Practical Nutrition for Sports Medicine and Fitness Professionals

HUMAN KINETICS

with

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introduction

A critical aspect of many sports is taking a time-out. Many games are fast paced, and a brief break allows athletes to rest, regroup, analyze the situation, and strategize. Professionals who work with athletes can relate to a fast-paced environment, especially when they consider the world of scientific research. New research studies are being released every day. Some of the studies confirm long-held principles, but others suggest new or different ways to help athletes enhance their performance. If you've been in practice for a while, taking a time-out to review your knowledge of a particular subject can be worthwhile.

Practical Nutrition for Sports Medicine and Fitness Professionals is a course designed specifically for sports medicine professionals, certified strength and conditioning coaches, and other certified fitness professionals who want to update their knowledge of sports nutrition principles.

The text is divided into three parts and six chapters. Part I, "Nutrition Standards, Patterns, and Trends for Sport Performance," provides a base level of nutrition information that can be used throughout this book. The first chapter, "Nutrition Standards and Guidelines," reviews current and updated dietary guidelines and scientific data applicable to adults and emphasizes healthful nutrient intake. Nutrition standards are better defined than they were in the past, and practitioners have tools such as the Dietary Reference Intakes and the Tolerable Upper Intake Levels. Many people, including athletes, need help translating nutrition guidelines into food. The second chapter, "Dietary Patterns for Macronutrients, Micronutrients, and Fluid Intake," gets to the heart of the matter by reviewing the macronutrients carbohydrate, protein, and fat; some vitamins and minerals; and fluid intake recommendations for athletes. Specific recommendations are made based on grams per kilogram of body weight. Emphasis is placed on macronutrient balance. The quality of carbohydrate, protein, and fat receives as much attention as the quantity. The hydration message has changed from "drink as much as you can" to "balance fluid intake with fluid loss."

Knowing the most recent recommendations is imperative, but translating those recommendations into meal plans and beverage choices is also important. Part II focuses on planning a nutritious diet that is flexible and takes individual preferences into account. Planning meals for health and sport performance is addressed in the third chapter, "Meal Planning." This chapter uses nutrition label information and the exchange system as examples of how athletes can individualize their diets.

As a sports medicine or fitness professional, you have undoubtedly been asked about some of the products marketed directly to athletes—sport beverages, energy drinks, energy bars, gels, and so on. Some of these products can enhance performance, but others can impair performance if they are used inappropriately. Chapter 4, “Sport Beverages, Bars, and Gels,” examines the nutrient composition of some of these products. In practice, you need to be aware of new products available to athletes and become a savvy label reader to be able to answer athletes’ questions.

Dietary supplement use, safety, and necessity are frequent topics among recreational and highly trained athletes. Chapter 5, “Assessing Dietary Supplements,” covers regulation of dietary supplements and considers an example of how the regulations are implemented using the popular weight-loss and “energy” supplement ephedra. Because athletes often express weight-loss concerns, a short section that reviews several currently popular weight-loss diets is included. The common denominator of all weight-loss plans is a reduction in total calories. The plans manipulate carbohydrate, protein, and fat intakes in various ways, but no one plan appears to be superior for producing weight loss.

Nutrition is a complex subject, and many people, including athletes, are confused about it. Part III, "Professional Practice," helps sports medicine and fitness professionals present clear and concise nutrition messages and understand when an athlete’s nutrition education needs fall outside their professional practice. Chapter 6, “Educating and Referring Clients,” outlines practice standards for several types of certified professionals. Although sports medicine and fitness professionals have knowledge of basic nutrition, it is not the primary focus of their training. So scope of practice is discussed by including information on how to educate athletes about nutrition without crossing professional practice boundaries. Athletes with serious nutrition problems, those with medical conditions in which nutrition therapy plays an important role, and those who may have disordered eating (DE) or eating disorders (ED) must be identified. In such cases an immediate referral must be made. The chapter outlines the referral process and the team approach to nutrition screening, assessment, and education.

The text also is designed for use with the *Practical Nutrition for Sports Medicine and Fitness Professionals* online course. After reading the book and completing the course, you will have advanced knowledge of performance nutrition and will be able to translate that knowledge into practical advice for physically active people. The course has separate online learning units that correspond to chapters in the book. In online course units you will learn to use the MyPlate system as an effective teaching tool, to compare an athlete’s dietary intake with established nutrient standards, and to have an in-depth discussion about sport nutrition recommendations. The online units also feature practical information such as learning how to read labels, evaluate sport nutrition products, and combat widely held myths about nutrition. You’ll be able to give up-to-date answers to nutrition-related questions posed by coaches, parents, and athletes, and be able to hone your critical-thinking skills. If you would like to purchase and complete the course, log in to www.HumanKinetics.com, click on the “More” tab at the top of the page, then select “Courses” from the drop-down menu.

part I

Nutrition Standards, Patterns, and Trends for Sport Performance

This text is organized into three parts, each with its own purpose. Part I contains two chapters that describe the basic nutrition principles that all sports medicine and fitness professionals should understand and be able to describe to the athletes and active people with whom they work. Chapter 1, "Nutrition Standards and Guidelines," provides a detailed overview of the Dietary Reference Intakes (DRIs), which describe the standards of nutrient needs and excesses for the United States and Canadian populations. The Dietary Guidelines for Americans and the MyPlate system use the DRIs and other scientific data to create a set of educational messages and guidelines for how the U. S. population should eat to achieve and maintain good health.

Chapter 2, "Dietary Patterns for Macronutrients, Micronutrients, and Fluid Intake," builds on the nutrition principles in chapter 1 and discusses carbohydrate, protein, and fat (the macronutrients) separately by narrowing the focus to describe macronutrient needs and desirable intake levels for athletes and active people. Similarly, the vitamins and minerals (micronutrients) are discussed with emphasis on a few vitamins and minerals that are of the most concern to athletes. Water is an often forgotten essential nutrient. Water and fluid benefits, requirements, and types of beverages are introduced in chapter 2 and will be referenced throughout the rest of this text.

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chapter 1

Nutrition Standards and Guidelines

Like any scientific field, sport nutrition has benefitted from reams of new research during the past 5 to 10 years. In some cases the concepts are new, but in most instances the information is not new, just better defined. Older standards and guidelines have been updated, and practitioners must use these new standards. The Dietary Reference Intakes (DRIs) have been updated and expanded. The Dietary Guidelines for Americans have been updated, and the MyPyramid food guidance system has been replaced with the new MyPlate system.

The past decade has also brought changes to the way that people eat. Portion sizes have substantially increased, not just in restaurants but also at home. Liquid nutrition has become popular with athletes and nonathletes as the heavily advertised sport beverage market has expanded. Adolescents have more exposure to high-sugar and high-fat foods both at school and at home. Soda machines have proliferated on high school campuses, although the wisdom of that is now being reconsidered. In many respects the way that people *do* eat is contrary to the way that people *should* eat for better health and wellness. We will examine the way that people should eat using the guidelines provided by the Dietary Reference Intakes, the Tolerable Upper Intake Level, the Dietary Guidelines, and the MyPlate symbol.

Dietary Reference Intakes

The Institute of Medicine (IOM) is responsible for interpreting and compiling dietary standards in the U.S. The Dietary Reference Intakes are the current dietary standards for the U.S. and Canada. The DRIs have expanded on and replaced the Recommended Dietary Allowances (RDAs) and the Recommended Nutrient Intakes (RNIs) of Canada. The current guidelines reflect the most recent scientific research and the amount of nutrients needed for preventing nutrient deficiencies and the onset of chronic disease.

The Dietary Reference Intake is used to quantify and classify nutrient needs and excesses for healthy individuals. Several terms are found under the umbrella of the DRI: RDA, Estimated Average Requirement (EAR), Adequate Intake (AI), and Tolerable Upper Intake Level (UL). The RDA is the average daily dietary intake level sufficient to meet the needs of 98% of individuals in a healthy population. These RDA levels are further delineated by factors such as age, gender, and pregnancy. In comparison, the EAR is the level of daily intake of a nutrient that meets requirements of 50% of a healthy population within a life stage and gender group. The AI is used when insufficient scientific data is available to assign either an RDA or an EAR. The AI is based on intake levels of healthy people, but results of studies on that particular nutrient are not conclusive enough to meet the EAR or RDA standard. Tolerable Upper Intake Levels (UL) are the highest level of a nutrient in which daily intake would pose no adverse health risk for almost all people in the population. Intakes above that level may pose adverse effects.

The DRIs were issued as a series of reports, and each report covered several related nutrients. The first report was published in 1997, and the latest reports were released in 2005. Early reports are now being considered for revision. The DRIs can be accessed for free at www.nap.edu (1, 5–9). From the homepage, search for the term *Dietary Reference Intakes*.

Dietary Reference Intakes for vitamins, minerals (elements), and electrolytes according to age and gender are shown in figures 1.1 through 1.3. Men of all ages need the same amount of most vitamins and minerals, but men over age 70 need more vitamin D, vitamin B6, and calcium than younger men. A similar pattern exists for nonpregnant women. Women older than 70 need more vitamin D, vitamin B6, and calcium than younger women. Postmenopausal women need considerably less iron than menstruating women. Pregnant and lactating women have the greatest nutrient needs of all women, and a prenatal vitamin and mineral supplement is usually prescribed. For the purposes

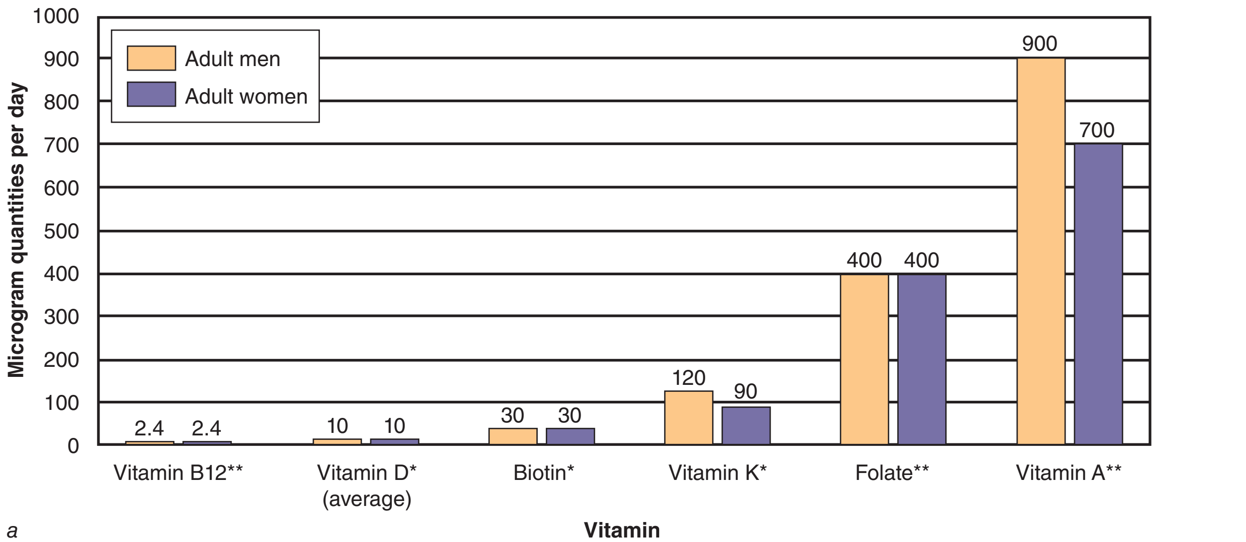

FIGURE 1.1 Vitamin Daily Reference Intakes: (*a*) vitamins with DRIs in microgram quantities per day; (*b*) vitamins with DRIs in milligram quantities per day. *AI = Adequate Intake; **RDA = Recommended Dietary Allowance

Data from Food and Nutrition Board and Institute of Medicine, 2006, *Dietary reference intakes: The essential guide to nutrient requirements* (Atlanta, GA: National Academies Press).

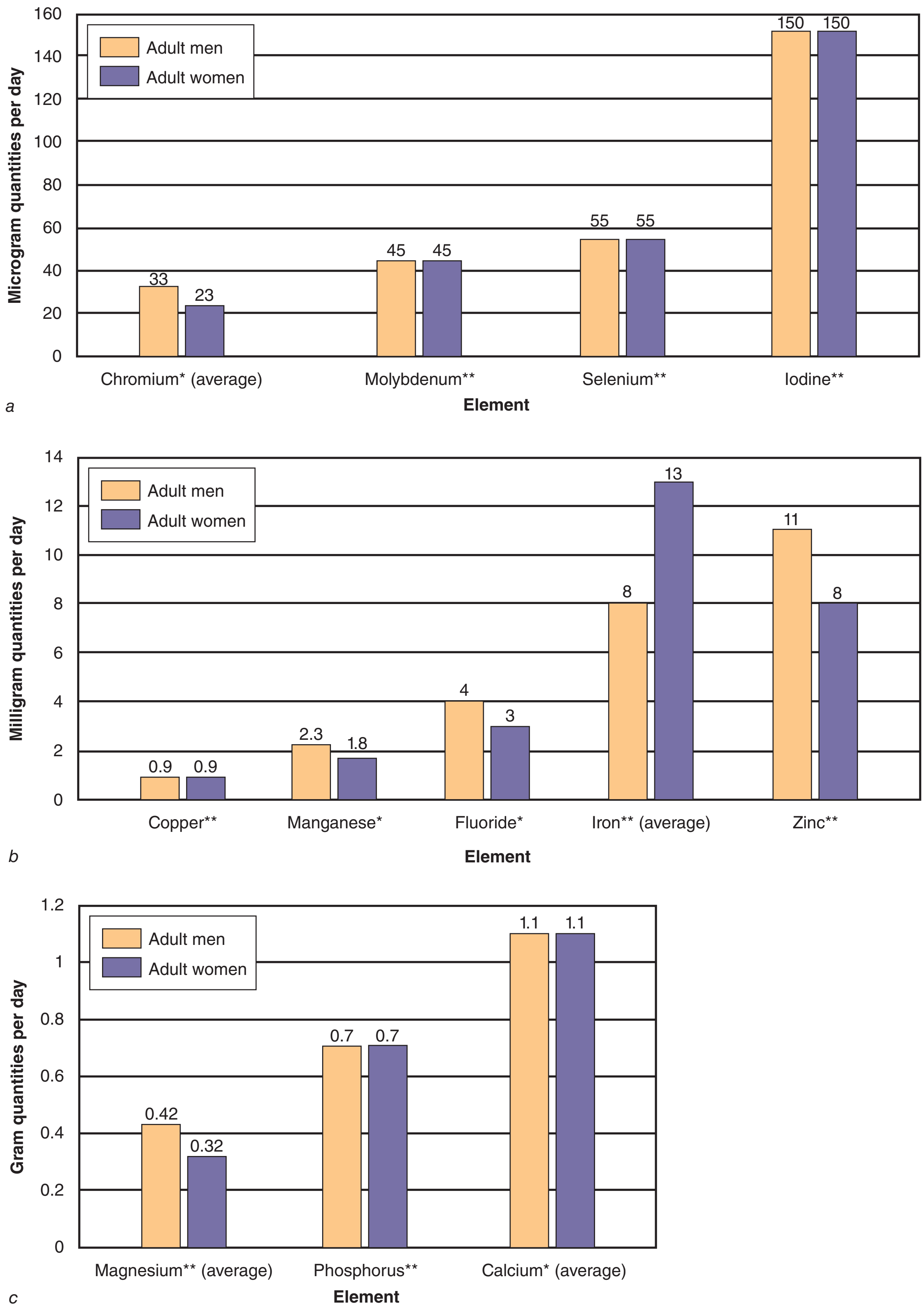

FIGURE 1.2 Elements Dietary Reference Intakes: (*a*) elements with DRIs in microgram quantities per day; (*b*) elements with DRIs in milligram quantities per day; (*c*) elements with DRIs in gram quantities per day. *AI = Adequate Intake; **RDA = Recommended Dietary Allowance

Data from Food and Nutrition Board and Institute of Medicine, 2006, *Dietary reference intakes: The essential guide to nutrient requirements* (Atlanta, GA: National Academies Press).

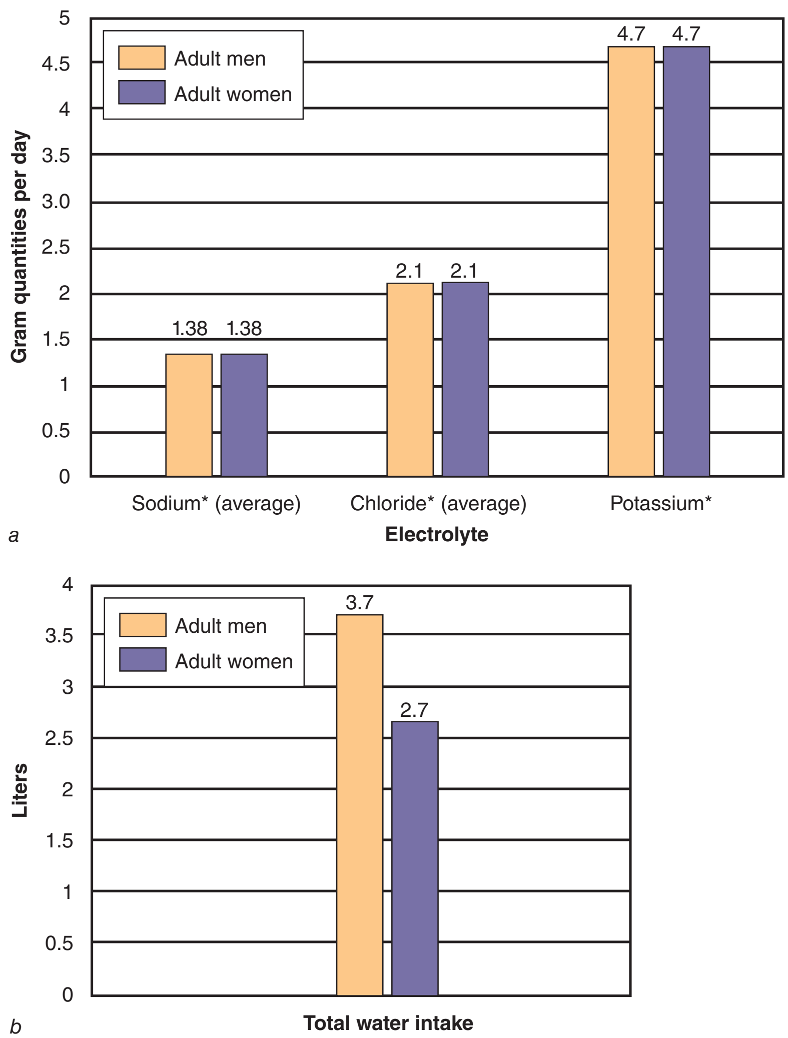

FIGURE 1.3 Dietary Reference Intakes: (*a*) electrolytes with DRIs in gram quantities per day; (*b*) total water intake per day. *AI = Adequate Intake; 1 L = 33.8 fl oz

Data from Food and Nutrition Board and Institute of Medicine, 2006, *Dietary reference intakes: The essential guide to nutrient requirements* (Atlanta, GA: National Academies Press).

of this book, recommendations are given for adult males and nonpregnant, nonlactating adult females.

Because the Dietary Reference Intakes were released in phases, at one point nutrient guidelines used both the older Recommended Dietary Allowances and the newer Dietary Reference Intakes. Now that all the Dietary Reference Intakes have been released, a special effort should be made to use the current guidelines and the generic term *Dietary Reference Intakes*. You will see RDA and AI in the DRI tables for the various nutrients. As described previously, the difference between AI and RDA is the level of scientific information available for each nutrient.

If you are familiar with the Recommended Dietary Allowances, you might be surprised by some of the Dietary Reference Intakes. Many of the DRIs are greater than the RDAs, but a few are lower. Some nutrients, such as fluoride, pantothenic acid, biotin, and choline, have been added. Keep in mind that the DRIs reflect a different philosophy than the RDAs. The RDAs were first developed in 1941, a time when many people in the United States suffered from nutrient deficiencies. Although preventing deficiencies will always be important, the new research on vitamins and minerals and disease prevention was a major consideration in the development of the Dietary Reference Intakes (9). The Dietary Reference Intakes will help set a guideline for optimal nutrition. As scientific research continues and nutrient consumption data continue to be gathered, the DRIs will be updated using all available research.

In 2002 Dietary Reference Intakes were released for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. A new term was introduced—*Estimated Energy Requirement (EER)*, which is an estimate of the number of calories required for maintaining energy balance in healthy adults. The estimate is based on age, gender, weight, height, and a certain coefficient or multiplier related to a person's physical activity level (PAL):

If the person is sedentary, the PAL coefficient is 1.0.

If the person is somewhat active, the PAL coefficient is 1.12.

If the person is active, the PAL coefficient is 1.27.

If the person is very active, the PAL coefficient is 1.45.

The formula to determine estimated energy requirements for men ages 19 years and older is

$$\text{EER} = 662 - [9.53 \times \text{age (y)}] + \{\text{PAL} \times [15.91 \times \text{weight (kg)} + 539.6 \times \text{height (m)}]\}$$

For example, a sedentary 25-year-old man who weighs 176 pounds (80 kg) and is 5 feet, 9 inches (1.75 m) tall needs approximately 2,640 calories; the same man who is active, however, needs almost 3,000 calories. The effect of aging reduces the need; if the sedentary man is 45 years old instead of 25, his need lowers to 2,450 calories.

The formula to determine estimated energy requirements for women ages 19 years and older is

$$\text{EER} = 354 - [6.91 \times \text{age (y)}] + \{\text{PAL} \times [9.36 \times \text{weight (kg)} + 726 \times \text{height (m)}]\}$$

For example, a sedentary 25-year-old woman who weighs 132 pounds (60 kg) and is 5 feet, 5 inches (1.65 m) tall needs approximately 1,940 calories. If she is active, her caloric need increases to almost 2,100 calories. A larger body size results in a higher need; if the sedentary woman weighs 198 pounds (90 kg) at the same height, her need increases to 2,222 calories to maintain that body size.

Consuming energy above the EER would likely result in weight gain. Estimated Energy Requirement charts are available at http://books.nap.edu/openbook.php?record_id=10490&page=186 (1).

Keep in mind that these are just estimates.

The *2008 Physical Activity Guidelines for Americans* (3) recommends physical activity to prevent weight gain and achieve cardiovascular health. Adults can achieve significant health benefits from 150 minutes per week of moderate-intensity aerobic physical activity or 75 minutes per week of vigorous-intensity aerobic physical activity, and additional health benefits can be achieved with more activity. Aerobic physical activity can be performed in bouts as short as 10 minutes. The guidelines also recommend that adults do muscle-strengthening activities targeting all major muscle groups at least twice weekly. The Canadian government has recently endorsed very similar guidelines (4).

The American College of Sports Medicine (ACSM) and the American Heart Association published updated physical activity guidelines for adults. These guidelines are written for the general adult population to maintain health, prevent chronic disease, and prevent weight gain. These guidelines recommend

- a minimum of 30 minutes of moderately vigorous activity 5 days of each week,
- or a minimum of 20 minutes of vigorous activity 3 days of each week,
- and activities to maintain muscular strength and endurance (strength training) a minimum of 2 days each week (2).

Also new are the recommendations for carbohydrate, protein, and fat intake expressed as ranges. Acceptable Macronutrient Distribution Ranges (AMDR) are given as percentages of total calories (assuming that calories are adequate). These ranges are based on scientific studies that examined macronutrient intake and reduced risk for chronic diseases such as cardiovascular disease. Because the figures are given as ranges, one macronutrient cannot be independent of the others. In other words, carbohydrate, protein, and fat intake ranges are relative to each other.

The Acceptable Macronutrient Distribution Range for carbohydrate for adults is 45 to 65% of total energy (calories). The lower figure, 45%, was chosen to prevent fat intake higher than 35%. The report also recommends a minimum amount of carbohydrate per day. For adult men and nonpregnant adult women, that daily carbohydrate figure is 130 grams. This amount is based on the minimum amount of glucose the brain needs without depending on alternative energy sources such as protein or fat (1).

The AMDR for protein for adults is 10 to 35% of total energy. The higher end of the range allows for diets higher in protein while still providing adequate levels of carbohydrate and fat. The lower end of the range covers the minimum amount of protein needed daily. To estimate adequate daily protein intake for sedentary adults, multiply body weight in kilograms by 0.8 grams of protein. For example, a 55-kilogram (121 lb) adult needs approximately 44 grams of protein daily.

The Acceptable Macronutrient Distribution Range for fat is 20 to 35% of total calories. Thirtyfive percent represents a change from the traditional advice (30% or less of total calories from fat). Bear in mind that the AMDR is recommended for healthy people and is associated with a reduced risk for the onset of chronic diseases. Less than 20% of total calories from fat (considered a very low-fat diet) is not recommended because studies have shown that these diets in healthy people can result in declines in high-density lipoprotein (HDL) cholesterol.

Table 1.1 shows some of the possible combinations that reflect the Acceptable Macronutrient Distribution Ranges for carbohydrate, protein, and fat. Represented are diets that would be considered high protein and high carbohydrate. For healthy people, the AMDR allows for dietary flexibility. Recommendations for alcohol, also a substance that contains energy, were not made, but the effects of alcohol on health and disease will be the subject of a future report.

In addition to the Acceptable Macronutrient Distribution Range for fat, recommendations for cholesterol, trans fatty acids, and saturated fatty acids are made. These recommendations are not defined numerically; rather, it is recommended that levels of these nutrients be as low as possible while not allowing the diet to become nutritionally inadequate.

High amounts of dietary cholesterol (>300 mg daily) are known to raise blood-cholesterol levels in some people. This effect is true, in particular, of low-density lipoprotein (LDL) cholesterol. Increased LDL cholesterol, because of its tendency to deposit cholesterol in arteries, is associated with an increased risk for heart disease. Cholesterol is found only in foods from animal sources; thus, the diets lowest in cholesterol are plant based.

Trans fatty acids are a result of structural changes in the chemical bonds of fatty acids. When liquid fats, such as corn oil, are processed into harder fats, such as margarine, the hydrogenation process causes structural changes. Specifically, hydrogen atoms are added, and the shape of the fatty acid is changed. The original fatty acid (known as a cis fatty acid) changes into a trans fatty acid, a type of fatty acid not normally found in oils. Many processed snack foods contain trans fatty acids. Trans fatty acids negatively affect blood lipids by increasing LDL cholesterol levels.

Saturated fats are hard at room temperature (e.g., the fats found in butter or cheese) and are generally associated with animal fats. But two plant fats are highly saturated: palm oil and coconut oil. Saturated fats are found in many processed foods, especially snack products. In general, high levels of saturated fats increase the risk for heart disease because they raise LDL cholesterol.

The Dietary Reference Intakes recommend low levels of cholesterol and trans and saturated fatty acids, advice that is consistent with reducing the risk for cardiovascular disease. Some practitioners would like *low levels* to be better defined. As a rule, low dietary levels of trans fats, saturated fats, and cholesterol would be achieved if fat in the diet were primarily from heart-healthy sources such as fish, nuts, olive oil, and other vegetable oils. Note that low levels are recommended, whereas complete elimination is not. Although trans fatty acids have no known nutritional value, complete elimination from the diet would require dramatic changes in dietary intake, particularly the elimination of most processed foods. The FDA is now requiring that the amount of trans fatty acids appear on food labels. This new label regulation is explained in chapter 3, "Meal Planning."

Perhaps the most controversial recommendation made in the 2002 report is the recommendation that added sugars be limited to no more than 25% of total energy intake. Some health professionals believe that the 25% figure is too high. Added sugars are defined as sugars and syrups added to foods and include products such as soft drinks, desserts, and candy. These added sugars provide energy but do not provide vitamins or minerals. If people get more

TABLE 1.1 Acceptable Macronutrient Distribution Ranges

Diet	PERCENT OF TOTAL ENERGY (ASSUMES ADEQUATE ENERGY INTAKE)		
	Carbohydrate: AMDR 45–65%	Protein: AMDR 10–35%	Fat: AMDR 20–35%
Lower carbohydrate and fat, high protein	45	35	20
High carbohydrate, moderate fat, low protein	65	10	25
Moderate carbohydrate, high fat, lower protein	50	15	35
Moderate carbohydrate, protein, and fat	55	20	25

than 25% of their calories from added sugar, they might not consume adequate amounts of vitamins and minerals. Therefore, this recommendation does not mean that people should strive to eat a diet that is 25% added sugar; instead, they should strive to keep 25% the upper limit. Most health professionals still recommend that sugar intake be no more than 10% of a person's total calorie intake.

The Dietary Reference Intakes are the best standard for North Americans for estimating the amount of nutrients required for preventing deficiencies and the development of chronic diseases. Another standard has been developed to help estimate upper levels for intake.

Tolerable Upper Intake Level

Tolerable Upper Intake Level (UL) is a new standard that is tremendously helpful in determining the risk posed by taking in excessive amounts of a particular nutrient. UL is *not* a recommended level for intake, but rather the highest level that a person may ingest that is likely to pose no risk of adverse health effects with long-term consumption (see figures 1.4–1.6). As with any standard, some people may experience harmful effects at lower levels. The adverse effects vary by nutrient; the following are some examples:

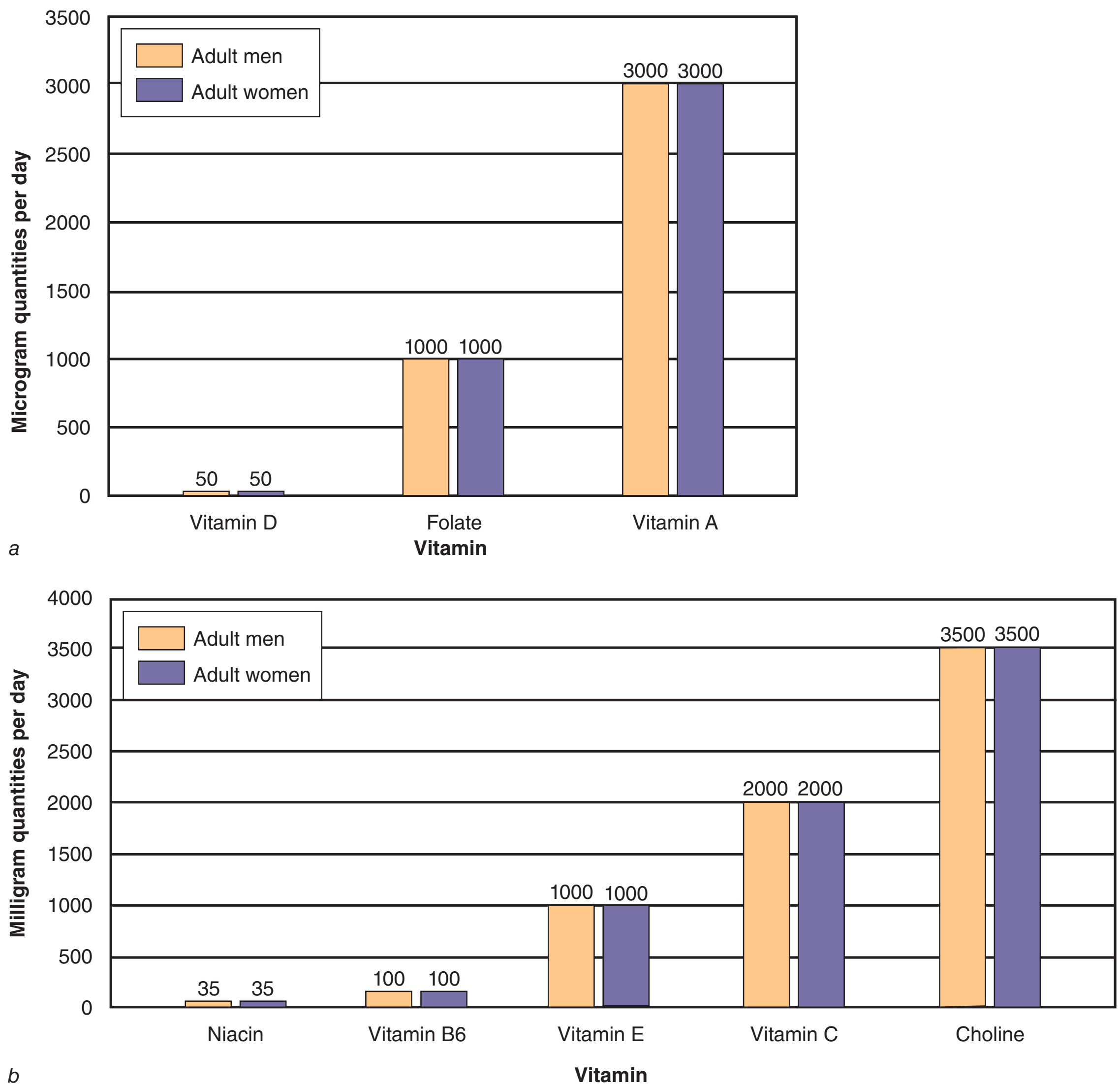

FIGURE 1.4 Tolerable Upper Intake Levels: Vitamins. (*a*) Vitamins with tolerable upper intake levels in micrograms per day; (*b*) vitamins with tolerable upper intake levels in milligrams per day. *Tolerable upper intake levels for biotin, pantothenic acid, riboflavin, thiamin, vitamin B12, or vitamin K have not been established.

Data from Food and Nutrition Board and Institute of Medicine, 2006, *Dietary reference intakes: The essential guide to nutrient requirements* (Atlanta, GA: National Academies Press).

