- Provide slow, progressive weight loss.
- Emphasize health and emotional benefits, not aesthetics.
- Include a sound, nutritionally balanced eating plan.
- Include physical activity and exercise.
- Include favorite foods in small amounts as part of the regular meal plan.
- Include behavior modification changes and skill development for lifelong habits.
- Include reasonable short- and long-term goals for weight loss, physical activity, nutrition, and health.
- Be developed or monitored by credible medical personnel with experience in nutrition, exercise, and health.

of self-induced dehydration and starvation to reach a certain predetermined weight. It occurs often during a season, depending on how many events the athlete competes in and how well weight loss is maintained over the course of the season. Common weight cutting or rapid weight loss practices include excessive exercise, exercising in rubber or plastic suits, exercising in saunas or hot environments, fluid restriction, food restriction, spitting, fasting, self-induced vomiting, and laxative and diuretic abuse. Alderman reported that the most common rapid weight loss practices of wrestlers were excessive running, using saunas, and wearing vapor-impermeable suits.[30] These methods are usually undertaken immediately prior to the event so that rapid weight loss occurs in time for the weigh-in. Once the weigh-in is completed, rapid weight regain typically occurs through rehydration and food intake.

Some of these rapid weight loss methods can have significant health consequences. Dehydration and electrolyte imbalances caused by fluid restriction, exercising in saunas, and/or the use of diuretics and laxatives can negatively affect the cardiovascular system. Rapid weight loss, induced by a variety of methods, can quickly decrease plasma volume, thus acutely straining the cardiovascular system, thermoregulation system, and renal function. Food restriction can cause hypoglycemia, resulting in fatigue, an inability to mentally focus, and a decrease in physical stamina.[31] Clearly, all of these consequences are a detriment to sport performance, the safety of the athlete, and overall health.

Wrestling has been a very popular sport for years and is one of the sports most commonly known for weight loss practices. Significant research has been conducted on wrestlers' weight loss methods and the associated concerns. In 1997, three collegiate wrestlers died trying to cut weight for competition.[32] This unfortunate event prompted the National Collegiate Athletic Association (NCAA) to change collegiate wrestling rules in part to curb excessive weight-cutting practices. The new rules included adding 6 pounds to each of the 10 weight class categories; holding weigh-ins closer to the start of the competition; starting a wrestling weight certification program, including a body fat assessment at the beginning of the season; and requiring the minimum competitive weight classification to be determined by December. Wrestlers can move up in a weight classification after December, but not down to a lower weight classification (see Figure 11.10). These new rules were implemented in full for the 1998–1999 NCAA season. The wrestling weight certification program (WWCP) requires the weigh-in at the beginning of the season to be a hydrated weight.[33] The program uses the specific gravity of urine to determine hydration status. If specific gravity is at or below 1.02, then the athlete is well hydrated; if specific gravity is above 1.02, the athlete must come back the next day for a retest and weigh-in. High schools now have similar weight management guidelines to discourage rapid weight loss. Beginning with the 2006–2007 season, the weight certification program includes a hydration level not to exceed 1.025 urine specific gravity and minimum body fat percentage no lower than 7% for male wrestlers and 12% for female wrestlers.[34]

Opplinger et al.[35] studied 741 responses to questions from 43 collegiate wrestling teams about weight loss practices since the institution of the new rules. They reported that 40% of wrestlers in the study indicated that the new NCAA rules influenced their weight management practices; however, more than 25% of the wrestlers continued to use saunas and rubber/plastic suits and fasting as weight loss techniques. They also found that weight management behaviors were more extreme among wrestlers in lighter weight classes and became less extreme at the heavier weight classes. Little evidence existed for disordered eating in this sample. Davis reported

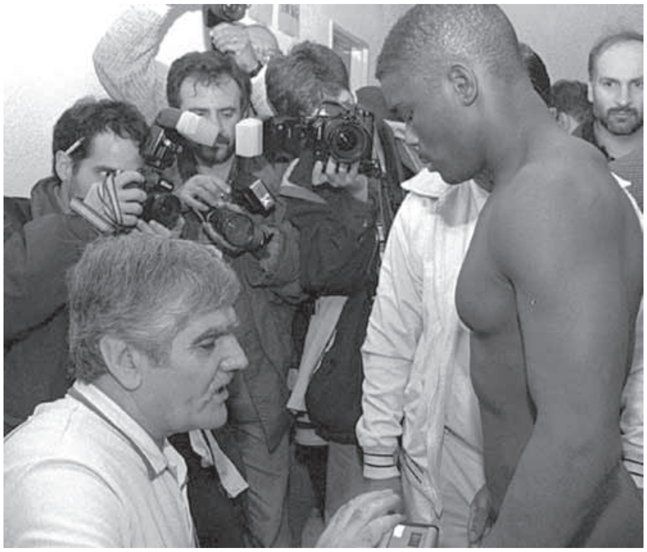


Figure 11.10 Weighing in. The NCAA discourages athletes from reducing their weight through intentional dehydration, a dangerous and potentially deadly practice.

that, based on their data, they believe the new NCAA WWCP and corresponding rule changes have begun to break the sport's historical cycle of weight cutting.[33]

Weight cutting can have both physical and emotional consequences. There is concern that athletes in sports that use weight-cutting practices may be at increased risk for eating disorders. Dale and Landers used the Eating Disorders Inventory (EDI) and Eating Disorders Examination (EDE) to assess wrestlers for eating behaviors.[36] The EDI is made up of eight different subscales. Only data collected from the first three subscales—drive for thinness, bulimia, and body dissatisfaction—were used. These three subscales examine attitudes and behaviors relating to body image, eating, and dieting. The EDE is a semistructured interview that was used on participants identified as being at high risk based on their EDI scores. The researchers found that there was an increased drive for thinness in wrestlers but not an increase in actual eating disorders or eating disorder risk. Wrestlers in the study actually had a better body satisfaction rate than the matched nonwrestler controls. Wrestlers are more weight conscious than nonwrestlers, but this does not mean they have eating disorders. Often the worrisome weight control practices occur only in-season. During the off-season, eating and weight control issues are not a concern. It is clear, however, that weight-cutting practices can be harmful to physical health, and focusing research and education on the physical consequences of weight-cutting practices may help alleviate these harms to athletes in the future.

Similar concerns for making weight are seen in other sports. Lightweight crew (rowing) is a team sport that requires the entire team to meet a weight standard to compete. If one athlete does not make the weight, then the entire team may be excluded from the event. Athletes in sports that require weigh-ins should focus their nutrition and exercise plans on maintaining a consistent weight throughout the season, rather than struggling to make weight prior to each event. Although dramatic weight loss methods are used less frequently by rowers than by wrestlers, they still may use unhealthy nutrition and weight loss practices during their training and competitive seasons. Coaches, trainers, and dietitians working with these athletes need to be aware of fast weight loss methods the athletes may be using and encourage healthful weight loss that can be maintained during the season.

When competing in events where weight must be measured, the best defense is a good offense. Athletes should attempt to maintain body weight year round within a few pounds of the weight class in which they compete. Some athletes may need to move up a weight class to comfortably maintain weight year round, which potentially means competing against tougher opponents. However, weight classes are designed to even out the competition from a weight standpoint. An athlete that moves up a weight class is likely to have more muscle mass and competitively should be on the same playing field as other athletes in the same weight class.

In summary, athletes in weight class sports face additional challenges in maintaining a competitive weight. Strategies for athletes to lose and maintain a healthy, competition weight are similar to the strategies used by other athletes. Establishing an appropriate, achievable weight early in the season or in the off-season, and then aiming to maintain that weight within a few pounds over the entire year, can help athletes avoid drastic weight loss measures to make weight. Coaches, strength trainers, dietitians, and athletic trainers can help the athlete decide the best competition weight to work toward. A sports diet and exercise plan that helps achieve that weight in a healthy manner can help the athlete achieve and maintain a stable competitive weight throughout the competitive season.

What happens when weight loss efforts develop into disordered eating patterns?

