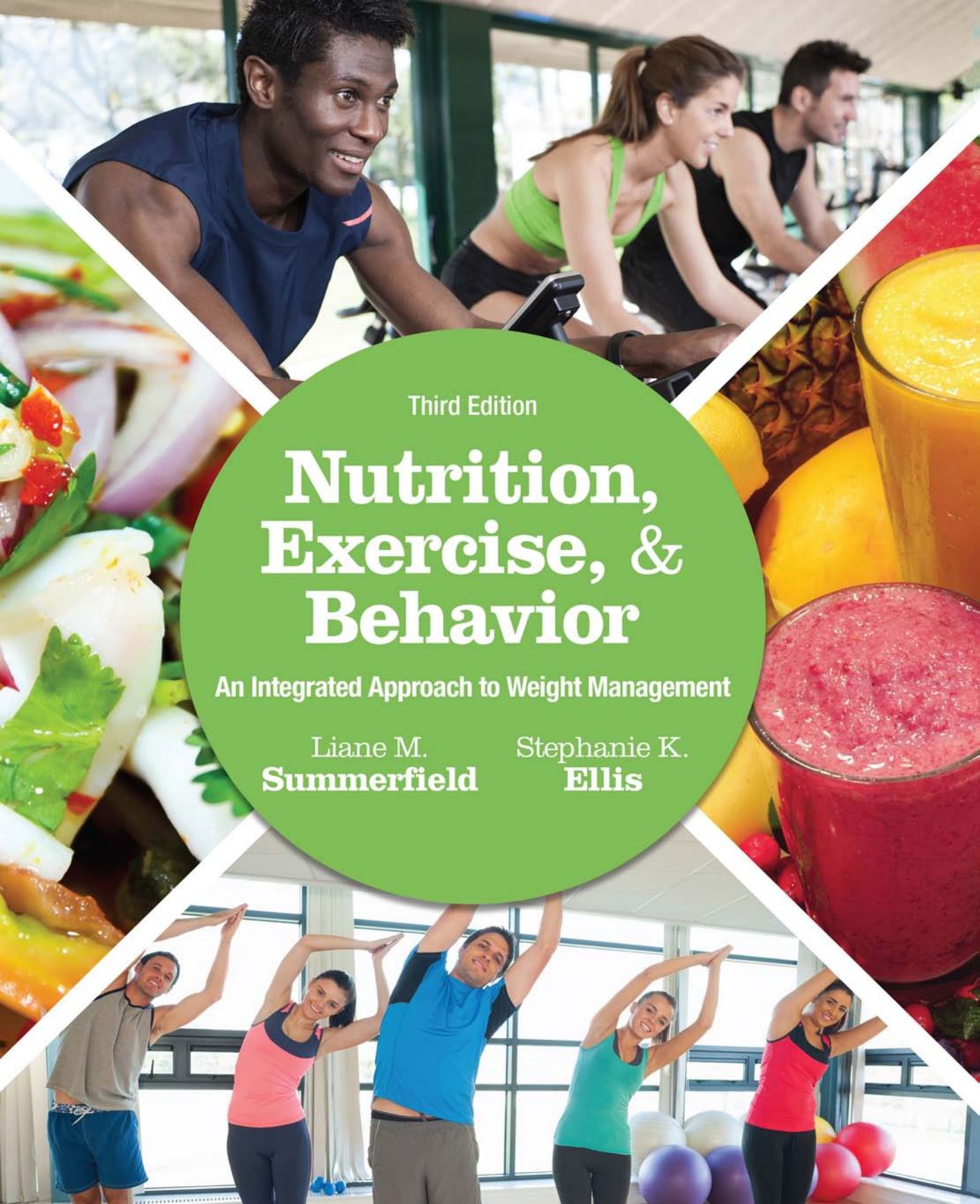

Third Edition

Nutrition, Exercise, & Behavior

An Integrated Approach to Weight Management

Liane M. **Summerfield**

Stephanie K. **Ellis**

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Nutrition, Exercise, and Behavior

AN INTEGRATED APPROACH TO WEIGHT MANAGEMENT

THIRD EDITION

LIANE M. SUMMERFIELD, Ph.D.
Marymount University

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To Barry, for keeping life interesting.

—Liane

To my parents for all their encouragement and support.

—Stephanie

Brief Contents

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PART III Physical Activity for Health and Weight Management

Preface

Since the publication of the first edition of this text in 2001, we have learned more about the incidence, prevalence, and consequences of obesity/overweight and eating disorders, we have seen updates to Dietary Guidelines and recommended nutrient intakes, and have been given revised exercise guidelines. Additional physiological factors affecting weight have been discovered and treatment approaches to weight management problems have evolved. And yet obesity is still on the rise, in the United States and around the world.

In the United States today, over two-thirds of the adult population and one-third of children and adolescents are overweight or obese. Only Mexico has a higher rate of overweight and obesity, and rates continue to increase in most industrialized nations and in many developing countries as well. On May 29, 2014, the journal *Lancet* reported that 2.1 billion people around the world are overweight or obese; this was widely covered by the media. Excess fat in particular is responsible for a rise in serious health conditions and an increase in health care costs by billions of dollars each year. Obese adults—and some children!—are more likely to have cardiovascular disease, hypertension, and type 2 diabetes.

Obesity is now seen at much earlier ages. While rates are slowing in several nations, almost 20% of American preschoolers, children, and adolescents are obese. These rates are poised to have a profoundly negative effect on health and longevity, possibly lowering life expectancy of younger generations for the first time in decades.

Weight management is a complex topic; far more complicated than popular diet books, reality television programs, or exercise videos would suggest. This book looks at weight management holistically, considering the role of physiology, culture, the environment, and human behavior to explain obesity and eating disorders. It offers in-depth coverage of important areas supported by current evidence with tables and figures to synthesize and summarize key points. An extensive reference list at the end of each chapter allows students to read original research.

WHY THIS TEXT WAS DEVELOPED

The first edition of this book was written to fill a gap in the textbook market. There were no comprehensive texts on weight management. Such a gap still exists, and the need for information has never been greater. Many people who want to lose weight will try almost anything that seems to offer a glimmer of success. This makes the promotion of evidence-based treatment approaches very important, and this text offers consideration of many of these. It also incorporates a public health approach to issues of weight management, where not only individual factors but societal, family, community, and environmental factors contributing to eating disorders and overweight/obesity are reviewed in each chapter.

This book is designed for students and professionals in many disciplines who are confronted—and confounded—by weight-management issues. While many people think of excess weight as an individual failure—not enough exercise and too much food—addressing this problem requires more than individual effort. Cultural and environmental factors so significantly influence people's individual behaviors that any interventions aimed at lowering rates of obesity and preventing overweight must take into consideration the individual, family, community, and broader environment. Rising rates of overweight and obesity around the world show the importance of a multifaceted approach.

ORGANIZATION OF THIS BOOK

This third edition reorders and updates information from the previous edition. It features 11 chapters organized in five sections: (1) An Introduction to Weight Management, (2) Biological Aspects of Weight Management, (3) Physical Activity for Health and Weight Management, (4) Nutrition for Health and Weight Management, and (5) Approaches to Weight Management.

Three introductory chapters lead off the text: an overview of overweight, underweight, and obesity; methods of assessment relevant to weight management professionals, including anthropometric, clinical, and biochemical measures and assessment of comorbidities; and eating disorders. Chapters 4 and 5 review metabolic and physiological aspects of weight management with updated material. These chapters introduce readers to concepts of energy transformation in the body, the components of energy expenditure, and the roles of body systems and genetics in determining how and where we store fat.

Chapters 6 and 7 focus on the role of physical activity in promoting health and weight management. And Chapters 8 and 9 provide parallel material on the role of diet. Chapter 9 is a new chapter that focuses specifically on diet planning and dietary approaches for promoting good health.

Updated Chapters 10 and 11 provide information on "nonbehavioral" approaches to weight management (weight loss drugs, commercial and fad diets, and surgery) and lifestyle modifications that promote health and weight management. Chapter 11 also includes new material on the influence of culture on diet and weight management.