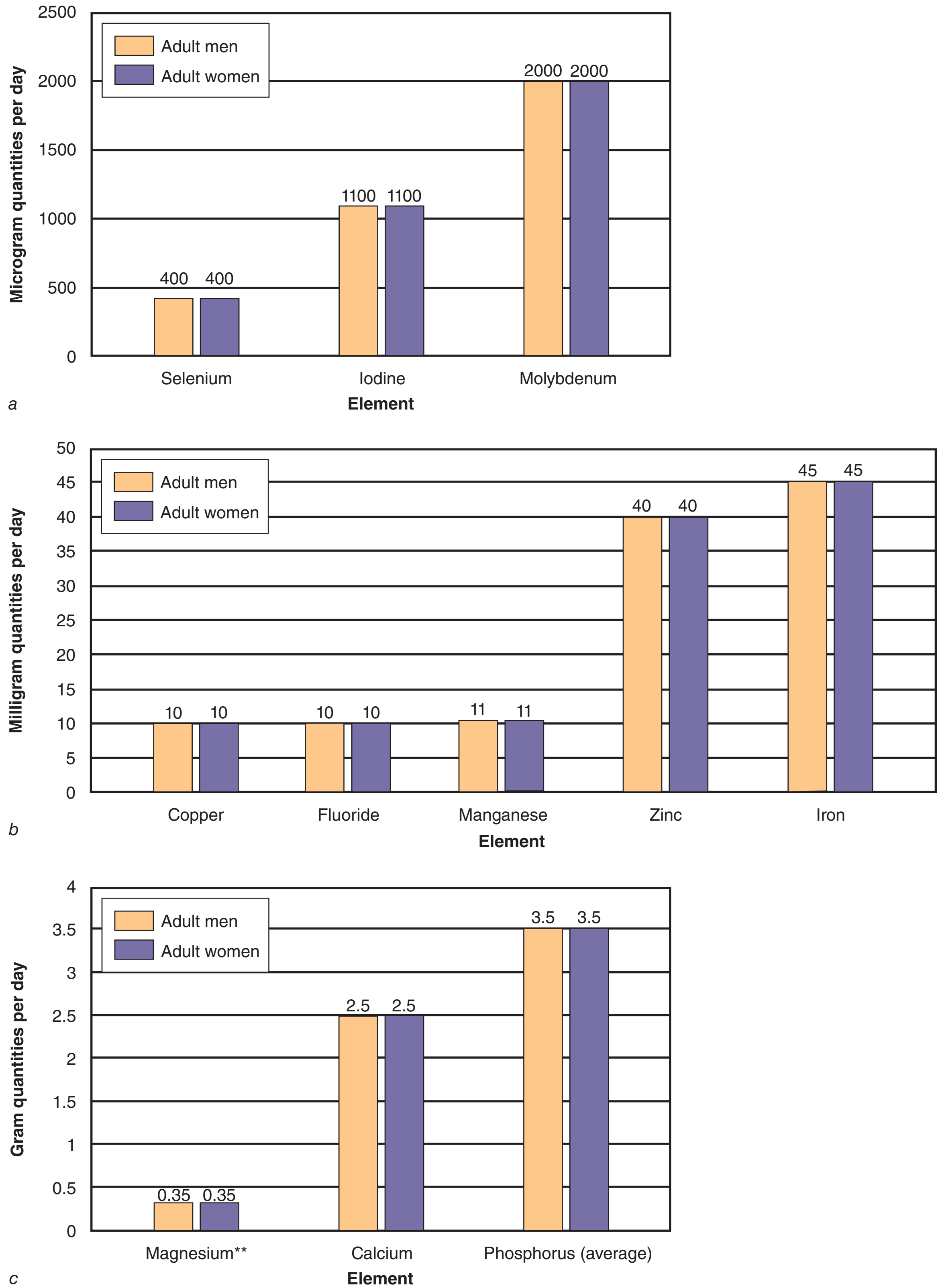

FIGURE 1.5 Tolerable Upper Intake Levels: Elements. (*a*) Elements with tolerable upper intake levels in micrograms per day; (*b*) elements with tolerable upper intake levels in milligrams per day; (*c*) elements with tolerable upper intake levels in grams per day. A tolerable upper intake level for chromium has not been established. **The tolerable upper intake for magnesium is an amount in addition to what is consumed in food (i.e., consumed as a supplement). A tolerable upper intake for magnesium that includes what is consumed in food has not been established.

Data from Food and Nutrition Board and Institute of Medicine, 2006, *Dietary reference intakes: The essential guide to nutrient requirements* (Atlanta, GA: National Academies Press).

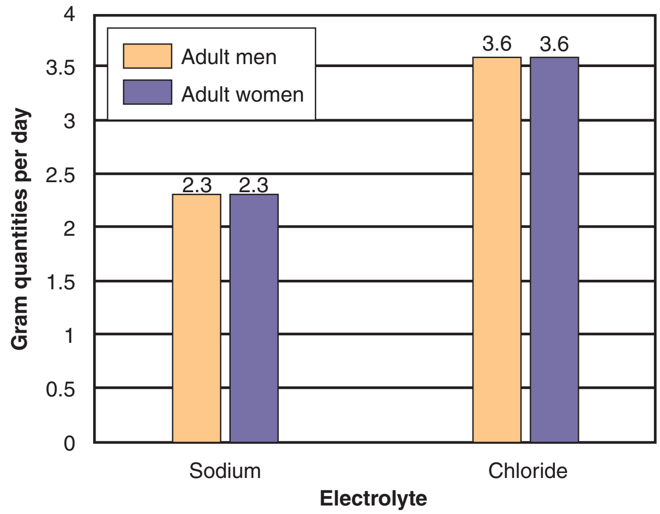

FIGURE 1.6 Tolerable Upper Intake Levels: Electrolytes. A tolerable upper intake level for potassium has not been established.

Data from Food and Nutrition Board and Institute of Medicine, 2006, *Dietary reference intakes: The essential guide to nutrient requirements* (Atlanta, GA: National Academies Press).

- Hypotension (excess choline)
- Vasodilation (excess niacin)
- Diarrhea (excess vitamin C, magnesium)
- Hypercalcemia (excess vitamin D, calcium)

Tolerable Upper Intake Levels have been set for only some vitamins and minerals (5). Insufficient scientific data precludes establishing ULs for all known vitamins and minerals. In future reports ULs may be revised and expanded to include more nutrients.

Food and Nutrition Trends

As standards and guidelines change, so do philosophies. There is renewed emphasis on macronutrient balance and less emphasis on low-fat or fat-restricted diets for athletes and physically active people. Sugar and fat are not the enemy, and their inclusion in a well-balanced diet provides fuel and good taste. The operative words are *well balanced*.

Unfortunately, the diet of the average American, including some athletes, is not well balanced. Approximately 60% of adults consume too many calories given the amount of physical activity they engage in. Balancing calorie intake with calorie output is an important concept. Weight gain is a frequent problem for athletes with a defined off-season who do not reduce their food intake when they reduce their training level. Another important point is that calorie balance over many years is difficult to achieve because increasing age slows the basal metabolic rate. Injury, pain, or lack of motivation can also reduce physical activity.

On the other end of the spectrum are athletes who restrict calories in an effort to attain or maintain a low body weight. Calorie-deficient athletes tend to consume insufficient protein and are deficient in many vitamins and minerals. They might begin to engage in disordered eating patterns and can eventually develop full-blown eating disorders such as anorexia, bulimia, or a combination of the two. In general, calorie deficiency and disordered eating result from a diet that is not well balanced.

The average American diet is both excessive and lacking. This is especially true of the diets that adolescents consume. One of the reasons for excessive intake of calories, fat, and sugar is the increase in portion sizes. Popularly known as supersizing, portion sizes have been steadily increasing in fast-food establishments, other restaurants, and at home. Since 1977 portions of salty snacks, desserts, soft drinks, fruit drinks, french fries, hamburgers, cheeseburgers, and Mexican food have all increased in size. The serving size for soft drinks and fruit drinks (sugared water with fruit flavoring) has increased dramatically. Since the late 1970s the calorie content of salty snacks has increased by 93 calories, soft drinks by 49 calories, hamburgers by 97 calories, and french fries by 68 calories. The average cheeseburger in 1977 contained 397 calories; by 1996 the average cheeseburger contained 533 calories. Although the supersizing phenomenon may have started as a value-added marketing campaign for fast-food restaurants, the result is that large portions of food are being served, and presumably eaten, at all types of restaurants and at home (10). Portion sizes are even too large for many physically active people.

Today's fast-food meal of a hamburger, fries, and a soft drink contains an average of 214 more calories than a similar meal did 20 years ago. Although increasing physical activity can offset calorie increases, most people in the United States don't exercise regularly (11). To put these increases in calorie intake in perspective, an excess of 10 calories per day for a year would result in an increase in body weight of 1 pound (0.45 kg) per year. Ten calories is about 1 ounce (30 ml) of soda or 3/4 teaspoon of sugar.

In the 1990s physicians and other health professionals emphasized lowering the amount of fat in the diet of the average American. Nutrition experts cited the role that diets high in total fat and in saturated fat played in the development of heart disease. The public was convinced that it should reduce its fat intake, and the food industry responded in force with low-fat and nonfat products. With the emphasis on reducing dietary fat, it seemed likely that fat intake would decline.

Did fat intake decline in the 1990s? The answer is interesting. At first glance, it appears that it had because fat intake in the 1960s was 40 to 42% of total caloric intake compared with the 1990 figure of 34 to 36% of total calories. But in the same period, total caloric intake increased substantially. The reality of the 1990s is that total caloric intake increased; total fat intake increased, albeit modestly; and total carbohydrate intake (in the form of sugar) increased significantly (12).

In some cases consumers switched to low-fat or nonfat versions of high-fat products. In the case of milk, nonfat (skim) and low-fat (1% and 2%) milk are all lower-fat and lower-calorie versions of whole (3.5%) milk. But in many cases, high-fat products were reformulated, and they became lower in fat but higher in sugar and calories. An example is the large number of low-fat pastries on the market. Although these are lower in fat than traditional pastries, they are often higher in sugar and calories.

There is still some focus on reduced-fat foods and eating healthier types of fat. However, the latest trend is reducing sugar and refined carbohydrates. Diet plans that focus on lower glycemic index foods and emphasize whole grains and higher fiber are quite popular. Enhanced-fiber products (yogurt, cereals, cereal bars, breads) and weight-loss plans focused on fiber-containing carbohydrate and reduced sugar are quite common, although the population as a whole does not seem to be significantly reducing sugar intake.

The average American diet also lacks important foods and nutrients. Although the intake of fruits and vegetables is increasing, many people still do not eat enough. Consequently, about 25% of the adult population does not meet vitamin C recommendations. Additionally, some of the vegetables, such as zucchini, are fried, and frying adds fat and calories. If potatoes are included in the calculations, vegetable intake goes up because of the amount of french fries consumed, but fat and calorie intakes increase as well.

The rise of sugared beverages, both soft drinks and fruit drinks, has affected calcium intake. In many cases these beverages replace milk and thus the calcium that normally would be consumed, especially by children and adolescents. The popularity of refined, sweetened grains in the form of sugared cereals and snack foods has reduced the intake of whole grains and fiber.

A well-balanced, nutritious diet emphasizes carbohydrate foods that contain fiber; whole grains; beans and legumes; lean protein foods; fats from fish, nuts, and vegetable oils; lots of fruits and vegetables; and enough water. Foods containing calcium should also be included. Sugar and fat are an important part of the diet, but their intake should be moderate. Sports medicine and fitness professionals likely work with adults and adolescents who consume large portions of foods and beverages with added sugar and fat. Professionals can use several teaching tools and guidelines to help athletes and clients understand the basis of a nutritious diet. The Dietary Guidelines for Americans and the accompanying graphic symbol MyPlate, which replaced the MyPyramid food guidance system, provide diet and nutrition information and tools to help people meet and maintain a healthful eating plan.

Dietary Guidelines for Americans

The Dietary Guidelines for Americans are developed and revised approximately every 5 years by the United States Department of Agriculture (13). The purpose of the guidelines is to interpret and synthesize scientific evidence of food intake and dietary adequacy and chronic disease and create a set of recommendations targeted to a healthy population. For the first time in the history of the Dietary Guidelines, the recommendations set forth in the 2010 guidelines and the accompanying MyPlate symbol are intended for a healthy population *and* those at risk for chronic disease, particularly populations struggling with overweight and obesity. The guidelines use the most current nutrient and food consumption research in developing the main messages that will be distributed to the public. The 2010 Dietary Guidelines include several main consumer messages:

- Balancing calories—enjoy food but eat less; avoid oversized portions.
- Foods to increase—eat fruits and vegetables; switch to fat-free or 1% milk.
- Foods to reduce—choose foods like soups and frozen meals with lower sodium; drink water instead of sugary drinks.

The graphic symbol of MyPlate (figure 1.7) is the visual tool that describes the implementation of the Dietary Guidelines for Americans. The MyPlate symbol and corresponding messages replaced MyPyramid (figure 1.8) as the consumer friendly tool to help the public make healthful food choices. Similar to the previous Food Guide Pyramid and the MyPyramid systems, MyPlate is an educational tool to help consumers translate scientific recommendations into food choices.

The new MyPlate system contains nutrient and physical activity information similar to that provided by the former Food Guide Pyramid and MyPyramid system. In fact, some of the interactive web pages found at www.choosemyplate.gov offer nearly the same information as was found previously in the MyPyramid web pages and print

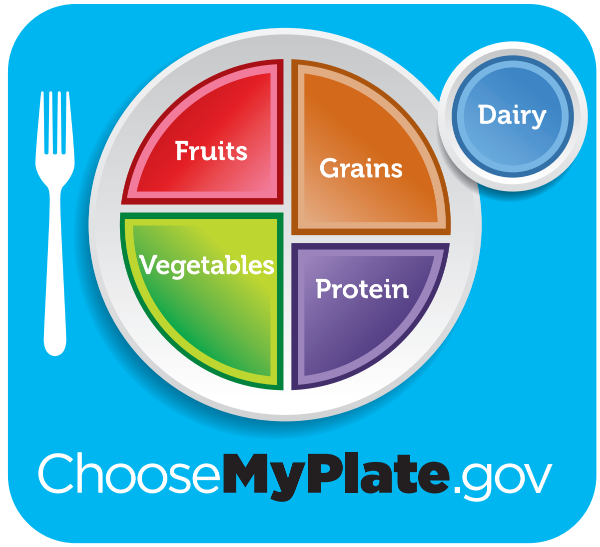

FIGURE 1.7 MyPlate.

U.S. Department of Agriculture and the U.S. Department of Health and Human Services.

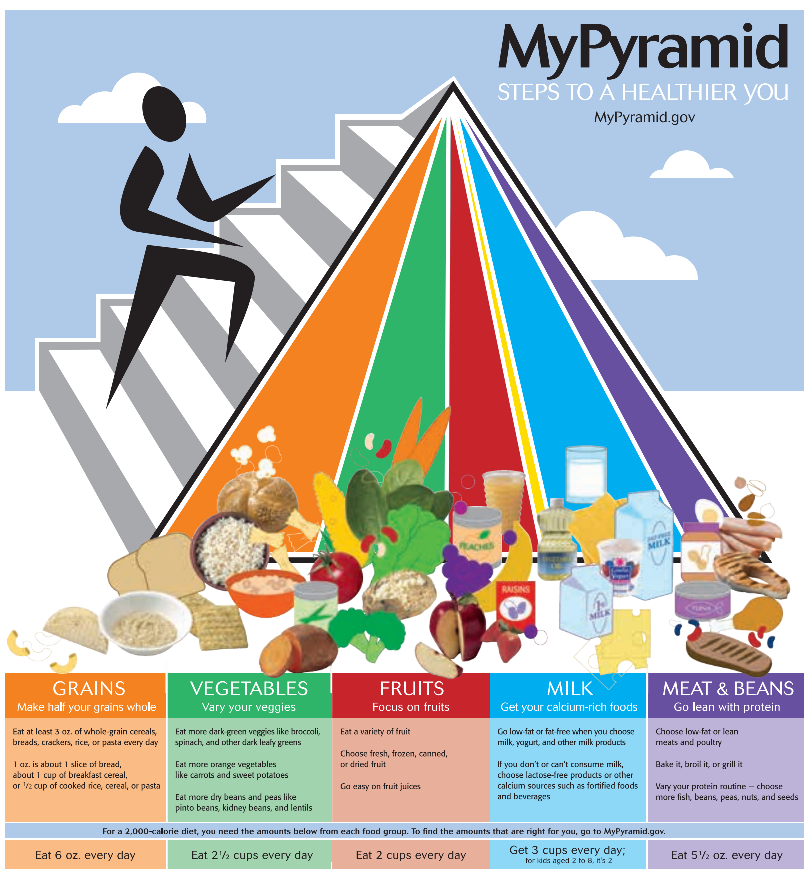

FIGURE 1.8 MyPyramid.

U.S. Department of Agriculture and the U.S. Department of Health and Human Services.

materials. The purpose of the graphic symbols is similar in that they help people visualize how to apply the dietary guidelines. The plate replaced the MyPyramid symbol to help consumers see how to put together a meal based on the main food groups. The MyPyramid system was not a clear visual to the consumer, and significant time and one-on-one education was often needed to help individuals implement the system.

Understanding MyPlate

The MyPlate symbol uses a typical place setting as a visual illustration to depict the main food groups. These include grains, vegetables, fruits, dairy, and protein foods. The main message of MyPlate is proportionality. Half the plate should be filled with fruits and vegetables, and whole grains and lean proteins should make up the other half of the plate. The circle in the upper right corner of the place setting symbolizes the dairy food group and can be used as a message for beverages in general. Excellent online educational materials help consumers use the MyPlate system. Charts that take into consideration gender, age, weight, and activity level will help athletes determine their range of recommended calorie intake. Interactive web pages describe the foods and portion sizes within each food group.

Not represented in the MyPlate graphic as food groups but still an important part of the MyPlate plan are three additional concepts that help people implement the guidelines: oils, empty calories, and physical activity. A brief summary of each food group and the additional concepts are listed in the following sections.

Grains

The catch phrase for this group is "make half your grains whole." Whole grains are minimally processed and contain fiber and minimal amounts of added sugar and fat. Food sources in this group include breads, cereals, rice, and pastas. Consuming some of these foods in a more processed form is inevitable, but consuming at least half of these types of foods as whole grains improves nutrient quality and fiber intake.

Vegetables

This group includes a huge variety. Some contain more vitamins, minerals, and other nonnutrient substances (phytochemicals) that may benefit health. These types of vegetables are emphasized. This group is divided into five subcategories based on nutrient content: red and orange, dark green, starchy, beans and peas, and other vegetables. The slogan "vary your veggies" means that eating vegetables from all five categories will provide different nutrients that complement each other. The beans and peas group is found in both this and the protein foods group. Beans and peas contain higher levels of protein than other vegetables and a good variety of vitamins and minerals as well. Half of the plate should be fruits and vegetables.

Fruits

"Focus on fruits" is the slogan, and variety is the emphasis in the fruit group. Variety is important because some fruits contain large amounts of vitamins such as vitamin C and beta-carotene (a form of vitamin A), whereas other fruits contain little or none. Although 100% fruit juice contains nutrients, consumers should choose whole fresh, canned, frozen, or dried fruits more often, since fruit juices are often high in calories. Half of the plate should be fruits and vegetables.

Dairy

Dairy foods are an excellent source of calcium. Fluid milk, cheese, yogurt, milk-based desserts (like pudding and frozen yogurt), and calcium-fortified soy milk are all part of this food group. Most dairy choices should be low fat or fat free. Cream cheese, butter, cream, and whipping cream that are made from milk but do not retain much calcium or other nutrients from milk do not count in the dairy group. All people need calcium throughout their lives, which is reflected in the slogan "get your calcium-rich foods."

Protein Foods

A variety of protein-rich foods are found in the food supply. Meat, poultry, seafood, beans and peas, nuts, and processed soy products are in the protein food group. These sources all provide protein and contain various other micronutrients. Meat and poultry sources should be lean or low fat. Consumers should choose a variety of protein sources and include 8 ounces (250 g) of fish each week.

Table 1.2 summarizes the food groups in MyPlate and clarifies the main educational messages. Although not a part of the MyPlate graphic symbol, the following concepts are also part of the MyPlate system and the Dietary Guidelines for Americans.

TABLE 1.2 Ways to Clarify MyPlate Messages

Food group	Message
Grains	**Make at least half of your grains whole grains.** Whole grain examples include whole-wheat flour, oatmeal, and brown rice. Refined grain examples include white flour, white bread, and white rice.
Vegetables	**Vary your veggies.** Make half of the plate fruits and vegetables. Eat dark green, starchy, and red and orange vegetables.
Fruits	**Focus on fruits.** Make half of the plate fruits and vegetables. Whole fresh, frozen, or canned fruits count. One hundred percent fruit juice counts as part of this group.
Dairy	**Get your calcium rich foods.** Choose fat-free or low-fat (1%) milk or calcium-fortified soy milk. Low-fat yogurt and puddings are part of this group. Choose low-fat cheeses.
Protein foods	**Go lean with protein.** Choose low-fat meat and poultry. Vary the types of protein eaten. Eggs, soy products, beans and peas, and nuts and seeds are in the protein food group.

Oils

Oils are not a food group, but they are included in the U.S. Department of Agriculture (USDA) food patterns and do provide essential nutrients. Oils are fats that are liquid at room temperature. Corn, safflower, canola, olive, soybean, and sunflower oils are commonly used in cooking, baking, and in making salad dressings, mayonnaise, and soft tub margarines. Nuts, avocados, and some fish are food sources of oils. Solid fats, like butter, shortening, and fat found in meats, poultry, or hydrogenated vegetable oil, should be limited. These fats can contain saturated fat, trans fats, or cholesterol. Fats and oils of any type are calorie dense and should be limited in the diet and balanced with total calorie intake. Healthier oils and fats from mono- and polyunsaturated plant and fish sources should make up the majority of fat consumed. These items provide essential fatty acids, some vitamin E, and flavor and enjoyment of food.

Empty Calories

The MyPlate system categorizes solid fats and added sugars as empty calories. They add calories or increase the calories in a food without increasing nutrient density. Cakes, cookies, pastries, soda, fruit drinks, cheese, ice cream, and high-fat meats (like sausages and ribs) are examples of foods high in solid fats, added sugars, or both. Consuming some empty calories is OK. Many food choices contain less solid fat and added sugar but still provide excellent flavor and enjoyment, such as lean ground beef, low-fat cheeses, and unsweetened cereals. When choosing empty-calorie foods, people should limit the portion size and drink water instead of soda or sugared beverages more often.

Physical Activity

Moderate to vigorous physical activity done on a regular basis can reduce cardiovascular disease risk and produce other long-term health benefits. Any activity that gets the body in motion and increases heart rate (walking for exercise, bicycling, vigorous yard work, running, cardio workouts) can produce these benefits. Physical activity combined with nutritious eating helps maintain a healthy body weight.

Specialized Diet Guidelines

Over the years, the original Food Guide Pyramid has been modified by the USDA and by many other organizations or diet programs. The Mediterranean diet, the zone diet, and diets for the elderly, vegetarians, and athletes have all been depicted as Food Guide Pyramids because the pyramid is widely recognized by consumers. Because of the simplicity of a pyramid symbol, others have used the same format but arranged the pyramid in different ways. The many versions have caused confusion among consumers as to which pyramids are approved by the USDA and which are unauthorized modifications. This issue will not be a problem with the switch to MyPlate, but other organizations are still likely to use a pyramid as a visual symbol for eating plans.

Perhaps the most widely recognized alternative pyramid is the Mediterranean Diet Pyramid (figure 1.9), created by the Oldways Preservation & Exchange Trust in 1994. The pyramid illustrates the types and proportions of foods in a primarily plant-based diet. It does not include recommended servings or serving sizes. Olive oil is the primary source of fat and, along with cheese and yogurt, is recommended for daily consumption. Fish, poultry, eggs, and sweets are recommended a few times a week and red meat a few times per month.

All the teaching tools, whether based on a pyramid or a plate, have the same goal: to help people understand the foods that form a healthy diet. Because all the published pyramids use simple graphics to represent complex nutrition concepts, further explanations are needed to help consumers correctly interpret the nutrition messages. By explaining the concepts depicted in the pyramids, sports medicine and fitness professionals can help consumers understand the foods that should be included in a healthy diet.

Summary

"Moderation in all things" is still the catchphrase. As a cultural attribute, moderation is not typical of Americans. Perhaps most striking is the enormous portions served and consumed at restaurants and at home. Many of these foods are high in calories, fat, and sugar. This pattern of eating, along with physical inactivity, has resulted in a rapid rise in

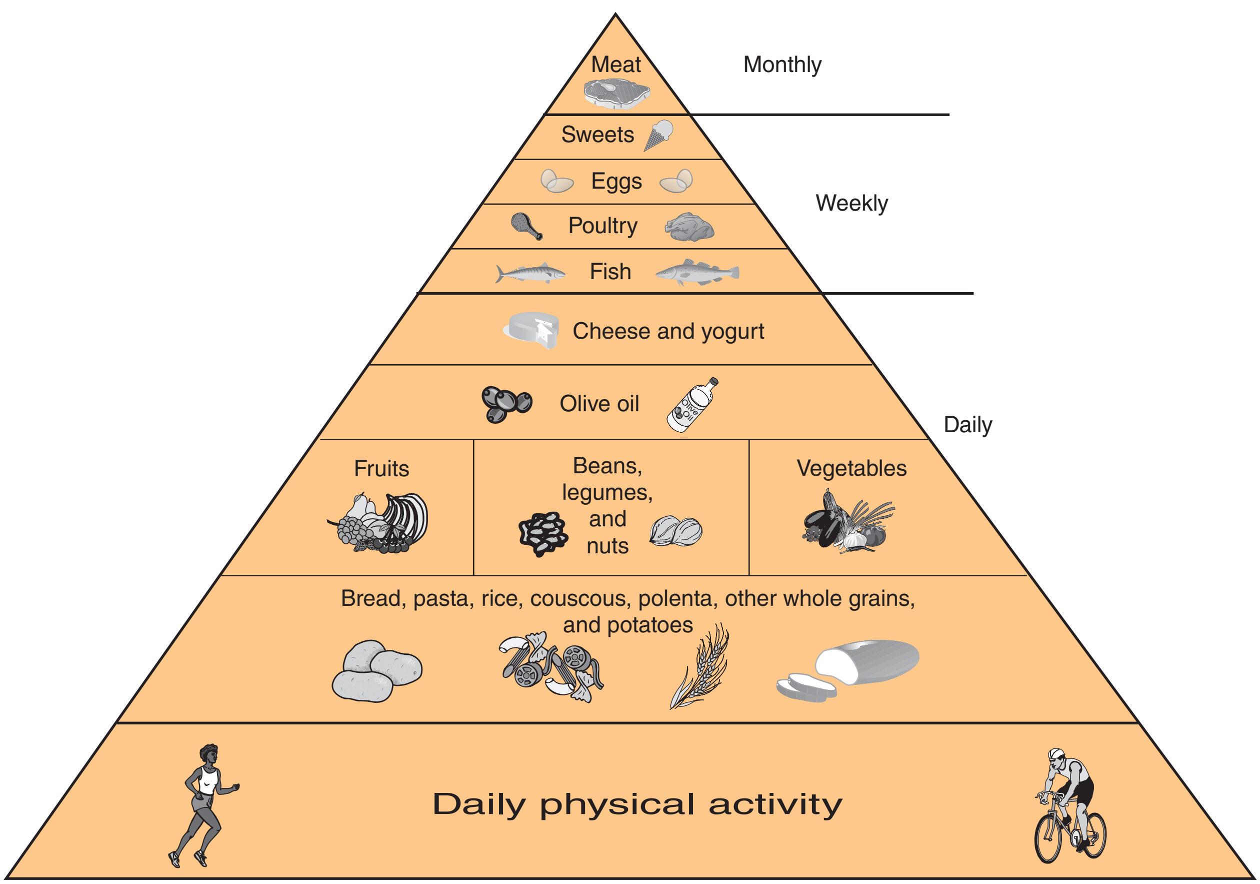

FIGURE 1.9 Mediterranean Diet Pyramid.

2000 Oldways Preservation & Exchange Trust: www.oldwayspt.org.

the past decade in the number of people who are overweight and obese.

Today, nutrient standards are better defined than they had been. The Dietary Reference Intakes and the Tolerable Upper Intake Levels help define an optimal diet. An optimal diet is not only free from nutrient deficiencies but also protects against the development of chronic disease. When compared with the general population, athletes need additional nutrients in some cases (e.g., protein), and they may need to modify the relative proportions of carbohydrate, protein, and fat at times (e.g., when carbohydrate loading). But the DRIs and the ULs are the nutrient standards used for both athletes and nonathletes.

Unfortunately, many people fall short when translating nutrient recommendations into food choices. Uninformed consumers can misinterpret the Dietary Guidelines and the MyPlate information. Guidelines, pyramids, or other public resource tools from various national or multinational sources may use conflicting messages that confuse athletes; therefore, all health professionals must be able to explain the elements of a nutritious diet and support the efforts of the people they work with to consume healthier diets.

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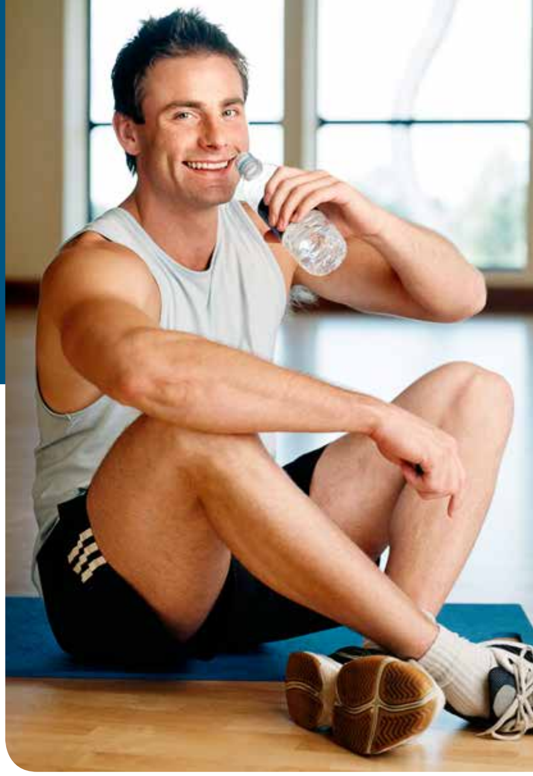
chapter 2

Dietary Patterns for Macronutrients, Micronutrients, and Fluid Intake



Athletes need to know the amount of carbohydrate, protein, and fat (the macronutrients) to consume each day to support their training and performance. The amount required will depend on their gender, sport, and level of training, but general guidelines are helpful. Vitamins and minerals (the micronutrients) from food or supplement sources are also essential to good health and sport performance. Some specific vitamins and minerals that are particularly important for athletes are discussed in this chapter. Water is an often-overlooked essential nutrient. Guidelines for fluid intake are also offered, but the exact amount necessary to maintain peak performance depends heavily on the individual's loss of fluid, the type and intensity of exercise, and the environmental conditions in which he or she exercises. General recommendations must always be tailored to the individual athlete's situation.

Carbohydrates and Athletic Performance

Carbohydrate is the logical starting point for a discussion of athletes' nutrient needs because it is a primary fuel for exercise and because the body can store only a limited amount of carbohydrate. Exercise depletes carbohydrate stores; therefore, athletes must replenish carbohydrate to be able to train daily. In this section we examine the recommendations for daily carbohydrate intake, food sources of carbohydrate, the glycemic responses of various carbohydrates, and carbohydrate-loading protocols.

Daily Carbohydrate Intake

Sufficient carbohydrate in an athlete's diet is critical for optimal training and performance. Exercise depletes muscle- and liver-glycogen stores, and dietary carbohydrate is needed daily to replenish them. In the past, carbohydrate recommendations were often expressed only as a percentage of total energy (calorie) intake. For example, a common recommendation for endurance athletes was to take in 65 to 70% of total calories as carbohydrate. This recommendation assumed an adequate energy intake, an incorrect assumption for many people, especially female endurance athletes. An athlete who consumes 70% of 1,000 calories does not consume enough carbohydrate, even though the amount is 70% of the total. Carbohydrate recommendations expressed as grams per kilogram of body weight are a more personalized and accurate way of determining carbohydrate needs for athletes. Often, calculating carbohydrate in both grams per kilogram and as a percentage of total caloric intake will provide the most accurate and balanced approach for athletes.

Adult athletes should consume 5 to 10 grams of carbohydrate per kilogram of body weight per day. A daily intake of 5 to 7 grams of carbohydrate per kilogram is recommended for any athlete in training. Strenuous training that depletes muscle glycogen, such as distance running or hours of strength training, requires higher amounts of carbohydrate intake: 7 to 10 grams of carbohydrate per kilogram (1). When expressed as a percentage of total caloric intake, 50 to 65% is a reasonable range. Keep in mind that the AMDR for carbohydrate is 45 to 65%, so it may be helpful to determine carbohydrate needs for athletes both in grams per kilogram and as a percentage of the total diet to be sure that all macronutrient needs fall within acceptable ranges.

These recommendations apply to both female and male athletes, but consuming more than 8 grams of carbohydrate per kilogram may be difficult for many women because of their lower daily caloric intake. When people restrict calories, they often restrict carbohydrate, too. Female athletes who train strenuously (70% of $\dot{V}O_2max$) for at least 2 hours per day should strive to consume 6 to 8 grams of carbohydrate per kilogram of body weight daily. Women apparently need to consume more than 8 grams of carbohydrate per kilogram per day to carbohydrate load successfully (2).

For carbohydrate consumption to fall within the recommended range of 5 to 10 grams per kilogram, a 121-pound (55 kg) female athlete must consume between 275 and 550 grams of carbohydrate daily. The energy (calorie) value of carbohydrate is 4 calories per gram. Therefore, to meet the minimum recommendation, 5 grams of carbohydrate per kilogram per day, she must consume 1,100 calories of carbohydrate daily (275 grams of carbohydrate times 4 calories per gram). This level of carbohydrate would provide 55% of the total diet when 2,000 calories are consumed (2,000 calories times 0.55). Surveys reveal that low carbohydrate intake is usually associated with energy (calorie) restriction (3).