Problems with eating behaviors have become more prevalent in the last decade in the United States and in other parts of the industrialized world. Athletes not only face the same sociocultural influences on eating behaviors, size, and shape as the general population, but they also have the pressure of fitting into the "ideal" for their sport. They see other athletes in their sport and assume they should look a certain way. Coaches, parents, and trainers may also suggest that a certain body type is advantageous and encourage changes in the athlete's body size or shape to help them excel in their sport. In many sports, athletes and coaches believe excess weight inhibits speed, agility, and endurance while increasing fatigue.[37] Although optimal body types may exist in general for certain sports, some athletes simply cannot achieve these stereotypes. Disordered eating develops when athletes continue to strive for that "ideal" at the expense of overall health and sport performance. As the obsession to achieve or maintain a certain ideal continues, athletes may develop eating disturbances that can lead to diagnosable eating disorders. Eating disorders have serious health consequences. Athletes with full-blown eating disorders often have decreased sport performance, are more likely to become injured, and suffer emotional and psychological consequences that affect life functioning.

Certain sports have an increased likelihood of encouraging negative body image and eating disorders. These sports place more emphasis on a certain body type as ideal or emphasize lean body shape or low body weight as optimal for the sport. Casual comments from coaches, officials, judges, and peers within competitive or practice environments can lead to negative self-perceptions associated with disordered eating.[38] **Social physique anxiety** is a sense of anxiety resulting from situations in which one's physique or figure is being observed or evaluated by others.[39] Monsma and Malina, in a study of female figure skaters, found that after controlling for age and BMI, social physique anxiety was related to the EDI score.[38] The authors suggest that disordered eating may be a response to social physique anxiety stemming from the subjective evaluative nature of figure skating. Clothing choices within sports can place athletes at greater risk for developing body image issues and disordered eating patterns, especially when not only the body, but also the clothing, can be subjected to judgment.

social physique anxiety A feeling of personal uneasiness or nervousness about how other people view or perceive the athlete's body shape or fatness level.

ACSM developed the following list of sports likely to place athletes at risk for developing eating disorders:

- Sports where the athlete is subjectively judged, such as diving, skating, gymnastics, and ballet.
- Sports where minimal, tight, or revealing clothing is required, such as track, swimming, diving, gymnastics, and volleyball, which can make athletes uncomfortable.
- Endurance sports, such as long-distance running, cycling, and triathlons, where excess body weight may hinder performance, and therefore emphasis is placed on a lean body type.
- Sports where weigh-ins are required, such as wrestling, horse racing, boxing, martial arts, and rowing.[40]

These sports by their nature can place athletes, female or male, at greater risk for developing disordered eating. However, many women and men in these sports have normal dietary and exercise patterns, maintain their weight in a comfortable range, and never develop eating disorders. The sports listed are not the only sports in which athletes could potentially develop disordered eating patterns. Any athlete in any sport can succumb to the pressures of their sport or other issues in their lives and ultimately develop an eating disorder.

What are the different types of eating disorders?

The prevalence of eating disorders is difficult to determine because many individuals do not seek treatment. There are no national research projects or databases that gather statistics about eating disorders, and treatment can be sought from a variety of professionals—medical, nutrition, or mental health. Studies of the prevalence of eating disorders in athletes suggest an increased risk and incidence in athletes compared to the general population. Sundgot-Borgen and Torstveit reported a 13.5% incidence of eating disorders in athletes compared to a 4.6% incidence in nonathlete controls.[41] They studied a large group of elite Olympic athletes in Norway and a comparable control group. The researchers found the incidence of athletes who exhibited eating disorders was different based on the sport. In females, those in aesthetic sports had a 42% incidence, endurance sports 24%, technical sports 17%, and ball game sports 16%. Among male athletes, the prevalence of eating disorders was more common in antigravitation sports such as gymnastics or skating (22%) than in ball game sports (5%) and endurance sports (9%).[41]

The major classifications of eating disorders are defined by specific medical and emotional criteria. The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition (*DSM-5*), defines the classifications for diagnosis of three different eating disorder categories: anorexia nervosa, bulimia nervosa, and binge eating disorder.[42]

Anorexia nervosa is a complex disorder with many causes and manifestations in behaviors. The main dietary concern with anorexia is severe caloric restriction leading to significantly low body weight relative to the individual's

anorexia nervosa A clinical condition manifested by extreme fear of becoming obese, a distorted body image, and avoidance of food. Anorexia nervosa can be life-threatening and requires medical and psychiatric treatments.

age, gender, developmental stage, and physical health. Individuals with anorexia do not maintain a body weight at or above a level considered minimally normal. They have an intense fear of weight gain or demonstrate behaviors that interfere with weight gain despite their low body weight. They also have a distorted body image. Some of these individuals also binge and purge the food they consume, whereas others just maintain a constant low energy intake.

Complications of anorexia can be quite severe. Energy deficit and hormonal imbalances can lead to decreased bone density. Irregular and slow heart rates are commonly observed in anorexic patients. Dehydration, nutritional deficiencies, dizziness, fatigue, and social withdrawal are other common complications of anorexia. These complications can be dangerous to the overall health of the athlete and can significantly reduce sport performance levels.

bulimia nervosa A clinical condition characterized by repeated and uncontrolled food bingeing in which a large number of calories are consumed in a short period of time followed by purging methods, such as forced vomiting or use of laxatives or diuretics.

Bulimia nervosa is characterized by an individual who binges on larger-than-normal amounts of foods and then uses inappropriate compensatory methods to rid him- or herself of the food consumed. The binge episodes are characterized as being out of control, with an inability to stop eating despite being overly full. The common misconception of bulimia is that purging is done exclusively through vomiting. The inappropriate compensatory behaviors after a binge can be any one of the following: vomiting, laxative abuse, excessive exercise, fasting, or any combination of these behaviors. Bulimia, similar to anorexia, is also characterized by a distorted body image and appearance having undue influence on self-esteem, eating, and exercise behaviors.

The prevalence of bulimia is higher in all population groups than anorexia is. Complications of bulimia nervosa can be quite severe. Erosion of tooth enamel, tears in the esophagus, chronic reflux, heart abnormalities, aspiration pneumonia, and even death can occur with vomiting as the main purging method. If laxatives are abused as a purging method, the intestinal tract becomes dependent on laxatives to move the bowels. This can lead to chronic constipation. Excessive exercise places the individual at greater risk for athletic-related injuries. Emotional and psychological concerns of lack of self-worth, self-loathing, anxiety, and depression can be concurrent conditions with bulimia nervosa.

binge eating disorder A clinical condition characterized by frequent feelings of being unable to control what or how much is being eaten. Typically the amount eaten is considered an abnormally large amount of food.

anorexia athletica A subclinical condition in which individuals practice inappropriate eating behaviors and weight control methods to prevent weight gain and/or fat increases. Anorexia athletica does not meet the criteria for a clinically defined eating disorder, but the behaviors exhibited are on a continuum that could lead to the more severe clinically recognized eating disorders.

The third eating disorder is **binge eating disorder**. Binge eating is characterized by frequent overeating at least one time per week for 3 months. These episodes of overeating are combined with feelings of lack of control and depression or guilt afterwards. Eating food very rapidly, eating until uncomfortably full, and eating alone are all diagnostic criteria associated with binge eating disorder. As with any type of eating disorder, the effects of low energy intake and/or the binge/purge cycle can eventually be detrimental to sport performance.

Anorexia athletica is not in the *DSM-5*, but it is important in the discussion of athletes and eating disorders. There are many similarities to both bulimia and anorexia in the description of anorexia athletica. However, athletes are a unique population, and their behaviors and symptoms may be somewhat different from those manifested in nonathletes. As a result, an athlete's behavior might not meet the diagnostic criteria required for an eating disorder. Several factors distinguish anorexia athletica from the other eating disorders. Often athletes (both male and female) with anorexia athletica show a reduced energy intake and reduced body weight but maintain high levels of physical performance; athletes with other eating disorders typically have a diminished capacity or tolerance for training and competition. Another distinguishing factor of anorexia athletica is that the reduction in body weight or loss of body fat is based on performance rather than appearance or concern with body shape or size.

The actual criteria for defining anorexia athletica are still not completely agreed upon by researchers in this area. However, several reviews of the characteristics of anorexia athletica have been published by different authors working with athletes in the eating disorder arena. With anorexia athletica, the athlete often has a rigid training schedule, tries to delay eating to save calories, and then often binges because of excessive hunger and lowered glucose levels. The common characteristics of anorexia athletica are listed in **Table 11.8** and are similar to anorexia nervosa, but with some additional characteristics related specifically to female athletes.[41,43]

Many athletes do not meet the criteria for anorexia, bulimia, or binge eating but still struggle with eating issues. These may be athletes who rarely binge and use compensatory behaviors, but might do so in a particularly stressful situation. They may also chronically diet; be overly concerned with their weight, body composition, and appearance; and make judgments about themselves based on the types of foods they have eaten or the number on the scale. Sport performance can suffer if the athlete does not eat enough calories to maintain energy levels during practice or competition. Some athletes may avoid carbohydrates as a way to diet, and glycogen stores will chronically be low, resulting in poor sport performance. Excessive exercise as a means to burn more calories could lead to injuries that keep the athlete out of competition. Although athletes with these types of eating behaviors do not meet the criteria for an eating disorder, the behaviors can negatively affect daily life and inhibit maximal sport performance.