As college pedagogy continues to evolve from teacher-centered approaches, where lecture predominates, to student-centered approaches, where case studies and other active learning techniques are used, so has the design of this text. Each chapter includes an Application that helps students apply text material to real-life situations. Instructors can assign students to read the applications before the class meets, initiate class with a brief lecture, and then use class time to discuss elements of the application in small groups. Research outside of class can also supplement each of the applications.

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Everything you need for your course in one place! This collection of book-specific lecture and class tools is available online via www.cengage.com/login. Access and download PowerPoint presentations, an instructor's manual, and test questions.

ACKNOWLEDGEMENTS

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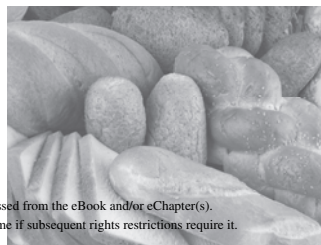
CHAPTER 1

Overweight, Underweight, and Obesity

CHAPTER OUTLINE



Over two-thirds of American adults and one-third of American children are overweight. Of those, about 17% of children and 35% of adults are at a high enough level of fatness to be considered obese. This is a matter of concern from a public health standpoint because excess weight may be associated with chronic disease. The cost of health problems associated with excess weight is perhaps as much as $147 billion annually.[1] This is also a concern from an individual's standpoint. Most people do not want to be overweight for a variety of reasons—feeling better, looking better, fitting into clothes. Bookstores stock hundreds of "diet" books, and these books as well as special foods, weight-loss programs, and over-the-counter diet aids generate an estimated $35–50 billion in sales each year.

Our national preoccupation with weight has not only kept the weight-loss industry alive, but it has also contributed to a rise in disordered eating and other behaviors. In the quest for thinness, millions of individuals engage in severe caloric restriction, excessive exercise, and abuse of laxatives and other drugs. Underweight has increasingly been recognized as a factor associated with early death. And concern about weight and adoption of extreme dieting and exercise behaviors lead to clinical eating disorders in 1–4% of the adult and adolescent population.

Losing weight is difficult. People who enter weight-loss programs can usually lose about 10% of their body weight; however, keeping off lost weight is even harder, and an unacceptably high proportion of those who lose weight regain it within 3–5 years. The psychological and physiological tolls of this repeated cycle of "failure" can be considerable.

We now know that far more than gluttony and poor choices contribute to excess weight. Physiological, social, cultural, and environmental factors are contributors to the development and continuation of overweight and obesity. Social, familial, and cultural pressures also share responsibility with physiological factors for eating disorders and underweight.

Two-thirds of American adults and one-third of American children are at an unhealthy weight.

This chapter provides an introduction to weight management terminology and the prevalence of overweight, underweight, and obesity in the United States and elsewhere. Several explanations for the increased rates of overweight and obesity are presented within a social-ecological and public health framework. Health at Every Size is discussed as an approach for reducing weight bias and improving self-acceptance.

AN OVERVIEW OF WEIGHT MANAGEMENT DEFINITIONS AND PREVALENCE

What Do the Terms *Overweight, Underweight,* and *Obese* Mean?

Health professionals often use the terms *overweight* and *obesity* interchangeably, and words such as *plump, full-figured, large*, and even *fat* are common euphemisms for both terms. Obese women and men in a recent study did not like the terms *fat, fatness, excess fat, obese, large size*, or *heaviness*.[2] These individuals found the terms *weight, excess weight*, and even *body mass index (BMI)* to be more acceptable.

The point of this is that when professionals are talking among themselves, they should be clear about the meanings that they assign to the terms *underweight, average weight, overweight*, or *obese*. And when talking with clients, parents, or the public, they should avoid pejorative or censorious terms and adopt neutral terminology, such as *weight* and *BMI*. In this book, the terms *obese* and *overweight* are used as characterized below, and when something applies to both, the term *overweight/obese* is used.

overweight
Weight in excess of the average for a given height based on height–weight tables; or, in adults, a BMI of 25–29.9 kg/m^2.

underweight
Weight less than the average for a given height based on height–weight tables; or, in adults, a BMI less than 18.5 kg/m^2.

obesity
Excessive accumulation of body fat generally considered to be 25% or more in men and 32% or more in women; sometimes defined as BMI 30 kg/m^2 or greater.

body mass index (BMI) *Indicator of overweight and obesity calculated by dividing the weight in kilograms by the height in meters squared.*

BMI as an Indicator of Overweight, Underweight, and Obesity

Overweight has historically meant weight in excess of the average for a given individual's height, just as **underweight** refers to weight that is less than average. Determination of each required the measurement of height and weight and consultation with a height–weight chart. **Obesity** is defined as an excess of body fat, and its determination was not possible for the average person or even for a health care provider.

In the past 15 years, the **body mass index (BMI)** has come into widespread use as an indicator of overweight, underweight, and obesity. As illustrated in Table 1-1, BMI is calculated by dividing body weight in kilograms by height in meters squared (kg/m^2), or by using pounds and inches with a formula (or by using a table in which all calculations have already been done, such as the one in Appendix A, Table 1). Because height and weight are easy to obtain, BMI is a relatively simple method of assessment. In addition, a good correlation between BMI and body fat has been found, especially at high BMIs, which means that most of the time people who have BMIs above 30 are not only overweight but are also obese.

In 1998, the National Heart, Lung, and Blood Institute (NHLBI), part of the National Institutes of Health (NIH), issued the first federal guidelines on the identification, evaluation, and treatment of overweight and obesity. An expert panel defined overweight as a BMI of 25–29.9 kg/m^2 and obesity as a BMI of 30 kg/m^2 and above.[3] These cutoff points for designating overweight and obesity are also used internationally. NHLBI classification of underweight, overweight, and obesity is found in Table 1-2. The NHLBI classifies underweight as a BMI $<$18.5 kg/m^2.

TABLE 1-1 Formulas for Calculating BMI

BMI = weight in kilograms (kg) ÷ (height in meters)^2
or
BMI = [weight in pounds (lb) × 703] ÷ (height in inches)^2

Source: © Cengage Learning®.

Obesity can also be determined by measuring body fat. Desirable body fat ranges have more consensus than the ranges that constitute obesity. Men are considered to be in healthy fat ranges when between 10% and 20% of their body weight is composed of fat; for women, the range is 17–25%. Men are said to be obese when 25% or more of their body weight is in the form of fat; women are considered obese at 32% fat or higher. In nonclinical settings, percent fat is usually determined by using skinfold measurements or bioelectrical impedance analysis. These techniques require a great deal more skill than measuring weight and are discussed at length in Chapter 2.

Defining obesity based on BMI is more difficult with children and adolescents because they have not yet reached their maximum height and their body composition is changing. When skinfold measurements are used, a fat percentage of 20% in boys and 25% in girls is considered moderately high. When BMI is used, gender- and age-specific charts must be consulted (these charts may be found in Appendix A). For ages 2–19 years, a BMI at or above the 85th percentile designates overweight and a BMI at or above the 95th percentile defines obesity.

Use of Height and Weight to Define Overweight, Underweight, and Obese

Because it is easier to measure body weight than body fat, and because bathroom scales are readily available, indicators of fatness based on weight are still used by the general public. The 1959 Metropolitan Desirable Weights Table and the 1983 Metropolitan Height and Weight Tables are examples of these and can be found in Appendix A, Tables 2 and 3. A person whose weight falls within the desirable range for height is said to be at ideal body weight (IBW). Sometimes health professionals refer to people at IBW as of "normal" weight, suggesting that anyone who either exceeds or weighs less than the IBW is somehow abnormal and in need of correction; or at "healthy" weight, suggesting that over- or underweight would automatically be cause for concern. A better way to describe an individual at IBW is at "expected" weight.

TABLE 1-2 Classification of Obesity

Obesity may be classified by	
A. Level of fatness	
32% fat in women	25% fat in men
B. Body weight	
120% of ideal body weight in women	124% of ideal body weight in men
C. Body mass index (kg/m^2)	
Underweight ≤18.5	
Overweight 25–29.9	
Obesity 30–34.9	
Obesity (Grade 2) 35–39.9	
Obesity (Grade 3) ≥ 40	

Source: © Cengage Learning®.

The oversized muscles of a bodybuilder.