Consuming 5 to 10 grams of carbohydrate per kilogram of body weight daily is recommended for athletes in training. More specific recommendations take into consideration gender, sport, and training level.

Now that you know the amount of carbohydrate that athletes need, you need to recognize the foods that provide it.

Carbohydrate Food Sources

Because carbohydrate is both maligned and praised, confusion surrounds this nutrient. Food sources of carbohydrate include breads, cereals, rice, pasta, fruits, vegetables, dried peas and beans, milk, and sugar. All these foods contain carbohydrate, but not all of the carbohydrate foods have the same nutrient content. Clearly, broccoli and soft drinks, both sources of carbohydrate, are not in the same category when the discussion turns to nutrients.

Most carbohydrate in a person's diet should come from foods that contain fiber and are nutrient dense. These foods include whole-grain breads, cereals, and pastas; beans and legumes; vegetables; and fruits. These foods are minimally processed, contain many vitamins and minerals, and contribute to good health. Even those who recommend a lower carbohydrate and higher protein diet do not dispute the value of these foods. For example, the maintenance phase of the South Beach diet includes fruits such as strawberries, blueberries, and grapefruit; nuts and seeds; vegetables; and moderate portions of beans and whole grains.

Unfortunately, the carbohydrate foods that are highly advertised, purchased, and eaten by most Americans and by many athletes are highly processed, do not contain much fiber, and have lower nutrient density. Many of these foods contain added sugar or fat or both. Apples become apple pie, fresh zucchini becomes zucchini bread, and potatoes become potato chips. Sweetened breakfast cereals are correctly identified as carbohydrate-containing foods, but processing destroys nutrients, and sugar adds carbohydrate, calories, and flavor without adding nutrients. These cereals are not the nutritional equivalents of minimally processed, whole-grain cereals.

The message must be clear: Minimally processed, nutrient-dense, and fiber-containing foods should be consumed daily and should constitute the majority of the carbohydrate foods consumed. *Majority* is the operative word. Including sugar and sugared foods in the diet is not bad or wrong. In some circumstances athletes need sugar as an immediate energy source, and its consumption, as a sport drink, bar, or gel, is sometimes highly recommended. But in the broad context, most carbohydrate should come from food that is minimally processed and contains fiber.

Table 2.1 shows an example of two meals containing the same amount of carbohydrate. In the case of the first meal, most of the carbohydrate foods are minimally processed. In the second case, the meal contains highly processed foods. A comparison of the nutrient content of these meals tells the full story.

Foods that contain carbohydrate can be differentiated by their fiber and nutrient content, but another way to distinguish carbohydrate sources is by their glycemic response.

Glycemic Response

Some carbohydrate sources are quickly absorbed and contribute to a rapid rise in blood glucose and insulin (known as a high glycemic response), whereas some are absorbed slowly, resulting in a slow rise in blood glucose and insulin (a low glycemic response). In some circumstances, such as restoring muscle glycogen immediately after exercise, consuming carbohydrate with a high glycemic response is advantageous. But the long-term consumption of foods with a high glycemic response is associated with increased risk for diabetes and heart disease (4).

The glycemic index (GI) is a tool for determining the glycemic response of a food. Glycemic index scores are based on 100, and foods are commonly categorized as having low, medium, or high glycemic indexes as shown in table 2.2 (5). Beans and legumes, dairy products, and some fruits have a low glycemic index. Some sugary foods such as cookies or ice cream have a medium glycemic response. Although these foods contain sugar, they also contain fat, and fat is known to delay gastric emptying, one factor that affects the glycemic index. Also notice the differences between fructose, sucrose, and glucose. Fructose has a low GI because it does not raise blood glucose; instead it is transported to the liver for metabolism. White bread, which contains little fiber, results in a rapid rise in blood glucose (5). Foods that contain no carbohydrate, such as meats and oils, do not produce a glycemic response when eaten alone. Because of their protein and fat content, they can blunt the glycemic response when eaten in combination with other foods.

Glycemic index is a measure of carbohydrate *quality*. Another important aspect is *quantity*. Glycemic load (GL) is a tool that considers both quality and quantity. Glycemic load is determined by multiplying the amount of carbohydrate in a typical portion (quantity) by the glycemic index (quality) of that food. That value is then divided by 100. Foods with a high glycemic load are expected to produce a greater elevation in blood glucose and thus a greater insulin response. Eating a steady diet of foods with a high glycemic load is associated with a greater risk for cardiovascular disease and

TABLE 2.1 Comparison of Two Meals Containing Carbohydrate

SAMPLE MEAL 1	SAMPLE MEAL 2
2 tuna sandwiches on whole-grain bread Medium apple 4 small Fig Newtons (cookies) 8 oz (240 ml) nonfat milk 16 oz (480 ml) mineral water	Double hamburger Small fries 24 oz (720 ml) soft drink

NUTRIENT ANALYSIS

	Carbohydrate (g)	Fiber (g)	Energy (cal)	Protein (g)	Fat (g)	Calcium (mg)
Meal 1	167	19	1,130	43	37	430
Meal 2	167	6	1,636	57	83	130

TABLE 2.2 Foods With Low, Medium, and High Glycemic Indexes

HIGH GLYCEMIC INDEX FOODS (GI > 85)			
Angel food cake	Cornflakes	Maltose	Rye flour bread
Bagel, white	Cornmeal	Melba toast	Shredded wheat
Barley flour bread	Couscous	Millet	Soda crackers
Brown rice	Cream of wheat	Molasses	Soft drinks
Cake doughnut	Crispix cereal	Mueslix	Sport drinks
Carrots	Croissant	Muffins	Sucrose
Cheerios	Glucose	Oatmeal	Total cereal
Cheese pizza	Grape-Nuts	Potatoes	Waffles
Corn bran cereal	Hard candy	Raisins	Watermelon
Corn Chex cereal	Honey/syrups	Rice cakes	White bread
Corn chips	Ice cream	Rice Krispies	Whole-wheat bread
MODERATE GLYCEMIC INDEX FOODS (GI = 60–85)			
All-Bran cereal	Durum spaghetti	Mixed-grain bread	Rye kernel bread
Banana	Fruit cocktail	Oat bran bread	Special K cereal
Basmati rice	Grapefruit juice	Oat bran cereal	Sponge cake
Bran Chex cereal	Grapes	Orange (whole or juice)	Sweet corn
Buckwheat	Ice cream, low fat	Parboiled rice	Sweet potato or yams
Bulgur	Kiwi fruit	Pastry	Wheat, cooked
Bulgur bread	Linguine	Pita bread, white	White rice, long grain
Cracked barley	Mango or papaya	Popcorn	Wild rice
LOW GLYCEMIC INDEX FOODS (GI < 60)			
Apples	Cherries	Milk	Rice bran
Apricots (dried)	Dried peas	Peaches (fresh)	Spaghetti
Barley	Fructose	Peanuts	Tomato soup
Barley kernel bread	Grapefruit	Pears (fresh)	Wheat kernels
Beans (all types)	Lentils	Plums	Yogurt (all types)

White bread (50 g) was used as the reference food and has a GI of 100.

Based on Brand-Miller, J. and K. Foster-Powell. 2009. *The new glucose revolution shopper's guide to GI values 2009*. New York: Da Capo Lifelong Books.

diabetes. Some scientific studies suggest that regularly eating foods with a low glycemic load might protect against colon and breast cancers. Some evidence suggests that foods with a low glycemic load help keep people from becoming obese (4).

For many foods, such as fructose (fruit sugar), peanuts, bran cereal, and baked beans, glycemic load mirrors glycemic index. In other words, these foods have both a low glycemic load and a low glycemic index. Similarly, bagels and baked potatoes have a high glycemic load and a high glycemic index. But a food such as white spaghetti noodles has a low glycemic index but a high glycemic load. Conversely, watermelon has a high glycemic index and a low glycemic load. This is because the quantity consumed is one factor in glycemic load, whereas the glycemic index is always based on a 50-gram portion.

There is no recommended numerical guideline for glycemic load at this time. In the research studies that associated high glycemic load with greater risk for cardiovascular disease and diabetes, those with the greatest risk ate large amounts of highly processed carbohydrate foods that were rapidly absorbed and digested (6).

The World Health Organization has endorsed the use of glycemic index as a way to provide information about the glycemic response of a food, which the consumer may use when making food choices. Countries such as Australia include GI values on food labels; therefore, low-GI foods are readily identified. The use of glycemic index and glycemic load has been controversial in the United States. Opponents argue that not enough research has been done, especially on mixed foods, and that the concepts are too complicated for consumers to use. Proponents counter that the evidence is sufficient and that the benefits are clear. Beans and legumes; some whole grains, nuts, fruits, and vegetables; and low-fat dairy products are all low glycemic index foods that have been associated with reduced risk for chronic disease (4, 5).

We have just established that carbohydrate can be distinguished by its glycemic response. Now let's see how athletes might use this information in planning diets.

Athlete's Use of Foods with High and Low Glycemic Indexes

When carbohydrate found in foods or fluids is consumed, digested, and absorbed, blood-glucose levels temporarily increase above the normal range (hyperglycemia). This hyperglycemia is a signal to the pancreas to secrete insulin, which mediates the uptake of glucose into cells. As glucose is transported from the blood to cells, blood-glucose levels return to the normal range of 70 to 100 milligrams per deciliter (euglycemia) in the absence of diabetes. If blood-glucose levels fall below the normal range (hypoglycemia), the pancreas secretes glucagon. Glucagon stimulates the breakdown of liver glycogen and the release of glucose into the blood. This additional blood glucose resolves the hypoglycemia, and euglycemia is again achieved.

A small percentage of people experience an oversecretion of insulin when their blood glucose rises rapidly. In these people, high insulin levels cause the glucose to leaving the blood rapidly, causing them to become hypoglycemic. They feel fatigued and shaky. If the glucagon response is slow, attaining a euglycemic state may require some time. Some athletes have reported a similar response. When these athletes consume certain kinds of carbohydrate less than 1 hour before exercise, they experience both hyperglycemia and hyperinsulinemia, followed by hypoglycemia as exercise begins. The reasons for this rebound hypoglycemia are not known, but athletes who experience rebound hypoglycemia might want to consume carbohydrate with a low glycemic index in the hour before starting to exercise. Because the cause is not known, trial and error during training will help those susceptible to hypoglycemia determine the amount, type, and timing of their carbohydrate intake (7). Most athletes, however, do not experience rebound hypoglycemia.

Before Exercise

In the past, athletes were advised not to consume high-glycemic carbohydrate within 30 minutes of starting to exercise. This recommendation was made on the basis of one study that reported a shorter time to exhaustion in trained cyclists who consumed 75 grams of glucose (high glycemic index) 30 minutes before intense exercise, which is defined as 80% of $\dot{V}O_2$max. Subsequent studies, however, did not find the same result, and avoiding high-glycemic foods before exercise is no longer a general recommendation (8).

Some researchers have studied the effects of consuming low-glycemic foods preexercise (e.g., high-fiber unsweetened cereal, low-fat unsweetened yogurt, lentils) to determine whether these foods provide a slow but sustained source of glucose during exercise (9, 10). Research results are mixed; some studies showed no change in performance, and others showed improvement. No studies reported that consuming carbohydrate with a low glycemic index was detrimental. Many athletes choose carbohydrate with a low glycemic index right before exercise because its slow absorption provides glucose for the muscles after exercise begins. But consuming high-fiber foods before exercise may cause gastrointestinal discomfort. Again, athletes should experiment with preexercise foods to determine what works best on an individual basis.

During Exercise

The glycemic response to carbohydrate consumed during intense exercise has not been well documented, but it is not thought to be a major influence. Glucose, sucrose, maltodextrin (corn sweetener), and glucose polymers (chains of glucose) are absorbed at about the same rate. Fructose is absorbed more slowly because it needs a carrier molecule to cross the gastrointestinal cell membrane and it must be transported to the liver for conversion to glucose, so a delay occurs from the time that fructose is absorbed to the time that it appears in the blood as glucose. By itself, fructose ingestion is not an effective way to maintain blood-glucose levels. Too much unabsorbed fructose in the gastrointestinal tract causes gastrointestinal distress. But fructose is usually mixed with other sugars in sport drinks, so these problems are avoided.

After Exercise

Athletes should consume carbohydrate with a high glycemic index after exercise (along with protein, which will be explained later). High-glycemic carbohydrate has been shown to aid muscle-glycogen recovery because it rapidly provides glucose to the blood. Additionally, carbohydrate with a high glycemic index stimulates insulin release. Insulin and amino acids stimulate muscle-protein synthesis (11).

Timing carbohydrate intake after exercise is important for rapid muscle-glycogen resynthesis. A 2-hour delay in postexercise carbohydrate consumption can reduce the amount of glycogen resynthesized by almost 50% (12). Athletes should consume 50 to 100 grams of rapidly absorbed carbohydrate plus 10 to 20 grams of protein within 15 minutes after exercise. Carbohydrate consumption should continue over the next 4 to 6 hours (13, 14).

Rapidly absorbed carbohydrate is becoming a popular term, and in many cases this carbohydrate has a high glycemic index. But a 2003 study suggested that glycemic index is not a good predictor of the ability of a carbohydrate-containing food to promote muscle-glycogen resynthesis (15). The glycemic index measures how quickly glucose appears in the blood, but it does not measure or predict how quickly that glucose is transferred to tissue. Carbohydrate with a low glycemic index (the 2003 study used bran cereal) may effectively promote muscle-glycogen resynthesis. The bottom line is that athletes need 50 to 100 grams of carbohydrate and 6 to 20 grams of protein within 15 minutes after exercise. Although researchers are still determining which types of foods most effectively aid recovery, nutritionists most often recommend high-glycemic carbohydrate. Some, but not all, low-glycemic carbohydrate may also be effective.

Considering the glycemic response of carbohydrate foods is one way that athletes can fine-tune their diets. Carbohydrate loading is another way to manipulate a diet to improve performance.

Latest Thoughts on Carbohydrate Loading

Athletes deplete muscle-glycogen stores daily by exercising, and they promote muscle-glycogen restoration by consuming carbohydrate. An important competition, however, calls for maximum muscle-glycogen stores. Endurance athletes who will perform continuously for more than 90 minutes and bodybuilders (as part of their precontest preparations) look for ways to attain maximum glycogen stores, a process known as *carbohydrate loading.*

The concept of carbohydrate loading was first introduced in 1967 (16). Researchers in Sweden discovered that 3 days of exhaustive exercise and an extremely low-carbohydrate diet (10% of total energy intake) followed by 3 days of little exercise and a high-carbohydrate diet (90% of total energy intake) resulted in substantial increases in muscle-glycogen stores. But this protocol was difficult to execute; the depletion stage of exhaustive exercise and a low-carbohydrate diet made training extremely difficult, increased the risk of injury, and caused the athletes to be irritable. When carbohydrate was reintroduced and exercise was stopped, gastrointestinal distress occurred. Additionally, the repletion process, with its focus on high carbohydrate intake, resulted in increased storage of water in the muscles (a normal part of glycogen resynthesis) that left many athletes feeling heavy and uncomfortable. But the gains in muscle-glycogen stores meant that the protocol had promise.

In 1981 research using a modified carbohydrate-loading protocol was published (17). The modified protocol suggested that depletion and repletion of muscle glycogen could be achieved with a less severe approach. For 4 to 6 days before competition, recommended carbohydrate intake was 5 grams per kilogram of body weight daily. Six days before competition, 90 minutes of hard training (70% of $\dot{V}O_2$max) were prescribed. Days 4 and 5 before competition consisted of 40 minutes of hard training. This exercise and diet pattern resulted in glycogen depletion but reduced the risk of injury and irritability. The repletion stage consisted of consuming 10 grams of carbohydrate per kilogram of body weight daily for 3 days before competition. During this phase, 20 minutes of exercise for two days was followed by a rest day. Table 2.3 outlines the differences between the two protocols.

Two recent studies suggest that a 1-day carbohydrate-loading protocol is sufficient. In these studies, well-trained male endurance athletes consumed 10 grams of high glycemic index carbohydrate per kilogram of body weight. Subjects in the first study consumed carbohydrate over 3 days and were physically inactive (18). Subjects in the second study consumed the carbohydrate 1 day after performing near maximal-intensity exercise for approximately 3 minutes (19). Biopsies of Type I, IIa, and IIb muscle fibers revealed that maximum glycogen levels were achieved within a 24-hour period.

If further research confirms the effectiveness of a 24-hour carbohydrate-loading regimen, achieving maximum glycogen stores will become easier for endurance athletes. Over the years carbohydrate loading has evolved from a severe process to a less severe one to a relatively easy procedure. Some bodybuilders still engage in the most severe process, which includes a demanding depletion stage. But this severe approach is not in an endurance athlete's best interest. Instead, the 24-hour carbohydrate-loading protocol along with a routine diet sufficient in carbohydrate should prepare endurance athletes well for competition.

The amount and timing of carbohydrate intake are critical to successful athletic performance. But

TABLE 2.3 Traditional Versus Modified Carbohydrate-Loading Protocols

TRADITIONAL CARBOHYDRATE-LOADING EXERCISE AND DIET PROTOCOL		
	Exercise	**Diet**
7 days before competition	Exhaustive exercise	Low carbohydrate[1]
6 days before competition	Exercise to continue depleting muscle glycogen	Low carbohydrate
5 days before competition	Exercise to continue depleting muscle glycogen	Low carbohydrate
4 days before competition	Exercise to the extent possible	Low carbohydrate
3 days before competition	Rest or very light exercise	High carbohydrate[2]
2 days before competition	Rest or very light exercise	High carbohydrate
1 day before competition	Rest or very light exercise	High carbohydrate
MODIFIED CARBOHYDRATE-LOADING EXERCISE AND DIET PROTOCOL		
	Exercise	**Diet**
6 days before competition	90 min of training at 70% of $\dot{V}O_2max$	Moderate carbohydrate[3]
5 days before competition	40 min of training at 70% of $\dot{V}O_2max$	Moderate carbohydrate
4 days before competition	40 min of training at 70% of $\dot{V}O_2max$	Moderate carbohydrate
3 days before competition	20 min of light training	High carbohydrate[4]
2 days before competition	20 min of light training	High carbohydrate
1 day before competition	Rest	High carbohydrate

[1]Low-carbohydrate diet is defined as 10% of total energy intake as carbohydrate. It consists of protein and fat foods and only a small amount of fruit juice or other carbohydrate foods.

[2]High-carbohydrate diet is defined as 90% of total energy intake as carbohydrate. It consists of all carbohydrate foods, some of which naturally contain protein. Foods containing fat or foods prepared with fat are not allowed. This diet is very high in fiber.

[3]Moderate-carbohydrate diet is defined as 5 grams of carbohydrate per kilogram of body weight.

[4]High-carbohydrate diet is defined as 10 grams of carbohydrate per kilogram of body weight.

no single nutrient can provide all that is needed for athletic success. Protein is another important nutrient for athletes.

Protein and Athletic Performance

Sports medicine and fitness professionals must help athletes understand the need for dietary protein. Protein is made up of amino acids. Amino acids contain carbon, hydrogen, oxygen, and nitrogen. The body breaks down protein found in foods into amino acids. The amino acids are used to manufacture proteins that build and repair muscle; form enzymes and hormones; maintain fluid, electrolyte, and acid–base balance; and support the immune system, and they can be burned for energy. In this section we examine the recommendations for daily protein intake, the food sources of protein, the potential problems associated with excessive intake, and the timing of protein intake.

Daily Protein Intake

Daily recommendations for protein for athletes range from 1.2 to 1.7 grams of protein per kilogram of body weight (assuming that energy intake is adequate). An athlete in a sport in which maximum muscle mass and strength are the goals, such as bodybuilding and weight lifting, should use the higher end of the range. Higher intake (for example, 2 grams of protein per kilogram of body weight per day) has not been shown to be advantageous to training or performance, and there is no evidence that higher protein intake accelerates the rate of muscle protein synthesis (20). Recreational athletes need 1 to 1.5 grams of protein per kilogram of body weight per day.

Effect of a High-Protein Diet on an Athlete's Health

For many years athletes have been cautioned not to consume more than 2 grams of protein per kilogram per day because of the belief that these diets pose health risks. The most commonly raised concerns are the risk for kidney or liver damage and the loss of calcium through urine.

High-protein diets do not appear to impair renal or liver function in healthy athletes. A study of bodybuilders and other well-trained athletes detected no harmful effects on renal function when protein intake was as much as 2.8 grams per kilogram per day (21). Athletes should be aware, however, that they can experience problems if they have latent (hidden) or known kidney or liver conditions. Those with kidney or liver disease may experience problems with a high-protein diet because of increased stress on those organs. An athlete who consumes high amounts of protein should monitor his or her health and contact a physician if problems appear.

Studies of both athletes and nonathletes have shown that excessive amounts ofprotein can result in increased urinary excretion of calcium (22). When protein is metabolized, acid is produced. To neutralize the acid, the body draws calcium carbonate from bones. The carbonate neutralizes the acid, and the calcium is excreted with the urine. Thus, excessive levels of protein result in greater urinary excretion of calcium. This consequence is particularly important for female athletes, who are at greater risk of osteoporosis than male athletes are. Female bodybuilders and strength athletes tend to consume large amounts of protein, but the long-term effects, if any, on osteoporosis are not clear.

Athletes who consume excessive amounts of protein (≥2.5 grams of protein per kilogram of body weight per day) face several potential problems. They are at risk for dehydration, low carbohydrate intake, excessive caloric intake, and increased urinary excretion of calcium. They must be aware of the need for more fluid to metabolize the protein. Adequate carbohydrate intake is necessary for promoting sufficient glycogen stores; therefore, athletes cannot sacrifice carbohydrate intake to consume more protein. And to avoid unwanted weight gain,calories burned must balance the calories taken in. Otherwise, if increased protein intake results in increased caloric intake without an increase in activity body fat levels will increase. Finally, excessive loss of calcium should be offset by increased calcium intake.

Besides monitoring the amount of protein consumed daily, athletes must also consider the timing of that intake. More research is also being conducted on the types of protein that athletes should ingest.

Effect of Timing and Type of Protein on Glycogen Storage and Muscle Anabolism

Although trained athletes need more protein than sedentary adults do, most athletes in the United States consume sufficient protein. But athletic trainers will encounter some athletes who take in too little protein, most commonly women who are restricting energy (calories) and men who compete in weight-restricted sports. Bodybuilders and weightlifters most commonly consume excessive amounts. All these athletes would benefit from nutritional counseling. But even athletes who consume proper amounts of protein might want to fine-tune their intake by considering the effects of timing and type of protein on glycogen storage and muscle anabolism (building tissues).

Postexercise Protein Consumption

Consuming carbohydrate immediately after exercise is widely recommended, but recent studies suggest that adding protein to the postexercise feeding is also beneficial (23). Carbohydrate stimulates insulin secretion, and insulin is known to influence glycogen resynthesis and the uptake of amino acids into muscle. The increased uptake of amino acids increases cellular hydration, which may stimulate the formation of glycogen (24). But the most important reason for postexercise protein consumption is the role that it plays in muscle anabolism.

A brief review of protein metabolism helps set the stage for our discussion of muscle anabolism. Anabolism is the building process of metabolism, whereas catabolism is the breakdown process of metabolism. Amino acids constantly circulate in the blood, and an active exchange occurs between the liver, the blood, and the cells of the body. Cells seek specific amino acids from a pool found in the blood and body fluids. Amino acids are removed from the amino acid pool to make specific proteins, including muscle protein. Dietary protein and the breakdown of cellular protein add amino acids back to the pool. A constant turnover of amino acids occurs as cells build and break down body tissues, hormones, enzymes, and antibodies.

Athletes break down protein tissues during training in part because training results in microscopic tears in the muscle. Exercise stimulates the DNA in the muscle to increase the protein synthesis process during the recovery period when training is completed. This postexercise increase in protein synthesis occurs if dietary protein and caloric intake are adequate (25).

For muscles to grow, muscle-protein synthesis (anabolism) must exceed muscle-protein breakdown (catabolism). Without food in the recovery period, the rate of breakdown exceeds the rate of synthesis. The presence of essential amino acids during the recovery period can greatly affect muscle-protein anabolism. Studies show that consuming at least 6 grams of essential amino acids immediately after resistance exercise results in a net increase in muscle-protein balance. Larger amounts do not appear to be more effective because past the point of saturation, additional amino acids do not have an effect (26, 27).

The first 1 to 2 hours of recovery may open an "anabolic window" during which consuming amino acids helps promote muscle-protein synthesis. Although most of the studies used amino acids added to beverages, amino acids found in protein foods such as chicken, fish, or milk are probably just as effective.

Effect of Protein Type on Protein Anabolism

Food sources of protein include milk, meat, fish, poultry, eggs, and soy. Protein supplements may contain a variety of protein including whey, casein, and soy. Bodybuilders have long touted the benefits of whey protein, and its popularity among other athletes, particularly strength athletes, is increasing. Whey is favored for its high biological value (a measure of protein quality) and solubility, positive influence on the immune system, and potential antioxidant effects.

Both whey and casein are milk proteins. Whey is the liquid portion of coagulated milk; casein is found in the semisolid portion (curds). The whey is processed into whey protein isolate by concentrating the protein and removing the lactose and fat. The final product is high in protein, specifically essential amino acids and branched-chain amino acids. Whey protein isolates are found in sport supplements and infant formulas. People who are lactose intolerant must be aware that whey powder and whey protein concentrate, which are different from whey protein isolate, contain significant amounts of lactose (28).

Whey has a higher biological value and greater solubility than casein. The amino acids found in whey enter the bloodstream faster, whereas casein provides a slower, more prolonged response. Researchers are beginning to study whey protein supplementation during resistance exercise (29).

Until more studies are published, the role that whey protein may play in increasing muscle mass or strength will remain unknown. Therefore, it is too early to make specific recommendations about whey protein in an athlete's diet, but early indications show promise for both recovery and anabolism.

The amount and timing of protein intake are important issues for athletes. Although carbohydrate and protein are important macronutrients, our discussion is not complete until we consider fat intake.

Fat and Athletic Performance

Our discussion of fat includes the recommendations for not only daily fat intake but also type of fat. Athletes must consider their fat intake in the context of successful athletic performance and the prevention of chronic diseases.

Daily Fat Intake

Fat is an important source of energy for the body. The amount and type of dietary fat consumed plays an important role in maintaining good health. The newest guidelines for healthy adults, as explained in chapter 1, "Nutritional Standards and Guidelines," suggest that 20 to 35% of total calories should come from fat. Consuming less than 20% of total calories from fat is not recommended because studies have shown that these diets in healthy people can result in a decline in high-density lipoprotein (HDL) cholesterol. Moreover, diets extremely low in fat may affect fat-soluble vitamin distribution and storage in the body.

As a rule, if an athlete consumes sufficient energy (calories), then 20 to 25% of total energy intake can be consumed as fat. This recommendation is at the lower end of the recommendation for the general adult population because it takes into account higher intakes of carbohydrate and protein. A diet that derives 20 to 25% of its energy from fat will provide the essential fatty acids and a feeling of satiety without being severely restrictive. For an athlete consuming 3,000 calories daily, 20% of energy intake as fat is equivalent to about 65 grams of fat per day.

Situations vary, however, and studies have shown that fat intake in elite athletes may range from as low as 15% to as high as 40% of total energy intake. Some athletes focus on attaining or maintaining a low level of body fat, and restricting dietary fat is one way to attain it. In sports in which the body must be moved, excess body fat is detrimental because it increases body mass without increasing power. For example, distance runners strive for a low percentage of body fat to reduce the weight that they have to carry which increases their efficiency. The demands of training require that distance runners consume large amounts of carbohydrate to maintain glycogen stores and moderate amounts of protein to support strength training. In an effort to control energy (calorie) intake, both male and female distance runners often reduce fat intake to as low as 15% of total calories. A diet this low in fat restricts a person's food choices and often does not provide satiety. As a result, the athlete may feel hungry and find it difficult to maintain the diet.

Limiting fat too much can be a sign that an athlete is losing perspective on his or her overall diet. Some athletes can become so obsessed with keeping fat intake low that they become "fat phobic" in terms of their food intake and body composition. This fear of fat intake or body-fat stores could be a sign of disordered eating. In some cases, low intake of fat and energy is detrimental to the athlete's training, performance, and mental well-being.

In certain precompetition situations where loss of body fat is a goal, such as in wrestling or bodybuilding, fat intake may be reduced temporarily to 15% or less of total energy intake. This severe reduction in fat intake is usually short term, and most wrestlers and bodybuilders do not suffer from long-term disordered eating.

In some sports, such as distance cycling and cross-country skiing, daily training requires exceptionally high energy intake. Male athletes in these sports may consume more than 5,000 calories daily, and their fat intake may exceed 30% of their total energy (calorie) intake. Fat is the most energy-dense nutrient. When carbohydrate and protein needs are met, fat helps provide the energy to support high-level training. For these athletes, a higher dietary fat intake, primarily from heart-healthy sources, is necessary for providing enough energy to fuel workouts and competition. Conversely, when these athletes are not training or competing, they should reduce fat intake.

In the face of a food supply loaded with fat, athletes must limit, but not eliminate, dietary fat. Everyone must consume enough dietary fat to provide the essential fatty acids: linoleic acid (an omega-6 fatty acid) and linolenic acid (an omega-3 fatty acid). The body cannot manufacture these essential fatty acids; therefore, they must be included in the diet. Only a small amount is needed daily (equivalent to approximately 1 tablespoon of oil), because the body can store essential fatty acids. Omega-3 fatty acids, which are found in salmon, sardines, tuna, and canola and soybean oils, appear to benefit the heart, especially when they are consumed in the proper proportions. In the United States, people consume too few omega-3 fatty acids and proportionately too many omega-6 fatty acids from mayonnaise, margarine, and vegetable oils that are not soy or canola. People in the United States are generally advised to consume more fish in an effort to increase omega-3 fatty acid intake.

Carbohydrate and protein recommendations for athletes are expressed as grams per kilogram of body weight, but fat recommendations are generally expressed as a percentage of energy (calorie) intake. Some sport nutritionists are beginning to make fat recommendations based on kilograms of body weight. A good starting point is to recommend that an athlete consume at least 1 gram of fat per kilogram of body weight. This figure may be adjusted individually, but in general it provides adequate fat while allowing the athlete to take in the recommended amount of carbohydrate and protein.

To consume the proper amount of fat, athletes must master a tricky balancing act. On the one hand, they must consume enough fat to provide the essential fatty acids and a feeling of satiety after a meal. On the other hand, they must limit fat consumption so that they can meet carbohydrate and protein needs without taking in too much fat and too many calories. Perhaps the biggest challenge for certified athletic trainers and others who work with athletes is helping athletes keep fat intake in its proper perspective. Fat is not good or bad, but some types of fat should be emphasized because they contribute to good health, and some fats should be limited because they contribute to heart disease.

Emphasizing Heart-Healthy Fat

The total amount of fat contained in the diet is just one aspect when considering the role of fat in an eating plan. The type of fat to include is another consideration. Types of fat differ in their degree of saturation. Animal fat and coconut and palm kernel oils are high in saturated fat, and their intake should be limited. Vegetable fat contains mostly polyunsaturated and monounsaturated fats, which are better for the heart than saturated fat. Trans fats occur when vegetable oils are processed to become harder, such as when corn oil is turned into margarine. Margarine is not as heart healthy as corn oil because the margarine contains trans fatty acids.

Products containing fat contain a mixture of fatty acids, but one type of fat predominates, as shown in figure 2.1. For example, olive and canola oils have a very high percentage of monounsaturated fat and are considered heart healthy, but they do contain some saturated and polyunsaturated fats. The predominant fat in butter or coconut oil is saturated fat, so consumption of those items should be limited. The predominant fat in most vegetable oils (other than olive or canola) is polyunsaturated.

In general, high levels of saturated fats, trans fats, and cholesterol (a fatlike substance) increase the risk of heart disease because they raise low-density lipoprotein (LDL) cholesterol. Saturated fats and cholesterol are found in animal products. Saturated and trans fats are found in many processed foods, especially snack products. Foods that contain large amounts of polyunsaturated and monounsaturated fatty acids such as fish, nuts, olive oil, and vegetable oils are often referred to as *heart-healthy fats* and should be chosen over other kinds of fats in the diet.

Athletes wonder whether they should be concerned about trans fatty acids, a fat that received

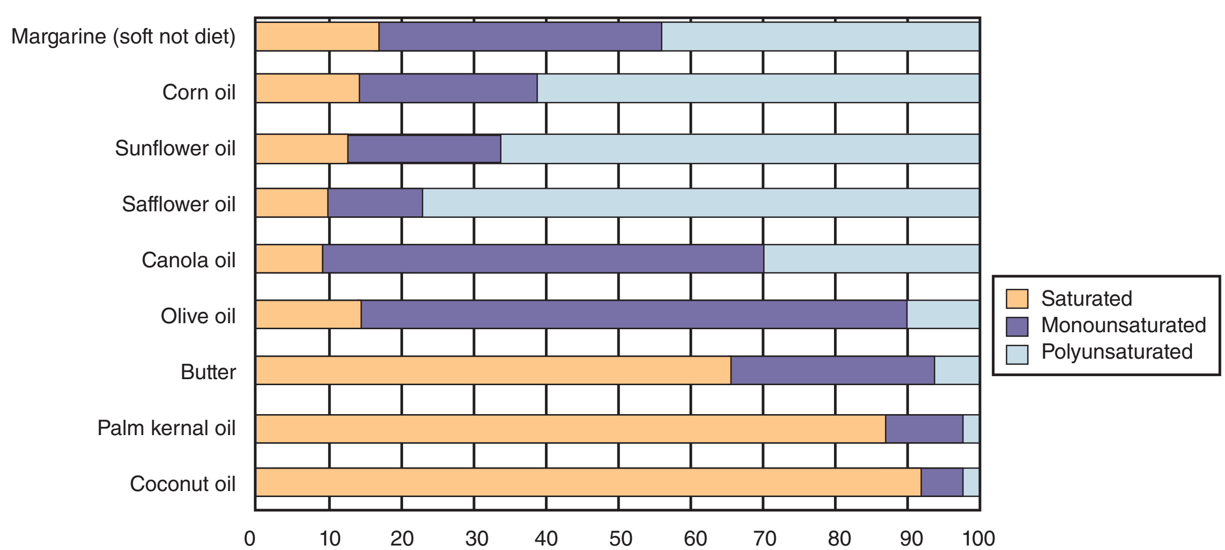


FIGURE 2.1 Saturated, monounsaturated, and polyunsaturated fatty acids in food.