What are the effects of eating disorders on athletic performance?

Athletes with eating disorders may appear normal and healthy and be able to maintain training levels for a period of time before any concerns develop. Typically, a change in weight is noticed that may not initially affect performance. Behavioral changes, such as withdrawal from teammates and coaches or atypical behaviors relating to other members, can also occur. Mental toughness and typical competitiveness may decrease, especially as caloric intake is decreased. Self-esteem and self-confidence may be reduced, and depression or anxiety can occur.

Physically, once the eating disorder has progressed, the athlete's performance during training and competition suffers. In some athletes this happens within a few months of restricting intake or bingeing and purging, whereas others can maintain a low caloric intake or binge and purge for many months before performance is altered. Eating-disordered athletes may develop nutritional deficiencies over time as a result of reduced caloric intake, chronic vomiting, or laxative abuse. If calories are significantly decreased, carbohydrate levels are often low. This causes an increased reliance on fat and protein as energy sources. When more protein is used for energy, less is available to maintain muscle mass. A decreased muscle mass almost certainly will decrease sport performance. Calcium, iron, and other vitamins and minerals may be lacking in the diet. This may eventually lead to iron deficiency, bone loss, and other consequences of vitamin and mineral deficiencies. Possibly most significant is the effect that reduced energy availability has on physical performance and health. When too few calories are consumed, energy expenditure from exercise is extreme, or a combination of both occurs, the body lacks the energy necessary to sustain high levels of exercise intensity. In addition, this "energy drain" affects hormone responses that lead to menstrual irregularities and potential issues with bone health described later in the section titled "What is the female athlete triad?"

Some of the health concerns and psychological effects that may be noticed in athletes with eating disorders include the following:

- Decreased fat-free mass.
- Dehydration.
- Glycogen depletion.
- Hormonal disturbances.
- Decreased BMR.
- Increased risk of poor nutritional status.
- Poor exercise performance.
- Anxiety, rapid heart rate, inability to sleep, and dehydration caused by the stimulant effect of diet pills and diuretics.

TABLE 11.8 Characteristics of Anorexia Athletica

- Decreased energy intake
- Decreased weight in the absence of medical illness or affective disorder explaining the weight reduction
- Maintenance of high physical performance
- Desire to lose weight not based on appearance
- Desire for weight loss based on performance or perceived performance improvements
- Intense fear of weight gain
- Weight cycling based on training levels
- Dietary restraint
- Bingeing and purging
- Gastrointestinal complaints
- Menstrual dysfunction
- Compulsive exercise despite illness or injury
- View self-worth by athletic ability or performance
- Individual does not meet *DSM-5* criteria for eating disorders, but possesses many eating-disorder characteristics

- Dehydration, electrolyte loss, and gastrointestinal complications resulting from laxative use.
- Increased risk of overuse injuries and fatigue caused by excessive exercise.
- Decreased concentration.
- Increased likelihood of food and weight obsession.

What are the main concerns regarding female athletes and eating disturbances/disorders?

Female athletes are at greater risk for developing eating disorders than age-matched nonathletes.[43–45] Identifying eating concerns in female athletes early on can keep the athlete from developing a diagnosable eating disorder in the future. Certain physical characteristics, strict training regimens, dietary restraint, and attitudes and behaviors toward food and body weight are accepted as normal for many female athletes, making it difficult to use the usual criteria for defining disordered eating in this population. Many different questionnaires are used to assess eating behaviors in this population (such as the EDI, EDI-2, and EDE discussed earlier), but few assessment tools have been designed specifically to determine early signs of eating problems in female athletes.

The Female Athlete Screening Tool (FAST), designed by Affenito et al.[46] and researched by McNulty et al.,[47] can be used as a screening tool for eating disorders in female athletes. The FAST is able to measure the purpose of aberrant exercise and eating behaviors in those athletes with eating disorders, whereas the EDI-2 and EDE do not consistently differentiate between athletes and nonathletes with eating disorders. Athletic programs in which female athletes participate at a highly competitive level should screen these athletes for eating disorders as part of an annual physical.

What is the female athlete triad?

The **female athlete triad** (see Figure 11.11), typically observed in young female athletes, consists of three definable symptoms: disordered eating, menstrual irregularities, and osteopenia/osteoporosis. Cobb et al. reported that the actual existence of all three parts of the triad at the same time has not been well documented in the research.[48] These authors report that the relationship between disordered eating and menstrual irregularities, as well as separate studies that establish the relationship between menstrual irregularities and low bone mineral density, are well documented. Regardless of the ability to document all or some of the three components of the female athlete triad existing simultaneously, female athletes with one or more of the triad symptoms need early diagnosis and treatment for these concerns.

female athlete triad A group of three interrelated conditions, typically diagnosed in young female athletes: disordered eating, menstrual irregularities, and osteopenia/osteoporosis.

Amenorrhea The absence or abnormal cessation of menstruation; defined as fewer than four cycles per year.

Disordered eating includes restrictive eating behaviors associated with eating disorders but may not meet the actual diagnostic criteria for eating disorders. Female athletes that exhibit disordered eating behaviors often restrict caloric intake and fat intake. They maintain a high training intensity and duration, thus producing a high energy expenditure and calorie deficit. Loucks and others have researched issues of energy availability and its effects on female athlete menstrual function. This research consistently reports that **amenorrhea**

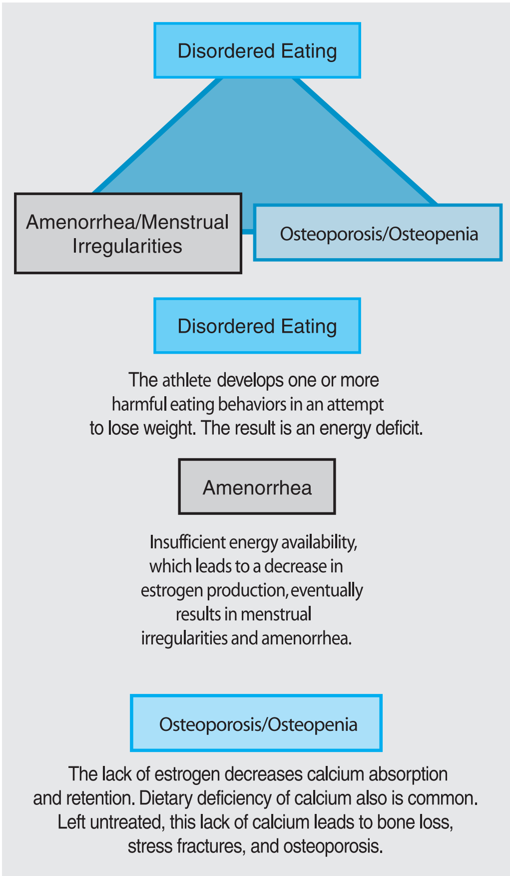


Figure 11.11 Female athlete triad. Disordered eating in female athletes that results in significant weight loss, energy drain, amenorrhea, or menstrual irregularities can also cause a loss of bone mineral density or osteoporosis.

occurs because of insufficient energy availability or ingestion of too few calories to fuel both physical activity and normal body functions.[49–51] The disordered eating patterns seen in the triad are similar to those described earlier in this chapter for anorexia nervosa and anorexia athletica.

Irregular menstruation can be defined based on the number of menstrual cycles in 1 year. **Eumenorrhea** is defined as at least 10 or more menses per year and is considered normal. **Oligomenorrhea** is defined as four to six cycles per year, and amenorrhea is defined as fewer than four cycles per year. Oligomenorrhea and amenorrhea both are seen with the female athlete triad. These menstrual irregularities often cause changes in sex hormone secretion. Changes in hormone regulation are one of the causes of the decrease in bone mineral density found with dysmenorrheic female athletes.

Eumenorrhea A term used to describe normal menstruation consisting of at least 10 menstrual cycles per year.

Oligomenorrhea A condition in which the female menstrual period is irregular, with cycles occurring only four to six times per year.