Although 120% IBW in women and 124% IBW in men (based on the 1983 Metropolitan Height and Weight Tables) are sometimes used as indicators of obesity, body weight alone is not a reliable measure. Total body weight consists of fat, bone, water, muscle, organs, and other tissues. Overweight individuals may have an excess of any or all of these components. Many overweight people have excessive body fat, but some, especially those at lower levels of overweight, may not. Bodybuilders, for example, carry a lot of muscle weight and may weigh more than their IBW, but most are not overfat (obese) or even unhealthy.

As people gain progressively more weight, it is increasingly likely that the excess weight is fat, not muscle. Individuals who weigh twice their IBW or who are more than 100 pounds over IBW are most certainly obese. So, you would be safe in saying that not everyone who is overweight is obese, but probably everyone who is obese is overweight.

How Many People Are Overweight, Obese, or Underweight?

The National Center for Health Statistics has been collecting data on the diet behaviors and health status of U.S. residents since 1960 in a series of studies known as the National Health and Nutrition Examination Surveys (NHANES). Each survey has included thousands of adults and children ages 6 through 74 years. Data from NHANES I (1970–1974) suggested that a quarter of the adult population was overweight. When data were examined from the first phase of NHANES III (1988–1994), researchers were startled to find that there had been a dramatic increase in the prevalence of overweight among U.S. adults in

a relatively short time. Based on the findings from NHANES III, one-third (33.3%) of the adult population of the United States was estimated to be overweight—31% of men and 35% of women. Results from NHANES (2003–2006) indicated that, while rates of overweight (BMI 25–29.9 kg/m^2) held to about one-third of the population, rates of obesity (BMI ≥ 30 kg/m^2) continued to increase. NHANES data from 2007 to 2008 showed some leveling-off of obesity rates for women and small increases for men.[4]

The newest data for 2011–2012 found increased rates of obesity, although slowing; in some groups, overweight prevalence has decreased.[5]

Table 1-3 provides current estimates of adult overweight and obesity in the United States. Today, over two-thirds of the adult population (72% of men and 64% of women) is overweight or obese (having a BMI at or above 25), and 34% has a BMI $\geq$ 30 (32% of men and 35.5% of women). Racial-ethnic minorities, particularly women, have higher rates of obesity than whites. Over half of African American women are obese, and over 40% of Hispanic men and women are obese. (Note: NHANES, from which these data were derived, was designed to study only people of Mexican origin and not all Hispanic groups in the

TABLE 1-3 Prevalence of Overweight and Obesity, U.S. Adults[1]

	Overweight (BMI $\geq$ 25–29.9 kg/m^2) (percentage of population)			Obese (BMI $\geq$ 30 kg/m^2) (percentage of population)		
	1976–80	2003–06	2011–12	1976–80	2003–06	2011–12
All	32.2	32.8	33.9	15.1	34.1	35.1
Male	40.1	39.5	37.9	12.8	33.1	33.7
Female	24.9	26.0	30.0	17.1	35.2	36.5
Non-Hispanic white						
Male	41.4	39.1	39.6	12.4	33.0	33.1
Female	23.3	24.9	30.9	15.4	32.5	33.7
Non-Hispanic black						
Male	34.8	35.7	32.1	16.5	36.3	37.0
Female	31.6	26.2	25.4	31.0	54.3	56.7
Non-Hispanic Asian						
Male	—	—	32.0	—	—	10.4
Female	—	—	23.0	—	—	11.4
All Hispanics						
					2007–08	
Male	—	—	37.2	—	34.3	40.7
Female	—	—	32.9	—	43.0	43.3

[1]Adults are ages 20 and over.

Sources: 1976–2006 data adapted from *Health 2009, United States*, pp. 320–321.

Data in the 2011–12 column are from Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011–12. *Journal of the American Medical Association, 311*(8), 811.

Data in the 2007–08 column are from Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among U.S. adults, 1999–2008. *Journal of the American Medical Association, 303*(3), 236.

TABLE 1-4 Prevalence of Obesity, U.S. Children Ages 2–5 years

	BMI ≥ 95th percentile (age- and sex-specific) (percentage of population)		
	2007–08	2009–10	2011–12
All	10.1	12.1	8.4
Boys		14.4	9.5
Non-Hispanic white		11.9	6.3
Non-Hispanic black		20.5	9.0
Non-Hispanic Asian		—	1.9
Hispanic		17.8	18.0
Girls		9.6	7.2
Non-Hispanic white		6.0	0.6
Non-Hispanic black		17.0	13.9
Non-Hispanic Asian		—	4.7
Hispanic		14.6	15.2

Sources: Data in the 2007–08 column are from Ogden, C. L., Carroll, M. D., Curtin, L. R., Lamb, M. M., & Flegal, K. M. (2010). Prevalence of high body mass index in U.S. children and adolescents, 2007–2008. *Journal of the American Medical Association, 303*(3), 244–245.

Data in the 2009–10 column are from Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *Journal of the American Medical Association, 307*(5), 483–490.

Data in the 2011–12 column are from Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011–12. *Journal of the American Medical Association, 311*(8), 810.

United States. There has only been a category for all Hispanics since 2007–2008.) Asian Americans, included in the data for the first time in 2010, are the one minority group that has much lower rates of overweight and obesity than other groups in the U.S. population.

The prevalence of overweight and obesity among children and adolescents has increased significantly as well, although it appears to be slowing among many population groups. Approximately 8% of 2–5 year olds, 18% of 6- to 11-year-olds, and 20% of 12- to 19-year-olds are at or above the 95th BMI percentile and considered obese.[5] Tables 1-4 and 1-5 present obesity prevalence data for children and adolescents.

Contrast these figures with the prevalence of underweight. Just under 2% of the adult U.S. population is underweight (BMI $< 18.5\ kg/m^2$). Most of these individuals (3%) are 20- to 39-year-olds; 1% are 40 and older.[6] Among children and adolescents, about 3% are underweight (below the 5th age- and gender-specific BMI percentile)—3% of 2- to 11-year-olds and 4% of those over age 11.[7] As mentioned in the introduction to this chapter, 1–4% of the population has an eating disorder, and underweight may be an indicator of anorexia nervosa, a very serious eating disorder discussed in Chapter 3.

Global Perspectives on the Prevalence of Overweight, Underweight, and Obesity

Excess weight is not only a problem in the United States. The World Health Organization (WHO) estimates that more than 450 million adults throughout the world are obese and 1 billion adults are overweight. Among school-age children, 200 million are overweight or obese.

TABLE 1-5 Prevalence of Obesity, U.S. Children Ages 6–19 years

	BMI ≥ 95th percentile (age- and sex-specific) (percentage of population)			
	1976–88	2003–06	2007–08	2011–12
6–11 years of age				
All	6.5	17.0	19.6	17.7
Boys	6.6	18.0	21.2	16.4
Non-Hispanic white	6.1	15.5	20.5	8.8
Non-Hispanic black	6.8	18.6	17.7	25.9
Non-Hispanic Asian				13.2
Hispanic			28.3	28.6
Girls	6.4	15.8	18.0	19.1
Non-Hispanic white	5.2	14.4	17.4	17.9
Non-Hispanic black	11.2	24.0	21.1	21.7
Non-Hispanic Asian				3.7
Hispanic			21.9	23.4
12–19 years of age				
All	5.0	17.6	18.1	20.5
Boys	4.8	18.2	19.3	20.3
Non-Hispanic white	3.8	17.3	16.7	18.3
Non-Hispanic black	6.1	18.5	19.8	21.4
Non-Hispanic Asian				14.8
Hispanic			25.5	23.9
Girls	5.3	16.8	16.8	20.7
Non-Hispanic white	4.6	14.5	14.5	20.9
Non-Hispanic black	10.7	27.7	29.2	22.7
Non-Hispanic Asian				7.3
Hispanic			17.5	21.3

Sources: 1976–2006 data adapted from *Health 2009, United States*, p. 305.

Data in the 2007–08 column are from Ogden, C. L., Carroll, M. D., Curtin, L. R., Lamb, M. M., & Flegal, K. M. (2010). Prevalence of high body mass index in U.S. children and adolescents, 2007–2008. *Journal of the American Medical Association, 303*(3), 244–245.