Reprinted, by permission, from M. Dunford, 2001, *Exercise nutrition* (Champaign, IL: Human Kinetics), 14.

media attention after the Food and Drug Administration announced in 2006 that the amount of trans fat must appear on food labels. Because trans fatty acids provide no known health benefit, consuming as little trans fat as possible is best. Because trans fat and saturated fats are common in snack foods such as chips, candy bars, cookies, and pastries, limiting intake of these foods is wise.

Although there are exceptions, the general recommendation for athletes is to consume 20 to 25% of total calories as fat. Endurance athletes, however, may have questions about high-fat diets and the potential for the body to adapt to them. Most athletes do not improve performance with high-fat diets, so they are not recommended.

Effect of Fat Loading on Performance

From time to time, fat loading becomes popular as a proposed method for enhancing endurance and ultraendurance performance. Fat loading, known as a *fat-adaptation diet,* refers to the consumption of a high-fat, low-carbohydrate diet for 2 to 4 weeks. These diets usually contain more than 60% of total calories from fat, and the athlete consumes enough calories to maintain body weight. A 1-day carbohydrate-loading diet may precede the day of performance.

This diet regimen is based on the hypothesis that the body will adapt and use fat at higher rates during exercise. Theoretically, the ability to oxidize more fat during prolonged low- to medium-intensity exercise could spare muscle glycogen. With the addition of a 24-hour period of carbohydrate loading, fat loading may hold promise of improved performance.

Studies to date have not shown that fat-adaptation diets (even with carbohydrate loading 24 hours before competition) enhance endurance or ultraendurance performance. But in several of the studies, some athletes were "responders" and made performance gains. Responders may have different biochemical or physiological responses, possibly driven by genetics, that result in successful adaptation. But the studies suggest that most athletes are nonresponders, so fat-adaptation diets are not recommended. Research continues in this intriguing area (30, 31).

The macronutrients provide athletes with the energy needed for exercise and at rest. Food sources of carbohydrate, protein, and fat also contain vitamins, minerals and other compounds that are essential to health and disease prevention and enhance exercise performance.

Micronutrients and Athletic Performance

Vitamins and minerals provide many functions in the body. Vitamins can act as coenzymes involved in metabolic reactions, provide antioxidant properties, and support many physiological functions in the body. Minerals have important roles in neuromuscular function and the development of hard and soft tissue, and several minerals are classified as electrolytes that have additional roles in fluid balance and muscular contraction. Vitamins and minerals are considered essential nutrients; we must consume foods with appropriate levels of all the vitamins and minerals because, with rare exceptions, the body cannot manufacture these vital nutrients. A discussion of each vitamin and mineral is beyond the scope of this publication. The following section summarizes some key points about vitamins and minerals that relate to athletes and their sport performance.

Vitamins

Vitamins are categorized as either water soluble or fat soluble. Water-soluble vitamins include the B-complex vitamins and vitamin C. Fat-soluble vitamins are vitamins A, D, E, and K. Solubility is an important classification. Water-soluble vitamins can be transported in the watery environment in the blood. Fat-soluble vitamins must have some fat to allow the body to digest, absorb, and use them. Water-soluble vitamins are not stored in the body, whereas fat-soluble vitamins can be stored. This concept is important for athletes who may consider taking high doses of fat-soluble vitamins. Athletes should be encouraged to consume foods with adequate nutrients and only take vitamin supplements that do not exceed the Tolerable Upper Limit (UL) unless under a physician's recommendation.

The B-complex vitamins are worth discussing as they relate to athletes. Most of these play significant roles in the metabolic pathways that produce energy for the working muscle. For that reason, B-vitamins are seen in sport beverages, specialized waters marketed toward active people and in some sport bars and gels.

Vitamins A, C, and E have antioxidant properties and are similarly advertised to athletes as necessary for energy metabolism and recovery after hard exercise. During exercise, oxidation occurs and free radicals are formed. Free radicals are unpaired electrons that if left unpaired cause damage. Skin damage from the sun and pollution that releases free radicals that we breathe while exercising outside are additional examples of free radical formation. Many studies have been done to determine whether the increase in oxidation and thus the increased production of free radicals during exercise would benefit from increases in vitamins A, C, or E and the mineral selenium. Most studies have shown that when free radicals are produced with exercise, the body upregulates itself and produces the extra electrons to neutralize the radicals. For athletes who consume adequate antioxidant vitamins and selenium, there is no evidence that overconsumption of these substances will produce better results during exercise or in the recovery phase.

Minerals

The functions of several minerals are crucial to sport performance, although not all are discussed in this section. Calcium is important in skeletal and cardiac muscular contraction and in bone health. Iron plays a significant role in the transport and utilization of oxygen. Sodium and potassium are electrolyte minerals important in fluid balance, blood pressure regulation, and muscular contraction. The importance of electrolytes is briefly discussed in the water section in this chapter and will be revisited in chapter 4.

Calcium is a major mineral that may be lacking in the diets of athletes and the general population. One of the MyPlate food groups is dairy, which has the slogan "get your calcium-rich foods." This recommendation underlies the importance of this mineral. Calcium, along with phosphorus and vitamin D, plays a significant role in bone development and maintenance.

The role of iron in transporting oxygen to the cells makes it one of the most critical minerals for athletes. Athletes (and nonathletes) use aerobic metabolic pathways to produce the energy needed for exercise. If oxygen delivery or the saturation of oxygen in the blood is low, aerobic energy production decreases. This shortfall obviously decreases sport performance. Appropriate use of iron and other supplements will help athletes meet but not exceed the UL of the micronutrients. Athletes who are deficient in iron should follow a physician's recommendations for the dose and length of time to stay on iron supplementation.

Athletes' Needs for Vitamins and Minerals

Athletes who follow the recommended guidelines for macronutrient and calorie intake may be able to consume adequate micronutrients as well. The challenge that many athletes face, however, is the need to take in sufficient calories to sustain high levels (duration and intensity) of exercise daily. Often, athletes do not feel like eating after hard workouts, or they have to balance their commitment to preparing and eating food with their obligation to do other things such as work or study. Over a long season or with year-round training, diet may have a lower priority. If a variety of foods and total intake are lacking, intake of recommended amounts of vitamins and minerals may fall short of need.

Sports medicine professionals must be aware of the athlete's training goals, dietary intake, and weight and body composition throughout the training season. Unexplained weight loss or a decline in the athlete's performance are indicators that nutritional intake may be suboptimal. Effort should be made to help the athlete assess her or his diet for both macronutrient and micronutrient intake. In addition to consuming additional calories (macronutrients), the athlete will likely need additional vitamins and minerals. With careful planning, an increase in variety of foods in the diet, and adequate intake of carbohydrate, protein, and fat, these additional needs for vitamins and minerals may be met.

Having athletes take a multivitamin or mineral supplement (MVI) may provide additional assurance that micronutrient needs are met in a safe way. Some athletes, despite adequate calorie intake and stable weight, may not consume enough vitamins and minerals to meet their needs. In most cases, athletes can safely take a MVI that contains in one pill approximately 100% of the daily requirements for the vitamins and minerals. Caution should be raised about athletes taking multiple supplements or too much of any one vitamin or mineral unless it is advised or prescribed by a physician.

Fluids and Athletic Performance

When educating athletes about fluid intake and athletic performance, sports medicine professionals must address the concepts of hydration status, particularly dehydration, sweat rate, and sodium loss. Distinguishing between recommendations for athletes and the public, most of whom are not physically active, is particularly important.

Water is an essential nutrient responsible for regulating many important functions in the body. It is present in and around cells, helps provide structure to tissues, and is an important component of watery body fluids like blood plasma, lymph, and saliva. Water also helps the body regulate temperature, provides a medium for chemical reactions such as those necessary for energy metabolism, and carries nutrients, enzymes, hormones, and other molecules throughout the body.

Adequate daily water intake is essential to good health and sport performance. Plain water, juices, milk, foods made with those fluids, and other foods with high water content like fruits and some vegetables all contribute to meeting daily water needs. Water is a nutrient and has a DRI established for daily intake. The DRI is an Adequate Intake (AI) level, which for adult males is 3.7 liters per day and for adult females is 2.7 liters per day (32). Additional fluids are necessary to support the increased needs that result from exercise.

The National Athletic Trainers' Association (NATA) has been a leader in educating athletes about the vital need for fluids before, during, and after exercise. Published position papers on exercise and fluid replacement are widely available from NATA, the American College of Sports Medicine, and other groups concerned about athletes' performance and health (20, 33–35). Many factors must be considered in the consumption of fluids including volume, frequency, concentration, timing, and the presence of electrolytes. Individual differences can be substantial, and published guidelines must be adjusted to individual tolerances.

Dehydration, a potentially life-threatening situation, is a frequent problem for athletes. Dehydration can be especially dangerous when people exercise in the heat, but it can occur in any training or performance situation including exercising in the cold and in the water. Studies have shown that athletes who are dehydrated fatigue earlier, use glycogen more rapidly, and impair their ability to sweat and regulate body temperature (34, 36–38). Besides resulting in a decline in performance, dehydration puts the athlete's health at risk. Potential medical problems include heat syncope (fainting); heat cramps; heat exhaustion, which is signaled by symptoms of fatigue, nausea, and increasing body temperature; and ultimately heatstroke, which can be fatal.

Dehydration during exercise occurs when an athlete loses more fluid than he or she takes in. Athletes lose fluids through sweat, urine, and respiration, although sweat represents the vast majority of fluid lost during exercise. People replace fluids primarily through oral consumption, although postcompetition intravenous (IV) fluid replacement has become more common for elite athletes. In general, athletes become dehydrated when sweat loss exceeds oral fluid intake (35).

All athletes should be concerned about dehydration.

Recommendations for fluid ingestion have an interesting history. As late as the early 1970s athletes were advised not to drink during exercise because it was believed to impair performance. In some sports, restricting fluids during practices held in hot and humid conditions was thought to be a way to toughen up athletes. Deaths from heatstroke caused coaches and scientists to rethink this advice. In the last decade the prevailing advice to all athletes, especially to distance runners, has been to "drink as much fluid as possible." Although this advice was intended to protect athletes from dehydration, it caused some distance runners to consume excessive amounts of fluid. The goal for athletes today is to determine individual fluid needs and balance fluid intake with fluid losses. Distance runners must prevent dehydration without overhydrating (35).

Determine individual fluid needs and balance fluid intake with fluid loss. Distance runners must prevent dehydration without overhydrating.

Monitoring Hydration Status

The two easiest ways to determine hydration status are to monitor urine color and pre- and postexercise weight. Urine should be clear to light yellow; darker-colored urine suggests dehydration. Comparing pre- and postexercise weight gives a fairly accurate measurement of the amount of fluid lost during exercise. A rule of thumb is "a pint and a half a pound," which refers to the need to consume one to one and a half pints (2-3 cups) of fluid for each pound lost, or about 1-1.5 liters for each kilogram of weight lost.

Taking a scale weight before and after exercise helps the athlete estimate how much fluid he or she must consume.

Determining Individual Sweat Rates and Sodium Loss

Sweat rates vary considerably and must be determined for each person. Some athletes lose 0.5 liters per hour, whereas others lose 2.5 liters per hour. Another important factor is the amount of salt lost in sweat, which is also subject to great individual variation. Patrick Rafter, a former professional tennis player, has lost the equivalent of 5 teaspoons of salt in 3 hours. Similar losses have been described in college and professional football players. These athletes might be at risk for muscle cramps because they dehydrate quickly and lose substantial amounts of sodium. People who lose a lot of salt when they sweat should routinely consume salty foods and use a sport drink with higher sodium content during and after exercise. The presence of salt crystals on skin, clothing, and hats and reports of burning or stinging when sweat gets in the eyes indicates that a person loses a lot of salt through sweat.

Guidelines for Optimal Hydration

The guiding principle for hydration is to *match fluid intake to fluid loss.* This plan is different from the popular "consume as much fluid as possible" philosophy. Each athlete should determine his or her sweat rate and approximate fluid needs per hour and then establish a program for optimal hydration. Procedures for calculating sweat rate are available on this website: http://www.beverageinstitute.org/en_us/pages/article-hydration-how-to-calculate-your-sweat-rate.html. Because environmental conditions change and acclimatization is a factor, sweat rate and fluid needs should be reassessed periodically. Sweat rate may be different at the beginning of a season or training period than later in the season or when exercising outdoors versus indoors, and it is highly dependent on temperature, humidity, and radiant heat from the sun. Sweat rates are also individual, so athletes on a team should assess their own sweat rate and adjust hydration schedules personally rather than as a team.

> The guiding philosophy for hydration is to match fluid intake to fluid loss.

The "match fluid intake to fluid loss" philosophy evolved in response to the problems that some endurance and ultraendurance runners experience with hyponatremia, defined as a blood sodium concentration less than 130 millimoles per liter. This condition occurs in some athletes who exercise for extended periods, usually 4 hours or more, and drink primarily water during exercise. Excessive fluid intake can cause a drop in the blood-sodium level, especially if the athlete takes in fluids containing little or no sodium. Hyponatremia is potentially fatal. Matching fluid intake to losses is important for all athletes when mild to moderate dehydration can significantly decrease sport performance.

As is the case with carbohydrate, the amount and timing of fluid and electrolyte intake are important.

Fluid, Carbohydrate, and Electrolytes Before, During, and After Exercise

Our discussion of hydration so far has focused on fluid and the electrolyte sodium. Carbohydrate does not play a direct role in fluid balance, but athletes need carbohydrate before and after exercise and, in some cases, during exercise. This need for carbohydrate and the ease of obtaining it through sport drinks makes carbohydrate a natural part of this discussion. As we've already discussed, athletes also need amino acids after exercise to aid recovery. The recommendations that follow provide general guidelines, and volume must be adjusted to individual needs and tolerances (34).

Preexercise Hydration

All athletes should begin exercise fully hydrated. Sports medicine professionals should provide this key message to the athletes with whom they work. Athletes who start a training session or competition at a fluid deficit are unlikely to catch up their hydration status during exercise. The best way to determine hydration status is to check urine color. Remind athletes to check urine color regularly so they become accustomed to their hydration status throughout the day, not just before or after exercise. One word of caution: Dietary supplements, especially vitamin supplements, can darken urine color.

The following are guidelines for fluid intake before exercise:

- Drink 5 to 7 milliliters of water or sport drink per kilogram of body weight (about 1 oz per 10 lb of body weight) 2 hours before exercise.
- Drink an additional 3 to 5 milliliters per kilogram of body weight 2 hours before exercise if urine color is dark.
- Avoid carbonated beverages because they can cause gastrointestinal distress.

Hydration During Exercise

Balancing fluid loss with intake is important. The goal of hydration during exercise is to prevent a level of dehydration that affects sport performance. Athletes who don't replace fluid become dehydrated and are at risk for potentially serious medical problems. On the other hand, runners or walkers who exercise for many hours in one bout and overhydrate are susceptible to hyponatremia.

Making broad recommendations that fit every athlete's needs for hydration during exercise is difficult because of the differences in sport and exercise activities and disparities in sweat rates. The following are guidelines for fluid intake during exercise:

- Replace body water lost through sweat by drinking during exercise.
- Include carbohydrate and electrolytes or both if engaged in exercise for 1 hour or longer.
- Distance runners or people completing endurance exercise should drink approximately 0.4 to 0.8 liters (13 to 26 oz) of fluid per hour, adjusted to individual tolerances.

Postexercise Hydration

Replenishment after exercise is key. Athletes must replenish fluids, electrolytes, and carbohydrate (to restore glycogen stores). Consuming amino acids in the first 1 to 2 hours of recovery helps promote muscle-protein synthesis. One convenient way to consume carbohydrate, electrolytes, and amino acids is through sport beverages. Food sources, however, are equally effective.

The following are guidelines for fluid intake after exercise:

- Replace fluid lost during exercise. The rule is to consume 1-1.5 pints (2-3 cups) of fluid per pound of weight lost (1.5 liters per kilogram).
- Consume sodium to speed rehydration, replace lost sodium, and stimulate thirst.
- The temperature of the fluids should be cool (10 to 15 °C, or 50 to 59 °F) if tolerated.
- Flavored drinks may be more appealing.

With few exceptions, athletes are dehydrated after training and competition. Immediately after exercise and for the next 6 to 8 hours, rehydration is imperative so that athletes do not begin the next training session or competition in a compromised state. Consuming sodium after exercise helps the body retain fluid and helps maintain the drive to drink. Sodium and water are found in sport beverages, but the amount of sodium is low. After exercise, athletes should also salt their food lightly or eat salty foods such as nuts.

Coaches may require team members to remain at practice until postexercise weight has been restored to preexercise levels, a sign that the athlete has consumed nearly as much fluid as she or he has lost. This fluid intake may not be enough if the athlete was not fully hydrated at the start of exercise, but it is a good way to ensure that athletes rehydrate immediately after exercise. But most athletes are on their own during the recovery period, and many fail to consume enough fluid and other nutrients. Athletes may prefer other activities, such as sleep or socializing, but preparing the body nutritionally for the next training session is important. Coaches and sports medicine professionals should remind all athletes of the importance of postexercise fluid and nutrient replacement.

Recommendations for the amount and timing of fluids and electrolytes have been made based on scientific research, but each athlete must individualize the recommendations based on variables such as the sport, amount and composition of sweat, and environmental conditions. The type of beverages to consume during exercise and throughout the day is an additional consideration. Comparisons of sport-specific beverages and ways to choose the best sport beverage are found in chapter 4.

Caffeine and Dehydration

Athletes are often told to eliminate or limit their intake of caffeine because of the suspected diuretic effect of caffeine. Although this recommendation seems logical, it is not based on scientific studies that measure the extent of caffeine-induced urinary losses or the effect that these losses might have on hydration status. New scientific information on caffeine, fluid balance, and exercise has caused health professionals to rethink their advice about caffeine (39).

A daily intake of up to 300 milligrams of caffeine does not appear to impair performance or health. Although this amount of caffeine produces a mild diuretic effect (similar to that of water), it does not cause excessive loss of fluid or electrolytes. Those who have developed a caffeine tolerance are less affected by caffeine than those who consume it infrequently.

Athletes should be aware of the effects of caffeine. It is a central nervous system stimulant, and too much can cause an athlete to feel jittery. In the United States the average coffee drinker consumes 2 to 4 cups of coffee daily, each containing approximately 80-100 milligrams of caffeine. One cup of strong black tea and a 12-ounce (360 ml) soft drink each contain about 50 milligrams of caffeine. Various over-the-counter and prescription medications also contain caffeine. Because caffeine is restricted at high doses by some sports governing bodies, athletes need to know the sources and amounts of the caffeine that they ingest.

Caffeine probably doesn't have much influence on the hydration status of athletes who routinely consume less than 300 milligrams from dietary sources. But certified athletic trainers should be aware that some athletes abuse caffeine. For example, wrestlers use caffeine in calorie-free beverages or in medications to make weight, and bodybuilders use it in their final contest preparations. Under these circumstances athletes use caffeine because it is a mild diuretic and a stimulant that masks fatigue. Caffeine use in these circumstances can be dangerous because these athletes are often dehydrated, sometimes severely. The mild diuretic effect of caffeine in a dehydrated person is a potentially serious problem.

Voluntary Dehydration

Although it is not recommended, some athletes voluntarily dehydrate. Athletes such as wrestlers, boxers, and lightweight rowers use dehydration to make weight, and bodybuilders use it to improve appearance. Mild dehydration in wrestlers may be reversed before competition because they have time to rehydrate after weigh-in. But time may be insufficient to reverse severe dehydration, and in these instances wrestlers compromise their performance and health. In 1997 three collegiate wrestlers died of severe dehydration, one of the techniques that they used to make weight (40).

Some athletes use diuretics to shed body water. Diuretics are powerful medications that force the body to excrete water and electrolytes such as sodium and potassium. They can cause dehydration and electrolyte imbalances, and a few bodybuilders have died from overusing them in an effort to dehydrate voluntarily. Certified athletic trainers must educate athletes about the risks associated with dehydration.

> Voluntary dehydration can result in poor performance, illness, and even death.

Beverages provide necessary nutrients as well as hydration. Some nutrients in sport beverages, such as the electrolytes sodium and potassium, are effective in maintaining performance during exercise. Other beverages, such as 100% fruit juices and soy or dairy milk, contain calcium and vitamins D and A and are excellent choices for meeting daily hydration needs.

Summary

In general, athletes need 5 to 10 grams of carbohydrate per kilogram of body weight daily, but the exact amount depends on gender, sport, and training level. Most carbohydrate should come from minimally processed foods that contain fiber. A less severe carbohydrate-loading process may be just as effective as the more severe processes used in the past. Types of protein and the timing of protein consumption are new areas of research that hold promise for optimal muscle-protein synthesis. Nutritionists are again emphasizing macronutrient balance, and the quality of carbohydrate, protein, and fat is receiving as much attention as the quantity. Concerns about dehydration and its effects on performance remain, but a new philosophy has emerged: Match fluid intake with fluid loss. Sweat rates and composition vary, and people may experience large losses of water and electrolytes, notably sodium. These losses must be replaced. Dehydration and overhydration are serious performance and health issues. Voluntary dehydration is always a concern because of the potential performance and medical problems that can accompany it. Adequate vitamin and mineral intake is essential for good health and effective sport performance. Many minerals are important in fluid balance and muscular contraction, and many vitamins are essential to the energy production pathways. Consuming a balanced diet from a variety of food and beverage sources will help athletes achieve and maintain good health and sport performance.

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part II

Practical Guidelines for Food and Fluid Choices

At the heart of any interaction with athletes about the topic of nutrition for sport performance is the ability to apply nutrition knowledge accurately to everyday food and fluid intake. Part II has exactly that focus. This part contains three chapters that help sports medicine and fitness professionals translate nutrition principles into practice in meal planning, choosing sport specific products, and assessing dietary supplement products.

Chapter 3, "Meal Planning," uses the diabetic exchange system and nutrition labeling information to guide meal and snack selections. Chapter 4, "Sport Beverages, Bars, and Gels," focuses on sport-specific foods and fluids designed for athletes' use before, during, or after training or competition. Many dietary supplements or supplemented foods and beverages are targeted toward active people and athletes. Chapter 5, "Assessing Dietary Supplements," provides information about labeling laws that are both similar to and different from the rules regarding Nutrition Facts Label information, found in chapter 3. Chapter 5 will help sports medicine and fitness professionals and the athletes with whom they work sort through supplement information and critically analyze the safety, efficacy, and need for nutritional supplements.

chapter 3

Meal Planning

Assuming that energy (calorie) intake is adequate, athletes need 5 to 10 grams of carbohydrate per kilogram of body weight per day, 1.2 to 1.7 grams of protein per kilogram of body weight per day, and 20 to 35% of total calories as fat daily (see chapter 2, "Dietary Patterns for Macronutrients, Micronutrients, and Fluid Intake"). Fluid intake should balance fluid loss. These recommendations are based on scientific research, but nutritious eating is both an art and a science. This chapter shows you how to translate the scientific recommendations and help athletes use nutrition labels to plan meals that meet nutritional requirements and feature healthful, tasty foods.

Helping Athletes Plan Nutritious Diets

Planning nutritious diets takes knowledge and skill. Well-planned diets are tailored to a person's preferences and are flexible. Using exchange lists or other diet-planning tools helps athletes devise well-balanced diets. A variety of nutrition information in the public domain can help athletes and the sports medicine professionals who work with them to plan healthful diets that also maintain good sport performance.

Allowing Flexibility

On paper, planning a nutritious diet is not difficult. We know the nutrient composition of foods and the recommended intake of most nutrients. In some respects it's a mathematical problem. But in reality, meal planning is difficult because it requires considerable flexibility. For example, an athlete may pack a sack lunch according to plan, but a group of friends may invite him to go to a nearby restaurant after practice. How does he order off the menu and still meet his diet plan?

Athletes who are precise about their nutrient intake run the risk of becoming rigid. Rigid meal planning might meet the scientific requirements of nutrition, but it falls short when it comes to the art of eating. An unexpected lunch invitation has no place in the diet plan of a rigid athlete. Rigidity can lead to social isolation and can be a sign of compulsive behavior, which can become problematic. Flexibility results in short-term over- and undereating, but it will likely produce long-term weight stability, proper nutrition, and enjoyment of eating. Flexible eating is not the same as unplanned eating.

Because no diet plan is perfect for every situation, people must choose from a host of available foods every day. Athletes need a general plan and should choose foods to fit it. But some athletes don't think much about their diets, or they choose foods for reasons other than the nutrients that they provide, such as foods that are convenient or available. Those who don't plan their food intake run the risk of falling short of their nutrient goals. Just as athletes must have a plan for training, they must also have a flexible but well-thought-out diet plan to help them meet their energy and nutrient needs. Because sport nutrition is complicated, failure to plan usually results in poor nutrient intake, which may hamper performance and undermine long-term health.

Grouping Foods According to Nutrient Content

The science of sport nutrition has evolved to the point that generally agreed upon guidelines exist for carbohydrate, protein, fat, and fluid intake. In other words, athletes know (or should know how to find out) how much of each nutrient they need. The next step is to know the nutrient composition of foods. With so much food available, there is a lot to learn.

To make food and nutrition decisions easier, foods are often grouped according to their nutrient composition. People then choose a certain number of foods from specific categories. A dietitian can help the athlete develop a plan containing the appropriate amount of calories, carbohydrate, protein, and fat. This approach makes it simpler to choose foods, but it also means that people usually don't know the precise nutrient values of the foods that they're eating.

One system for categorizing food is the exchange lists, which have been used for years by people diagnosed with diabetes and by some weight-loss plans. The American Dietetic Association and American Diabetes Association published updated exchange lists for weight management in 2003 (1). (See appendix.) The exchange lists include three groups: carbohydrate, meat and meat substitute, and fat. The carbohydrate group and the meat and meat substitute group contain several subgroups. Foods listed within each group or subgroup have approximately the same carbohydrate, protein, fat, and energy content (2). Thus, foods on the same list can be exchanged for one another. Becoming familiar with the exchange lists is one way to learn the macronutrient content of foods.

An important factor when using the exchange lists is portion size. Because foods are grouped according to their carbohydrate, protein, fat, and caloric content, the portion sizes might be different. One fat exchange equals 5 grams of fat and 45 calories. The portion size for an avocado is 2 tablespoons, but for olive oil it is 1 teaspoon. Attention to portion size is important.

The exchange lists can be effective tools, but some criticize their simplicity. Some foods within an exchange group are more nutritious than others. Although the macronutrient composition might be similar, micronutrient composition, such as vitamin or mineral content, can be considerably different. The exchange lists try to compensate for this by indicating foods that should be chosen more often because of their nutrient density. Table 3.1 illustrates differences among foods on the same list.

The simplicity of the lists also causes problems when trying to categorize complicated foods. Table 3.2 shows how mixed foods, such as pizza, are represented by a combination of exchanges. This table also gives exchange information for fast foods, many of which are combination foods.

Another problem arises in the milk group. Some adults experience a decline in the enzyme lactose, which makes it hard for them to tolerate milk or milk products, so they eliminate them from their diets. Because the primary nutrient in this group is the mineral calcium, people who eliminate these foods must get calcium from other sources. Lactose-free products such as Lactaid or calcium-fortified soy or rice milk are alternatives to dairy products. Calcium-containing foods found in other groups include canned salmon, broccoli, figs, and whole-wheat muffins and pancakes. People who consume

TABLE 3.1 Differences Among Foods on the Same Exchange List

Exchange group	More nutrient dense	Less nutrient dense
Starch	Whole-grain bread (good source of fiber)	White bread (little fiber)
Fruit	Cantaloupe (good source of vitamin C and beta-carotene)	Apple (lacks vitamin C and beta-carotene)
Other carbohydrate	Frozen juice bar (contains some vitamins)	Sugar (contains no vitamins)
Nonstarchy vegetables	Bok choy (good source of vitamin C and beta-carotene, cruciferous vegetable)	Zucchini (lacks vitamin C and beta-carotene, not a cruciferous vegetable)
High-fat meat and meat substitutes	Peanut butter (contains unsaturated fat)	Hot dog (contains saturated fat)
Fat	Olive oil (contains monounsaturated fat)	Butter (contains saturated fat)

TABLE 3.2 Combination Foods and Fast Foods

COMBINATION FOODS LIST		
Food	**Serving size**	**Exchanges per serving**
ENTRÉES		
Tuna noodle casserole, lasagna, spaghetti with meatballs, chili with beans, macaroni and cheese*	1 cup (8 oz, or 250 g)	2 carbohydrates, 2 medium-fat meats
Chow mein (without noodles or rice)*	2 cups (16 oz, or 500 g)	1 carbohydrate, 2 lean meats
Tuna or chicken salad	1/2 cup (3 1/2 oz, or 100 g)	1/2 carbohydrate, 2 lean meats, 1 fat
FROZEN ENTRÉES AND MEALS		
Dinner-type meal*	generally 14–17 oz (400–500 g)	3 carbohydrates, 3 medium-fat meats, 3 fats
Meatless burger, soy based	3 oz (90 g)	1/2 carbohydrate, 2 lean meats
Meatless burger, vegetable and starch based	3 oz (90 g)	1 carbohydrate, 1 lean meat
Pizza, cheese, thin crust*	1/4 of 12 in. (30 cm) (6 oz)	2 carbohydrates, 2 medium-fat meats, 2 fats
Pot pie*	1 (7 oz, or 200 g)	2 1/2 carbohydrates, 1 medium-fat meat, 3 fats
Entrée or meal with less than 340 cal	about 8–11 oz (250–325 g)	2–3 carbohydrates, 1–2 lean meats
SOUPS		
Bean*	1 cup (8 oz, or 250 g)	1 carbohydrate, 1 very lean meat
Cream (made with water)*	1 cup (8 oz, or 250 g)	1 carbohydrate, 1 fat
Instant*	6 oz (175 g) prepared	1 carbohydrate
Instant with beans or lentils*	8 oz (250 g) prepared	2 1/2 carbohydrates, 1 very lean meat
Split pea (made with water)*	1/2 cup (4 oz, or 125 g)	1 carbohydrate
Tomato (made with water)*	1 cup (8 oz, or 250 g)	1 carbohydrate
Vegetable beef, chicken noodle, or other broth type*	1 cup (8 oz, or 250 g)	1 carbohydrate
FAST FOODS LIST**		
Food	**Serving size**	**Exchanges per serving**
Burrito with beef*	1 (5–7 oz, or 150–200 g)	3 carbohydrates, 1 medium-fat meat, 1 fat
Chicken nuggets*	6	1 carbohydrate, 2 medium-fat meats, 1 fat

(continued)

TABLE 3.2 ***(continued)***

FAST FOODS** LIST		
Food	**Serving size**	**Exchanges per serving**
Chicken breast and wing, breaded and fried*	1 each	1 carbohydrate, 4 medium-fat meats, 2 fats
Chicken sandwich, grilled*	1	2 carbohydrates, 3 very lean meats
Chicken wings, hot*	6 (5 oz, or 150 g)	1 carbohydrate, 3 medium-fat meats, 4 fats
Fish sandwich with tartar sauce*	1	3 carbohydrates, 1 medium-fat meat, 3 fats
French fries*	1 medium serving (5 oz, or 150 g)	4 carbohydrates, 4 fats
Hamburger, regular	1	2 carbohydrates, 2 medium-fat meats
Hamburger, large*	1	2 carbohydrates, 3 medium-fat meats, 1 fat
Hot dog with bun*	1	1 carbohydrate, 1 high-fat meat, 1 fat
Individual pan pizza*	1	5 carbohydrates, 3 medium-fat meats, 3 fats
Pizza, cheese, thin crust*	1/4 12 in. (30 cm) (about 6 oz, or 175 g)	2 1/2 carbohydrates, 2 medium-fat meats
Pizza, meat, thin crust*	1/4 12 in. (30 cm) (about 6 oz, or 175 g)	2 1/2 carbohydrates, 2 medium-fat meats, 1 fat
Soft-serve cone	1 small (5 oz, or 150 g)	2 1/2 carbohydrates, 1 fat
Submarine sandwich*	1 sub (6 in., or 15 cm)	3 carbohydrates, 1 vegetable, 2 medium-fat meats, 1 fat
Submarine sandwich (less than 6 g of fat)*	1 sub (6 in., or 15 cm)	2 1/2 carbohydrates, 2 lean meats
Taco, hard or soft shell*	1 (3–3 1/2 oz, or 90–100 g)	1 carbohydrate, 1 medium-fat meat, 1 fat

* = 400 mg or more sodium per exchange.

**Ask at your favorite fast-food restaurant for information about your favorite fast foods or check websites.

The Exchange Lists are the basis of a meal planning system designed by a committee of the American Diabetes Association and the American Dietetic Association. Although they are designed primarily for people with diabetes and others who must follow special diets, the Exchange Lists are based on principles of good nutrition that apply to everyone.

American Diabetes Association and American Dietetic Association 2003.

small amounts of foods containing calcium might need supplements to meet their daily calcium requirements.