The third part of the female athlete triad, osteopenia/osteoporosis, can occur when female athletes decrease nutrient intake and lose significant body fat. A significant reduction in body fat to unhealthy levels can alter hormone levels that affect bone mineral density. A reduction in nutrients that are necessary for bone health, such as calcium, vitamin D, and magnesium, can also contribute to bone loss. Bone mineral density (BMD), as previously discussed in the body composition section, is often measured by a DEXA scan. BMD can be decreased in females exhibiting disordered eating and dysmenorrheic tendencies. Cobb et al. found that BMD was lower in the lumbar spine, hip, and whole body in oligomenorrheic and amenorrheic female athletes in their study.[48]

The relationship among all components of the triad is complex. Cobb et al.[48] completed an extensive study of all three components separately as well as the interrelationship of each component. Ninety-one female competitive runners 18 to 26 years old were surveyed by questionnaire and EDI to assess disordered eating, and BMD testing was performed using DEXA. The authors confirmed that the triad exists and that in female runners: (1) disordered eating is correlated with oligomenorrhea, (2) the association between oligomenorrhea and amenorrhea and low BMD is independent of body weight and composition, and (3) new evidence reveals that disordered eating is associated with low BMD in eumenorrheic women. The female athletes with elevated EDI scores reported 19% lower daily caloric intakes compared with the female athletes with normal EDI scores. Both groups had adequate calcium intakes. Of the 23 women with increased EDI scores, 65% had oligomenorrhea versus 25% of the 67 with normal EDI. Total energy intake was not associated with menstrual disturbance; however, a positive correlation was found with low percent fat intake. BMD was lower in the oligomenorrheic/amenorrheic women when compared to eumenorrheic women. When adjusted for body weight and composition, women with increased EDI scores had significantly lower BMD compared to women with normal EDI.

In summary, female athletes are at higher risk for developing eating disorders than female nonathletes. Disordered eating is one part of the triad, and the decrease in nutrient intake seen in disordered eating can lead to the other two parts of the triad. A reduction in body fat percentage and the hormone abnormalities occurring with this reduction can lead to the development of menstrual irregularities and decreased bone mineral density. Early detection and treatment of one or all of the triad components can help the athlete avoid chronic health issues and poor sport performance.

What are the main concerns regarding male athletes and eating disturbances/disorders?

Most research, public concern, and prevention and treatment strategies for eating disorders are aimed at females. However, as many as 1 million men and boys have eating disorders. As with female athletes, male athletes may be at higher risk for developing eating disorders than their sedentary counterparts. However, it is difficult to determine the actual prevalence of eating disturbances and disorders in male athletes because there is a lack of research in this area. As with females, there is also a lack of reporting, and men are even less likely than women to seek help for their eating or body image concerns.

Certain sports may place male athletes at higher risk for eating disturbances. Sports with established weight classifications and those where low body weight is emphasized, such as distance running, are considered higher-risk sports. Body builders and weight lifters also appear to be at high risk for developing disordered eating and body image distortion/disturbance. These athletes are more concerned with a "drive for bulk" rather than a "drive for thinness" as described in anorexia.

muscle dysmorphia A type of distorted body image in which individuals have an intense and excessive preoccupation and/or dissatisfaction with body size and muscularity. Muscle dysmorphia is most prevalent in male body builders and weight lifters.

Muscle dysmorphia is a newly defined syndrome characterized by highly muscular individuals (usually men) having a pathological belief that they are of very small musculature.[52] Pope et al.[53] first coined this phrase and defined it as an intense and excessive preoccupation or dissatisfaction with body size and muscularity.[54] This concept also is referred to as reverse anorexia or bigorexia[55] because it is characterized as seeing oneself as small or frail, when in fact the individual is large and muscular. Athletes with muscle dysmorphia exhibit a strong drive for muscularity.[56] They have a strong compulsion for spending hours resistance training, purchasing nutritional supplements, and following diets that supposedly help increase muscle mass. Similar to those with anorexia and bulimia, they have a preoccupation with body size and weight and demonstrate pathologic eating patterns and behaviors. Pope et al.[54] have determined a list of characteristic features suggesting muscle dysmorphia in males. Table 11.9 lists these features.

TABLE 11.9 Signs of Muscle Dysmorphia

1. Preoccupation with body shape and size. Feels insufficiently lean and/or muscular. Common signs of preoccupation exhibited include appearance checking; frequent weighing; criticizing self about weight, size, and shape; camouflaging body with baggy clothing.
2. Preoccupation with muscularity causes significant distress or impairment of social, occupational, or other life functioning such as personal relationships. This is demonstrated by two or more of the following:
   - Avoids social, occupational, or recreational activities to maintain compulsive exercise or diet regimens.
   - Avoids situations where body would be exposed (pool, beach) or is very anxious in these situations.
   - Preoccupation about inadequacy of size/muscularity causes clinically significant distress or impairment in social, occupational, and personal functioning.
   - Individual continues to exercise, diet, and use performance-enhancing drugs/supplements despite knowledge of or experience with adverse physical or psychological consequences.
3. Individual engages in excessive exercise, demonstrates preoccupation with food, follows strict diet regimen, or abuses steroids or other supplements.

Source: Adapted from Pope HG, Gruber AJ, Choi P., et al. Muscle dysmorphia: an underrecognized form of body dysmorphic disorder. *Psychosom*. 1997;38:548–557.

What are the best treatment options for eating disorders?

Treatment of eating disorders is best accomplished with a team approach to assessment and management of the condition.[57] A multidisciplinary team made up minimally of the team physician, psychological and psychiatric staff, and dietitians who can assess and provide treatment for the athlete is necessary. Including athletic trainers, coaches, and parents, if indicated, will give the eating-disordered athlete the best chance of regaining physiological and psychological health.

A thorough medical examination, including medical history; weight assessments; laboratory tests; bone scans, if needed; electrocardiogram; and patient history should be conducted. This information can be used to determine whether it is safe for the athlete to continue sport activities or whether restrictions in activity are necessary. Most athletes with diagnosable eating disorders will not be allowed to continue to compete if medical information obtained suggests that training and competition could compromise their health status. Medical staff should provide ongoing monitoring of physical health, especially if the athlete continues to train.

Eating disorders are not about food; they are based on emotional and psychological issues in the athlete's life that manifest themselves in disordered eating and exercise behaviors. An evaluation with a psychologist, clinical social worker, or psychiatrist is encouraged to assess emotional issues that underlie the eating problems. Athletes with eating disorders require regular counseling for long-term recovery. Without help from a therapist to discover the root of the problem, athletes are unlikely to be able to make the necessary dietary and behavior changes to recover from the eating disorder. It may also be necessary to consult with a psychiatrist to evaluate the need for psychotropic medications to improve the eating disorder recovery process.

The dietitian should assess current dietary intake and compare that to estimated calorie needs, assess weight status, and determine any nutritional deficiencies. Dietitians play an integral role in the treatment team to help athletes understand the need for food as fuel as well as to help them make dietary behavior changes. Many athletes with eating disorders are very knowledgeable about nutrients, vitamins, minerals, and calories; however, their knowledge is not enough to translate needed changes into action plans to improve nutrition intake. Dietitians need to establish rapport with the athlete and work with him or her to develop a plan that aids in treatment of the disorder and also provides the nutrients required for exercise and competition.

How can eating disorders be prevented?

Prevention of eating disorders is the best defense against the development of an unhealthy relationship with food, medical problems, and the associated negative effects on sport performance. Prevention of eating disorders, including the diagnosable eating disorders, anorexia athletica, and muscle dysmorphia, occurs on three levels: primary, secondary, and tertiary. Each of these levels can help the athlete prevent the development of disordered eating patterns, recognize that problems are occurring, or seek out medical and psychological treatment to prevent the problem from becoming chronic and debilitating.