Data in the 2011–12 column are from Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011–12. *Journal of the American Medical Association, 311*(8), 810.

WHO's International Obesity Task Force maintains the Global Database on Body Mass Index (available at *apps.who.int/bmi/*). Table 1-6 is derived from this database and includes a sampling of nations and shows that, while the United States leads the way in prevalence of adult obesity and overweight, other countries are catching up. The rate of overweight in several countries—the United Kingdom, Canada, Poland, Hungary, Chile, Saudi Arabia,

TABLE 1-6 Global Prevalence of Adult Underweight, Overweight, and Obesity, Selected Countries (Percentages)

Country	Underweight (BMI < 18.5)	Overweight (BMI > 25.0)	Obese (BMI > 30)
Australia	1.0	49.0	16.4
Brazil	4.0	40.6	11.1
Canada	2.6	59.1	23.1
Chile	0.8	59.7	21.9
China	8.0	18.9	2.9
Denmark	2.2	41.7	11.4
France	4.9	49.3	16.9
Germany	n/a	66.5	12.9
Hungary	2.0	53.2	17.7
Indonesia	n/a	53.2	17.7
Japan	11.5	23.2	3.1
Mexico	n/a	n/a	23.6
Nauru	n/a	n/a	78.5
Norway	5.1	44.0	10.0
Poland	2.2	52.2	18.0
Republic of Korea	4.7	32.1	3.2
Saudi Arabia	7.0	72.5	35.6
Singapore	9.2	32.5	6.9
Switzerland	3.5	37.3	8.2
United Kingdom	5.1	61	22.7
United States	2.4	66.9	33.9
Zimbabwe	9.9	37.3	15.7

Source: Global Database on Body Mass Index. apps.who.int/bmi/index.jsp. Accessed March 6, 2014.

Germany, Indonesia—has surpassed half the population, and in other countries—France and Australia—includes just under half of the adult population.

There is evidence that the rate of childhood obesity has begun to slow in several nations, including Australia, China, England, France, the Netherlands, New Zealand, Sweden, Switzerland, and the United States.[8] There are several potential reasons for these changes:

- Many of these nations have recognized childhood obesity as a major health concern for several years and have developed preventative programs and policies to address early risk factors and promote healthy eating and physical activity. It is possible that these programs are having a cumulative impact on the prevalence of childhood obesity in several nations.
- Perhaps rates of childhood obesity stabilized as a result of saturation in the population, where those predisposed toward obesity became obese because the structure of society favors a diet with excessive calories and a sedentary lifestyle.

- Less likely, the stabilization of childhood obesity may have resulted as a selection bias. In other words, as the stigma attached to obesity has increased, parents of obese children may have declined participation in studies of health and wellness so are not being counted.[8]

Summary

In the United States, about two-thirds of the adult population is overweight or obese. While the prevalence of overweight has remained about the same for the past 30 years, obesity rates have more than doubled in that time period, with some racial and ethnic groups disproportionately affected. Globally, rates of overweight and obesity are increasing at a similar rate in higher-income nations, and lower-income nations are also seeing weight gain in their populations.

EXPLANATIONS FOR THE RISE IN WEIGHT GAIN IN THE UNITED STATES AND ELSEWHERE

Obesity unquestionably has biological origins. Thousands of years ago, periodic food shortages and, in times of severe environmental challenge, outright food scarcity favored individuals who could store fat. This was particularly true for pregnant or nursing women, who needed enough stored energy for themselves as well as their developing fetus or a breastfeeding baby. Survivors passed on their fat-conserving or thrifty genotype to their children, giving future generations the ability to store more fat to adapt to food shortages.

Obesity almost certainly became socially advantageous. Early carvings and paintings from times when obesity was rare feature people with large hips and buttocks. So, to the extent to which food availability allowed it, weight gain was probably once considered to be desirable.

The increase in the prevalence of overweight and obesity today no doubt results from a combination of factors, including genetics. The increase cannot be explained solely by biologic factors, which presumably would always have been present in humans and would affect a predictable proportion of the population. Although heredity gives us the capacity for obesity, a multitude of factors outside the individual promote behaviors that encourage us to store excessive quantities of fat.

How Does a Social-Ecological Framework Help Explain the Rise in Overweight and Obesity?

social-ecological framework
A framework for recognizing the relationship between individual, social, environmental, and broader societal factors that influence health.

Health experts use a **social-ecological framework** to explain the complex relationship between individuals and their social, physical, and broad societal environments. Figure 1-1 illustrates this interaction in the context of the two factors that are primarily responsible for the fattening of the population—diet and inactivity. An individual's genetic and biological makeup, including race/ethnicity, in addition to income, knowledge, skills, and attitudes, interact with the social environment (family and peer influences) and physical environment (neighborhood, school, workplace) to affect dietary and activity behaviors. Overarching this are broader societal factors, such as laws and policies, marketing and media, and economic factors that influence access to healthy foods and activity environments.

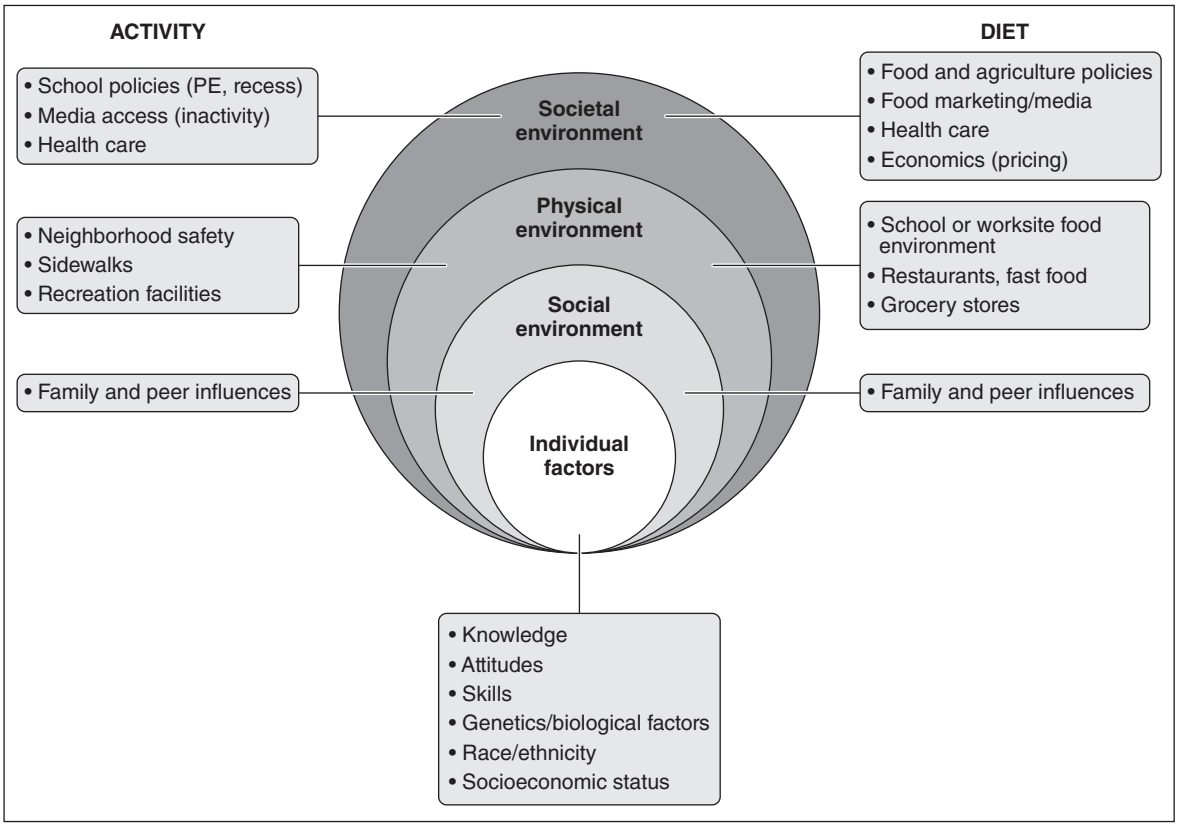


FIGURE 1-1 The Role of Diet and Activity in Promoting Obesity: A Social-Ecological Perspective.