Many food manufacturers are developing foods and beverages specifically formulated to enhance athletic performance. These products can fit into the exchange lists as long as the nutrient content is known. For example, some energy bars are the equivalent of 2 carbohydrate exchanges and 1 fat exchange. Others contain a significant amount of protein. For those who frequently use the exchange system, the number of exchanges can be determined by looking at the nutrient content on the label.

Although the exchange lists are simple and this simplicity can cause problems, the lists are an easy way to learn the nutrient composition of foods and can serve as an effective tool. Another way to learn about the nutrients in food is to read food labels. A computerized diet analysis is another tool that provides excellent food composition data, and it compares current intake with recommended guidelines. Each of these tools helps athletes, sports medicine and fitness professionals, and others learn more about foods and nutrition.

Using Exchange Lists

The plan in table 3.3 was created by a dietitian for a 132-pound (60 kg) female athlete using the Exchange Lists for weight management. It contains approximately 2,400 calories, 364 grams of carbohydrate (6 grams per kilogram of body weight), 94 grams of protein (1.5 grams per kilogram of body weight), and 60 grams of fat (1 gram per kilogram of body weight). The foods are commonly found in the grocery store.

Athletes who want to consume more protein and less carbohydrate than the diet shown could add more protein foods (from the milk and meat lists) and reduce carbohydrate (especially from the "other carbohydrate" section of the list).

You might ask, "What is the best diet plan?" The answer is, "The one that the athlete prefers." The diet-planning theme can have hundreds of variations. But despite the differences, the key issues are the same: adequate caloric intake, meeting recommended nutrient guidelines, flexibility in diet planning, and emphasis on individual preferences.

TABLE 3.3 Example of Planning a Diet Using Exchange Lists

Food	Exchange	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (cal)
1 1/2 cups unsweetened ready-to-eat cereal	2 starches	30	6	0	160
1 cup fat-free milk	1 fat-free milk	12	8	0	90
1 piece whole-wheat toast	1 starch	15	3	0	80
2 tsp margarine	2 fats	0	0	10	90
1 tbsp jam	1 other carbohydrate	15	0	0	60
1 cup orange juice	2 fruits	30	0	0	120
1 large banana	2 fruits	30	0	0	120
6 ginger snaps	2 other carbohydrates	30	0	0	120
4 oz (125 g) canned tuna (in water) with 3 tsp mayo	4 very lean meats + 3 fats	0 0	28 0	4 15	140 135
2 small rolls	2 starches	30	6	2	160
3 tsp margarine	3 fats	0	0	15	135
1 cup salad greens	1 nonstarchy vegetable	5	2	0	25
1/2 cup pudding	2 other carbohydrates	30	0	0	120

(continued)

TABLE 3.3 ***(continued)***

Food	Exchange	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (cal)
1 cup nonfat yogurt (plain or artificially sweetened)	1 fat-free milk	12	8	0	90
1 cup canned unsweetened pineapple	2 fruits	30	0	0	120
1 cup carbohydrate sport drink	1 other carbohydrate	15	0	0	60
4 oz (125 g) chicken breast (no skin)	4 very lean meats	0	28	4	140
1 small corn on the cob	1 starch	15	3	0	80
2 tsp margarine	2 fats	0	0	10	90
1/2 cup cooked carrots	1 nonstarchy vegetable	5	2	0	25
1/2 cup sherbet	2 other carbohydrates	30	0	0	120
1 1/4 cup fresh strawberries	1 fruit	15	0	0	60
1 cup carbohydrate sport drink	1 other carbohydrate	15	0	0	60
Totals		**364**	**94**	**60**	**2,400**

Carbohydrate, protein, fat, and calorie values are estimates. Calorie values may be rounded up or down.

Although diet planning requires time and knowledge, it is achievable. Exchanges lists might make planning easier, but they are just one tool. Other ways to plan a diet are to follow a plan published in a sport nutrition book or article or to read labels carefully.

Nutrition Labeling

The Nutrition Labeling and Education Act (NLEA) of 1990 is a Food and Drug Administration (FDA) regulatory law that governs food labeling guidelines that manufacturers must follow (3). Part of the NLEA implementation occurred in 1994, when the FDA mandated that a Nutrition Facts Label must appear on all food products except meats (regulated by USDA) and some very small packages that require a modified label. The purpose of the act is to help consumers compare similar products with one another and to have accurate information about the nutrients contained in each food.

The Nutrition Facts Panel (figure 3.1) has explicit guidelines for how the panel appears on the food label and the nutrient information contained within the panel. The order in which nutrients are placed is consistent across all products starting with serving size and servings per container, total calories, and calories from fat near the top. Total fat, saturated fat, trans fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, and protein appear in descending order down the panel. Only two vitamins (A and C) and two minerals (calcium and iron) are required to be placed on the Nutrition Facts Panel. Obviously, all the vitamins and minerals are important, but those four nutrients are important to the overall population and are those for which population data suggest intake is low.

This consistent Nutrition Facts Label makes comparisons of like products simple and helps consum-

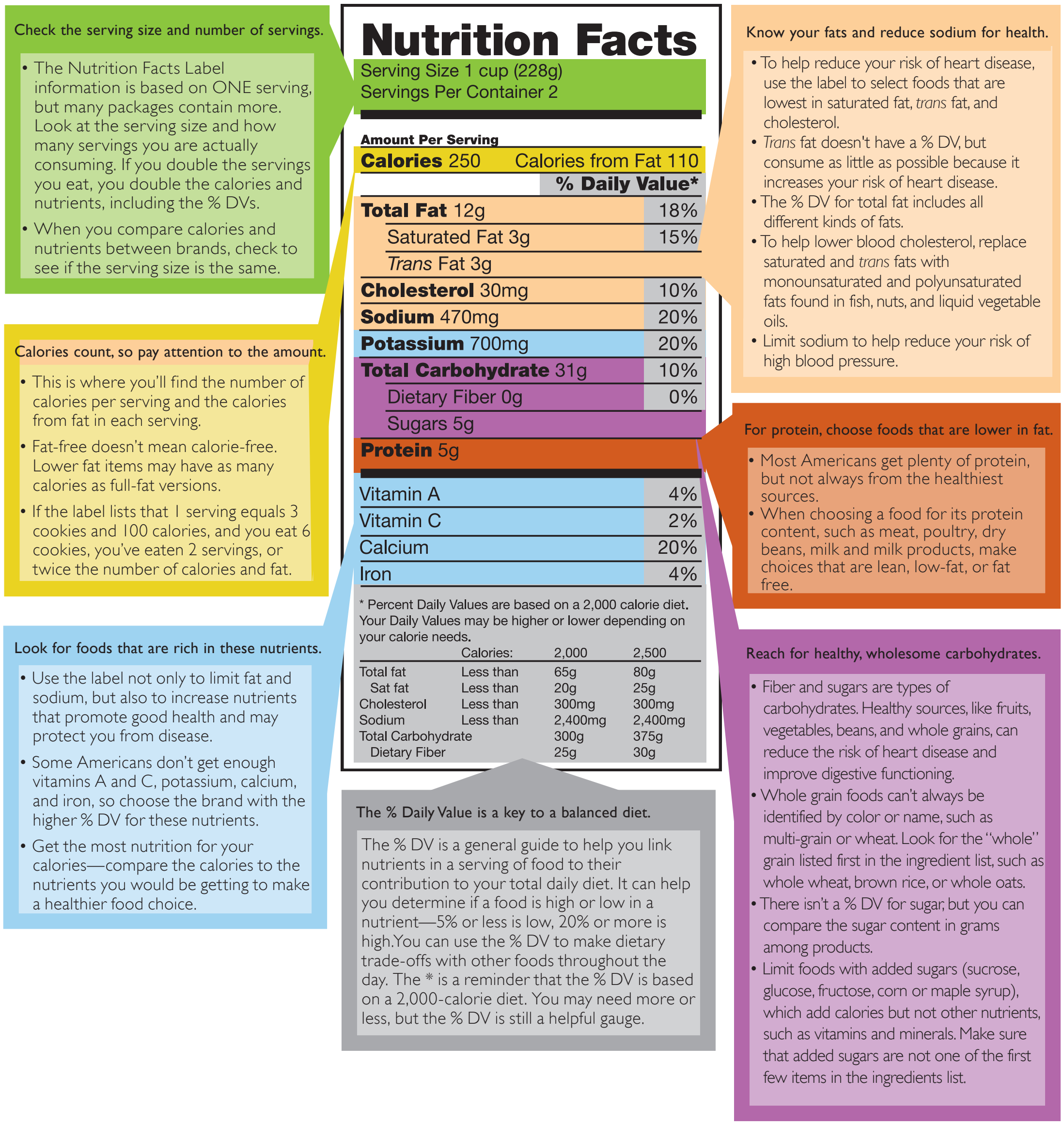

FIGURE 3.1 Nutrition Facts Panel.

Reprinted, by permission, from J.M. Mora, 2009, *Triathlon 101*, 2nd ed. (Champaign, IL: Human Kinetics) 122.

ers who have specific conditions such as diabetes or high cholesterol make food choices appropriate for their diets. Part of the NLEA requires updating nutrition labeling that relates to public health. Since 2006 trans fats must be shown on the nutrition label. Trans fats have been shown to raise cholesterol levels, and they have no health benefits. Trans fats are found in processed foods in which the fat has been hydrogenated. The amount of trans fat must be listed on a separate line under saturated fat. Usually it will be listed in 0.5-gram increments, but if the product contains less than 0.5 grams, the amount listed will be 0. Amounts greater than 5 grams may round to the nearest gram. There is no Daily Value (DV) for trans fat, because people should eat as little trans fat as possible.

The addition of trans fat on the Nutrition Facts Panel is a good example of a government regulation designed to help the public choose a more healthful diet. Another example is allowing specific nutrient content and health claims to be placed on the food label. Nutrient content claims are simple phrases that have explicit criteria that the food must meet for the claim to be allowed on the label. For example, "low fat" means that one serving of the food contains 3 grams of fat or less. Other examples of allowed nutrient content claims include the following:

- Fat free—less than 0.5 grams of fat per serving
- Sugar free—less than 0.5 grams of sugar per serving
- Low sodium—less than 140 milligrams of sodium per serving
- Reduced—contains at least 25% less of a specific nutrient or of calories than the regular product

Athletes who read food labels to help make healthful nutrition decisions may see these or other allowable nutrient content claims on food labels and be confident that the product meets these strict criteria.

Health claims may also appear on food and supplement labels. The FDA regulates these claims carefully and allows only claims that have strong scientific support. Health claims characterize the relationship between a food or food component and a health-related condition. They can claim only disease or condition risk reduction; they cannot make claims about the diagnosis, cure, mitigation, or treatment of disease (4). A thorough review process rating the scientific evidence is required by the FDA before the claim can be used. A sample allowable health claim relates to the consumption of fruits and vegetables and cancer. The claim "diets low in fat and rich in fruits and vegetables may reduce the risk of certain cancers" is allowed. Note that this message is consistent with the Dietary Guidelines and the MyPlate symbol in which fruits and vegetables make up one-half of the traditional meal plate. More health claims can be approved as scientific investigation offers new evidence that a particular nutrient or group of foods provides health benefits to consumers.

Unfortunately, some of the claims are confusing. For example, the following statements appear to mean the same thing:

- Statement 1: Calcium builds strong bones.
- Statement 2: Calcium helps prevent osteoporosis.

The first statement is a health claim that is acceptable on a label because it relates to the structure and function of bone and does not make a statement about a specific disease. But the second statement cannot be used on food (or supplement) labels because osteoporosis is a disease and health claims related to disease prevention are not allowed.

The health and nutrient content claims discussed for foods can also be used on dietary supplement labels. The rules that apply to food manufacturers apply as well to manufacturers of dietary supplements. Chapter 5 discusses some of the similarities and differences in labeling regulations between foods and dietary supplements.

Summary

Translating nutrient recommendations into a diet plan takes knowledge, time, and effort. Using exchange lists is one way to make diet planning simpler. A dietitian can help athletes understand the use of exchange lists in meal planning. Sports medicine and fitness professionals are an important part of the nutrition education and planning process. Helping athletes identify nutrient-dense foods and make informed choices about what and how much to eat is critical to their sport performance and well-being. Food labels provide excellent information to help athletes make these healthful choices. No matter the method used for meal planning, flexibility and individual preferences must be taken into account.

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chapter 4

Sport Beverages, Bars, and Gels

One of the greatest challenges for a professional is translating scientifically based recommendations into practice. In the area of nutrition this means first understanding the science-based recommendations and then helping athletes choose foods that meet those recommendations. This task requires knowing the composition of various foods and beverages.

Against the backdrop of the nutrients that athletes need and the foods in which they are found is an intense effort by companies to market foods to those who exercise. The sport beverage market is a classic example. Once dominated by a single product, the market is now crowded with products. Sales of sport beverages have been brisk. Sales, and the advertising budgets that fuel those sales, are predicted to continue to increase. Because of heavy advertising and aggressive sales forces that target universities, gyms, and clubs; the use of scientific research as a marketing tool; and the testimony of world-class athletes, sports medicine and fitness professionals must keep up with the changing sport beverage industry and accurately assess the advertised science behind those products.

In addition to the mounting sales of sport beverages, the number and type of energy gels and bars, meal-replacement products, and exercise recovery products is also rapidly growing. The advertising for these products is also becoming more intense as companies compete with each other for market share of similar products.

This chapter discusses products that are frequently marketed to athletes—sport beverages, energy drinks, sport gels, and energy bars. Reading and evaluating food label claims will help sports medicine and fitness professionals assess the various products and determine their appropriateness for athletes' use.

Sport Beverages

Forty years ago, water was the only fluid-replacement beverage available to athletes, and they were often prohibited from drinking it during practice. Much has changed! Today it is known that withholding fluid is dangerous, and athletes have access to many fluid-replacement beverages besides water.

Sport beverages were originally developed to replace the nutrients lost in sweat: water, sodium, chloride, and potassium. In addition, a small amount of sugar was added to provide energy. As the science behind dehydration, rehydration, and glycogen resynthesis has evolved, sport beverages have also evolved. Today's beverages contain water and one or more of the following: carbohydrate, electrolytes, protein, antioxidant vitamins, B vitamins, central nervous system stimulants, and other substances known to influence performance.

Carbohydrate is perhaps the most studied nutrient for athletes, and recommendations for carbohydrate consumption before, during, and after exercise have been made. In addition to investigating the amount and timing of carbohydrate intake, studies have examined the type of carbohydrate (e.g., glucose or fructose) and its influence on blood glucose. Research has shown the benefits of well-formulated sport beverages, and many beverages have been designed for particular situations, such as preexercise or postexercise intake. Most sport beverages contain carbohydrate; what differentiates them is the amount and type of carbohydrate.

Water or sport beverage? The choice depends on the type and duration of exercise, fluid goals, nutrient goals, and individual preferences.

Because sport beverages are popular, understanding the various options is important. Preexercise beverages could be different from postexercise beverages because pre- and postexercise fluid and nutrient goals are different. Beverage choices appropriate during exercise or competition vary depending on the duration and intensity of exercise and environmental conditions.

Sport beverage manufacturers keep a careful watch on the scientific publications related to fluid, carbohydrate, and electrolyte intake and improved performance. They have successfully developed drinks that help athletes meet the demands of their training. Significant differences occur between beverage categories, but few differences exist among the drinks within a category (1).

Categories of Sport Beverages

With numerous sport beverages on the market, many formulated for particular situations, understanding the similarities and differences is easier if the beverages are grouped into categories. For our purposes three broad categories are used: (1) carbohydrate and electrolyte beverages, (2) meal-replacement beverages, and (3) "energy" drinks. A fourth group of miscellaneous beverages has also been included. These products are not as easily categorized, but they usually exhibit similarities to and marked differences from the beverages in the major categories. Nutrition is complicated and defies easy answers; sport beverages are no exception. When athletes ask, "Which is the best sport beverage?" the following information should help sports medicine and fitness professionals provide a useful answer. Let's look at our first category: carbohydrate and electrolyte beverages.

Carbohydrate and Electrolyte Beverages

Beverages that contain carbohydrate are beneficial for athletes who need carbohydrate and water before or during exercise (2). The concentration of carbohydrate is important because concentrations that are too high delay gastric emptying. Fluid must empty quickly from the stomach into the gastrointestinal (GI) tract, where it is absorbed; otherwise, it might slosh around in the athlete's stomach. Water that stays in the gut is not getting to the body where it is needed to help dissipate heat and deliver vital nutrients to the working muscles. In the GI tract carbohydrate and sodium increase the rate of water absorption; therefore, their presence in sport beverages is advantageous.

In addition to knowing the carbohydrate concentration, knowing the source of carbohydrate is important because sources vary in their influence on blood glucose. Carbohydrate may be in the form of glucose, sucrose, fructose, high-fructose corn syrup, or glucose polymers (chains of glucose). Glucose polymers are absorbed more slowly than the other forms of carbohydrate.

These beverages usually contain 6 to 8% carbohydrate, a concentration that is emptied quickly enough from the gastric area to prevent GI distress (3). These drinks contain approximately 15 grams of carbohydrate per 8-ounce (240 ml) serving.

Including carbohydrate in sport drinks serves an important physiological function. As discussed in chapter 2, carbohydrate is a main energy source during exercise. Athletes exercising for more than 1 hour at a time or at high intensity gradually deplete carbohydrate stores (glycogen). Consuming carbohydrate in beverages delays glycogen depletion and helps an athlete continue to exercise longer and at higher intensity.

Beverages containing 6 to 8% carbohydrate also contain small amounts of electrolytes, usually 50 to 120 milligrams of sodium and 30 to 50 milligrams of potassium. These amounts are not significant and are certainly not adequate to replenish electrolytes entirely, but they are beneficial. In general, after exercise athletes should remember to salt naturally low-sodium foods such as fresh vegetables, eat salty snacks such as nuts, and consume potassium by eating a variety of fruits and vegetables. Additional table salt is not needed if the athlete's diet contains a lot of processed foods that contain salt such as canned soup or packaged snacks.

The rule of thumb for carbohydrate concentration in beverages consumed before and during exercise has been 6 to 8%. Some athletes, however, cannot tolerate these concentrations and either dilute these drinks with water or choose drinks with lower concentrations. Athletes usually use trial and error to dilute sport drinks until they find a combination of beverage and water that does not induce GI distress.

A second category of sport drinks contains a higher percentage of carbohydrates. Elite distance cyclists, such as Tour de France riders who depend on high carbohydrate concentrations while on the bike to fuel their grueling exercise over the 3-week race, use this technique. These drinks also contain water and electrolytes (predominantly sodium), but they have more carbohydrate than the typical 6 to 8% carbohydrate sport drink and often contain slightly more sodium. Each 8-ounce (240 ml) drink contains about 50 grams of carbohydrate. These drinks should be used whenever athletes need a significant carbohydrate source: several hours before exercise, immediately after exercise, and during carbohydrate loading. Highly concentrated carbohydrate products are clearly the exception and not the rule.

Carbohydrate and electrolyte beverages are used before exercise to top off glycogen stores and fluid levels and during exercise to provide small amounts of carbohydrate to improve GI emptying and delay glycogen depletion. The electrolytes help replace some of the sodium and potassium lost in sweat. In general, when athletes exercise for 1 hour or longer or exercise in heat and high humidity, a carbohydrate and electrolyte beverage is preferred over water.

Although carbohydrate and electrolyte beverages are the most common drinks sold to athletes, meal-replacement drinks are also popular.

Meal-Replacement Beverages

Meal-replacement beverages are a convenient substitute for a preexercise meal if they are consumed several hours before exercise. They also provide a suitable postexercise meal. They can provide a high-energy snack for athletes on high-calorie diets. These beverages are an excellent source of nutrients and calories for athletes who skip meals, eat foods that have low nutrient densities, or have heavy travel or training schedules that make meal preparation difficult. They are a convenient source of nutrients, especially for athletes who have rigorous training schedules and need more than 3,000 calories a day.

Meal-replacement beverages contain between 200 and 400 calories. These beverages provide 30 to 55 grams of carbohydrate, 9 to 22 grams of protein, and 6 to 11 grams of fat. The percentage of total calories from carbohydrate, protein, and fat varies, so there is a meal-replacement beverage for every diet. For example, Ensure is a high-carbohydrate beverage (65% of total calories are carbohydrate), whereas 40-30-30 Balance drink is high in protein (29%) and meets the guidelines of the zone diet. Gatorade's Nutrition Shake is lower in fat than most in this category. Some vitamins and minerals are added to enhance the nutrient profile of all meal-replacement beverages.

Consuming carbohydrate along with protein immediately after exercise promotes glycogen resynthesis (4), and taking in sodium helps the body retain fluid and helps maintain the body's drive to drink (5). Therefore, meal-replacement beverages are particularly appealing after exercise because they provide a convenient way to replenish a significant amount of carbohydrate, protein, and electrolytes, especially for athletes who train or compete every day. Sport beverages containing 6 to 8% carbohydrate, on the other hand, do not contain enough carbohydrate for adequate glycogen resynthesis or enough sodium. And water provides only fluid to help the athlete rehydrate.

From a practical perspective, athletes find meal-replacement beverages to be convenient because they cover all the bases, but athletes should know that glycogen resynthesis and rehydration can also be achieved with a combination of food and water. Some athletes don't like meal-replacement beverages because they are not "real" food or because they may be more expensive than food that can be prepared at home.

Similar to meal-replacement beverages are sport recovery beverages. These ready-to-drink products contain varying amounts of carbohydrate and protein and rarely contain any fat. Athletes who have a difficult time eating food after hard workouts need the convenience of a ready-to-drink beverage. Likewise, those who have high calorie needs are ideal candidates for these types of beverages. Most of these products contain less than the amount of carbohydrate (50 to 100 grams) necessary to start the replenishment of glycogen stores but do contain the level of essential amino acids necessary (6 to 20 grams) for postexercise needs. Recovery drinks can be a convenient addition to early postexercise replenishment by getting some carbohydrate and protein into the system immediately. The athlete can then get a more substantial meal to recover fully.

A new drink category that has taken the market by storm is "energy" drinks. Let's look at the composition of energy drinks.

Energy Drinks

Perhaps no word is more powerful to athletes and active people than *energy*. Advertisers know this, so energy drinks are heavily advertised to people who might be fatigued, a common condition for athletes. When athletes complain of fatigue it is important to determine what caused the problem and whether it is a long-term situation. Fatigue might be caused by one or more of the following: insufficient energy (calories), insufficient carbohydrate, dehydration, iron-deficiency anemia, lack of sleep, or overtraining. Chronic fatigue is a serious issue, and the cause of fatigue must be determined and reversed.

Fatigue is a complex issue. When athletes are fatigued, they may be tempted to apply the easy solution by ingesting a stimulant to mask it. In the case of energy drinks, caffeine provides the stimulant. If the source is herbal, less-than-savvy consumers might not recognize that caffeine is present. In general, energy drinks are highly sweetened and contain caffeine. They contain about 30 grams of carbohydrate in the form of high-fructose corn syrup. Most include vitamins, although the amount may vary considerably, amino acids such as taurine, and herbs such as ginkgo and ginseng.

An 8-ounce (240 ml) energy drink is too concentrated (11 to 13%) to consume during exercise, but many advertisements for energy drinks promote the benefit of drinking them before exercise. Before considering its use before exercise, athletes must know how a caffeine-containing drink will affect the body. Caffeine is a central nervous system stimulant. For people who ingest caffeine infrequently or those who are sensitive to its effects, a large dose can cause a jittery, nervous response that could impair athletic performance. Some people experience light-headedness or nausea after consuming too much caffeine. Caffeine may also disrupt an athlete's sleep pattern (6). Some athletes like the effect that caffeine has and report that they feel "stimulated" to train harder or longer when they consume it before workouts, especially strength training. One of the known effects of caffeine is a heightened sense of awareness and a decreased perception of effort (7).

Energy drinks may contain 80 to 200 milligrams of caffeine, depending on the brand. Coffee brewed using a high caffeine extraction method such as a drip coffeemaker contains about 10 to 20 milligrams of caffeine per ounce (30 ml). The size of a serving of coffee in the United States is getting larger; 8 ounces (240 ml) is now a standard serving. Therefore, a typical large cup of coffee may contain 80 to 160 milligrams of caffeine. A 12-ounce (360 ml) caffeinated soft drink has 30 to 60 milligrams of caffeine. Athletes should consider the effect that a large cup of coffee has on them when deciding whether to consume energy drinks.

In some respects energy drinks and soft drinks are the same. High-fructose corn syrup provides the carbohydrate for both, and both are about 11% carbohydrate. The energy drinks usually contain added vitamins, something that the FDA does not allow in soft drinks.

Athletes should read energy drink ingredient labels carefully to determine the contents. Guarana, kola nuts, and mate are herbal sources of caffeine, but the FDA does not require manufacturers to list the amount of caffeine on the label. Herbs might be included, but unless the herbal extract has been standardized, the amount contained in the drink may differ from batch to batch. Therefore, consumers can't determine how much caffeine and herbs these drinks contain.

Caffeine might be appropriate for some athletes, but dose is important, and many athletes are subject to guidelines that restrict excessive caffeine intake. Caffeine is on the NCAA banned substance list, and athletes can be disqualified from competition and future competitions if a high level of caffeine is found in the urine test (8). Over-the-counter medications might also contain caffeine. Athletes have been disqualified and therefore must be aware of their overall caffeine intake, especially when competing or performing.

Other Beverages Marketed to Athletes and Active People

Since the 1970s sweetened beverages have become an increasing part of the American diet. Sport beverages, once marketed to only competitive athletes, are now widely advertised to athletes at all levels of training, including recreational athletes who exercise but do not train. In recent years companies have expanded their marketing base to include "active and busy people," some of whom participate in little physical activity. Distributors of energy beverages target people who are physically or mentally fatigued or both. In the eyes of the most aggressive marketers, everyone can benefit from a sport or energy beverage.

Sport and energy beverages are points on the sweetened-beverage continuum that range from flavored water to highly concentrated carbohydrate solutions. Many contain high-fructose corn syrup, the main ingredient in soft drinks. Although athletes need beverages containing carbohydrate in certain circumstances, these drinks can add unwanted calories to the baseline diet, especially for people who do not expend many calories during exercise. Therefore, sports medicine and fitness professionals must always consider the circumstances in which sport beverages will be used.

Other beverages have been introduced to the market. The newest trend in sport drinks is "enhanced water," which is lightly flavored water with added vitamins and other nutrients. Popular additions include the antioxidant vitamins—A, C, and E—and some of the B-complex vitamins, usually niacin, pantothenic acid, and vitamins B6 and B12, and occasionally protein, caffeine, fiber, and herbal supplements.

Many beverage companies produce multiple types of enhanced waters with varied nutrients and flavors. Some are specifically marketed for a particular concern or condition such as the "stress waters," which contain B-complex vitamins with herbal flavorings such as lavender or chamomile or "defense" formulations, which contain antioxidant vitamins purported to diminish free radical production. In most cases the herbal or nutrient supplement level in these waters is quite low; eating foods that contain the nutrients will provide far greater amounts. Additionally, these waters often contain sugars for flavor enhancement, thus adding calories at a level similar to that in soft drinks. Others are calorie free because they use artificial sweeteners or other noncalorie flavoring.

Many people who purchase sport drinks are recreational athletes trying to lose weight, so they're more interested in a calorie-free product than a drink to replace carbohydrate and sodium. Because this market segment is large, many sport beverages now contain artificial sweeteners, so they are sugar free and calorie free. A look at the labels might reveal surprising nutrient information. Some sport beverages are little more than flavored water with vitamins added. It is ironic that the original sport drinks—initially marketed to provide athletes energy through calories from carbohydrate—are not appealing to recreational athletes who exercise primarily to lose weight.

The sport beverage market is not static, so sports medicine and fitness professionals must keep an eye out for new products. The key to determining the appropriateness of a new product is to consider the athlete's goals and then evaluate the ingredients listed on the label to determine whether the product will meet those goals.

Adequate fluid consumption for all active people is certainly important for health and sport performance. Enhanced waters may be part of the hydration schedule just as sport drinks and plain water are part of the hydration equation. Sport beverages are popular, but the same goals may be achieved through a combination of the right foods and water.

Now that you understand the wide range of choices, it's time to discuss which is best.

Which Sport Beverage Is Best?

Athletes will be quick to ask which sport beverage is best. Before recommending one, you must know the athlete's need for fluid, carbohydrate, and electrolytes. Ask the athlete whether he or she will consume the beverage before, during, or after training or competition. Consider the athlete's overall diet and whether sweetened drinks represent an excessive number of calories.

When helping an athlete choose sport beverages, you should present all the options. Although a particular beverage might be the most popular in its category, not every athlete will like it and a less popular beverage can be just as effective. Coaches and certified athletic trainers must recognize that individual differences exist. Teammates performing the same exercise will differ in the amount and concentration of a beverage that they can tolerate. Taste preferences will vary; not everyone on the team will like the same beverages. One size does not fit all, so as many options as possible should be offered to athletes.

Consider the type, duration, and intensity of exercise and the environmental conditions in which the athlete exercises when deciding which groups of beverages to recommend. In most cases, you will recommend several different beverages to the same athlete to be consumed at different times of the day. Athletes may need a meal-replacement or recovery beverage after a hard workout but only water and a small snack after an easy or taper workout. An athlete exercising in a climate-controlled and air-conditioned gym may be able to alternate water and sport drinks throughout a workout, whereas the same athlete running outside when it is hot and humid would do best with a sport drink for the entirety of the training session. Table 4.1 summarizes the categories of beverages discussed in this chapter and provides guidelines for the appropriate use of each.

After you determine the athlete's needs, you should recommend a group of beverages rather than a specific brand. Encourage athletes to try a variety of drinks to find the one that suits them best. Even teammates performing the same exercise will have individual differences and preferences. Inform

TABLE 4.1 Summary of Sport Beverage Categories

Beverage category	Nutrient information	Recommended uses
Carbohydrate (CHO)–electrolyte	6–8% CHO (~15 g CHO/8 oz, or 240 ml) ~55–100 mg sodium/8 oz (240 ml) ~30–50 mg potassium/8 oz (240 ml)	Before and during exercise. Best option for during exercise lasting 1 hour or longer and for exercise in high temperatures. Solutions of 6 to 8% CHO enhance gastric emptying. Sodium in these beverages enhances thirst, which helps increase total volume consumed.
Meal replacement and recovery	200–350 cal per serving ~8–20 g protein 30–50 g CHO 6–10 g fat Often contain added vitamins and minerals	Ideal as a snack or part of a meal for athletes with high energy needs. Also good for athletes who find it difficult to consume solid foods immediately after exercise. Most have the correct amount of protein (6–20 g) for recovery but may lack CHO recovery amounts (50–100 g).
Energy drinks	Vary in CHO content from 0–30 g/8 oz (240 ml); sugar-free versions have 0 g CHO Stimulant substances vary, but most contain caffeine or guarana Often contain added B vitamins	Not recommended for athletes, but some athletes may choose these over other traditional caffeinated beverages without much concern. These beverages contain caffeine and potentially other stimulant substances that may be banned by some sport organizations.
Other beverages	Multiple products such as flavor-enhanced waters and soft drinks with added vitamins and some minerals Sugar-free versions are offered, so CHO content varies	Ideal for athletes who find plain water boring or unpalatable. These beverages can stimulate healthier levels of fluid intake because of the flavors. Not intended for endurance athletes during exercise bouts.

athletes that in many cases they can obtain the same nutrients from food and water combinations.

In addition to having to choose from a variety of sport beverages, athletes also face numerous choices in energy bars.

Energy Bars

Energy bars are generally marketed as a pre- or postworkout snack. One bar usually contains 200 to 300 calories, as shown in table 4.2. In the case of energy bars, the word *energy* refers to calorie-containing nutrients, not caffeine. All bars are highly fortified with a variety of vitamins and minerals. Some limit carbohydrate and are appropriate for diets such as the zone diet, whereas others are high in carbohydrate. Protein and fat content varies, so consumers can choose one with the macronutrient contribution that they prefer. Energy bars are a convenient choice for athletes who won't be able to eat a meal for several hours and need a substantial snack. But people who take in too many calories might want to limit the number of energy bars that they eat during the day.

Certified athletic trainers and fitness professionals who work with athletes at NCAA Division I institutions must be aware of NCAA bylaws regarding energy bars. NCAA Division I institutions may provide only non-muscle-building nutritional supplements to athletes, provided that they do not contain NCAA-banned substances. Non-muscle-building supplements are defined as carbohydrate and electrolyte drinks, energy bars, carbohydrate boosters, and vitamins and minerals that contain less than 30% of calories from protein. The rationale behind this rule is that muscle-building supplements enhance performance and benefit athletes enrolled in programs that can afford to provide them.

Muscle-building supplements are carbohydrate and electrolyte drinks, energy bars, carbohydrate boosters, and vitamins and minerals that contain more than 30% of calories from protein (based solely on the package label). The following examples are provided by the NCAA to assist certified athletic trainers and others in calculating the percentage of calories from protein (8):

- Energy bar contains 24 grams of protein with a caloric value of 250; 24 grams × 4 = 96 calories; 96/250 = 0.384.

  Percentage of protein = 38%. As an example, this energy bar would not be permissible.
- Energy bar contains 17 grams of protein with a caloric value of 250; 17 grams × 4 = 68 calories; 68/250 = 0.272.

  Percentage of protein = 27%. As an example, this energy bar would be permissible.

An institution that is thinking about providing energy bars must follow the NCAA regulations. Some companies market products that comply with these NCAA guidelines. Guidelines will change as collegiate sport regulations evolve, so sports medicine professionals working in the collegiate arena need to stay abreast of the rules.

Athletes often choose to consume both liquid (sport beverages) and solid (energy bars) foods, but semisolid foods are also available.