Primary prevention includes practices that help identify, eliminate, and reduce personal, social, and cultural factors that contribute to eating disorders. Nutrition strategies for primary prevention include nutrition education focused on healthful eating to fuel sport activities, including eating nutrient-dense foods for adequate dietary intake. Nutrition education that emphasizes health and improved performance, not weight loss, encourages a healthy relationship with food and a well-balanced diet. Coaches, parents, and athletic trainers can influence athletes using various primary prevention strategies, including the following:

- Taking the emphasis off weight and body composition by eliminating weekly weigh-ins or body fat testing (unless it is required by the sport).
- Emphasizing skills and performance and recognizing that athletes come in different shapes and sizes; this will encourage a positive sport-based atmosphere that helps prevent body image distortions and eating problems.
- Discouraging the use of fad diets or quick weight loss methods.
- Modeling of healthy eating and exercise behaviors by coaches, parents, athletic trainers, and other staff.
- Preventing muscle dysmorphia through early identification of body image distortion that often occurs in strength athletes, as well as establishing standard prevention strategies for preventing eating disorders.
- Developing a healthy gym environment where education about myths associated with physique, dietary supplements, and the ability to obtain the "perfect" body are not perpetuated.
- Setting achievable goals, avoiding comments about specific parts of the body, and dispelling myths about certain supplements and dietary practices that are unhealthy; this can be done by personal trainers, athletic trainers, and strength coaches.

gaining the performance edge

Athletes are at higher risk for developing eating disturbances and disorders than the general population. Preventing eating disorders is essential for athletes to avoid negative consequences to health and sport performance. Regular screening of athletes at high risk for developing eating disorders helps identify problems early and prevents more serious complications later.

Secondary prevention includes identifying and recognizing warning signs that suggest early development of eating disorders. Once warning signs are recognized, immediate referral to medical, psychological, and/or nutrition professionals is essential for the athlete. Coaches, athletes, dietitians, teammates, trainers, and parents of athletes should educate themselves about the warning signs of eating disorders. Knowing the resources available in the community and establishing relationships with these resource personnel will help the referral process proceed smoothly for the athlete. Early detection and treatment mean better outcomes. Education of high-risk teams and their coaches early in the season or during recruitment will help athletes and those who work with them recognize early warning signs in themselves and others. Table 11.10 lists common warning signs that indicate an athlete may be moving toward disordered eating behaviors.

Tertiary prevention includes efforts to keep the disorder from becoming chronic. An athlete who is diagnosed with an eating disorder should get immediate evaluation and treatment from a physician and a mental health professional. These professionals should refer the athlete to a registered dietitian who can help the athlete with an appropriate nutritional plan. Obtaining professional assistance through

TABLE 11.10 Warning Signs of Eating Disorders in Athletes

Behavioral Signs	Physical Signs
Preoccupation with food, weight, or body composition	Normal, underweight, or overweight
Criticism of weight, shape, body composition; comparisons of these to other teammates	Fatigue
Limited type and amount of food eaten	Lethargy
Fear of becoming "fat"	Weakness
Excessive rigid exercise; exercise more than at scheduled practices	Impaired concentration
Recent switch to restrictive diet	Dizziness
Secretive eating (food disappears)	Abdominal pain
Consumption of large amounts of food inconsistent with athlete's weight	Faintness
Evidence of self-induced vomiting—bathroom smells, trips to bathroom immediately after meals	Salivary gland enlargement
Laxative, diuretic, or diet pill abuse	Sore muscles
Recurring injuries, especially overuse injuries	Chills or cold sweats
Isolation from social situations, family, friends, teammates	Frequent sore throat
Withdrawal from team activities or change in interaction with teammates	Diarrhea
Mood changes, depressive signs, anxiety	Constipation
	Tooth enamel erosion
	Esophagitis
	Callus on fingers, back of hand
	Oligomenorrhea
	Amenorrhea

TABLE 11.11 Eating-Disorder Prevention and Treatment Resources

Organization	Resources Offered
National Institute of Mental Health www.nimh.nih.gov/health/topics/eating-disorders/index.shtml	Website provides information on signs and symptoms, treatment, statistics, and outreach programs for eating disorders.
National Eating Disorders Association www.nationaleatingdisorders.org	Website offers information on eating-disorder education, treatment, and links to referral sources for individuals struggling with eating concerns.
Harris Center, Massachusetts General Hospital www.harriscentermgh.org	Website focuses on expanding knowledge of eating disorders, research, and education on identifying, treating, and preventing eating disorders.
American College of Sports Medicine www.acsm.org	Website contains position papers on the female athlete triad, weight management, and sports nutrition. Other educational materials and resources are available at this site.
The Renfrew Centers and Foundation www.renfrewcenter.com 1-800-renfrew	Residential treatment center for people with eating disorders. Several centers exist in various locations throughout the United States.
Sports, Cardiovascular and Wellness Nutritionists (SCAN) Dietetic Practice Group of the American Dietetic Association www.scandpg.org	Information on sports nutrition, eating disorders, rapid weight loss in wrestlers, and how to find a registered dietitian with sports nutrition experience.

either an inpatient or outpatient treatment facility is critical. Athletes with eating disorders may resist treatment because it means time away from their sport and requires them to realize they have a problem. Pushing the athlete to accept and work at treatment with trained professionals to guide the process may save the athlete a lifetime of struggles with eating problems.

Food for Thought 11.4

Weight Loss Issues: Female Athlete Triad and Eating Disorders

Describe the components of the female athlete triad and warning signs indicative of eating disturbances/disorders.

Several nationwide resources are available to help athletes prevent eating problems and to help sports professionals treat athletes with eating problems (see Table 11.11). Resources may also be available in the athlete's local community. Professionals working with athletes should know the resources in their communities so that referrals can be made quickly to match the athlete's needs with the resources available.

How can athletes gain weight healthfully?

Although it seems that most athletes and the general public are spending most of their time trying to maintain or lose weight, there are some athletes who are interested in increasing body weight. As has already been discussed, gaining fat weight for most athletes is not desirable; therefore, any weight gain strategies should focus on increasing muscle mass. By increasing muscle mass, the athlete not only accomplishes his or her goal of gaining weight, but also becomes stronger, thereby increasing his or her strength-to-weight ratio, which is a desirable training adaptation for most athletes. Gaining weight via increases in fat mass decreases the strength-to-weight ratio, which is why weight gain should be aimed at increasing muscle mass with minimal contribution from added fat mass. There are three main requirements for increasing body weight, particularly in regard to muscle mass:

- Participation in an appropriately planned resistance training program.
- Achieving a positive energy balance.
- Achieving a positive nitrogen balance.

Each of these requirements is discussed in more detail in the following sections.

What kind of resistance training program is best for gaining weight?

Most athletes know that regular resistance training (also referred to as strength training) is effective for improving muscle mass, strength, and power. They also know that it can strengthen connective tissues such as tendons, ligaments, and bone, thus decreasing risk for injuries. However, many athletes do not know that not all resistance training programs produce the same results. The type of exercises performed, the amount of weight lifted, the number of repetitions performed in each set, the total number of sets completed for each exercise, and the amount of rest taken between sets can all affect the outcomes of a resistance training program.

The first criterion for any resistance training program designed to increase muscle mass is that it must challenge the muscles to work against resistances to which they are not accustomed. One of the basic principles of training, known as the "overload principle," states that resistance training must place a greater-than-normal stress on the muscle cells to stimulate adaptation. The amount of stress imposed on the muscle can be altered based on how much weight is being lifted and the number of repetitions and sets performed. When the muscle is challenged to contract against an appropriate resistance, the muscle cells respond and are stimulated to grow. The end result is muscle hypertrophy (i.e., the muscle gets bigger), and thus increased muscle mass.

The resistance training program chosen by an athlete wishing to gain weight should focus on stimulating muscle hypertrophy. As noted earlier, a common misconception is that all resistance training programs are created equal. Training for muscle hypertrophy is different from training for maximal strength or power. Resistance training programs designed to increase muscle mass should work all the major muscle groups with a training frequency of at least twice per week and incorporate weight loads that allow a minimum of 8 and a maximum of 12 repetitions per set. Three to five sets should be performed for each exercise. Athletes should allow 48 hours between workouts for the same muscle groups so that the muscles can recover and adapt to the training. As the muscles adapt and become stronger, the amount of weight lifted should be increased to keep the repetitions performed per set in the 8 to 12 range. By progressively increasing the loads to accommodate the strength increases, the muscles will continue to be challenged and thus continue to hypertrophy. This format of resistance training is often referred to as "progressive" resistance training.

How can an athlete achieve a positive energy balance?

The second requirement of a weight gain program is that the athlete must attain a positive energy balance.

In other words, calorie intake must exceed calorie expenditure for muscle gains to occur. A positive energy balance can be achieved by consuming more calories, decreasing energy expenditure, or both. In many instances, decreasing energy expenditure (i.e., training less) is not an option because of the necessity of training for the sport. Thus, increasing food intake is the most productive way for most athletes to gain weight; however, it should not be done indiscriminately. Doing so can result in higher levels of fat weight gain.