Source: © 2016 Cengage Learning®.

social determinants of health *Factors within families, communities, and the environment that affect health, including income, education, employment relationships with others, and access to health care.*

kilocalories (kcal) *Measure of the energy value of food or physical activity.*

Social, physical, and societal factors are known as **social determinants of health**, defined by the WHO as "the conditions in which people are born, grow, live, work, and age, including the health system" (*www.who.int/social_determinants/en/*). Social determinants of health—standard of living, education, employment, the built and natural environments in which we live, social relationships, freedom from discrimination, and access to health care—are factors that lead to health disparities and contribute to higher rates of overweight and obesity among racial and ethnic minorities.

What Is the Role of Diet?

Today, food is abundant for most residents of higher-income countries. For the average American, this has translated into consumption of about 200 **kilocalories (kcal)** more each day than in 1980. The reason caloric consumption has increased is no mystery.

Cultural and Familial Factors

- Attitudes about exercise, food preparation methods, and preferred foods are all responsive to cultural influences. In addition, parents who were raised in poverty may model the same dietary behaviors that they were exposed to as children.

- Some cultures and some families have a greater acceptance of—and even a preference for—heavier body weight. A larger child may mean "healthier" in these families; a larger parent may be seen as "stronger."
- The number of single-parent families and women working outside the home has increased, so there may be less time for meal preparation and greater reliance on convenience foods.

Socioeconomic Factors

Educational attainment, income, and occupation combine to determine socioeconomic status. In industrialized societies, obesity is more prevalent among people at low socioeconomic levels, regardless of race or ethnicity. In the United States, poverty rates are higher for African Americans and Hispanics than for whites, which is linked to obesity for several reasons:

food deserts
Areas, often in low-income communities and neighborhoods, where there is limited access to healthy foods.

- Many socioeconomically disadvantaged communities are said to exist in **food deserts**, areas with limited access to lower-fat foods, including fresh fruits and vegetables, whole grains, low-fat milk, and fresh fish. A study in Chicago found that residents of predominantly African American neighborhoods had to go twice as far to access a supermarket as a fast-food restaurant.[9]
- Prices may be higher in these urban markets, and poor access to transportation creates an additional barrier to finding healthy, affordable food.[10]
- When people must rely on government-surplus foods and donated foods from community agencies, they do not necessarily receive low-fat or reduced-calorie items.
- Lack of equipment and instruction may result in less use of healthy food preparation techniques, such as steaming and microwaving.
- Less access to health care prevents regular contact with health professionals who could advise families on healthy eating.

Physical Environmental Factors

Access to restaurants and grocery stores affects our dining behaviors and food choices:

- There has been a proliferation of fast-food restaurants (more than 240,000 in the United States alone). According to a Center for Science in the Public Interest (CSPI) study, 93% of children's meals in chain restaurants exceed 430 calories, 86% are high in sodium, and 45% are high in saturated fat.[11]
- Whether at a fast-food restaurant or big-box store, foods and beverages are increasingly available in "supersized" portions, encouraging people to value quantity more than quality. There is some evidence that overweight adolescents not only consume more fast food but are less likely than their lean peers to cut back on food consumption during the rest of the day to compensate.[12]
- Access to food has made us a nation of snackers, and these foods are typically energy-dense (high in sugars, fats, and oils). Snackers eat as much as 25% more in a typical day than nonsnackers.[13]
- In addition, food access causes us to eat more throughout the day. Researchers recently reported that the time between "eating occasions" decreased by an hour over the past 30 years.[14]

Broader Societal Environment

This affects food consumption in a multitude of ways, including:

- Exporting inexpensive sweeteners and oils has increased globally, allowing even poor nations to supplement the diet with products that improve food flavor—but at greater caloric cost.[15]
- Unhealthy foods are generally less expensive than healthy foods due in part to government subsidies.
- Food advertising continues to be aimed at children, often using appealing cartoonlike characters.
- Food served in schools: Federal regulations govern the quality of school meals provided under the National School Lunch Program (NSLP) and the School Breakfast Program (SBP). However, foods are available at school from many additional sources—cafeteria a la carte items; vending machines; school stores, canteens, or snack bars; fundraising items. Until passage of the Healthy, Hunger-Free Kids Act of 2010, these foods, known as **competitive foods**, were largely exempt from regulations. Not unexpectedly, such foods tend to be high in fat, sodium, and added sugars, as depicted in Figure 1-2. The Institute of Medicine has developed standards for competitive foods that sets limits for calories, added sugars, sodium, and fat. The Centers for Disease Control and Prevention (CDC) recently assessed the degree to which these standards were being met and found that no state had policies that met all standards.[16]

competitive foods *Foods sold in schools outside the oversight of the National School Lunch and School Breakfast Programs, such as vending machines, snack bars, a la carte cafeteria lines, and fundraisers.*

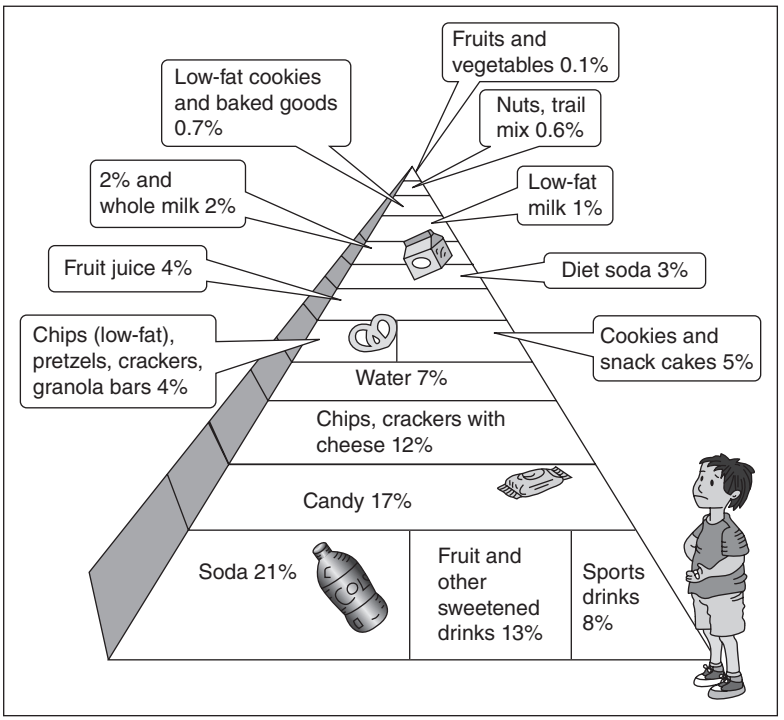


FIGURE 1-2 School vending machine pyramid.

Source: Center for Science in the Public Interest.

Application 1.1 Understanding the Impact of a Social-Ecological Framework on Diet

Food matters (physical health matters, the pleasure of eating matters), and because the stories that are served with food matter. The stories bind our family together, and bind our family to others. Stories about food are stories about us—our history and our values. Within my family's Jewish tradition, I come to learn that food serves two parallel purposes: it nourishes and it helps you remember. Eating and storytelling are inseparable—the saltwater is also tears; the honey not only tastes sweet, but it makes us think of sweetness; the matzo is the bread of our affliction. (Reprinted from Saffran Foer, J. [2009]. *Eating animals*. Boston: Little, Brown, pp. 11–12)

Partner with a classmate to conduct an interview on your family food norms and traditions. You will use the questions below as a guide for your interview (feel free to add any other questions you may have to the list). You will want to take detailed notes during the interview process. The notes you take should be typed up in chronological order. Please remember to include the name of the individual you are interviewing. As a general rule, you also want to include the date that the interview took place.

Describe what a typical meal looks like for your family.

- Who was typically present?
- Who prepared the food?
- What types of food did you typically eat? (What were some of your family staples?)
- Were some meals or particular foods reserved for special occasions? (How were these different? Do you have family recipes, holiday food traditions, etc.? Why do you think these are important?)
- What are the important stories that are told around your dinner table (or maybe breakfast/lunch)? (Are these stories connected to certain meals/holidays?)
- What do you remember most about family meals?
- Did you have rules about food in your house? (Did you have any foods that you avoided? Why?)
- How do you think family food traditions and relationships influence diet?
- How do you think these traditions are a reflection of the values of your family? Your heritage? The larger society?
- How do you think family food traditions are related to weight management?