Gels and Alternative Products

Marathon runners, triathletes, and other ultraendurance athletes must consume carbohydrate to sustain themselves during long exercise sessions. Unfortunately, many runners have high gut intolerance for solid food products, including energy bars. Although these athletes know that they must take in carbohydrate during performance, they find it difficult to do so without suffering GI distress. Sometimes the distress is so severe that they cannot continue competing.

In the early 1990s a new carbohydrate-based product, energy gel, was created. This product, known simply as GU, first gained fame as a carbohydrate source that was neither liquid nor solid. As a carbohydrate gel, it provides energy but contains no fiber, fat, or protein, compounds that are difficult to absorb during long bouts of exercise.

Most energy gels contain approximately 25 grams of carbohydrate and 100 calories. Most of the carbohydrate is in the form of maltodextrin, which is a slow but sustained glucose source. Some fructose may also be included. Many manufacturers now offer sport gel products. Some newer gels are adding caffeine or vitamins, and all come in multiple flavors. Gels come in packets that athletes can easily rip open while running or cycling. The gel is washed down with water. A powdered form that can be used to make a hydration solution is also available. Many athletes experiment with gels and water during training to determine the proper amounts to use during competition.

Among the latest trends in endurance exercise are products similar to sport gels in nutrient content but different in delivery method. Carbohydrate cubes, blocks, and even jelly bean products are popular sources of carbohydrate for athletes who perform in long-duration competitions and workouts. These products contain a similar amount of carbohydrate in each package as gels do. During very long rides, runs, hikes, or other endurance events, chewing or sucking on a product with a different flavor and texture than a gel or bar is refreshing. Blocks and beans provide this option in convenient packaging that is lightweight and easy to carry. As with gels, they should be consumed with water, which is a perfect way to maintain adequate hydration while taking in the needed carbohydrate.

No matter which products athletes choose, they can find information about the product by carefully reading label information. Most sport nutrition products have a Nutrition Facts Label. Occasionally, particularly in the case of high-protein supplements, a Supplement Facts Label will be used instead of a Nutrition Facts Label. Food label information was discussed in chapter 3; supplement labels are discussed in chapter 5, which covers sport supplements. Those working with competitive athletes must distinguish between these two labels and be aware of the regulations that guide the different labels.

Using Nutrition Label Information

Athletes must use their knowledge of nutrition, their sport goals, and product label information to determine which of these specialized products to use during training or competition. An endurance

TABLE 4.2 **Energy Bars**

Product name	Energy (cal)	Carbohydrate (g)	Sugar (g)	Fiber (g)	Carbohydrate source	Protein (g), source	Lipids	Sodium (mg)	Potassium (mg)	Other nutrients
Balance Bar (original)	200	22–24	17–20	<1–2		14 (6.25 g are soy)	6 g fat (1.5–3.5 g saturated fat, 0–<5 mg cholesterol)	90–230	70–220	Exchange values: 2 lean meats, 1.5 carbohydrate ~40% carbohydrate, 30% each protein and fat 23 vitamins and minerals, including 100% DV of vitamins C and E GI = 28 (low)
Clif Bar	230–250	44–48	20–21	5	Various including brown rice syrup, rolled oats, cane juice, fig paste, dried fruits	8–10 (some soy)	3–5 g fat (0.5–1.5 g saturated fat, no cholesterol)	90–150	220–250	Certified organic 23 vitamins and minerals, including 100% DV of vitamins C and E 39–51% carbohydrate, 14–16% protein, 35–45% fat
EAS Advant-Edge Carb Control Nutrition Bar	240	21	2	3	Oligofructose	24 (blend of caseinate, soy, whey)	5 g fat (3 g saturated fat, <5 mg cholesterol)	125	80	10–35% DV of 24 vitamins and minerals ~42% carbohydrate, 36% protein, 22% fat Advertises only 4 g of impact carbohydrate, carbohydrate that does not raise insulin significantly
Power Bar	230	45	20	3	High-fructose corn syrup, fruit juice concentrate	10 (blend of milk protein, oats)	2.5 g (0.5 g saturated fat, 0 mg cholesterol	120	180	19 vitamins and minerals including 10 that meet 100% DV ~73% carbohydrate, 17% protein, 10% fat

Nutrient content is based on a serving size of one bar.

Nutrient content varies depending on the flavor; so many nutrients are listed as ranges.

athlete who is training for a marathon should look for carbohydrate-rich products that also contain some electrolytes. The concentration of carbohydrate and electrolytes will vary based on training level, duration, and the timing of product use—before, during, or after exercise. They may choose to use a combination of sport drinks, gels, or other carbohydrate products to meet energy and hydration needs. The product label can help athletes determine this combination of nutrients, and the choice of products is reflected in the athlete's desired taste, texture, and convenience in packaging. For example, an athlete exercising at moderately high intensity in a 2-hour training run would need approximately 100 to 130 grams of carbohydrate and a range of 40 to 60 ounces (1.2 to 1.8 L) of fluid. This requirement could be met by a combination of the following products:

- Sport drink—12 to 15 grams of carbohydrate per 8 ounces (240 ml).
- Energy gel—approximately 25 grams of carbohydrate per gel.
- Cubes or blocks—sizes vary; a package of six cubes is 45 to 48 grams.
- Beans—approximately 25 grams per package.
- Plain water—water should be consumed with gels, blocks, cubes, and beans.

The Nutrition Facts Label helps the athlete determine the number of grams of carbohydrate and amount of fluid in each product. Athletes must be sure to read the label for the serving size and adjust carbohydrate or other nutrition amounts based on value per serving. The athlete then can choose the combination that is most appealing on any given training day and during competition.

By every prediction, the sport product market will continue to grow. In this competitive marketplace, new products must offer something new or different to distinguish themselves from the others. The challenge for sports medicine and fitness professionals will be to evaluate the new products and determine situations in which they might benefit an athlete's training and performance.

Chapter 3 described the Nutrition Facts Label and ideas for reading and interpreting nutrition information on the product label (see figure 3.1). The information found on the label of most food products is tremendously helpful to consumers and health professionals. Athletes and the professionals helping them can study the label and learn the number of calories and the grams of carbohydrate, fat, and protein in the product. Other nutrient information includes the amounts of saturated fat, cholesterol, sodium, dietary fiber, sugar, and protein. The percent Daily Value also appears for many vitamins and minerals. The ingredient list helps consumers determine the source of the nutrients. Detailed information about nutrition labeling is found in chapter 3. As new food products targeted toward athletes hit supermarket and fitness store shelves, food labels will provide accurate information to help athletes evaluate the nutrients and health claims. Making informed food choices is essential for athletes' health and sport performance.

Summary

Because of the profusion of beverages, bars, and other specially formulated products on the market for athletes, making quick recommendations is no longer easy. The nutrient content of each product must be reviewed. The carbohydrate concentration of products consumed during exercise is important for preventing GI upset. A properly formulated carbohydrate beverage, bar, or gel can provide a source of carbohydrate to help endurance athletes sustain their exercise. Beverages also provide the fluid necessary to combat dehydration. During the recovery period, fluid, carbohydrate, protein, and electrolytes must be replenished. Meal-replacement and recovery beverages are a convenient way to provide these nutrients. These beverages may also serve as a preexercise meal if consumed several hours before exercise to allow adequate digestion. Energy drinks typically contain caffeine, which may be derived from herbal or nonherbal ingredients.

Energy bars can provide additional calories, carbohydrate, and protein, but their nutrient contribution should be considered part of the athlete's total dietary intake. More choices mean more decisions. Reading labels for nutrient information and health claims should help athletes, sport medicine professionals, and strength coaches compare and contrast the products. Although they are not magic, sport beverages, bars, and gels can contribute nutrients that are essential to an overall nutritious diet that will support training and health.

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Note: Product information was obtained directly from company websites or other written materials.

chapter 5

Assessing Dietary Supplements

Dietary supplements are big business. Supplement manufacturers tempt athletes and active people with attractive advertisements that tout scientific-sounding product benefits. A huge category of supplements includes those marketed for weight or fat loss. Athletes need help assessing the safety and efficacy of taking dietary supplements. Sports medicine professionals who work with them must be able to assess the science (or lack thereof) behind specific supplements. Those who work with elite, professional, or NCAA athletes need to understand the supplement regulations and banned supplements.

This chapter discusses supplement regulations, the Supplement Facts Panel, and guidelines to help athletes assess the safety and efficacy of sport supplements. Supplements that have scientific research outlining their safety and efficacy for use in sport will be used as examples of how to assess supplements. Because weight and body fat loss are topics that concern many athletes, a special section on weight loss and supplements marketed for weight loss, including the process of removal of ephedra, is included.

Dietary Supplement Regulations

In the United States dietary supplements are regulated under the Dietary Supplement Health and Education Act (DSHEA), 1994 (1). This act establishes legal definitions and label guidelines but does not ensure the safety, effectiveness, or quality of any dietary supplement. DSHEA gives authority to the U.S. Food and Drug Administration (FDA) to monitor the supplement industry. DSHEA expanded the regulatory process of dietary supplements but made it much easier for new supplements to hit the market without any scientific research about the ingredients. Regulations of health and nutrient content claims on supplement labels fall into the same regulatory system as food labels do, as discussed in chapter 3.

Under DSHEA, a supplement is a nonfood or food additive and is not intended for use as a food or meal item. To be considered a dietary supplement, the dietary ingredients must fall into one or more of the following categories (2):

- Vitamin or mineral
- Herb or other botanical substance
- Amino acid
- A substance designed to increase total dietary intake
- A concentrate, metabolite, extract, or constituent

The FDA has regulatory responsibility over dietary supplements. This oversight may sound like a positive thing, especially because the FDA also regulates drugs and the American food supply. But supplement regulations under the DSHEA are quite different from the regulatory processes for drugs or foods. Drugs have an extensive preapproval process that requires scientific research clearly describing the effectiveness and safety. Supplements do not go through any preapproval process. Foods and food additives have an extensive regulatory process in place in which only foods and additives that have been proved safe are allowed.

Under DSHEA the supplement manufacturer is responsible for the safety of the product and must ensure that the claims made about the product are substantiated by adequate evidence. In 2007 the FDA established current good manufacturing practice (cGMP) guidelines for dietary supplements. The cGMPs require manufacturers to evaluate identity, purity, quality, strength, and composition of the dietary supplements that they manufacture. Supplement makers should follow practices that ensure that each supplement batch has the same active ingredients, contains the same amounts, and is free of contaminants. The labeling, packaging, and marketing should all be consistent with the cGMPs. Although this step can help ensure the safety and efficacy of dietary supplements for consumers, preapproval of supplements is not in place. The FDA oversees dietary supplements after they are on the market. FDA uses adverse event monitoring and research to determine whether a product on the market is in violation of DSHEA or the cGMPs.

One consideration for athletes is that supplements could be cross-contaminated with a substance that is banned by their sport's organization or a substance that the manufacturer omitted on the ingredient list or Supplements Facts Label. The cGMPs are in place to prevent this situation from occurring, but, as with implementation of DSHEA in 1994, the oversight process by the FDA is essentially after the fact. If a banned substance is included in a supplement and the athlete is unaware but tests positive, the athlete will pay the consequences.

The dietary supplement market continues to produce new products. Unfortunately, the FDA does not have enough time and resources to monitor this huge and growing industry. The FDA does have the capability to evaluate and recommend withdrawal of a supplement if it is deemed unsafe or harmful to consumers. But this process can be protracted, as will be seen with the case of ephedra later in this chapter.

Supplement Facts Label

All dietary supplements must have a Supplement Facts Label and include a complete ingredient list, including active and inactive ingredients. This Supplement Facts Label (figure 5.1) appears similar to the Nutrition Facts Label described in chapter 3. Likewise, health claims and nutrient content claims can be placed on supplement labels. Although the look and claims on supplement labels are strikingly similar to those on food labels, the regulatory processes of supplement labeling as compared to food labeling differ in some ways. New food ingredients or additives must go through rigorous testing and approval before being allowed for sale. All ingredients in a food must be listed on the label in descending order by weight, most prevalent ingredient first. Supplements should put all ingredients on the label as well, but the guidelines are less specific about the amount of each ingredient.

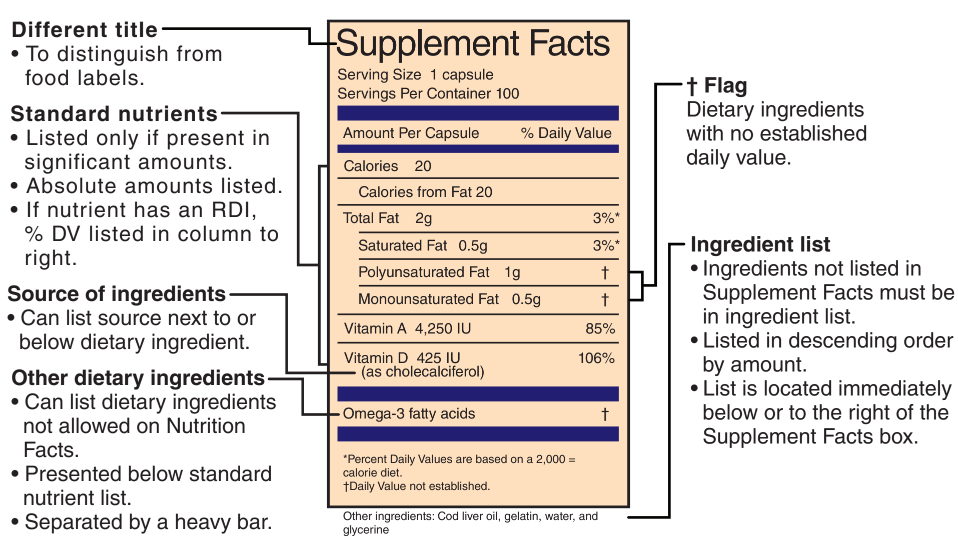

FIGURE 5.1 Supplement Facts Label.

Reprinted from SCAN'S PULSE, Fall 1998, Vol. 17, No. 4, official publication of Sports, Cardiovascular, and Wellness Nutritionists (SCAN), The American Dietetic Association, Chicago, IL.

As with foods, health claims are allowed on supplement labels. These health claims must go through the scientific approval process for food labels and must be worded correctly to prevent consumer confusion. But a different type of claim, a "structure or function" claim, is often found on supplement labels. These kinds of claims are not authorized or reviewed by the FDA. For example, a structure or function claim for a protein supplement can state that the proteins contained in the supplement "build muscle mass or increase muscular strength." If such a claim is made, however, the supplement manufacturer must place a disclaimer on the label. These disclaimers are found on many supplement labels and must include the following: "This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure or prevent any disease."

The marketing and advertising strategies for dietary supplements contain fantastic-sounding results with just enough scientific language to attract consumers. For that reason, sports medicine and fitness professionals must be able to understand the science behind these claims and help athletes determine whether the supplement is necessary, safe, and worth the expense. Some regulations based on the DSHEA and subsequent cGMPs help inform consumers about the ingredients in supplements, and regulations about marketing are designed to help protect consumers. People who work with athletes must be aware of these regulations and the extent of their enforcement so that they can help athletes make the most informed decisions possible about taking dietary supplements. The next section summarizes how professionals can help athletes make the best decision possible on a case-by-case basis. Athletes can apply these assessment principles when making decisions on their own about using any type of supplement.

Assessing Dietary Supplements

- Determine whether the scientific evidence or the efficacy of using the supplement has been thoroughly proven by reputable researchers and published in scientific, peer-reviewed journals.
- Review the product for safety. Does the supplement manufacturer have many years of supplement (or even drug) development experience? Does the manufacturer discuss good manufacturing practices on its website or in its publications? Go to http://www.fda.gov/Safety/MedWatch/default.htm to see whether the supplement has had any reported adverse events.
- Determine whether the supplement is banned by any sport organizations. Even if athletes participate in a sport or activity in which drug testing does not occur, consider the safety and ethical reasons that these organizations considered when banning these substances.
- If the advertising and marketing of the effects of a supplement sound too fantastic to believe, be careful about taking it. Research about the safety and efficacy of these products is a must.
- Talk with a physician, dietitian, certified athletic trainer, or other health professional before taking a dietary supplement. This step is particularly important for those who are taking prescription medications, over-the-counter drugs, or supplements that could possibly interact with each other.
- Evaluate the price of the supplement. Could similar benefits be achieved from a diet change? Some supplements are expensive and do not necessarily provide the benefit suggested by their advertising.

Many supplements have been researched extensively and have been found to be both safe and effective in helping athletes improve or maintain sport performance. This section provides a few examples of supplements (protein and creatine) that have sound research backing in both safety and efficacy when used as recommended. The multivitamin and mineral (MVI) supplement discussion at the end of this section describes how MVIs may help athletes and notes some current trends to be careful of when deciding on the type of supplement to be used.

Protein Supplements

Protein supplements have long been popular with strength and power athletes. Many endurance, team sport, and crossover sport athletes use protein supplements to meet their higher protein needs. Supplements can be an efficient way to get the necessary protein for muscle building and maintenance, especially for athletes with high energy needs. Good evidence suggests that protein supplementation can help athletes, and the safety and efficacy of using most types of protein supplements is well documented (see chapter 2). Still, athletes should consider several points about protein supplements, and sports medicine and fitness professionals can play an important role in helping athletes make the best choices for protein intake.

One consideration is the type and amount of protein necessary for athletes to meet their protein needs for either maintaining or increasing muscle mass. Many athletes with moderate protein needs who are not focused on anabolism will be able to meet their protein needs through high-quality protein sources in the diet. Athletes who have anabolic goals and choose to increase lean muscle mass as well as those with high energy output may benefit from a protein supplement. Consuming enough calories daily may be difficult, let alone taking in enough additional protein for muscle repair and generation.

In such cases a protein supplement or a protein and carbohydrate supplement may be indicated. These supplements generally come in powder form to be mixed with water or milk and may contain flavorings to encourage consumption. Most servings provide from 25 to 50 grams of protein and may include an additional 6 to 8 grams of protein if mixed with milk. The source of the protein has produced some new debate, and soy- and whey-based supplements are often compared. Whey-based protein supplements seem to be the most popular. Multiple research studies show positive effects of using whey protein as a recovery protein supplement and as a method to boost protein intake for daily use in athletes who have high protein needs.

The safety of the amount of protein consumed from supplemental sources is far less of a concern today than it was a decade ago. As stated in chapter 2, healthy people with healthy kidney function can tolerate fairly large amounts of protein in the diet and in supplements. A different safety concern is the issue of cross-contamination that could occur at the manufacturing plant. Some protein manufacturers may produce both soy- and whey-based protein supplements. If good manufacturing practices are not followed, cross-contamination can occur. Some people have strong allergic reactions to soy that could occur if contamination levels are high. When helping athletes choose a high-quality protein supplement, look for a manufacturer that has been in existence for a long time, has had no adverse events reported against it, and lists some good manufacturing practices on its website or printed label.

Creatine Supplements

As little as 15 years ago, athletes, particularly those in strength and power sports, started taking creatine in an effort to increase strength and bulk up. Many found creatine extremely effective and saw significant weight gains and strength increases in a short time. Sport and fitness professionals saw these gains in their athletes and were thrilled that creatine could be a valuable tool for helping athletes meet weight gain and muscle strength goals. Still, concerns were present about the safety of creatine, the amount that could be consumed safely, and the physiological mechanisms that allowed for this increased bulk.

A significant number of short- and long-term research studies have been done on creatine in the last decade. Creatine is one supplement that research has shown to be both safe and effective for athletes who are trying to increase in size and functional mass to improve strength and power. Here is a brief overview of creatine use and the research that supports this statement.

Creatine is found in the skeletal muscle cells. Enhancing the amount of creatine stored in these muscle cells is the goal of creatine supplementation. The desired effect is that creatine-enhanced muscles will have enhanced strength and bulk. Generally, a loading dose of 20 grams daily for 4 to 7 days will increase creatine levels in skeletal muscle (3). After the loading phase, 3 to 5 grams per day is considered a maintenance dose (3) that will keep creatine levels in muscle at a higher than normal or nonsupplemented level. Most sports medicine and fitness professionals also recommend a “washout” period during which no creatine is consumed for a 2- to 4-week period at approximately 2-month intervals (4). Because the effects of creatine may diminish over long-term use, this washout period improves the consistent effects of creatine supplementation over time.

Substantial evidence indicates that creatine supplementation increases body weight and strength, and recent evidence suggests that it may help increase explosive power used in sprints or multiple-sprint types of sports (3, 5). Increases in body weight help athletes who benefit from bulk, such as defensive linemen in American football. Increases in bulk may not be ideal for athletes who compete in sports in which strength is essential but weight is a factor as well, such as gymnasts who compete on uneven or parallel bars.

Initial concerns about the safety of creatine supplementation were about the significant weight gains seen in athletes. Little research was available to evaluate the type of gains. Anecdotal reports appeared about higher levels of muscle cramping in athletes who were taking creatine supplements. More than a decade of research on creatine supplementation in athletes suggests that safety is pretty good when creatine is used in appropriate loading and maintenance doses with some washout periods of no use (5, 6). Note that the majority of research on creatine supplementation has been completed using creatine monohydrate. Various forms of creatine (e.g., phosphate, citrate, and others) are available in supplement form, and the safety and efficacy of forms other than monohydrate have not been thoroughly studied.

Both creatine and protein supplements are generally considered safe and efficacious for athletes who have weight gain and muscle strength goals. Still, the principles discussed related to the DSHEA and the abundance of new and reformulated types of creatine and protein supplements require vigilance by athletes and the professionals who work with them. Some creatine or protein supplements may contain other ingredients that are not ideal for helping athletes reach their goals. As with any supplement, contaminants could inadvertently get into the supplement at the manufacturer's site. Careful review of the supplement label and research into the manufacturing practices of the supplement maker will help to assure that the supplement is what it says it is.

Vitamin, Mineral, and Herbal Supplements

Other supplements commonly marketed to and used by athletes are vitamin, mineral, and herbal supplements. Athletes often take multivitamin and mineral supplements or specific vitamins or minerals for medical conditions or to ensure that they are getting at least the minimum requirements of all vitamins and minerals.

A newer trend is to package specific vitamin and mineral supplements together for a specific population or type of medical or wellness concern. These packs or bundles are commonly sold over the Internet or in supplement stores in 1-month supplies. In Internet sales the consumer can often add one or two herbal supplements to the pack at no additional charge. Each type of herbal or vitamin and mineral combination will come in its own blister sealed package, and the packages are perforated in a set for one daily use. When helping an athlete decide between this type of delivery or other methods for consuming vitamin, mineral, and herbal supplements, carefully consider efficacy, safety, and necessity.

Chapter 2 included a short review of vitamin and mineral use. The principles outlined in that chapter apply to this discussion. Although many if not most athletes would benefit from a basic multivitamin and mineral supplement, careful consideration should be taken when taking supplement packs for specific purposes. Common packs often contain the following:

- Men's—MVI, minerals, lycopene, fish oil, multiple herbal supplements
- Women's—MVI, minerals plus iron and calcium, "energy," sometimes cranberry concentrate or conjugated linoleic acid
- Sport—MVI, minerals, branched-chain amino acids, thermogenic blend, sport blend, high levels of B vitamins

Some packs targeted toward athletes or active people may include herbal supplements in addition to a multivitamin and mineral combination tablet. Often the sport versions of these supplement packs have stimulant properties such as guarana, yerba mate, yohimbine and kola nut. These herbal remedies contain caffeine or stimulant herbs that may enhance mental alertness, as well as increase fat use as a source for energy during long-duration exercise. In fact, many of these prepacked vitamin and mineral blends contain some form of herbal stimulant. As discussed in chapter 4, caffeine appears to be safe and is beneficial to athletes at appropriate levels. Some herbal supplements, however, may contain several of these stimulant herbs, and the combined effects may cause overstimulation that can hinder exercise performance.

In some cases, the addition of herbals or higher levels of some supplements may be valuable. Lycopene in the men's version and iron and calcium in the women's version target areas where men and women may benefit from these additions. Lycopene intake has been shown to benefit prostate health in men. Women have higher iron needs during child-bearing years, and calcium intake is essential for bone health. Sports medicine and fitness professionals should pay attention to the needs of their athletes as they help them decide about what types of vitamin and mineral supplements they may need and help them avoid those that they do not.

Purchasing packs and combinations can be convenient for consumers, but the cost is quite high compared with purchasing a standard multivitamin supplement contained in one pill. Consumers pay for the extra packaging but could get similar nutrients in one bottle of several hundred multivitamin and mineral supplements that would last for 6 months or more. The marketing strategy focuses on the convenience of daily dosing and portability for those who travel. Although both of these features are helpful, the cost of this convenience and getting the correct level of supplemental vitamins and minerals should be considered. For example, does every athlete need the high levels of vitamin D found in many sport packs? Are adequate amounts of vitamins A, C, and E, which have antioxidant properties, included in all the packs or only in the sport packs? Finding the exact amount of the various vitamins and minerals contained in each pack is also difficult, especially for those bought on the Internet. Staying within reasonable percentages of the RDA for each vitamin or mineral is ideal. If this information is unavailable, find a brand that offers it to help athletes make good choices in supplement use.

Supplements like protein and creatine and vitamins and minerals have well-substantiated use in an athletes' daily nutrient intake. Even so, many supplements on the market and those new to the market do not have the scientific support of the supplements reported here. Athletes and sports medicine and fitness professionals who work with them need to research every supplement before use. Some websites that may be helpful in this search are listed in table 5.1.

TABLE 5.1 Supplement Information Websites

Organization	Web address	Type of information
National Institutes of Health (NIH), Office of Dietary Supplements	http://ods.od.nih.gov	Contains searchable databases of supplements, fact sheets, and information on botanicals; has an excellent section on how to evaluate health and supplement information found on websites
National Center of Complementary and Alternative Medicine, NIH	http://nccam.nih.gov/health	Includes easily searchable information on herbs and other dietary supplements and research briefs
FDA, Consumer Information on Dietary Supplements	www.fda.gov/Food/DietarySupplements	Overview of regulations, adverse reporting events, and tips for savvy supplement use
American Dietetic Association	www.eatright.org	Several position papers on dietary supplements and related sport diet information
US Pharmacopeia	www.usp.org/USPVerified	Assesses information sent by supplement companies, tests for potency and safety and provides a USP verified seal for packaging of supplements that meet these standards
United States Anti-Doping Agency (USADA)	www.usantidoping.org	Has lists of banned substances and supplements in the United States
World Anti-Doping Agency (WADA)	www.wada-ama.org	Has lists of banned substances and supplements worldwide
National Collegiate Athletics Association	www.ncaa.org	Has lists of banned substances and supplements specific to NCAA rules; contains additional nutrition and supplement information and education

Weight-Loss Diets

Weight-loss diets are always a hot topic. Nearly two-thirds of adults in the United States are overweight or obese, and many are turning to quick fixes for weight loss. Besides following popular diets, some people may take dietary supplements that promise rapid weight loss, but these substances are not without risks. Athletes, like those in the general population, may have questions about weight loss, although the amount of weight that they wish to lose may be small in comparison with recreational athletes or sedentary adults.

Thousands of diets and dietary supplements are marketed for weight loss. This section discusses the background of three popular diets marketed to active people and the dietary supplements typically marketed toward those seeking to lose weight. The concluding section summarizes the implementation of the DSHEA and the FDA action against ephedra and ephedra-like supplements.

Three diets that have maintained popularity over a long period, the Zone diet, the South Beach diet, and the Weight Watchers diet, are particularly popular with athletes and active people because they have a slightly higher protein content and focus on the glycemic effects of food. Before sports medicine and fitness professionals can answer questions about these diets, they must know the principles of each. Following is a brief synopsis.

Zone

The Zone diet targets the amount and type of carbohydrate consumed and emphasizes the intake of low-fat protein and monounsaturated fat (7, 8). The glycemic response of carbohydrate is a major focus of this diet because of the rapid rise in insulin that occurs in response to high-glycemic ("bad") carbohydrate. This diet also emphasizes eicosanoids, or hormones such as prostaglandins. The Zone diet promotes certain types of fat in an effort to influence the production of "good" rather than "bad" eicosanoids. Often known as the *40–30–30 diet,* the diet includes 40% of total calories from carbohydrate and 30% each from protein and fat. The timing of food intake is also important.

The first step in planning the Zone diet is to determine a daily protein requirement based on weight, percentage of body fat, and physical activity. The total protein requirement is divided into blocks, and each block consists of approximately 7 grams of protein. Low-fat protein is included in every meal and snack.

Each carbohydrate block contains approximately 9 grams of carbohydrate. Fruits and vegetables provide favorable carbohydrate, whereas carbohydrate from starches and grains is considered unfavorable. This distinction is made based on the ability of a food to promote the circulation of insulin. Carbohydrate that has a low glycemic index is desired. Another goal is to keep the ratio of protein blocks to carbohydrate blocks at 1:1.

Each fat block contains approximately 1.5 grams of fat. The emphasis is on monounsaturated fats, such as nuts, avocados, olives, and olive oil. Fat blocks are small; for example, 1 tablespoon of avocado is equal to one fat block.

The Zone diet plan recommends an equal number of protein, carbohydrate, and fat blocks at all three meals and in two snacks. Because fat blocks contain such small amounts of fat, the diet is considered low fat. Calculating calories is not emphasized, but the Zone diet is a low-calorie diet, usually ranging from 1,000 to 1,600 calories daily.

South Beach

The South Beach diet has some commonalities and differences with the Zone diet and other 40–30–30 diet plans. The South Beach diet was developed by a cardiologist in Miami to help his patients lose weight and improve their blood chemistry (9). He saw overweight and obese cardiac patients with abnormal lipids, high blood pressure, and diabetes. With weight reduction, these medical conditions improve significantly, but his experience was that the typical low-fat, higher carbohydrate diets of the 1990s were not working.

The main principle of the South Beach diet is a reduction in total carbohydrate and a focus on reducing "bad" carbohydrate, which includes sugar, white flour, and products containing the two. Meeting that goal means reducing or eliminating all sugars such as those found in candy and desserts as well as processed foods that contain added sugars or are made from predominantly white flour. These foods contain little fiber, and most have a high glycemic index.

The diet has three phases that move from very restricted carbohydrate in phase 1 to less restrictive in phase 3. None of the phases requires calorie counting or specific portion sizes. Phase 1 severely restricts carbohydrate of almost all types (including milk, fruit, pastas, potatoes, and breads) for 2 weeks. The goal of this restriction is to improve metabolism of carbohydrate, reduce cravings for high-carbohydrate foods, and decrease the insulin resistance seen with high-carbohydrate diets. In phase 2 healthy, or "good," carbohydrate (whole grains, some fruits, milk and yogurt) is added back to the diet in limited amounts. Phase 3 is considered the maintenance plan. It maintains a focus on good carbohydrate but is the least restrictive.

The more restrictive phases are quite low in total carbohydrate and may not be appropriate for athletes. But reducing consumption of sugar and sugary foods and highly processed carbohydrate, as previously discussed, is good for everyone.

Weight Watchers

The Weight Watchers program, developed in the early 1960s, has been used by millions of people worldwide (10). Weight Watchers is a proprietary program, and participants become members. Membership includes instruction in the weight-loss program and access to support groups, traditionally in person, but now also online.

Points Plus is the newest Weight Watchers program. All foods are assigned points based on the combination of carbohydrate, fat, fiber, protein, and caloric content. Foods with lower carbohydrate and more fiber and protein are generally worth fewer points than those that have higher carbohydrate content and less fiber. Fruits and vegetables are essentially free foods on the new Points Plus system. Dieters are assigned a point target based on their current weight. Points can also be earned by exercising. Participants can use exercise-related points to add more food to the diet plan or to accelerate the rate of weight loss. The Weight Watchers diet is a reduced-calorie, lower-fat, moderately reduced-carbohydrate, high-fiber diet. The program encourages daily exercise and teaches sensible eating skills. The hallmark of the program is its support system and weekly meetings and weigh-ins.

Diet Plan Similarities and Differences

These diet plans have two current trends in common: a focus on lowered carbohydrate or type of carbohydrate and a slightly higher intake of protein. Athletes know that carbohydrate intake is crucial to good sport performance. The carbohydrate principle outlined in these three diets and many others is to reduce the carbohydrate from sugars and the less nutrient-dense carbohydrate foods such as sugary desserts, beverages, candies, and foods with added sugars. Carbohydrate should be consumed by all people and certainly by athletes, but the principles of nutrient density, higher fiber, and less-processed foods are excellent for any athlete to follow. Similarly, adequate protein consumption is essential for athletes' development and maintenance of lean mass. Sports medicine and fitness professionals can help athletes distinguish between high-nutrient, fiber-containing carbohydrate and low-nutrient, non-fiber-containing carbohydrate and encourage some of the principles of adequate and balanced protein intake as they work to help athletes lose weight or body fat.

All the weight-loss plans are low in calories, but they vary in their macronutrient composition. The common denominator is decreased caloric intake. Many research studies on the effectiveness of carbohydrate or fat restriction or macronutrient composition have found that calorie restriction and length of time in the diet are the most important factors in weight loss (11, 12). Weight maintenance is a balance between calories in and calories out. Therefore, changing the caloric balance to produce weight gain or weight loss is the critical factor. Sports medicine and fitness professionals must be able to help athletes choose a plan that meets their weight-loss goals yet considers the macronutrient composition that is right for them. The recommended diet should stay close to the Acceptable Macronutrient Distribution Range for carbohydrate, protein, and fat and be sustainable so that the athlete can reach his or her weight-loss goals.

Sport medicine and fitness professionals might be asked about another approach to weight loss: dietary supplements.

Dietary Supplements for Weight Loss

Before taking dietary supplements, including those that target weight loss, athletes should evaluate them for safety and effectiveness. Many dietary supplements for weight loss are herbal supplements. Herbal or not, as discussed previously, these supplements may lack quality control in the production process, so the strength of the active ingredient (i.e., the dose) may vary from batch to batch and among similar products.