Approximately 2300–3600 calories above current requirements are needed to increase muscle mass by 1 pound. However, the body does not necessarily make more muscle solely because extra calories are consumed in the diet. The extra calories must be combined with the stimulus for muscle growth that results from resistance training. Even then, the body will use only what it needs to recover and adapt. A study involving individuals who were resistance training and consuming an extra 500–2000 calories per day indicated only 30–40% of the weight gained was lean body tissue.[58] The remaining calories are stored as energy, usually in the form of fat. In short, consuming large quantities of food will not result in increased muscle mass beyond what resistance training induces. The goal is to provide enough calories to cover the body's need to synthesize new muscle tissue without exceeding calorie requirements. The number of extra calories needed to support muscle growth is highly individual, and thus frequent body composition assessments should be performed so that caloric intake can be adjusted accordingly. Weight gain in the form of muscle is a gradual process, so increases in dietary intake should be modest to maximize muscle gain versus fat gain.

A weight gain goal of one-half to 1 pound per week is generally considered appropriate. The amount of additional calories needed to accomplish weight gain depends on the individual's goals for rate of weight gain, the intensity and volume of their current training, the ability of the athlete to consume additional calories, and genetics. Consuming an additional 300–500 calories per day could provide for a weight gain rate of half a pound to 1 pound per week. This modest increase in caloric intake can generally be consumed without the athlete feeling overly full or uncomfortable after meals. During the weight gain period, if increases in training volume occur, in particular any increases in aerobic-type exercise, then more than 300–500 additional calories may be needed to meet the additional energy demands of the training.

Finally, the composition of the additional calories is important. Many athletes assume that protein should make up the largest percentage of the additional calories because protein is essential for muscle synthesis. Protein intake is important, but it is more important to ensure that the total energy needs of the body are met regardless of the contributing macronutrients. Carbohydrates are a critical energy source and must be present in the diet or the body will break down and use protein for energy. In other words, carbohydrates spare proteins from being broken down for energy, thus enabling them to be used for muscle tissue building. As a result, the largest proportion of the additional calories (55–60%) should be obtained from carbohydrate-rich foods. In summary, consuming 300–500 extra calories per day, primarily in the form of carbohydrates, will place the athlete in a positive energy balance and support a rate of weight gain that increases muscle mass and minimizes fat gain.

How can an athlete achieve a positive nitrogen balance?

With adequate additional caloric intake, athletes can successfully gain weight. Even though carbohydrates should contribute a majority of the extra calories needed for muscle mass gain, adequate protein intake is also necessary. Protein needs for athletes are greater compared to sedentary individuals. During a targeted weight gain period, protein needs are also increased. Some of this additional protein is needed to support the energy costs of additional training. Most of the additional protein will be used to produce muscle hypertrophy. The RDA for protein is 0.8 grams per kilogram body weight for the average healthy individual. The recommendation for athletes during strength training activities ranges from 1.4–2.0 grams per kilogram body weight. This range provides a level of protein intake that is approximately twice the RDA and should be adequate to place the athlete in a state of positive nitrogen balance.

Attaining a daily protein intake of 1.4–2.0 grams per kilogram of body weight is not difficult for most athletes. In general, if an athlete is consuming enough food to meet his or her daily caloric needs and including protein-rich foods and beverages at each meal and snack throughout the day, obtaining adequate amounts of protein to support muscle mass gains is typically not of concern. For example, an 85-kilogram athlete who requires an estimated 3200 calories to meet daily energy demands and maintain weight will require approximately 3700 calories after adding 500 calories per day to support muscle mass gains (see **Training Table 11.3**). If the *gaining the performance edge*

To gain weight primarily as muscle mass, athletes must strength train to provide a stimulus for muscle growth, eat an additional 300–500 or more calories per day consistently, consume the majority of the additional calories as carbohydrate (to spare protein for muscle building), and consume adequate protein to achieve positive nitrogen balance.

athlete wanted to boost protein intake to 1.8 grams per kilogram of body weight, then a total of 153 grams of protein would be required daily. When comparing total energy needs to protein requirements, only 16.5% of total calories would need to come from protein ([153 grams × 4 kcal per gram of protein] ÷ 3700 kcal = 16.5% of total calories from protein). The normal diet of most individuals consists of 10–20% of calories from protein. Clearly, an athlete who eats a diet on the high end of normal will more than likely meet the daily protein requirements to support muscle growth.

Do athletes need dietary supplements to gain weight?

Use of protein supplements is common in athletes desiring to gain weight, primarily because the popular press touts the importance of supplementation for muscle growth (see Figure 11.12). The marketing efforts of supplement companies that promote high protein intake for muscle growth sway athletes into believing they need supplements to meet protein demands. However, as demonstrated in the previous example, supplementation is not a necessity if the caloric needs of the athlete are being met and protein intake is on the upper end of the recommended range for athletes. Athletes need to keep in mind that any excess protein (i.e., protein not used for muscle growth) will be stored as fat. Conversely, if the athlete has food intolerances or preferences that challenge the adequate intake of protein from food sources, then supplementation may be recommended. If protein supplements are incorporated into the athlete's eating plan, they should be used in moderation with a continued focus on food sources of protein.

Weight gain or calorie supplements may also be helpful for athletes who have extremely high energy needs and just can't seem to eat enough food necessary to gain weight (see Figure 11.13). These calorie supplements typically provide between 300 and 500 calories and are usually sold as an 8-ounce drink or in powdered form. As with any dietary supplement, athletes should pay careful attention to the Supplement Facts label. Some

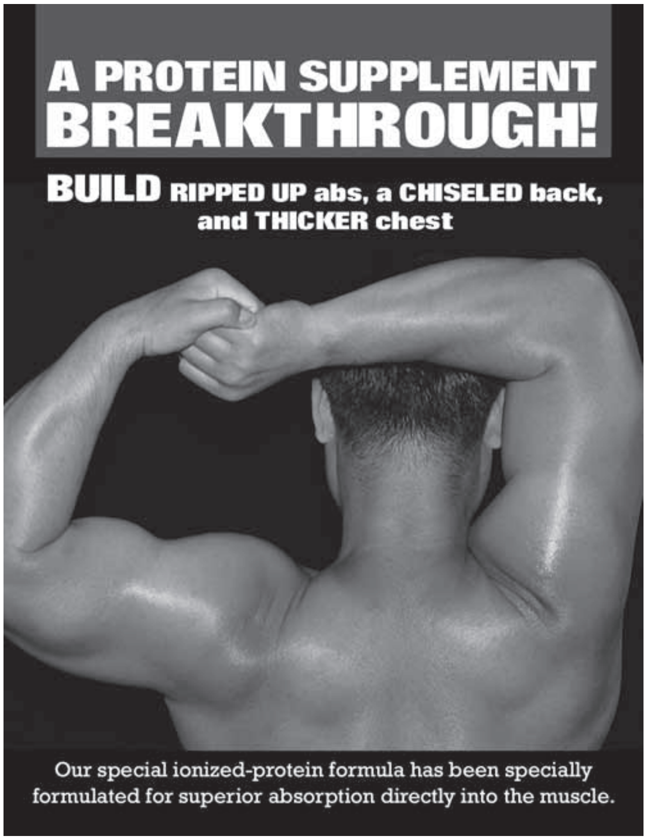
Training Table 11.3: Sample Meal Plan for Weight Gain

3200 Calories (166 g protein)	3700 Calories (183 g protein)
Breakfast	*Breakfast*
2 scrambled eggs, with salsa and shredded cheese	2 scrambled eggs, with salsa and shredded cheese
2 slices whole wheat toast with jelly	2 slices whole wheat toast with jelly
12 oz orange juice	12 oz orange juice
Mid-morning Snack	*Mid-morning Snack*
Granola bar	Granola bar
	Pear
Lunch	*Lunch*
3 oz turkey sandwich with Swiss cheese	3 oz turkey sandwich with Swiss cheese
Apple	Apple
Baked potato chips	Baked potato chips
12 oz 1% milk	4 small oatmeal cookies
	16 oz 1% milk
Mid-afternoon Snack	*Mid-afternoon Snack*
3 oz tuna with saltine crackers	3 oz tuna with saltine crackers
Dinner	*Dinner*
4 oz chicken breast	4 oz chicken breast
2 cups white rice	2 cups white rice
2 cups broccoli	2 cups broccoli
12 oz chocolate milk	16 oz chocolate milk
Evening Snack	*Evening Snack*
12 oz apple juice	2 oz ham sandwich
	12 oz apple juice

weight gain or protein supplements may contain stimulants or other herbal or synthetic ingredients that may be banned by the NCAA, the International Olympic Committee (IOC), and other professional sports organizations. Ignorance is not an excuse to these agencies, so reading the labels and asking about the ingredients of any supplement are very important.