Source: From Saffran Foer, J. [2009]. *Eating Animals*. Little Brown, pp. 11–12.

What Is the Role of Inactivity?

There is some evidence that more active people weigh less and store less fat. Unfortunately, most Americans do not exercise. Over one-third of the U.S. adult population engages in no leisure-time physical activity, and 30% are only somewhat active.[17] Only one-quarter of 12- to 15-year-olds get recommended amounts of physical activity.[18] Similar trends are being seen globally. The reasons for this are a combination of individual and environmental factors.

Cultural and Familial Factors

- The average household has three television sets,[19] and the average adult American watches just under 5 hours of television each day.[20] A study of preschoolers reported daily television viewing by 63% of those ages 6 months to 2 years (82% of 3- to 4-year-olds and 78% of 5- to 6-year-olds).[21] Not only are most people inactive while viewing television, they eat more.
- Attitudes about physical activity are susceptible to cultural and familial influences and may make exercise less acceptable.

Socioeconomic Factors

- Low-income areas may lack recreation centers, parks, and safe, walkable spaces.
- Socioeconomically disadvantaged communities may have poor access to public transportation to get residents to recreational facilities outside their neighborhoods.
- Health clubs, gyms, and afterschool sports programs may not be affordable.

Physical Environmental Factors

- Suburban sprawl in unwalkable communities results in people walking less and driving more.
- Suburban sprawl also tends to increase commuting time, which leads to less time for exercise (and healthy meal preparation) without careful planning.
- Rural communities may lack recreation centers.

Broader Societal Environment

- Greater access to various types of media may result in television viewing, computer use, and video games replacing afterschool recreational physical activity. In addition, social networking allows us to socialize without ever leaving our homes.
- To allow more time in the school day for academic subjects, physical education and recess have been eliminated in some schools. According to the 2006 School Health

Standard portion sizes are larger today, contributing to obesity.

Donna Day/The Image Bank/Getty Images

Television watching influences children's eating habits and activity patterns.

Policies and Programs Study (SHPPS), 21% of the nation's schools do not require physical education (31% of elementary schools, 16% of middle schools, and 5% of high schools). Of those schools that do require physical education, only 14–15% of elementary and middle schools and 3% of high schools provide it at least 3 days per week for the entire school year for students in all grades. About 20% of high schools allow students to substitute other activities, including band and chorus, for physical education.[22]

- Throughout the world technology has reduced the caloric expenditure required to perform many household and occupational tasks.

How Does the Public Health Model of Prevention Apply to Obesity?

primary prevention
Prevention efforts directed toward reducing the number of new cases of a disease or condition.

secondary prevention
Prevention directed at reducing the rate of established cases of a disease or condition.

tertiary prevention
Prevention directed at reducing chronic conditions or disabilities associated with a particular disease or condition.

The combination of a lot of available food and lower caloric expenditure is a "perfect storm" for creating overweight and obesity. Addressing this problem will require more than individual effort. Environmental factors so significantly influence people's individual behaviors that any interventions aimed at lowering rates of obesity and preventing overweight must take into consideration the individual, family, community, and broader environment.

The field of public health offers a model for addressing the rising prevalence of overweight and obesity that takes into consideration these factors outside the individual. Three levels of prevention guide approaches to weight management:

- **Primary prevention** of obesity involves interventions that take place before children and adults become overweight or obese. From a public health standpoint, this is the most effective strategy for lowering the number of cases of obesity in the U.S. population.
- **Secondary prevention** involves identifying overweight or obese children and adults and intervening before BMI increases further.
- **Tertiary prevention** not only aims at slowing excess weight gain but also preventing complications of obesity, such as heart disease, type 2 diabetes, metabolic syndrome, and others.

Table 1-7 links these concepts to examples from the social-ecological framework.

The public health effort to reduce tobacco use in the United States may offer some useful lessons for the prevention of obesity. Comprehensive policies on everything from the cost of a pack of cigarettes to cigarette advertising to smoking bans in public spaces resulted in a decrease in smoking rates from about 25% of the U.S. population in 1992 to 19% in 2006.

TABLE 1-7 Primary, Secondary, and Tertiary Prevention Interventions in Obesity

Primary Prevention Interventions	Secondary Prevention Interventions	Tertiary Prevention Interventions
Limited television viewing Quality, daily physical education in all schools School food services that reinforce nutrition education messages Accessible community programs that encourage physical activity Sidewalks and bikeways Limits on food marketing to children Restaurant menu labeling	Weight management programs that include nutrition, activity, and behavior School-based programs that promote healthy diet and physical activity for all children	Weight management programs aimed at weight maintenance so children can grow into their weight and adults can stop weight gain Therapeutic diets Pharmacological treatments for abnormal blood lipids, type 2 diabetes, hypertension, and obesity Bariatric surgery

Source: © Cengage Learning®.

Policies related to food and activity might have a similar effect on the prevalence of obesity. Table 1-8 illustrates parallel strategies for tobacco control and obesity prevention.

Diet and activity are presented in more detail in subsequent chapters of this book.

Summary

Consumption of excess calories and the widespread lack of physical activity seen in our society are probably most to blame for Americans' weight gain. Reversing this trend will require not only individual effort, but significant attention to social determinants of health and environmental interventions.

TABLE 1-8 Parallel Strategies for Preventing Smoking and Obesity

Strategy		
Cost	• Increase cigarette tax	• Reduce cost of fruits and vegetables • Tax unhealthy foods and earmark revenue for public health • Increase gasoline tax
Availability	• Antismoking laws	• Remove unhealthy foods from schools, hospitals, businesses
Image	• Restrictions on cigarette advertising on television • Prohibitions against using cartoon characters in cigarette advertising • Antismoking ads that show the true impact of smoking	• Restrict advertising of unhealthy foods, particularly during children's television programming • Develop advertisements that show the impact of harmful beverages and foods • Post calorie content of foods on fast-food menus

Source: © Cengage Learning®.

BODY WEIGHT AND QUALITY OF LIFE

Thus far in this chapter we have considered the extent of overweight, underweight, and obesity and some of the factors that have promoted weight gain in the United States and elsewhere. This section of the chapter looks at the potential impact of body weight on the overweight/obese individual.

Quality of life encompasses lots of things that affect well-being: physical functioning, perception of health, income, education, housing, family relationships, and job satisfaction, among others. Most research conducted with overweight/obese participants has looked at health-related quality of life, which is best characterized as an individual's perception of his or her physical and mental health.

The CDC added a health-related quality-of-life measure to its 1993 Behavioral Risk Factor Surveillance System. Data collected from the 2000 survey indicate that being obese—but not overweight—lowered respondents' health-related quality of life.[23] Compared to the nonobese, obese individuals reported more activity limitations and more days on which they were physically or mentally unhealthy. These findings are similar to those from the National Physical Activity and Weight Loss Survey, in which obese adults had lower self-rated health and more physically and mentally unhealthy days and days of activity limitation.[24] However, those at any BMI level who reported more physical activity had higher health-related quality of life.

comorbidities
Diseases that exist in clusters and contribute to overall morbidity.

An important question is whether obesity itself or the **comorbidities** of obesity result in lower quality of life. Comorbidities are likely as degree of obesity increases, and morbidly obese adults are likely to have the most health problems, which perhaps explains why health-related quality of life decreases as BMI increases. Heavier, sicker people certainly would be expected to have lower vitality, more pain, difficulty in mobility, and even depression and anxiety.

When we look at severely obese people who significantly reduce weight through gastric surgery, they report greatly improved health-related quality of life, which is sustained over at least a year.[25] Reductions in pain and improved vitality and physical function have also been reported in overweight adults who lost smaller amounts of weight.[25] Particularly effective in improving health-related quality of life are weight management strategies that include dietary changes *and* exercise.[26]

How Do Weight Stigmatism and Bias Affect Quality of Life?

During these decades in which the prevalence of obesity has dramatically increased, weight bias and discrimination has also risen. Much of this is fueled by people's belief that overweight and obesity are essentially personal problems—fat people are undisciplined, lazy, and unwilling to take responsibility for their weight—and shaming them into recognizing that they are too fat will motivate them to lose weight. These attitudes foster media bias and discrimination in schools, workplaces, and health care agencies. Lower health-related quality of life is directly related to weight stigmatism and bias.