Although dietary supplements have long been advertised for weight loss, the last decade has seen a substantial increase in the number of products, especially those advertised as herbal.

Athletes and others who want to lose body fat can choose from numerous products including weight-loss teas and a vast array of products described as “fat burning.” Common “fat burners” include products that contain caffeine, yohimbine, synephrine, green tea extract, and yerba mate. Fat burning can mean virtually anything, but most of the time it refers to a compound that by itself helps to burn stored body fat. Often the implication is that the person does not need to do anything but take the supplement to reduce body fat. The scientific studies cited to support the fat-burning properties of a compound are often performed on tissues or in test animals. Because the compound is studied in isolation, it is not known how the compound would work in the presence of other elements or if taken by humans. Most fat-burning supplements on the market contain several ingredients at quite variable levels. Most have stimulant properties that, similar to caffeine, can increase alertness and may have a thermogenic effect. When taken in combination, however, supplements can overstimulate. Anxiety, restlessness, and interference with sleep can result.

Fat burning is an exceptionally powerful advertising term because a reduction in body fat is difficult to achieve and maintain. Nearly all fat-burning or weight-loss supplements on the market recommend a change in diet that reduces calorie intake and an increase in exercise for additional calorie burning. The difficulty comes in determining whether the weight loss that occurs with these supplements is because of the supplement or the change in diet and exercise.

Athletes and nonathletes alike are drawn to supplements that could potentially reduce body fat. In the past when athletes talked about dietary supplements and weight loss, the discussion usually turned to ephedra (also known as ephedrine). Ephedrine-containing weight-loss supplements made national headlines because of their use by, and the subsequent deaths of, several professional athletes.

Currently, the sale of dietary supplements containing ephedrine is banned in the United States. But many supplements are marketed under different names, and derivatives of ephedra and ephedra supplements are available on the Internet. The following section reviews information related to dietary supplements that contain ephedrine and is an example of how the DSHEA and the FDA regulated the use of a particular supplement.

Dietary Supplements That Contain Ephedrine

Certified athletic trainers should be aware that *Ephedra, ephedrine alkaloids,* and *ephedrine* are technically different terms, although they are frequently used interchangeably. *Ephedra* is a botanical term that refers to a plant genus. *Ephedrine alkaloids* are found in the stems and branches of some species of *Ephedra.* One of the ephedrine alkaloids is *ephedrine.* In common usage, *ephedra* refers to the effects of ephedrine.

Ma huang is extracted from one species of *Ephedra* and contains six different ephedrine alkaloids. The most active of these alkaloids is ephedrine. Ma huang is an herbal source of ephedrine. Ephedrine can also be synthesized in the laboratory.

In traditional Chinese medicine, Ma huang is used to treat asthma and nasal congestion. In the United States, laboratory-derived ephedrine is added to over-the-counter medications for the same purposes. But most dietary supplements that contain ephedrine were marketed for two purposes: to lose weight and to increase energy. Athletes may consider the use of ephedrine for both purposes, an important issue to explore with them.

The safety of ephedrine-containing supplements has been controversial, partly because experts can’t agree on a safe dose. When supplements containing ephedrine were available for sale, the Food and Drug Administration’s position was that no more than 8 milligrams of ephedrine alkaloids should be used in a 6-hour period *and* not more than 24 milligrams in a 24-hour period. Usage at that level should not exceed 7 days (13).

But not all experts agreed with the FDA recommendations. Another group of scientists and researchers suggested that a single dose should not exceed 30 milligrams of ephedrine alkaloids and that up to 90 milligrams in a 24-hour period was safe. They suggested that usage should not exceed 6 months (14). The disagreement over dose made the issue particularly contentious among experts and confusing for consumers.

Safety

The most hotly debated ephedrine issue was safety. The FDA repeatedly expressed its concern about the safety of dietary supplements containing ephedrine, including a proposal for a mandatory warning label. The FDA was alarmed by the number of adverse event reports (AERs) it had received. Adverse events can be reported to a consumer hotline, and by 1997 half of the AERs received involved ephedrine. Some of the reported adverse events were expected because they reported known side effects of ephedrine use, such as headache, increased heart rate, increased blood pressure, and insomnia. But what concerned the FDA were the reported deaths of apparently healthy middle-aged and young adults.

In 2003 a study published in the *Journal of the American Medical Association* reviewed 16,000 adverse event reports (15). The authors found that 21 events were serious: two deaths, nine strokes, four heart attacks, one seizure, and five psychiatric problems. Ephedrine was believed to be the sole contributor, but evidence was insufficient to establish a cause-and-effect relationship. The authors also identified 10 additional cases where ephedrine-containing dietary supplements were a contributing factor. This study resulted in more debate.

Under the Dietary Supplement Health and Education Act (DSHEA), the FDA can stop the sale of a dietary supplement if "significant or unreasonable risk of illness or injury" is demonstrated. On December 30, 2003, the FDA notified manufacturers that it intended to ban ephedrine-containing dietary supplements including herbal sources such as Ma huang. The final rule, published on February 6, 2004, went into effect 60 days later, leaving a window during which consumers could legally buy dietary supplements containing ephedrine.

The basis for removing dietary supplements containing ephedrine is the documented deaths and serious cardiovascular and psychiatric events reported to date. The FDA questioned whether ephedrine offered health benefits and ruled that the risk-to-benefit ratio (high risk, low benefit) met the "unreasonable risk" portion of the criterion.

Weight-Loss Effectiveness

Ephedrine is a compound that mimics the effects of the natural hormones epinephrine (adrenaline) and norepinephrine (noradrenaline). Ephedrine increases metabolism by stimulating the central nervous system. Methylxanthine, an active ingredient found in caffeine, enhances the effectiveness of ephedrine as a weight-loss agent.

Do ephedrine and caffeine (methylxanthine) combinations help people lose weight? Studies have shown that the use of ephedrine and caffeine by obese people can produce a short-term weight loss of 8 to 9 pounds (3.5 to 4 kg). Studies to date have not been conducted for longer than 6 months, so the long-term effect or the effect of discontinuing the ephedrine and caffeine is unknown (15). Also unknown is whether ephedrine-induced, short-term weight loss has a long-term health or fitness benefit. Most athletes are not obese, so it is unclear whether the same short-term weight loss would occur in nonobese ephedrine and caffeine users. But we do know that some athletes use these compounds before and during training camp to lose weight gained in the off-season.

Some athletes claim that products containing ephedrine and caffeine give them more energy. They likely make this assertion because of the stimulant effect of these compounds, which can mask fatigue. Some brands sold as dietary supplements were spiked with norpseudoephedrine, and these products were stimulatory. An important issue to explore with athletes is the cause of their fatigue, which could be related to poor dietary intake (low muscle glycogen, decline in blood glucose during workouts), dehydration, overtraining, and lack of sleep, to name a few causes.

At least six studies have been conducted on the use of nonherbal ephedrine and caffeine as a performance enhancer in healthy male subjects. Exercise performance, as measured by time to exhaustion or by oxygen consumption, was not affected by either ephedrine or caffeine alone. Ephedrine and caffeine together resulted in a 20 to 30% increase in performance, usually measured as time to exhaustion. Studies show that supplements containing ephedrine are not effective in increasing muscle strength, muscle size, or anaerobic capacity. The authors concluded that evidence is insufficient to suggest an ergogenic (energy producing) effect (12). Clearly, more research is needed.

Quality Control

Lack of quality control in many dietary supplements is a concern. In 2000, well before the announced ban, Gurley and colleagues published a study of the ephedrine alkaloid content of 20 dietary supplements (16). The content of 10 products varied by more than 20% when compared with the amount listed on the label. The worst example was a product that contained more than 150% of the amount listed on the label. One product contained no active ingredient, although an active ingredient was listed on the label. Particularly troublesome was that five contained norpseudoephedrine, a controlled substance (drug) that by law must be prescribed by a physician.

Spiked dietary supplements are especially problematic because most athletes are subject to testing for banned substances (17). Some athletes are surprised when they test positive for a banned substance because they didn't know that the supplement they took contained a banned ingredient. Unfortunately, others who test positive but know they were taking banned substances invoke the same defense: "I thought I was just taking a dietary supplement."

New dietary supplements are being developed, especially in response to the ban in the United States of ephedrine alkaloids in dietary supplements. Sports medicine professionals and strength coaches must communicate to athletes that some dietary supplements might contain banned substances. Many ephedra-containing supplements are available through online sales, and athletes should be cautioned about their use. Although ephedra and ephedra-like weight-loss supplements are popular, they have not yet been shown to be safe and effective for athletes.

Summary

Dietary supplements are big business, and athletes often have questions about the need for supplementation to enhance their diet and exercise programs. New supplements hit the market every day, and some will become extremely popular with active people. Sports medicine professionals and strength coaches who work with athletes must be prepared to help athletes make these decisions. Staying current with the scientific literature of various types of supplements, knowing how to find accurate information about them, and being aware of potential safety issues is important.

The DSHEA of 1994 and the consumer good manufacturing product rules in place since 2007 provide some regulation of dietary supplements. But the oversight occurs after the supplement is on the market, and "buyer beware" is still the rule for sports medicine professionals and the athletes under their care. Some supplements, however, have stood the test of time. Creatine is a good example of this. Although there was once great concern over its use, significant research has shown that it provides the sport benefit intended and the safety that all athletes want. Another example is protein supplements that many years ago were thought to stress or overburden kidney function. It is believed that protein supplementation at even double the recommended AMDR is not likely to cause harm in healthy people.

The huge market of weight-loss supplements present similar challenges for sport professionals. New diets and new supplements for weight loss and sport performance appear every year. Sports medicine professionals play a critical role in helping athletes make the best, safest, and most appropriate choice when trying a new diet or dietary supplement.

Most athletes are not obese, but a reduction in body fat is often a goal, especially for recreational and adolescent athletes. The sale of supplements containing ephedrine is banned, but athletes may still have access to them through the Internet and ephedrine-like herbal supplements. Taking these supplements is risky for athletes because of unintended side effects and the inadvertent consumption of banned substances.

Taking a dietary supplement for any reason requires background research. This research should be done with an eye on the benefit of taking the supplement (efficacy), the safety issues, and a cost–benefit analysis. In some cases consuming different foods or a more balanced diet will provide the added sport benefit desired. In other cases a supplement may be a value-added asset in the athlete's overall nutrition and exercise plan. Making informed choices about supplements, as with choosing proper training techniques and nutritional plans, is essential.

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part III

Professional Practice

Part III, the final section of this text, contains chapter 6, "Educating and Referring Clients." This chapter provides critical information for sports medicine and fitness professionals who work regularly with athletes in training, nutrition, and optimizing sport performance. As the chapter title states, all professionals need to know their professional scope of practice and recognize when the expertise of another professional may be needed. This chapter provides information about the scope of practice for a variety of professionals, discusses educational strategies that are appropriate for those professionals, and gives examples of when referrals are necessary to help the athlete and to avoid working outside the scope of professional practice.

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chapter 6


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Educating and Referring Clients

Certified athletic trainers, registered dietitians, certified strength and conditioning specialists, and some other fitness professionals have certification boards and governance in place to regulate them. These professionals have varied experience, training, and focus when working with athletes and have varying degrees of knowledge, skill, and expertise in nutrition screening and education. This chapter provides guidelines for professionals to help athletes with nutrition concerns and provide education, screening, and appropriate referrals within the scope of professional practice.

Understanding and respecting scope of practice is important for both consumers and professionals. Educating athletes about general nutrition is within the scope of practice of most sports medicine professionals, but counseling athletes about nutrition is not. There is a clear difference between delivering education using nutrition information in the public domain and providing one-on-one or group counseling on specific medical conditions that warrant nutrition therapy.

Knowing the organizational, national, and state regulations about nutrition education and counseling will help health and fitness professionals in their practice and in knowing when to provide referrals to other professionals. This chapter discusses these regulations and provides suggestions for implementing effective nutrition education. Disordered eating (DE), eating disorders (ED), and diabetes serve as examples of conditions that require the referral of the athlete to the appropriate health professional for counseling.

Scope of Practice

Scope-of-practice definitions establish professional boundaries. Practitioners are held accountable professionally, and those who operate outside the established scope of practice may be professionally and personally liable if they harm clients. Therefore, scope of practice protects both consumers and professionals. When a client's needs fall outside a practitioner's scope of practice, the appropriate action is to provide a referral. Scope-of-practice definitions take into account the academic training and certifications of the practitioner.

Professionals who are certified or licensed are usually regulated by the state in which they practice. Most states have licensing boards, and applicable state regulations can usually be found on that agency's website. Depending on the state in which you practice, the scope of practice for professionals working with athletes may be legally defined. For example, a scope-of-practice definition for nutrition counseling and therapy is in effect in most states for registered and licensed dietitians. Similarly, certified athletic trainers require a state license to practice in approximately two-thirds of the United States. Professionals in these fields have met educational requirements (at least a bachelor's degree) and experiential requirements (many hours of supervised clinical practice) and have successfully passed a national examination from their respective professional organizations. These requirements allow them to apply for and receive licensure by the state in which they practice. Professionals must be aware of the state laws that are in force. Consumers should seek professionals with solid credentials, and sports medicine professionals need to be sure to follow the standards within the scope of practice in their field.

For example, in California the business and professions code allows anyone to give general nutrition advice (1). The code prohibits anyone from providing nutrition advice to prevent, treat, or cure a disease or disorder (i.e., medical nutrition therapy) unless he or she is legally designated to do so. Medical nutrition therapy requires extensive training. Physicians, registered dietitians, and those with graduate degrees in clinical nutrition are legally allowed to provide medical nutrition therapy. Other health and fitness professionals are not.

Certified athletic trainers (ATCs) receive training in fitness; injury assessment, treatment, and prevention; and general nutrition. The National Athletic Training Association (NATA) provides professional governance for the training and certification of ATCs. To become an ATC, the individual must obtain at least a bachelor's degree in athletic training and attend a university or college with an accredited athletic training curriculum. The candidate also must gain significant hands-on experience before being allowed to take the national board of certification (BOC) exam. Successful completion of the exam allows the person to use the ATC credential.

While participating in an accredited athletic training curriculum, students must meet certain proficiencies (2). NATA provides guidelines that postsecondary schools must follow to prepare students with the knowledge, skills, and clinical abilities to provide athletic training services in multiple settings after they complete their degrees and successfully complete the certification examination. For example, one nutrition competency requires students to be able to understand the MyPlate system and explain its use to athletes or clients in their care. Students are also expected to be able to explain the referral system for people with disordered eating and other medical conditions that require nutrition assessment and counseling. Collectively, these competencies reflect the scope of practice for certified athletic trainers. The overwhelming majority of the competencies are in injury evaluation, treatment, and prevention because these areas are the main scope of the profession.

People who have certifications from other professional organizations also have guidelines for scope of practice. Some certifications require no college coursework but do require the candidate to perform a certain number of hours of experiential practice before taking a certification examination. Others require a bachelor's or master's degree from an accredited institution of higher education, many hours of supervised experience, and successful completion of a board examination. The American College of Sports Medicine (ACSM) oversees certification of a variety of fitness professionals who work with athletes or active people.

The ACSM has several levels of certification, each of which outlines a specific scope of practice. The ACSM Certified Personal Trainer has no college education requirement. The scope of practice includes working with healthy people by leading and demonstrating safe and effective exercise methods, writing exercise recommendations, and motivating people to start and maintain healthy behaviors. The ACSM Certified Health Fitness Specialist (HFS) requires a bachelor's degree in kinesiology, exercise science, or other exercise-related field. The scope of practice is broadened; HFS practitioners can conduct physical assessments, interpret the results, and prescribe exercise plans for both healthy people and those with medical conditions such as diabetes, heart disease, and asthma. Note that assessment and prescribing diets or counseling for weight loss or other medical conditions is not part of the scope of practice for either certification. But as part of motivating clients regarding their health behaviors, either of these certified professionals can provide general education about healthful eating as part of their work with active people.

Registered dietitians (RD) are licensed medical professionals with extensive nutrition education, training, and experience. They are the most credible sport nutritionists. Registered dietitians receive clinical training in medical nutrition therapy, counseling theory and practice, and nutrition assessment. A 4-year degree from an accredited college or university is the first requirement to become a registered dietitian. As with the athletic training programs, each educational institution that educates dietetics students must meet a set of competencies. After completion of the degree, a dietetic internship from an accredited internship facility (hospital, graduate school, public health district) is required.

The intern must complete a minimum of 900 hours of hands-on experience in medical nutrition therapy, community dietetics, and food management under the supervision of a registered dietitian. After both of these requirements are completed, the prospective dietitian may take the national certification exam to become a registered dietitian. Upon successful completion, the person may use the credential "RD" and practice within the scope set forth by the American Dietetic Association (ADA).

A person must have excellent assessment skills and advanced training, such as that possessed by a registered dietitian, to counsel clients with complicated eating issues (3).

In 2006 the American Dietetic Association added a special certification for sports dietitians. The credential, Board Certified as a Specialist in Sports Dietetics (CSSD), is one of five specialty certifications approved by the American Dietetic Association's Commission on Dietetic Registration. The application and approval process for this credential is extensive. Several requirements must be met before taking the CSSD examination:

- Must be a registered dietitian
- Must have maintained registered dietitian status for 2 years
- For initial certification, 1,500 documented hours of practice specifically in sports nutrition over the previous 5-year period
- For recertification, 1,000 documented hours of sports nutrition practice over the previous 5-year period
- Application to sit for the exam, which includes proof of registration, transcripts, and documentation of hours
- $250 application fee

After the application is approved, the dietitian can sign up for one of two CSSD exam periods each year. Examinations are online and can be taken at specified examination sites throughout the United States (4).

The CSSD certification is good for 5 years, at which time the dietitian can chose to recertify. Recertification requires a new application, documentation of sport nutrition practice hours, a new application fee, and successful completion of the certification examination.

Nutrition Education

The distinction between nutrition education and nutrition counseling is important. Many sports medicine and fitness personnel may be familiar with the latest sport nutrition recommendations and can give advice, but counseling people, especially when eating involves deep-seated emotional issues, requires specific training. Many active people who seek and need nutrition counseling have a complex history of dieting, and some have developed pathological eating behaviors. Creating specific eating plans, especially when medical conditions such as diabetes or hypertension are involved, is considered medical nutrition therapy (MNT). This activity is within the scope of practice of registered dietitians or others who have been designated by state law to provide MNT.

To protect both practitioners and consumers, many organizations suggest that their members use and promote only nutrition materials that are in the public domain, which means that they can be freely copied and distributed. Some examples are the U.S. Department of Agriculture Dietary Guidelines and the MyPlate information, brochures, and online resources. Part of the certified athletic trainer's curriculum includes training related to the MyPlate and the Dietary Guidelines; therefore, its use falls within the ATC's scope of practice. Other credentialed health and fitness professionals can use MyPlate, the companion web resources, and information from similar public domain sources to help clients meet their fitness and nutrition goals. Large health care organizations, such as the American Heart Association, have created nutrition materials that are in the public domain. Most federal documents are in the public domain, but many state documents are not.

Perhaps the most controversial areas related to dispensing dietary advice are recommending and selling dietary supplements, which involve both legal and ethical issues. The NATA does not have a policy covering these areas. From a legal perspective, an ATC must abide by all state and federal laws addressing dietary supplements. From an ethical perspective, there is significant disagreement over who should recommend and sell dietary supplements. The American Dietetic Association, for example, cautions its members to evaluate that decision carefully because of real and perceived conflicts of interest (5).

Scope of practice is sometimes difficult to define. When does general nutrition advice become nutrition counseling? The distinction is not always clear. The basic diet-planning principles outlined in the following section fall in the realm of general nutrition advice. But as you will see, even general advice can be misinterpreted.

Basics of Diet Planning

The overarching principles of diet planning form the framework of a healthy diet and include the following: adequacy, balance, calorie (energy) control, nutrient density, moderation, and variety. All athletic and medical personnel can emphasize these principles (6). *Adequacy* refers to the consumption of enough of the essential nutrients. *Balance* is synonymous with correct proportions. These two concepts are closely related. For example, an athlete with iron deficiency anemia probably does not consume enough iron. If this athlete eats a predominantly dairy-based diet, he or she is likely to be low in iron because foods that are naturally high in calcium are usually low in iron. This diet is not balanced, and unbalanced diets are often not adequate. A balanced diet will contain some foods that are high in calcium and other foods that are high in iron.

Energy control is the middle of the consumption spectrum—consuming enough calories to support activity without consistently overeating or undereating. *Nutrient density* refers to the relationship between calories and nutrients. When comparing two foods with the same number of calories, the one containing the most nutrients is the most nutrient dense. Nutrient-dense foods are often those closest to their natural state. For example, an orange contains fiber and several vitamins and minerals, notably vitamin C. A fruit drink with 10% orange juice may contribute only one nutrient—carbohydrate in the form of sugar. The orange is nutrient dense but the fruit drink is not.

Moderation implies that no one food or nutrient is overemphasized. Carrot juice is an excellent source of beta-carotene (a form of vitamin A), but drinking too much can leave you a light shade of orange because the excess beta-carotene is deposited in fat stores close to the skin. *Variety* refers to eating different foods every day, which is important for two reasons. The first is that a variety of foods provides a variety of nutrients. Variety is also important because certain foods can contain excessive nutrients or contaminants. Eating a varied diet reduces the risk of exposure to those substances.

Examples of Widely Applicable Nutrition Messages

Nutrition messages are created from the six principles previously outlined. Let's examine some of the general messages addressed to the adult athletic population based on nutrition information found in the public domain.

- **Balance food intake with physical activity.** Problems result when food intake and exercise output are not balanced. Athletes who engage in continuous strenuous exercise but do not consume enough calories run the risk of premature fatigue caused by a lack of carbohydrate or fluid, inability to train, injury, nutrient inadequacies such as iron deficiency, and chronic fatigue syndrome. They are also at risk of illness caused by the low intake of nutrients, such as protein, needed to support the immune system. Those who routinely eat more calories than are necessary to balance exercise output will see an increase in body fat, which may lead to a decline in performance.
- **Change body composition in a manner that supports health and performance.** Those who need to lose body fat must unbalance the food and exercise equation by reducing food intake or increasing exercise output or both. Reducing daily energy (calorie) intake too severely hampers an athlete's ability to maintain or increase training or exercise. Overtraining, or excessive exercise, puts the athlete at risk of injury. As a rule, athletes who want to lose body fat should focus on a 200- to 500-calorie deficit daily. This shortfall would result in a slow loss of weight, about 1 pound (0.45 kg) every 7 to 18 days. A 200- to 500-calorie deficit is best accomplished by decreasing food intake and increasing exercise slightly for a time. For example, the athlete could switch from regular soda to water and walk to school or work instead of driving. Severely restricted diets, excessive daily exercise, voluntary dehydration, and other severe methods often provide quick weight loss, but the reduction is not permanent, sustainable, or safe. Because safe weight loss is a slow process, it should be a primary goal during the off-season or early in the training period rather than during the athlete's most highly competitive season.
- **Choose nutrient-dense foods most of the time.** The Dietary Guidelines provide multiple examples of this because they emphasize whole grains, fruits and vegetables, lean proteins, and low-fat dairy products. Every food category contains choices that are more nutrient dense and therefore more nutritious (table 6.1). Choosing nutrient-dense foods most of the time allows athletes to meet their nutrient and energy requirements. For most athletes this approach means limiting, but not eliminating, high-sugar, high-fat, low-fiber snacks and desserts and the typical menu choices from fast-food restaurants. When nutritious

TABLE 6.1 Foods With High or Low Nutrient Density

Food group	High nutrient density	Low nutrient density
Bread, cereal, rice, and pasta	Whole-grain bread	White bread
	Wild rice	Fried white rice
	Whole-wheat bagel	Donut
Fruits	Fresh apple	Apple pie
	Unsweetened applesauce	Sweetened applesauce
Vegetables	Baked potato	French fries
	Steamed zucchini	Fried zucchini
Meat, poultry, fish, dried beans, eggs, and nuts	Broiled white fish	Deep-fried fish sticks
	Boiled pinto beans	Refried pinto beans
Milk, yogurt, and cheese	Nonfat milk	Whole milk
	Reduced-fat cottage cheese and yogurt	Full-fat cottage cheese and yogurt
Miscellaneous		Soft drinks
		Alcohol
		Jelly and syrups

foods represent the majority of foods eaten, the diet has room for less nutrient-dense foods that are tasty and appealing but not particularly nutritious.

- **Eat a variety of foods to increase the nutrient content of the diet.** Eliminating entire food groups, such as fruits and vegetables, also eliminates important nutrients. When an athlete severely restricts food choices, he or she can feel deprived, and deprivation often leads to binge eating and disordered eating patterns. Athletes who don't eat a variety of foods often complain that their diets have become too regimented.
- **Practice moderation in all things.** Being moderate is sometimes difficult when faced with many eating possibilities. Portion sizes are large, so moderate consumption may mean that people leave food on their plates.

Nutrition is an extremely complex subject, and nutrition messages are often misinterpreted, especially when they are oversimplified. Let's look at what happens when messages are misinterpreted and discuss ways to help athletes correctly interpret nutrition messages.

Misinterpreting Nutrition Messages: Good Foods, Bad Foods

In the United States the foods that many people eat are high in calories, sugar, fat, and salt and low in fiber. In combination with low amounts of physical activity, high-calorie diets have resulted in rising obesity rates. Because these eating and activity patterns are detrimental to health, most nutrition messages are geared toward changing these patterns. The Dietary Guidelines for Americans is an example of restructured messages targeted at healthful eating and exercise that aid weight management. Messages intended for the general population, however, may not apply to a particular athlete. In addition, athletes can misinterpret those messages.

Although nutritionists never intended to do so, in the last 10 years foods have often been categorized as good or bad. This black-and-white characterization of foods has caused people to feel guilty about eating "bad" foods. The media, through sound bites and eye-catching headlines, have added to the problem by failing to devote enough time or space to explaining the issues and, more important, the context of how a particular food fits into a person's total diet and activity patterns. Too many people find themselves on one side or the other of the good–bad debate.

Athletes often ask sports medicine and fitness professionals what appear to be simple questions: "Is this food good for me?" or "Is this food bad for me?" There are no simple answers. If an athlete holds up a 12-ounce (360 ml) soft drink and asks, "Is this bad for me?" the sports medicine or fitness professional should rephrase the question by asking the athlete, "How does it fit into your diet plan?"

> "Is this food bad for me?" Rephrase the question by asking the athlete, "How does it fit into your diet plan?"

Soft drinks contain sugar and calories, but no other nutrients; thus, they have low nutrient density. Their sweet taste is appealing. For an athlete who generally eats a nutritious diet and balances caloric intake with exercise, that soft drink is a source of fluid, a small amount of carbohydrate, and pleasure. It fits well into the context of her overall diet. But another athlete may overconsume soft drinks, and that 12-ounce (360 ml) soft drink might be his eighth soda of the day. This pattern of soft-drink consumption is neither moderate nor part of a balanced diet. That athlete's reliance on soft drinks may result in overconsumption of calories and underconsumption of nutritious foods. Rephrasing the question helps the athlete consider a particular food in the context of the overall diet and reduces the pressure on a certified athletic trainer or fitness professional to say yes or no to a question that does not have a yes or no answer.

The good foods–bad foods mind-set can lead to inappropriate food choices. For example, for many years the nutrition messages surrounding fat have been negative: Fat is bad; cut out fatty foods; eating fat will make you fat. Athletes often adopt a very low-fat diet, but they then have difficulty meeting the recommended intake for vitamin E. Some athletes have taken the fat-is-bad message to heart and have become "fat phobic," fearful of eating any food that contains fat. They panic at the thought of eating a piece of cheesecake because they are convinced that "a minute on the lips means a lifetime on the hips." Taken to the extreme, athletes who fear fat end up eating a severely restricted diet and find it difficult to cope in social situations where many high-fat foods are present.

In a nutshell, foods are not good or bad. But some foods are everyday foods; high-fiber carbohydrate such as whole grains, beans and legumes, fruits and vegetables, and heart-healthy fat are examples. Nutrient-dense foods are everyday foods because they provide the nutrients and calories needed to support exercise and health. Foods with low nutrient density are occasional foods. Foods that are not nutrient dense can be eaten every day or every other day if the portion size is small or the energy needs of the athlete are high. People with disordered eating patterns might need counseling to help them stop characterizing foods as good or bad and to begin eating a variety of foods.

Conflicting Nutrition Messages

The following two statements have appeared frequently in the media and professional journals. Which is correct?

- Americans eat less fat today than they did in the past.
- Americans eat more fat today than they did in the past.

As is the case with so many opposing statements, both are correct depending on the context. In the mid-1960s the average fat intake was 40 to 42% of total calories, which steadily declined to 36% in the mid-1980s. By the mid-1990s fat intake was 33% of total calories. Thus the statement "Americans eat less fat today than they did in the past" is correct. But in the past, people consumed fewer calories than they do today, which dramatically affects percentage calculations. Today people in the United States eat more grams of fat—on average 76 grams daily. The percentage of calories consumed as fat is lower because the additional calories consumed are primarily from sweetened carbohydrate (7).

If the statements were worded more completely, they would not conflict. The following two statements are correct: Americans eat a lower percentage of fat in their diets today than they did in the past (they also consume more total calories than they did in the past); Americans eat more grams of fat in their diets today than they did in the past.

Conflicting messages will likely continue to be a problem in part because advertisers use nutrition information to their best advantage. Clever advertising copy is used to sell food products and weight-loss books, but the messages are often taken out of context. All professionals who work with athletes must take time to understand the context of the message and communicate it clearly when working with athletes or clients. By thoroughly researching these topics, correctly applying the public guidelines, and keeping up-to-date with new research, professionals can communicate accurate nutrition messages to their athletes.

Individualized Nutrition Messages

One of the major problems with nutrition messages is that there are always exceptions to the rules. Simple messages are directed to the majority of people. These messages are not appropriate for some people because of differences in biological response, eating habits, and exercise intensity and duration. Unfortunately, in some cases people interpret the message incorrectly.

Because only one-quarter of the adult population consumes five or more servings of fruits and vegetables daily, a frequent nutrition message is to increase fruit and vegetable consumption. But how does the lightweight woman struggling with disordered eating patterns and flirting with anorectic behaviors interpret that message? In some cases it might give her the green light to eat more fruits and vegetables, even though her intake is already high. She might use the message as permission to replace other foods in her diet with more fruits or vegetables. She might convince herself that she is doing something beneficial for her diet. In this scenario, the message intended to help people who don't eat enough fruits and vegetables is detrimental to this individual's health. Staff who work with athletes must individualize nutrition messages to make sure that each is appropriate for the athlete's situation.

By now it is clear that communicating nutrition messages can be a tricky business. Some messages are widely applicable, whereas others should be directed only to certain individuals. By using well-established nutrition guidelines and materials, sports medicine and fitness professionals can help support nutritious eating. But even the simplest nutrition messages can be misinterpreted or be conflicting. Understanding the basis for the message and the context in which it should be used helps keep nutrition messages clear and consistent.

How far should certified athletic trainers, personal trainers, and other nondietitian professionals go when it comes to nutrition advice? To answer this question, these professionals must understand their scope of practice. General nutrition issues are within the training and scope of practice for most. When issues become complex or exceed the practitioner's training and comfort level, referrals to professionals with the proper training are imperative.

Nutrition Screening and the Referral Process

One common approach to determine whether an athlete's nutrition education needs can be met by sport and fitness professionals is nutrition screening. Screening identifies people who may be at risk for nutrition deficiencies and helps identify areas where athletes can improve overall nutrition for sport performance and health. Nutrition screening helps sport professionals identify those educational needs and helps them determine whether a referral to a dietitian or other medical professional is necessary.

Varieties of screening tools are available or can be developed for the specific setting or group of athletes. Wellness or health risk appraisals, high school physical forms and screenings, and questionnaires for college teams can include basic nutrition and weight-related questions that help sport professionals identify nutrition and medical concerns. The following section provides some screening questions and assessments that should at minimum be completed on any nutrition screening tool used in the evaluation of active people. Those who are identified as being at risk need nutrition assessment.

Common Nutrition Screening Assessment Measures

- Height
- Weight
- Body composition
  - Percent fat mass
  - Percent lean mass
- BMI (calculation)
- Waist circumference (usually only in medical or wellness settings)

Common Nutrition Screening Assessment Questions

- Has your body weight changed in the past month? Three months? List the amount of change.
- Are you concerned about your weight or body composition numbers now?
- Have you been concerned about weight or body composition numbers measures in the past?
- Are you concerned about your eating habits or the nutritional adequacy of your diet? Describe those concerns.
- What are your sport performance goals?

- Do you have questions about how nutrition can help or hinder those sport performance goals?
- Has your doctor or other medical professional told you that you have a nutrition-related condition such as diabetes, high cholesterol, iron deficiency, or anemia?
- Do you have any food allergies?
- Are you interested in obtaining any specific nutrition information today?

Nutrition assessment is a more complicated process and involves laboratory tests, medical and diet histories, and other clinical measures; thus, a registered dietitian or physician should do it, and state law may require them to do so. Those professionals are skilled at interpreting laboratory and clinical data and integrating the information with the diet history and needs of the individual athlete. Calling on the services of dietitians and physicians is particularly important for medically diagnosed conditions such as diabetes, cardiovascular disease, gastrointestinal conditions, and other medical conditions in which specific foods are restricted or added to the diet for health maintenance. Food and diet issues that involve control, restriction, and emotions require the services of a psychiatrist or psychologist as well. Creating specific meal plans for those conditions is within the scope of practice for registered dietitians.