What other dietary practices might help an athlete gain weight?

For many athletes on a tight schedule, taking in extra calories during the day is not an easy thing to do. Likewise, there are other individuals who have to work very hard at consuming enough calories to gain weight. For these individuals and others



© Photos.com

Figure 11.12 Protein supplements are vigorously marketed to athletes. Adequate protein intake is necessary for muscle growth. If the athlete cannot meet daily protein needs through food sources, protein supplements might be appropriate. However, protein consumed in excess, whether from supplements or foods, can be stored as fat.

Figure 11.13 Weight gain powders and drinks. Athletes who have difficulty meeting high-energy demands and want to gain weight may benefit from easy-to-use powdered or liquid high-calorie supplements. Caution should be taken when using these supplements because they could contain banned or other substances the athlete does not want or should not consume.

wanting to add weight, **Training Table 11.4** lists some helpful dietary tips. Eating numerous small meals throughout the day and/or drinking juices or milk rather than water can help pack in the extra calories. This is especially helpful to athletes who already feel full after their meal and therefore need to add calories throughout the day versus solely at meals. Also, cutting back on drinking fluids during the meal, especially carbonated fluids, can leave more room for a few extra calories. For those athletes who are always on the go and find frequent snacking a bother, commercially prepared liquid meals can be an appropriate and easy-to-consume snack option. Alternatively, mixing up smoothies or calorie supplement drinks before leaving home will make taking in extra calories throughout the day more convenient. Finally, late-night snacking is an excellent way to add the extra calories needed for weight gain. Regardless of the weight gain strategies chosen, it is important that the methods are not too disruptive to the normal routine of the athlete. Dietary strategies that look good on paper but do not fit the athlete's behaviors/habits will not result in the regular boost of calories required for attaining specific weight gain goals.

Training Table 11.4: Nutrition Tips for Weight Gain

- Consume fluids after meals to avoid becoming full on liquids.
- Avoid carbonated beverages that produce gas and bloating and the feeling of fullness.
- Use predetermined cues to eat (e.g., plan meals with friends, always have a 10:00 A.M. snack).
- Have small, frequent meals and snacks throughout the day.
- Consume a variety of nutrient-dense and energy-dense foods.
- Consume high-calorie beverages with meals.
- Use sports drinks instead of water during training.
- Include a bedtime snack approximately 1 hour prior to sleep.

Food for Thought 11.5

You Are the Nutrition Coach

Apply the concepts from this chapter to several case studies.

The Box Score

Key Points of Chapter

- Athletes are concerned about weight loss for a variety of reasons. They may feel it will help improve their sport performance or make their appearance more attractive to judges. Many sports have a particular "look," such as the very thin appearance of long-distance runners. Athletes may aspire to change their weight to achieve a particular perceived ideal appearance for their sport.
- Body mass index (BMI) is equal to body weight (in kilograms) divided by height (in meters) squared. BMI measures can be calculated using the nonmetric pounds and inches conversions or the published nomogram charts as well. Although BMI is not a true measure of body composition, it is commonly used to provide an indication of body composition in the general population. Athletes should not solely use BMI as a measure of weight status because it is a crude indicator of body composition.
- Overweight and obesity are significant medical concerns for adults in the United States. Approximately two-thirds of the adult population has a BMI greater than 25, placing them in the overweight or obese category. Higher-than-normal BMI can result in increased risk for chronic illnesses such as diabetes, heart disease, and hypertension.
- A variety of methods to measure body composition are available. All have varying levels of cost, ease of assessment, and ability for use in the field with athletes. Skinfold measurements are a fairly accurate way to easily and inexpensively assess athletes' body composition in the training room. These measures can be done at intervals during the training season to track trends in body composition changes.
- Weight loss success is hard to achieve in many cases. Success depends on creating an energy deficit (i.e., negative energy balance) by reducing calorie intake, increasing energy expenditure, or a combination of both. The energy deficit created for weight loss in athletes should be small (approximately 500 calories per day). By creating a slight energy deficit, athletes losing weight will continue to have the energy needed to train and will minimize loss of muscle mass.
- Athletes in weight classification sports are at higher risk for using weight loss measures that are unhealthy. Athletes in these sports should attempt to maintain their training weight at competition weight to avoid having to "make weight" and use rapid weight loss measures that are detrimental to health.
- Eating disorders are more common in athletes than in nonathletes. Sports where appearance is judged or where subjective scoring occurs may impose a higher risk to athletes in developing eating disorders. Early detection of dieting or eating-disturbed behaviors will help prevent the associated consequences to health and sport performance.
- Weight gain for athletes can be as difficult to achieve as weight loss in some cases. Athletes need to consistently consume additional calories and adequate protein and maintain or increase resistance training to gain weight. Because athletes already have high calorie needs, increasing food consumption may be difficult for some athletes. Consuming more calorie-dense foods and beverages and including high-calorie snacks can help athletes achieve increased mass in a healthy way.

Study Questions

1. What are some of the various ways to determine an athlete's body composition? Briefly discuss the pros and cons of each.
2. How is body mass index (BMI) calculated? Is it truly a measure of body composition? Defend your answer.
3. Why do athletes tend to focus so much on body weight? Is this beneficial or detrimental? Defend your answer.
4. What is the significance of waist and hip measurements in regard to disease risk? What are the waist-to-hip ratios expected in individuals with gynoid and android fat distribution?
5. What is the difference between nonessential body fat and essential body fat? Do females have the same amounts of essential and nonessential fat as males?
6. What are the three major components of energy expenditure? Briefly explain each. Which component accounts for the largest portion of daily caloric expenditure?
7. How does the concept of energy balance pertain to weight gain or weight loss?
8. Discuss the various factors that can affect energy intake.
9. What is the recommended range of daily calorie deficit if weight loss is the goal?
10. What are some of the differences between credible diets and fad diets?
11. What are some dietary practices that will increase the chances of long-term weight loss success?
12. What are the commonly encountered eating disorders? Which athletes are at highest risk for eating disorders? Why?

13. What is muscle dysmorphia and what are some of its warning signs? Which athletes are at greatest risk for muscle dysmorphia?
14. What conditions make up the female athlete triad?
15. Discuss some of the ways that eating disorders can be prevented.
16. What are the three main requirements necessary for an athlete wanting to gain weight? What is an appropriate rate of weight gain for an athlete?