Weight bias has been documented in:

- *The media*. This is possibly the only place in our society that weight bias is overtly acceptable. Thin women dominate television and movie screens. With a few exceptions, larger characters tend to be guest actors on television shows, rather than regular players, and are portrayed as more passive. They are more likely to be seen on comedy programs than dramas and may be portrayed stereotypically.[27,28]

- *Health care settings*. Doctors, nurses, medical students, dietitians, and fitness professionals have been documented as fostering negative assumptions about obese individuals, in particular that they are lazy and unmotivated.[28] The environment itself may be unwelcome to patients with overweight/obesity—from small chairs, to blood pressure cuffs that don't fit a larger arm, to scales that only go up to 350 pounds.
- *The workplace*. Individuals with overweight/obesity are frequently discriminated against in hiring, they are often rated as less disciplined/competent than nonobese workers, and they earn less than nonoverweight workers.[29]
- *Education*. Some teachers rate overweight students as sloppy, and classmates consider them to be lazy and undesirable playmates.[29]
- *Interpersonal relations*. Stigma affects romantic relationships, as well as relationships with family and friends.

There is no federal law that recognizes weight discrimination, although the state of Michigan and several cities have such legislation. People who face weight bias may earn less, miss school days, avoid health care, and suffer psychological and physical consequences such as depression, lower self-esteem, and binge eating.[28] Given the difficulty in losing weight that most people encounter and the role of multiple social and environmental conditions in promoting weight gain, it is unreasonable to believe that blaming the "victim" will increase the likelihood of losing weight.

The Health at Every Size® Approach

Both the National Association to Advance Fat Acceptance (NAAFA) and the Association for Size Diversity and Health (ASDAH) support Health at Every Size (HAES). These organizations believe that size acceptance can help promote self-acceptance and reduce the negative consequences of stigma and bias.

The HAES approach is weight-neutral, in that it does not see weight loss as a primary goal. Rather, this approach advocates a healthy, varied diet and participation in regular physical activity. HAES also promotes attention to the sensations of hunger and fullness—eating when one is hungry and stopping when one feels full—rather than practicing dietary restriction. Equally important, the organizations that promote HAES reject weight stigma and are working to eliminate it.

The HAES principles are in Table 1-9.

TABLE 1-9 Health at Every Size® Principles

- Accepting and respecting the diversity of body shapes and sizes
- Recognizing that health and well-being are multidimensional and that they include physical, social, spiritual, occupational, emotional, and intellectual aspects
- Promoting all aspects of health and well-being for people of all sizes
- Promoting eating in a manner that balances individual nutritional needs, hunger, satiety, appetite, and pleasure
- Promoting individually appropriate, enjoyable, life-enhancing physical activity rather than exercise that is focused on a goal of weight loss

Source: Association for Size Diversity and Health (ASDAH). http://www.sizediversityandhealth.org/content.asp?id+197.

Garry Wade/Taxi/Getty Images

Physical activity is the best way to prevent obesity or minimize further weight gain.

Summary

Excess weight alone does not necessarily adversely affect quality of life. Weight stigmatism and bias can have a negative impact on individuals with overweight/obesity, which several organizations are trying to counteract with size acceptance.

Application 1.2 Factors Influencing BMI

Kate recently finished graduate school with a master's degree in developmental psychology. Kate was a runner in college and regularly logged between 30 and 40 miles per week, sometimes more. She was not a competitive athlete but liked to run several community races (5k, 10k, and half-marathon distances) in a given year. During her senior year in college, Kate fell and broke her ankle. The injury had a long and painful recovery period. Recovery, combined with time commitments for school and work, prevented her from training during graduate school. Kate did not change her eating habits, and given the time restraints of a busy schedule, she eats out for most meals during the week. She gained 20 lbs over the past 2½ years. Kate is 5'3" and weighs 150 lbs. Kate would really like to lose weight but worries about her ability to return to her college weight.

- Calculate Kate's current BMI (use Table 1-1 to determine her BMI classification).
- Calculate Kate's old BMI. How has the increase in weight influenced her current BMI?
- If you were giving advice to Kate, what other factors might be important to consider?
- What might be some of the advice that you would give Kate to help her improve her health and accomplish her weight loss goals?

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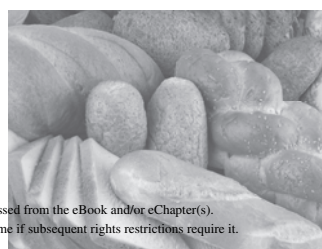
CHAPTER 2

Assessment of Body Weight, Body Composition, and Associated Comorbidities

CHAPTER OUTLINE



morbidity *Illness.*

mortality *Death.*

The relationship between body weight and health is a complex one. In general, both **morbidity** and **mortality** are increased at higher—and lower—body mass indexes (BMIs). Most health organizations consider obesity as a significant contributor to death and disease, along with tobacco, hypertension, and high blood glucose.[1] Underweight individuals may also have a greater risk of death from conditions such as cancer and diabetes. Recent studies have brought to light an interesting paradox—some overweight and obese individuals are more "metabolically healthy" than others of normal weight or underweight. This confounds our understanding of the impact of weight on health and disease.

comorbidities *Diseases that exist in clusters and contribute to overall morbidity.*

This chapter looks at how we assess body weight and body composition, as well as other assessments that are useful in identifying **comorbidities** related to obesity, overweight, and underweight. Dietary and physical activity assessment are included in Chapters 6 and 9.

WHY ASSESS?

Weight-management assessment has three broad purposes for the client and professional:

- To provide baseline information about body composition, health status, dietary practices, and activity habits.
- To help devise realistic goals for change and develop an individualized treatment program based on those goals.
- To document changes that occur as a result of treatment/behavior change.

An additional purpose of assessment is research—to document population trends in weight that can guide broad policy needs.

ANTHROPOMETRIC ASSESSMENT: BODY SIZE, SHAPE, AND COMPOSITION

anthropometrics *Measures of body size and proportion (height, weight circumference, and skinfolds).*

The first thing that usually comes to mind when you are working with overweight or underweight clients is the need to determine height, weight, and level of fatness. Measures of body size and proportions—height, weight, circumferences, and skinfolds—are known as **anthropometrics**. From these measures, we can calculate the BMI, pattern of fat distribution, and percent fat. This information, when used as part of an overall health evaluation, can be extremely helpful in assessing health risks associated with fat weight, fat distribution, or low body weight or muscle mass.

A word of caution: Some overweight and obese individuals may not significantly reduce weight or fatness in a weight-management program and may still be technically classified as overweight and/or obese after an intervention. Nevertheless, changes in diet or activity may have improved their health. Weight-management professionals should avoid overemphasizing anthropometric changes as markers of their clients' success.

fat mass *Proportion of body weight made up of storage and essential fat.*

fat-free mass (FFM) *Proportion of body weight made up of bone and other dense connective tissue, body water, and the fat-free portion of the body's cells.*

What Are We Made Of?

Two components of the human body are particularly relevant to weight management: **fat mass** and **fat-free mass**. Fat mass includes storage fat as well as small amounts of essential fat found in the nervous system and cell membranes. Fat-free mass (FFM) consists of bone and other dense connective tissue, body water, and the protein-rich, fat-free portion of the cells that comprises organs, muscles, and the immune system (collectively known as the body cell mass). Figures 2-1A and B illustrates the proportions of fat and FFM in a "typical" adult male and female and in children of various ages. These proportions can vary

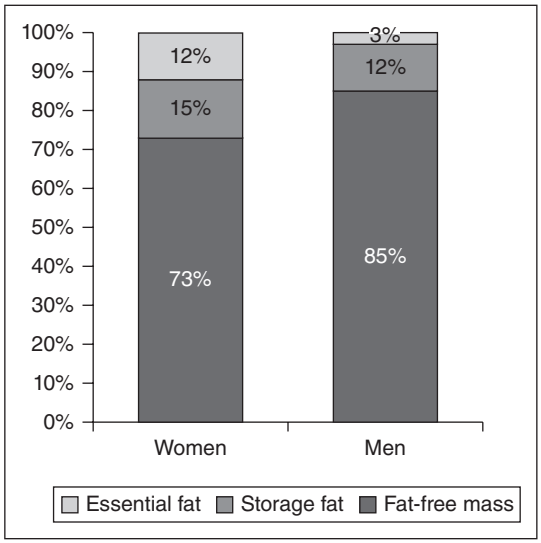


FIGURE 2-1A What are we made of? Adults.