Some certified sport and fitness professionals are qualified to look over a computerized dietary analysis that compares an athlete's dietary intake with recommended intake, usually the Dietary Reference Intakes (DRI). Usually the computer program automatically prints out the nutrients that are low and those that are excessive, and it lists foods that could be added or reduced in the diet. Reviewing these lists with athletes helps them increase their nutrition knowledge. But an athlete who requests a specific meal plan must be referred to a registered dietitian, ideally one who specializes in sport nutrition. Most universities have a dietitian on staff at the health center. The American Dietetic Association (ADA) website, www.eatright.org, lists dietitians who specialize in sport nutrition. You can search for them by zip code using the "Find a Nutrition Professional" feature.

The next section deals with an example of a condition in which referral to several qualified medical practitioners is necessary. It discusses the disordered eating spectrum and the way in which a team of professionals can work together to deal with this complicated issue.

Knowing When to Refer: Disordered Eating

Athletes in sports that use weight classes and sports in which appearance is important such as wrestling, lightweight crew, gymnastics, and figure skating are at high risk for nutrient deficiencies and disordered eating patterns if they severely restrict calories. Endurance athletes such as runners can become excessively focused on weight and develop inflexible eating patterns. Athletes in any sport can make poor dietary choices if they lack knowledge, time, or food preparation skills. ATCs must be aware that factors other than dietary choices might be involved. Clearly understanding the differences between disordered eating, eating disorders, and "normal" eating should help the ATC know when to refer rather than advise.

Eating disorders (ED) are extreme pathological conditions and include anorexia, bulimia, and binge eating disorder. Established criteria exist for identifying these conditions, which require medical intervention by highly trained physicians, dietitians, and psychiatrists or psychologists. Eating disorders such as anorexia have received much media attention, and pictures of emaciated athletes document the severe cases. But certified athletic trainers and fitness professionals are more likely to encounter disordered eating than eating disorders.

Disordered eating (DE) is not well defined or easily recognized. Perhaps the most useful approach is to understand "normal" eating and make comparisons. Although normal eating has no scientific definition, the following is widely used by dietitians.

> Normal eating is being able to eat when you are hungry and continue eating until you are satisfied. It is being able to choose food you like and eat it and truly get enough of it—not just stop eating because you think you should. Normal eating is being able to use some moderate constraint in your food selection to get the right food, but *not* being so restrictive that you miss out on pleasurable foods. . . . Normal eating takes up some of your time and attention, but it keeps its place as only one important area of your life. In short, normal eating is flexible. It varies in response to your emotions, your schedule, your hunger, and your proximity to food. (8, pp. 69–70)

Using the preceding definition, DE can be distinguished from normal eating. People who struggle with disordered eating patterns often restrict their food intake by not eating even when they are hungry or by prescribing the exact amount to be eaten regardless of how hungry they are. These athletes limit food intake because they think they should. Their diet tends to be based on a pattern of restriction rather than a pattern of inclusion. They overemphasize food, diet, and caloric intake in their daily life. Body composition and low body weight can become a measure of success, and athletes can become rigid about their food intake, worried that small deviations in intake will result in weight and fat gains. This theme includes many variations, but the core issue is that eating is no longer flexible.

Athletes are driven to excel, and as the level of competition increases from high school to college to the professional ranks, athletes must become more dedicated to their training regimens. Nutrition supports training, so competitive athletes monitor their food and nutrient intake. The keys are keeping food intake in perspective (it provides the fuel and nutrients for training and performance) and maintaining dietary flexibility.

Distinguishing between a highly dedicated athlete who engages in normal eating and one with disordered eating patterns that might lead to a full-blown eating disorder is sometimes difficult. Table 6.2 highlights the subtle differences between these athletes. Although many athletes exhibit only a few of the signs, some athletes will display all of them. Listening to athletes' comments about their food intake and body composition will help certified athletic trainers recognize the differences and make appropriate referrals

Certified athletic trainers and fitness professionals need to recognize the warning signs of DE and ED. Estimates are that 2 to 3% of female college athletes have clinically diagnosable eating disorders (usually anorexia or bulimia). Disordered eating appears to be more prevalent; 15 to 30% demonstrate DE behaviors or tendencies. Less than 1% of males have ED, and the number of males with DE is unknown. All athletes should be screened regardless of sex because ED and DE exist in males, although these conditions are not as prevalent as in females. Disordered eating in females often leads to amenorrhea and eventually premature osteoporosis, a syndrome known as the *female athlete triad* (9).

TABLE 6.2 Signs of Normal and Disordered Eating Patterns

Area	Athletes with disordered eating patterns might display the following:	Athletes with normal eating patterns might display the following:
Training	Aimless activity or exercise; self-imposed overtraining	Purposeful training; does not overtrain
Performance	Decreased or poor performance level	Increased or maintained performance level
Muscle mass	Decreased muscle mass or inability to increase muscle mass with resistance training	Increased muscle mass or maintenance of muscle mass with resistance training
Body image	Inaccurate body description; negative body image	Accurate body description; positive body image
Body composition	Unrealistic percent body-fat goals not related to gains in performance; not attainable without compromising health	Realistic percent body-fat goals related to gains in performance; attainable without compromising health
Dietary intake	Consumption of healthy foods but inadequate caloric intake; concern about or refusal to eat foods low in nutrient density	Consumption of healthy foods and adequate caloric intake; no concern about occasionally eating foods low in nutrient density
Energy intake	Controlled caloric intake	Monitored caloric intake
Energy (calorie) perspective	Restriction of energy to meet body composition goals	Adequate energy to meet demands of training
Dietary flexibility	Ritualistic and inflexible diet	Routine diet but flexible if necessary

Courtesy of Marie Dunford, PhD, RD.

Everyone who works with athletes should be able to recognize the warning signs of disordered eating and eating disorders. Screening for or treating DE or ED is outside the scope of practice of certified athletic trainers and fitness professionals, so they should refer at-risk athletes. Many institutions have protocols for identifying athletes who are at risk for eating disorders, including names of practitioners for referral. The protocol should be followed as written.

Perhaps the most difficult decision to make is when to intervene. Because disordered eating does not generally resolve itself and eating disorders can be fatal, the rule is to make a referral any time disordered eating is suspected. The need for confidentiality is imperative. The following are some of the warning signs of disordered eating (10).

- Preoccupation with dieting, weight, or weight loss
- Irregular or absent menstruation
- Recurring stress fractures
- Self-esteem that appears to be closely tied to weight or body composition
- Compulsive overexercise

Disordered eating patterns should not be ignored because they can be precursors to eating disorders, which are potentially fatal. If you are concerned about disordered eating in an athlete whom you work with, follow the referral protocol established by your institution.

This disordered eating example outlines the necessity of referring athletes to several health professionals to manage medical, emotional, and nutritional issues with this disorder. When an athlete has a medical condition like diabetes or cardiovascular disease, similar referrals may be necessary to manage the condition properly. An athlete with a new diabetes diagnosis will need a registered dietitian for dietary assessment and planning; a physician for diagnosis and management of medications, adjustments, and monitoring laboratory values; and possibly a psychologist to help cope with the emotions of the diagnosis of a chronic illness. The following section provides a summary to help professionals know when referral to another practitioner is appropriate and necessary.

When to Refer Athletes for Nutrition Counseling

- Medical conditions that require medical nutrition therapy
- Clinical laboratory values outside normal ranges
- Disordered eating, eating disorders, or excessive concern about specific foods, body weight, and appearance
- When the athlete requests or needs a specific dietary prescription or meal plan
- When unsure how to help the athlete with nutrition questions
- When public domain information is not specific enough to meet the athlete's nutritional goals

When referral to a dietitian or another member of the sports medicine team is deemed appropriate, the approach to that referral is important. Athletic trainers, personal trainers, or strength coaches often have excellent rapport with their athletes. Recommending a referral to a specialist with whom the athlete has no rapport or has never met may make the athlete uneasy. By clearly stating why the referral is appropriate and making it clear that they will continue their work, fitness professionals can help the athlete feel comfortable and increase the likelihood that he or she will accept and follow through with the referral. Simple statements based on facts such as "your weight has continued to drop and is now at a level that you are losing muscle mass" or "your body fat percentage has gone up the last 3 months in a row" provide clear evidence that further, in-depth nutrition assessment and medical nutrition therapy are indicated. Suggesting an appointment with a registered dietitian and giving explicit contact information and a description of the services that a dietitian provides is helpful. The athlete will feel comfortable with the referral if making an appointment is easy and he or she understands why it is necessary and important for future sport performance and health. People who work with athletes are an important part of the team that helps promote continued high levels of sport performance.

Team Approach

Sports medicine professionals work with athletes who may have a variety of medical conditions that warrant referral to providers with more expertise to handle dietary assessment, evaluation, and nutritional planning. Ideally, these professionals are readily available to the athlete and referrals can be made easily. The referral process may go the other way as well. Registered dietitians must be aware of concerns that athletes discusses with them that may also require referral. Some athletes mention sports injuries in a nutrition counseling session. Dietitians must be sure that the athlete seeks appropriate help from a physician or athletic trainer for assessment and treatment. Fitness specialists or certified athletic trainers often have more experience with body composition analyses than dietitians do. In this example, although body composition analysis is within the dietitians' scope of practice, a referral to someone more skilled makes sense.

All professionals who work with athletes need to know their own skills, their professional standards, and their scope of practice, and they must be able to work with other professionals to provide the best advice and care for the athletes with whom they work. Making professional contacts across professions is a must. When working with a sport team or in a sports medicine and physical therapy clinic, several professionals are likely available and the referral process is usually smooth. If it is less clear how to make referrals and to whom you can refer, work hard at connecting with dietitians, medical facilities, exercise physiologists, and athletic trainers so that the referral process, when needed, is simple and clear for the athlete.

Summary

Most sports medicine professionals have knowledge of nutrition, but nutrition is not the primary focus of their training or practice. Performing general nutrition screening and using nutrition materials that are in the public domain is appropriate. Unless you are a dietitian, planning special diets, engaging in medical nutrition therapy, or advising and counseling athletes with disordered eating or eating disorders is outside your scope of practice.

By using well-established nutrition guidelines and materials, sports medicine and fitness professionals can help support nutritious eating. Even the simplest nutrition messages, however, can be misinterpreted or appear conflicting. Understanding the basis for the message and the context in which it should be used helps keep nutrition messages clear and consistent. Treating serious nutrition-related problems requires sensitivity and special training. When food and diet issues become complex and are outside a professional's training and scope of practice, a referral is required.

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appendix

Exchange Lists for Meal Planning

STARCH LIST One starch exchange equals 15 g of carbohydrate, 3 g of protein, 0 to 1 g of fat, and 80 cal.	
Food	**One starch exchange**
BREAD	
Bagel, 4 oz (120 g)	1/4 (1 oz, or 30 g)
Bread, reduced calorie	2 slices (1 1/2 oz, or 45 g)
Bread, white, whole wheat, pumpernickel, rye	1 slice (1 oz, or 30 g)
English muffin	1/2
Hot dog bun or hamburger bun	1/2 (1 oz, or 30 g)
Naan, 8 × 2 in. (20 × 5 cm)	1/4
Pancake, 4 in. (10 cm) across, 1 in. (2.5 cm) thick	1
Pita, 6 in. (15 cm) across	1/2
Roll, plain, small	1 (1 oz, or 30 g)
Raisin bread, unfrosted	1 slice (1 oz, or 30 g)
Tortilla, corn, 6 in. (15 cm) across	1
Tortilla, flour, 6 in. (15 cm) across	1
Tortilla, flour, 10 in. (25 cm) across	1/3
Waffle, 4 in. (10 cm) square or across, reduced fat	1

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STARCH LIST One starch exchange equals 15 g of carbohydrate, 3 g of protein, 0 to 1 g of fat, and 80 cal.	
Food	**One starch exchange**
CEREALS AND GRAINS	
Bran cereals	1/2 cup
Bulgur	1/2 cup
Cereals, cooked	1/2 cup
Cereals, unsweetened, ready to eat	3/4 cup
Cornmeal (dry)	3 tbsp
Couscous	1/3 cup
Flour (dry)	3 tbsp
Granola, low fat	1/4 cup
Grape-Nuts	1/4 cup
Grits	1/2 cup
Kasha	1/2 cup
Millet	1/3 cup
Muesli	1/4 cup
Oats	1/2 cup
Pasta	1/3 cup
Puffed cereal	1 1/2 cups
Rice, white or brown	1/3 cup
Shredded Wheat	1/2 cup
Sugar-frosted cereal	1/2 cup
Wheat germ	3 tbsp
STARCHY VEGETABLES	
Baked beans	1/3 cup
Corn	1/2 cup
Corn on cob, large	1/2 cob (5 oz, or 150 g)
Mixed vegetables with corn, peas, or pasta	1 cup
Peas, green	1/2 cup
Plantain	1/2 cup
Potato, boiled	1/2 cup or 1/2 medium (3 oz, or 90 g)
Potato, baked with skin	1/4 large (3 oz, or 90 g)
Potato, mashed	1/2 cup

STARCH LIST One starch exchange equals 15 g of carbohydrate, 3 g of protein, 0 to 1 g of fat, and 80 cal.	
Food	**One starch exchange**
STARCHY VEGETABLES	
Squash, winter (acorn, butternut, pumpkin)	1 cup
Yam, sweet potato, plain	1/2 cup
CRACKERS AND SNACKS	
Animal crackers	8
Graham cracker, 2 1/2 in. (6 cm) square	3
Matzoh	0.75 oz (20 g)
Melba toast	4 slices
Oyster crackers	24
Popcorn (popped, no fat added, or low-fat microwave)	3 cups
Pretzels	0.75 oz (20 g)
Rice cakes, 4 in. (10 cm) across	2
Saltine-type crackers	6
Snack chips, fat free or baked (tortilla, potato)	15–20 (0.75 oz, or 20 g)
Whole-wheat crackers, no fat added	2–5 (0.75 oz, or 20 g)
BEANS, PEAS, AND LENTILS (count as one starch exchange plus one very lean meat exchange)	
Beans and peas (garbanzo, pinto, kidney, white, split, black-eyed)	1/2 cup
Lima beans	2/3 cup
Lentils	1/2 cup
Miso*	3 tbsp
STARCHY FOODS PREPARED WITH FAT (count as one starch exchange plus one fat exchange)	
Biscuit, 2 1/2 in. (6 cm) across	1
Chow mein noodles	1/2 cup
Corn bread (2 in., or 5 cm, cube)	1 (2 oz, or 60 g)
Crackers, round butter type	6
Croutons	1 cup
French-fried potatoes (oven baked)	1 cup (2 oz, or 60 g)
Granola	1/4 cup
Hummus	1/3 cup

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STARCH LIST One starch exchange equals 15 g of carbohydrate, 3 g of protein, 0 to 1 g of fat, and 80 cal.	
Food	**One starch exchange**
STARCHY FOODS PREPARED WITH FAT (count as one starch exchange plus one fat exchange)	
Muffin, 5 oz (150 g)	1/5 (1 oz, or 30 g)
Popcorn, microwaved	3 cups
Sandwich crackers, cheese or peanut butter filling	3
Snack chips (potato, tortilla)	9–13 (0.75 oz, or 20 g)
Stuffing, bread (prepared)	1/3 cup
Taco shell, 6 in. (15 cm) across	2
Waffle, 4 in. (10 cm) square or across	1
Whole-wheat crackers, fat added	4–6 (1 oz, or 30 g)
* = 400 mg or more of sodium per exchange.	

FRUIT LIST One fruit exchange equals 15 g of carbohydrate and 60 cal. The weight includes skin, core, seeds, and rind.	
Food	**One fruit exchange**
Apple, unpeeled, small	1 (4 oz, or 125 g)
Applesauce, unsweetened	1/2 cup
Apples, dried	4 rings
Apricots, fresh	4 whole (5 1/2 oz, or 160 g)
Apricots, dried	8 halves
Apricots, canned	1/2 cup
Banana, small	1 (4 oz, or 125 g)
Blackberries	3/4 cup
Blueberries	3/4 cup
Cantaloupe, small	1/3 melon (11 oz, or 325 g) or 1 cup cubes
Cherries, sweet, fresh	12 (3 oz, or 90 g)
Cherries, sweet, canned	1/2 cup
Dates	3
Figs, fresh	1 1/2 large or 2 medium (3 1/2 oz, or 100 g)
Figs, dried	1 1/2
Fruit cocktail	1/2 cup
Grapefruit, large	1/2 (11 oz, or 325 g)
Grapefruit, sections, canned	3/4 cup

FRUIT LIST One fruit exchange equals 15 g of carbohydrate and 60 cal. The weight includes skin, core, seeds, and rind.	
Food	**One fruit exchange**
Grapes, small	17 (3 oz, or 90 g)
Honeydew melon	1 slice (10 oz, or 300 g) or 1 cup cubes
Kiwi	1 (3 1/2 oz, or 100 g)
Mandarin oranges, canned	3/4 cup
Mango, small	1/2 fruit (5 1/2 oz, or 160 g) or 1/2 cup
Nectarine, small	1 (5 oz, or 150 g)
Orange, small	1 (6 1/2 oz, or 190 g)
Papaya	1/2 fruit (8 oz, or 250 g) or 1 cup cubes
Peach, medium, fresh	1 (4 oz, or 125 g)
Peaches, canned	1/2 cup
Pear, large, fresh	1/2 (4 oz, or 125 g)
Pears, canned	1/2 cup
Pineapple, fresh	3/4 cup
Pineapple, canned	1/2 cup
Plums, small	2 (5 oz, or 150 g)
Plums, canned	1/2 cup
Plums, dried (prunes)	3
Raisins	2 tbsp
Raspberries	1 cup
Strawberries	1 1/4 cup whole berries
Tangerines, small	2 (8 oz, or 250 g)
Watermelon	1 slice (13 1/2 oz, or 390 g) or 1 1/4 cup cubes
FRUIT JUICE, UNSWEETENED	
Apple juice or cider	1/2 cup
Cranberry juice cocktail	1/3 cup
Cranberry juice cocktail, reduced calorie	1 cup
Fruit juice blends, 100% juice	1/3 cup
Grape juice	1/3 cup
Grapefruit juice	1/2 cup
Orange juice	1/2 cup
Pineapple juice	1/2 cup
Prune juice	1/3 cup

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MILK LIST One milk exchange equals 12 g of carbohydrate and 8 g of protein.	
Food	**One milk exchange**
FAT-FREE AND LOW-FAT MILK (0–3 g of fat per serving)	
Fat-free milk	1 cup
1/2% milk	1 cup
1% milk	1 cup
Buttermilk, low fat or fat free	1 cup
Evaporated fat-free milk	1/2 cup
Fat-free dry milk	1/3 cup dry
Soy milk, low fat or fat free	1 cup
Yogurt, fat free, flavored, sweetened with nonnutritive sweetener and fructose	2/3 cup (6 oz, or 175 g)
Yogurt, plain, fat free	2/3 cup (6 oz, or 175 g)
REDUCED FAT (5 g of fat per serving)	
2% milk	1 cup
Soy milk	1 cup
Sweet acidophilus milk	1 cup
Yogurt, plain low fat	3/4 cup
WHOLE MILK (8 g of fat per serving)	
Whole milk	1 cup
Evaporated whole milk	1/2 cup
Goat's milk	1 cup
Kefir	1 cup
Yogurt, plain (made from whole milk)	3/4 cup

SWEETS, DESSERTS, AND OTHER CARBOHYDRATES LIST One carbohydrate exchange equals 15 g of carbohydrate, or one starch, or one fruit, or one milk.		
Food	**Serving size**	**Exchanges per serving**
Angel food cake, unfrosted	1/12 cake (about 2 oz, or 60 g)	2 carbohydrates
Brownie, small, unfrosted	2 in. (5 cm) square (about 1 oz, or 30 g)	1 carbohydrate, 1 fat
Cake, unfrosted	2 in. (5 cm) square (about 1 oz, or 30 g)	1 carbohydrate, 1 fat

SWEETS, DESSERTS, AND OTHER CARBOHYDRATES LIST One carbohydrate exchange equals 15 g of carbohydrate, or one starch, or one fruit, or one milk.		
Food	**Serving size**	**Exchanges per serving**
Cake, frosted	2 in. (5 cm) square (about 2 oz, or 60 g)	2 carbohydrates, 1 fat
Cookie or sandwich cookie with creme filling	2 small (about 2/3 oz, or 20 g)	1 carbohydrate, 1 fat
Cookies, sugar free	3 small or 1 large (3/4–1 oz, or 20–30 g)	1 carbohydrate, 1–2 fats
Cranberry sauce, jellied	1/4 cup	1 1/2 carbohydrates
Cupcake, frosted	1 small (about 2 oz, or 60 g)	2 carbohydrates, 1 fat
Doughnut, plain cake	1 medium (1 1/2 oz, or 45 g)	1 1/2 carbohydrates, 2 fats
Doughnut, glazed	3 3/4 inch (9.5 cm) across (2 oz, or 60 g)	2 carbohydrates, 2 fats
Energy, sport, or breakfast bar	1 bar (1 1/3 oz, or 40 g)	1 1/2 carbohydrates, 0–1 fat
Energy, sport, or breakfast bar	1 bar (2 oz, or 60 g)	2 carbohydrates, 1 fat
Fruit cobbler	1/2 cup (3 1/2 oz, or 100 g)	3 carbohydrates, 1 fat
Fruit juice bars, frozen, 100% juice	1 bar (3 oz, or 90 g)	1 carbohydrate
Fruit snacks, chewy (pureed fruit concentrate)	1 roll (3/4 oz, or 20 g)	1 carbohydrate
Fruit spreads, 100% fruit	1 1/2 tbsp	1 carbohydrate
Gelatin, regular	1/2 cup	1 carbohydrate
Gingersnaps	3	1 carbohydrate
Granola or snack bar, regular or low fat	1 bar (1 oz, or 30 g)	1 1/2 carbohydrates
Honey	1 tbsp	1 carbohydrate
Ice cream	1/2 cup	1 carbohydrate, 2 fats
Ice cream, light	1/2 cup	1 carbohydrate, 1 fat
Ice cream, low fat	1/2 cup	1 1/2 carbohydrates
Ice cream, fat free, no sugar added	1/2 cup	1 carbohydrate
Jam or jelly, regular	1 tbsp	1 carbohydrate
Milk, chocolate, whole	1 cup	2 carbohydrates, 1 fat
Pie, fruit, 2 crusts	1/6 of 8 in. (20 cm) com- mercially prepared pie	3 carbohydrates, 2 fats
Pie, pumpkin or custard	1/8 of 8 in. (20 cm) com- mercially prepared pie	2 carbohydrates, 2 fats

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SWEETS, DESSERTS, AND OTHER CARBOHYDRATES LIST One carbohydrate exchange equals 15 g of carbohydrate, or one starch, or one fruit, or one milk.		
Food	**Serving size**	**Exchanges per serving**
Pudding, regular (made with reduced-fat milk)	1/2 cup	2 carbohydrates
Pudding, sugar free or sugar free and fat free (made with fat-free milk)	1/2 cup	1 carbohydrate
Reduced-calorie meal replacement (shake)	1 can (10–11 oz, or 300–325 g)	1 1/2 carbohydrates, 0–1 fat
Rice milk, low fat or fat free, plain	1 cup	1 carbohydrate
Rice milk, low fat, flavored	1 cup	1 1/2 carbohydrates
Salad dressing, fat free*	1/4 cup	1 carbohydrate
Sherbet, sorbet	1/2 cup	2 carbohydrates
Spaghetti sauce or pasta sauce, canned*	1/2 cup	1 carbohydrate, 1 fat
Sports drinks	8 oz (250 g) (1 cup)	1 carbohydrate
Sugar	1 tbsp	1 carbohydrate
Sweet roll or danish	1 (2 1/2 oz, or 75 g)	2 1/2 carbohydrates, 2 fats
Syrup, light	2 tbsp	1 carbohydrate
Syrup, regular	1 tbsp	1 carbohydrate
Syrup, regular	1/4 cup	4 carbohydrates
Vanilla wafers	5	1 carbohydrate, 1 fat
Yogurt, frozen	1/2 cup	1 carbohydrate, 0–1 fat
Yogurt, frozen, fat free	1/3 cup	1 carbohydrate
Yogurt, low fat with fruit	1 cup	3 carbohydrates, 0–1 fat
* = 400 mg or more of sodium per exchange		

NONSTARCHY VEGETABLE LIST One vegetable exchange (1/2 cup cooked or 1 cup raw) equals 5 g of carbohydrate, 2 g of protein, 0 g of fat, and 25 cal.	
Food	
Artichoke	Mushrooms
Artichoke hearts	Okra
Asparagus	Onions
Beans (green, wax, italian)	Pea pods
Bean sprouts	Peppers (all varieties)
Beets	Radishes
Broccoli	Salad greens (endive, escarole, lettuce, romaine, spinach)

NONSTARCHY VEGETABLE LIST One vegetable exchange (1/2 cup cooked or 1 cup raw) equals 5 g of carbohydrate, 2 g of protein, 0 g of fat, and 25 cal.	
Food	
Brussels sprouts	Sauerkraut*
Cabbage	Spinach
Carrots	Summer squash
Cauliflower	Tomato
Celery	Tomatoes, canned
Cucumber	Tomato sauce*
Eggplant	Tomato or vegetable juice*
Green onions or scallions	Turnips
Greens (collard, kale, mustard, turnip)	Water chestnuts
Kohlrabi	Watercress
Leeks	Zucchini
Mixed vegetables (without corn, peas, or pasta)	
* = 400 mg or more sodium per exchange.	

MEAT AND MEAT SUBSTITUTES LIST	
Food	**One meat exchange**
VERY LEAN MEAT AND SUBSTITUTES LIST One very lean meat exchange is equal to 0 g of carbohydrate, 7 g of protein, 0 to 1 g of fat, and 35 cal. One very lean meat exchange is equal to any one of the following items.	
Poultry: chicken or turkey (white meat, no skin), cornish hen (no skin)	1 oz (30 g)
Fish: fresh or frozen cod, flounder, haddock, halibut, trout, lox (smoked salmon)*, tuna fresh or canned in water	1 oz (30 g)
Shellfish: clams, crab, lobster, scallops, shrimp, imitation shellfish	1 oz (30 g)
Game: duck or pheasant (no skin), venison, buffalo, ostrich	1 oz (30 g)
Cheese with 1 g of fat or less per ounce (30 g): fat-free or low-fat cottage cheese	1/4 cup
Fat-free cheese	1 oz
Other: processed sandwich meats with 1 g of fat or less per ounce (30 g), such as deli thin, shaved meats, chipped beef*, turkey ham	1 oz
Egg whites	2
Egg substitutes, plain	1/4 cup
Hot dogs with 1 g of fat or less per ounce (30 g)*	1 oz (30 g)
Kidney (high in cholesterol)	1 oz (30 g)
Sausage with 1 g of fat or less per ounce (30 g)	1 oz (30 g)
Beans, peas, and lentils (cooked)	1/2 cup (count as one very lean meat and one starch exchange)

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MEAT AND MEAT SUBSTITUTES LIST	
Food	**One meat exchange**
LEAN MEAT AND SUBSTITUTES LIST One lean meat exchange is equal to 0 g of carbohydrate, 7 g of protein, 3 g of fat, and 55 cal. One lean meat exchange is equal to any one of the following items.	
Beef: USDA select or choice grades of lean beef trimmed of fat, such as round, sirloin, and flank steak; tenderloin; roast (rib, chuck, rump); steak (T-bone, porterhouse, cubed); ground round	1 oz (30 g)
Pork: lean pork, such as fresh ham; canned, cured, or boiled ham; canadian bacon*; tenderloin, center loin chop	1 oz (30 g)
Lamb: roast, chop, or leg	1 oz (30 g)
Veal: lean chop, roast	1 oz (30 g)
Poultry: chicken, turkey (dark meat, no skin), chicken (white meat, with skin), domestic duck or goose (well drained of fat, no skin)	1 oz (30 g)
Fish: herring (uncreamed or smoked)	1 oz (30 g)
Oysters	6 medium
Salmon (fresh or canned), catfish	1 oz (30 g)
Sardines (canned)	2 medium
Tuna (canned in oil, drained)	1 oz (30 g)
Game: goose (no skin), rabbit	1 oz (30 g)
Cheese: 4.5% fat cottage cheese	1/4 cup
Grated parmesan	2 tbsp
Cheeses with 3 g of fat or less per ounce (30 g)	1 oz (30 g)
Other: hot dogs with 3 g of fat or less per ounce (30 g)*	1 1/2 oz (45 g)
Processed sandwich meat with 3 g of fat or less per ounce, such as turkey, pastrami, or kielbasa	1 oz (30 g)
Liver, heart (high in cholesterol)	1 oz (30 g)
MEDIUM-FAT MEAT AND SUBSTITUTES LIST One medium-fat meat exchange is equal to 0 g of carbohydrate, 7 g of protein, 5 g of fat, and 75 cal. One medium-fat meat exchange is equal to any one of the following items.	
Beef: most beef products (ground beef, meatloaf, corned beef, short ribs, prime grades of meat trimmed of fat, such as prime rib)	1 oz (30 g)
Pork: top loin, chop, boston butt, cutlet	1 oz (30 g)
Lamb: rib roast, ground	1 oz (30 g)
Veal: cutlet (ground or cubed, unbreaded)	1 oz (30 g)
Poultry: chicken (dark meat, with skin), ground turkey or ground chicken, fried chicken (with skin)	1 oz (30 g)
Fish: Any fried fish product	1 oz (30 g)

MEAT AND MEAT SUBSTITUTES LIST	
Food	**One meat exchange**
MEDIUM-FAT MEAT AND SUBSTITUTES LIST One medium-fat meat exchange is equal to 0 g of carbohydrate, 7 g of protein, 5 g of fat, and 75 cal. One medium-fat meat exchange is equal to any one of the following items.	
Cheese with 5 g or less fat per ounce (30 g): feta	1 oz (30 g)
Mozzarella	1 oz (30 g)
Ricotta	1/4 cup (2 oz)
Other: egg (high in cholesterol, limit to 3 per week)	1
Sausage with 5 g of fat or less per ounce (30 g)	1 oz (30 g)
Tempeh	1/4 cup
Tofu	4 oz (125 g) or 1/2 cup
HIGH-FAT MEAT AND SUBSTITUTES LIST One high-fat meat exchange is equal to 0 g of carbohydrate, 7 g of protein, 8 g of fat, and 100 cal. These items are high in saturated fat, cholesterol, and calories and may raise blood cholesterol levels if eaten on a regular basis. One high-fat meat exchange is equal to any one of the following items.	
Pork: spareribs, ground pork, pork sausage	1 oz (30 g)
Cheese: all regular cheeses, such as American, cheddar*, monterey jack, swiss	1 oz (30 g)
Other: processed sandwich meats with 8 g of fat or less per ounce (30 g), such as bologna, pimento loaf, salami	1 oz (30 g)
Sausage, such as bratwurst, italian, knockwurst	1 oz (30 g)
Polish, smoked	1 oz (30 g)
Hot dog (turkey or chicken)*	1 (10 per lb, or 22 per kg)
Bacon	3 slices (20 slices per lb, or 44 slices per kg)
Peanut butter (contains unsaturated fat)	1 tbsp
Hot dog (beef, pork, or combination)*	1 (10 per lb, or 22 per kg) (count as 1 high-fat meat, plus 1 fat exchange)
* = 400 mg or more sodium per exchange.	

FAT LIST One fat exchange equals 5 g of fat and 45 cal.	
Food	**1 fat exchange**
MONOUNSATURATED FATS LIST	
Avocado, medium	2 tbsp (1 oz, or 30 g)
Oil (canola, olive, peanut)	1 tsp
Olives: ripe (black)	8 large
Olives: green, stuffed*	10 large

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FAT LIST One fat exchange equals 5 g of fat and 45 cal.	
Food	**1 fat exchange**
MONOUNSATURATED FATS LIST	
Nuts: almonds, cashews	6 nuts
Mixed (50% peanuts)	6 nuts
Peanuts	10 nuts
Pecans	4 halves
Peanut butter, smooth or crunchy	1/2 tbsp
Sesame seeds	1 tbsp
Tahini or sesame paste	2 tsp
POLYUNSATURATED FATS LIST	
Margarine, stick, tub, or squeeze	1 tsp
Lower-fat spread (30% to 50% vegetable oil)	1 tbsp
Mayonnaise, regular	1 tsp
Mayonnaise, reduced fat	1 tbsp
Nuts: walnuts, English	4 halves
Oil (corn, safflower, soybean)	1 tsp
Salad dressing, regular*	1 tbsp
Salad dressing, reduced fat	2 tbsp
Miracle Whip salad dressing, regular	2 tsp
Miracle Whip salad dressing, reduced fat	1 tbsp
Seeds: pumpkin, sunflower	1 tbsp
SATURATED FATS LIST	
Bacon	1 slice (20 slices per lb, or 44 slices per kg)
Bacon, grease	1 tsp
Butter, stick	1 tsp
Butter, whipped	2 tsp
Butter, reduced fat	1 tbsp
Chitterlings, boiled	2 tbsp (1/2 oz, or 15 g)
Coconut, sweetened, shredded	2 tbsp
Coconut milk	1 tbsp
Cream, half and half	2 tbsp
Cream cheese, regular	1 tbsp (1/2 oz, or 15 g)

FAT LIST One fat exchange equals 5 g of fat and 45 cal.	
Food	**1 fat exchange**
SATURATED FATS LIST	
Cream cheese, reduced fat	1 1/2 tbsp (3/4 oz, or 20 g)
Fatback or salt pork*	Piece 1 in. × 1 in. × 1/4 in. (2.5 cm × 2.5 cm × 0.6 cm) if eating the fatback cooked with vegetables. Piece 2 in. × 1 in. × 1/2 in. (5 cm × 2.5 cm × 1.2 cm) if eating only the vegetables with the fatback removed.
Shortening or lard	1 tsp
Sour cream, regular	2 tbsp
* = 400 mg or more sodium per exchange.	

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