References

1. Ogden CL, Carroll MD, Kit BK, Flegal, KM. Prevalence of obesity in the United States, 2009–2010. Available at: http://www.cdc.gov/obesity/data/adult.html. Accessed January 29, 2013.
2. Centers for Disease Control and Prevention. Childhood Overweight and Obesity. Available at: http://www.cdc.gov/obesity/childhood/index.html. Accessed January 29, 2013.
3. Noel MB, Van Heest JL, Zaneteas P, Rodgers CD. Body composition in Division I football players. *J Strength Condition Res.* 2003;17(2):228–237.
4. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight and obesity. *JAMA.* 2005;293: 1861–1867.
5. Prentice A, Jebb SA. Beyond body mass index. *Obes Rev.* 2001;2(3): 141–147.
6. National Heart Lung and Blood Institute, National Institutes of Health. *The Practical Guide, Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. Washington, DC: U.S. Department of Health and Human Services; 2002.
7. National Heart Lung and Blood Institute, National Institutes of Health. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: Executive Summary. *Am J Clin Nutr.* 1998;68:899-917.
8. Keys A, Fidanza F, Karvonen MJ, Kimora N, Taylor, HL. Indices of relative weight and obesity. *J Chronic Dis.* 1972;25:329–343.
9. Deurenberg P, Weststrate JA, Seidell JC. Body mass index as a measure of body fatness: age- and sex-specific prediction formulas. *J Nutr.* 1991;65:105–114.
10. Gallagher D, Visser M, Sepulveda D, Pierson RN, Harris T, Heymsfield SB. How useful is body mass index for comparison of body fatness across age, sex and ethnic groups? *Am J Epidem*. 1996;143:228–239.
11. Chan J, Rimm EB, Colditz GA, Stampfer MJ, Willett WC. Obesity, fat distribution, and weight gain as risk factors for clinical diabetes in men. *Diabetes Care.* 1994;17:961–969.
12. Kuczmarski RJ, Carrol MD, Flegal KM, Troiano RP. Varying body mass index cutoff points to describe overweight prevalence among U.S. adults: NHANES III (1988–1994). *Obes Res.* 1997;5:542–548.
13. Nash NL. Body fat measurement: weighing the pros and cons of electrical impedance. *Physician Sports Med.* 1985;13(11):124–128.
14. Lohman TG. Basic concepts in body composition assessment. In: *Advances in Body Composition Assessment.* Champaign, IL: Human Kinetics; 1992:1–5.
15. Kohrt WM. Preliminary evidence that DEXA provides an accurate assessment of body composition. *J Appl Physiol.* 1998;84:372–377.
16. Van Loan MD. Is dual-energy X-ray absorptiometry ready for prime time in the clinical evaluation of body composition? *Am J Clin Nutr.* 1998;68: 1155–1156.
17. Saunders MJ, Blevins JE, Broeder CE. Effects of hydration changes on bioelectrical impedance in endurance trained individuals. *Med Sci Sports Exerc.* 1998;30(6):885–892.
18. National Institutes of Health. Bioelectrical impedance analysis of body composition measurement. *NIH Technolog Assess State*. 1996; December 12–14:1–35.
19. Withers RT, Craig NP, Bourdon PC. Relative body fat and anthropometric prediction of body density of male athletes. *Eur J Appl Physiol Occup Physiol*. 1987;56(2):191–200.
20. McArdle WD, Katch FI, Katch VL. *Exercise Physiology: Energy, Nutrition, and Human Performance*. 5th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2001.
21. Manore M, Thompson J. *Sports Nutrition for Health and Performance*. Champaign, IL: Human Kinetics; 2000.
22. Borchers JR, Clem KL, Habash DL, Nagaraja HN, Stokley LM, Best TM. Metabolic syndrome and insulin resistance in Division 1 collegiate football players. *Med. Sci. Sports Exer*. 2009;41(12):2105–2110.
23. American Dietetic Association. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: nutrition and athletic performance. *J Am Dietet Assoc*. 2000;100:1543–1556.
24. Wildman REC, Miller BS. *Sports and Fitness Nutrition*. Belmont, CA: Thomson and Wadsworth; 2004.
25. Frankenfield D, Roth-Yousey L, Compher C. Comparison of predictive equations for resting metabolic rate in healthy nonobese and obese adults: a systematic review. *J Am Dietet Assoc*. 2005;105(5):775–789.
26. Lee RD, Nieman DC. *Nutritional Assessment*. 3rd ed. New York, NY: McGraw-Hill; 2003.
27. Zeman FJ. *Clinical Nutrition and Dietetics*. New York, NY: Macmillan; 1991.
28. Wilmore J, Costill DL. *Physiology of Sport and Exercise*. 3rd ed. Champaign, IL: Human Kinetics; 2004.
29. Haskell WL, Lee I-M, Pate RP, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, Bauman A. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007;116(9):1081–1093.
30. Alderman B, Landers DM, Carlson J, Scott JR. Factors related to rapid weight loss practices among international-style wrestlers. *Med Sci Sports Exerc*. 2004;36(2):249–252.
31. Choma C, Sforzo GA, Keller BA. Impact of rapid weight loss on cognitive function in collegiate wrestlers. *Med Sci Sports Exerc*. 1998;30(4): 746–749.
32. Centers for Disease Control and Prevention. Hyperthermia and dehydration-related deaths associated with intentional rapid weight loss in three collegiate wrestlers—North Carolina, Wisconsin and Michigan, November–December 1997. *JAMA*. 1998;279(11):824–825.
33. Davis S, Dwyer GB, Reed K, Bopp C, Stosic J, Shepanski M. Preliminary investigation: the impact of the NCAA wrestling weight certification program on weight cutting. *J Strength Conditioning Res*. 2002;16(2):305–307.
34. National Federation of State High School Associations. NFHS Wrestling Rules. Available at: http://www.nfhs.org/content.aspx?id-3297. Accessed February 5, 2013.
35. Oppliger RA, Steen SA, Scott JR. Weight loss practices of college wrestlers. *Int J Sport Nutr Exerc Metabol*. 2003;13(1):29–46.
36. Dale K, Landers DM. Weight control in wrestling: eating disorders or disordered eating? *Med Sci Sports Exerc*. 1999;31(10):1382–1389.
37. Krane V, Waldron J, Michalenok J, Stiles-Shipley J. Body image concerns in female exercisers and athletes: a feminist culture. *Women Sport Phys Activ J*. 2001;10(1):17–54.
38. Monsma EV, Malina RM. Correlates of eating disorders risk among female figure skaters: a profile of adolescent competitors. *Psych Sport Exerc*. 2003;5(4):447–460.
39. Bartlewski PB, Van Raatle JL, Brewer BW. Effects of exercise on social physique anxiety and body esteem of female college students. *Women Sport Phys Activ J*. 1996;5(2):49–62.
40. Otis CL, Drinkwater B, Johnson M, Loucks A, Wilmore J. American College of Sports Medicine position stand: the female athlete triad. *Med Sci Sports Exerc*. 1997;29(5):1–10.
41. Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. *Clin J Sport Med*. 2003;14(1):25–32.

42. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington, DC: American Psychiatric Association; 2013.

43. Sundgot-Borgen J. Risk and trigger factors for the development of eating disorders in female elite athletes. *Med Sci Sports Exerc*. 1994;26:414–419.

44. Beals KA, Manore MM. The prevalence and consequences of subclinical eating disorders in female athletes. *Int J Sport Nutr*. 1994;4:175–179.

45. Wiggins DL, Wiggins ME. The female athlete. *Clin J Sport Med*. 1997;16:593–612.

46. Affenito SG, Yeager KA, Rosman JR, Ludemann MA, Adams CH, Welch GW. Development and validation of a screening tool to identify eating disorders in female athletes. *J Am Dietet Assoc*. 1998;98(9 suppl 1):A78.

47. McNulty KY, Adams CH, Anderson JM, Affenito SG. Development and validation of a screening tool to identify eating disorders in female athletes. *J Am Dietet Assoc*. 2001;101:886–892.

48. Cobb K, Bachrach LK, Greendale G, et al. Disordered eating, menstrual irregularity, and bone mineral density in female runners. *Med Sci Sports Exerc*. 2003;35(5):711–719.

49. Loucks AB. Energy availability, not body fatness, regulates reproductive function in women. *Exerc Sport Sci Rev*. 2003;31:144.

50. Loucks AB, Verdun M, Heath EM. Low energy availability, not stress of exercise, alters LH pulsatility in exercising women. *J Appl Physiol*. 1998;84:37.

51. Sherman RT, Thompson RT. Practical use of the International Olympic Committee Medical Commission position stand on the female athlete triad: a case example. *Int J Eat Dis*. 39;3:193–201.

52. Choi PYL, Pope HG, Olivardia R. Muscle dysmorphia: a new syndrome in weightlifters. *Br J Sports Med*. 2002;36:375–376.

53. Pope HG, Gruber AJ, Choi P. Muscle dysmorphia: an unrecognized form of body dysmorphic disorder. *Psychosom*. 1997;38:548–557.

54. Pope HG, Katz DL, Hudson JI. Anorexia nervosa and "reverse anorexia" among 108 male body builders. *Comp Psychiatry*. 1993;34:406–409.

55. Mosley PE. Bigorexia: bodybuilding and muscle dysmorphia. *Eur Eat Disorders Rev*. 2009;17:191–198.

56. Robert CA, Munroe-Chandler KJ, Gammage KL. The relationship between the drive for muscularity and muscle dysmorphia in male and female weight trainers. *J. Strength Cond Res*. 2009;23(6):1656–1662.

57. Bonci CM, Bonci LJ, Granger LR, Johnson CL, Malina RM, Milne LW, Ryan RR, Vanderbunt EM. National Athletic Trainers' Association Position Statement: preventing, detecting, and managing disordered eating in athletes. *J Athletic Training*. 2008;43(1):80–108.

58. Kreider RB. Dietary supplements and the promotion of muscle growth with resistance exercise. *Sports Med*. 1999;27:97–110.

Additional Resources

Miller WC, Niederprume MG, Wallace JP, Lindeman AK. Dietary fat, sugar and fiber predict body fat content. *J Am Dietet Assoc*. 1994;94(6):612–617.

Siri WE. The gross composition of the body. In: Lawrence JH, Tobias CA, eds. *Advances in Biological and Medical Physics*. 4th ed. New York, NY: Academic Press; 1956:239–280.