Source: Adapted from Behnke, A. R., & Wilmore, J. H. (1974). *Evaluation and regulation of body build and composition.* Englewood Cliffs, NJ: Prentice-Hall.

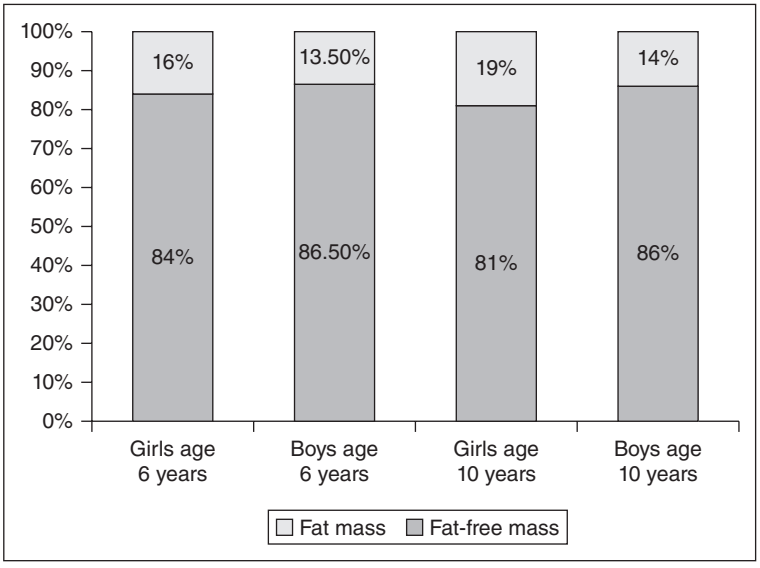


FIGURE 2-1B What are we made of? Children.

Source: Adapted from Fomon, S. J, Haschke, F., Ziegler, E. E., & Nelson, S. E. (1982). Body composition of reference children from birth to age 10 years. *American Journal of Clinical Nutrition, 35*, 1169–1175.

significantly, however, as a result of physical training, aging, obesity, and significant weight loss, including anorexia nervosa.

essential fat
Minimum percentage of body fat needed to support physiological functions.

Fat Mass and FFM

Notice in Figure 2-1A that fat is classified as essential or storage fat. **Essential fat** is the minimum percentage of fat needed to maintain health. Females need more essential fat than males to support reproductive functions (12% vs. 3%). Storage fat is fat accumulated over and above physiological need. Although storage fat is not required for physiological

functions, it will support health during times of famine and is harmful only when accumulated in excessive amounts and in particular areas of the body.

FFM comprises the largest portion of body weight. FFM is mostly water, about 16–19% protein and 5–8% mineral. There are age, gender, and ethnic differences in the composition of the FFM. For example, children have a lower mineral content than adults, more water in their fat-free tissue, and more variability in the FFM.[2] Because of these variations, mathematical equations used to convert measures of body size into estimates of percent fat or percent FFM are population specific. (This concept is further explained in the section on skinfold measurement.)

Laboratory Determination of Fat and FFM

Several sophisticated techniques that permit accurate assessment of body composition are summarized in Table 2-1: underwater weighing, whole-body air-displacement

TABLE 2-1 Laboratory Methods for Assessment of Body Composition

Assessment Methods	Description	Limitations
Underwater weighing (hydrodensitometry; hydrostatic weighing)	Person seated in chair suspended in water tank exhales maximally and then submerges. Accounting for residual lung volume, body density is calculated by dividing weight in air by loss of weight in water.	Cannot be used with people unable to submerge. Density of fat mass and FFM have not been validated by cadaver studies in populations other than Caucasian males.
Whole-body air-displacement plethysmography (ADP; Bod Pod)	Person sits in small chamber in which body volume is determined by subtracting air volume in empty chamber from volume while subject is in chamber.	Few limitations other than expense of device and training of operator. Compares well with DXA and underwater weighing. Can be used with wide range of subjects but not validated with subjects under 40 kg. Research is new.
Computed tomography (CT)	X-ray produces high-resolution body image based on differences in density of tissues. Examination of cross-sectional areas permits regional determination of fat, muscle, and bone and calculation of body composition.	Exposes subjects to ionizing radiation. Cannot be used with children or during pregnancy. Costly and trained technician required.
Nuclear magnetic resonance imaging (NMR; MRI)	Electromagnetic radiation causes cell nuclei to spin and absorb energy. When nuclei realign, released energy creates an image. Examination of cross-sectional areas permits regional determination of fat, muscle, and bone and calculation of body composition.	No known health risks. Costly and time-consuming. Access to equipment may be limited and trained technician required.
Dual-energy x-ray absorptiometry (DXA; DEXA)	Low-dose x-ray scans produce image of bone and other tissues. Fat and FFM can be calculated. Regional fat can also be assessed.	Costly. Can be used with a wide range of subjects, although not during pregnancy. People taller or larger than the scan area cannot be measured.

Source: © Cengage Learning®.

plethysmography (ADP; Bod Pod), computed tomography (CT), nuclear magnetic resonance imaging (NMR, MRI), and dual-energy x-ray absorptiometry (DXA, DEXA). These techniques are costly, complex, and reserved for the research laboratory, but they serve as the foundations for the body composition assessments that health professionals use in the field. Books and articles about body composition analysis often refer to these methods, so it is a good idea to become familiar with them.

What Are Common Measures of Body Size?

Even though measures of body size do not directly address body composition, the relationship between height and weight has been used as a standard indicator of health since the 1950s. Until a decade ago, height–weight tables were the primary tools for this. Today experts recommend using the BMI to determine a person's healthy weight. To calculate a person's BMI, height and weight must be determined.

Determination of Stature

stature *Standing height.*

stadiometer *Sturdy wall-mounted or free-standing device used to measure stature.*

Standing height, or **stature**, is most accurately measured using a sturdy, wall-mounted **stadiometer**. A stadiometer is a vertical measuring board attached to a wall with a sliding headpiece affixed to the board at a right angle. Alternatively, a nonflexible measuring tape can be affixed to a wall, and a piece of wood or other nonflexible object can be placed at a right angle to the wall. The flexible measurement rod that is part of a balance-beam scale should not be used to determine height because it is usually too loose and floppy to provide an accurate measurement.

Measure the individual as follows, which is illustrated in Figure 2-2:

- With shoes off, the client should stand as straight as possible with the shoulder blades, buttocks, and heels touching the stadiometer. The back of the head may or may not be touching the stadiometer.
- The client should look straight ahead, holding the head in the **Frankfort horizontal plane**. Most people assume this position naturally. (See Figure 2-3 for an illustration of this position.)
- The client's arms should be at the sides with palms facing the thighs.
- Lower the stadiometer headpiece (or block of wood) to the crown of the client's head as he or she straightens the spine as much as possible while taking a deep breath.
- Record the measurement to the nearest millimeter or quarter-inch. When the reading falls directly between 2 millimeters or quarter-inch, use the lower number.[2]

Frankfort horizontal plane *In the measurement of stature, a head position that aligns the lowest margin of the orbit of the eye with the tragion of the ear. The tragion is the deepest part of the notch just above the cartilage projection of the ear known as the tragus.*

Weight

Weight should be measured on the most accurate scale available. Bathroom-type scales, although found in most homes, are not acceptable for professional use. A balance-beam scale (sometimes called a physician's scale) or, preferably, an electronic (digital) scale are used for determining the weight of children and adults.

For measurement of weight, the client should wear minimal clothing and remove shoes. While the client stands in the center of the scale's platform, record weight to the nearest 0.1 kg or 0.25 lb. Scales should be calibrated regularly. Calibrating a scale is not difficult. Simply weigh yourself, then step back onto the scale while holding a 10-lb calibrated weight. Your weight should increase accordingly.

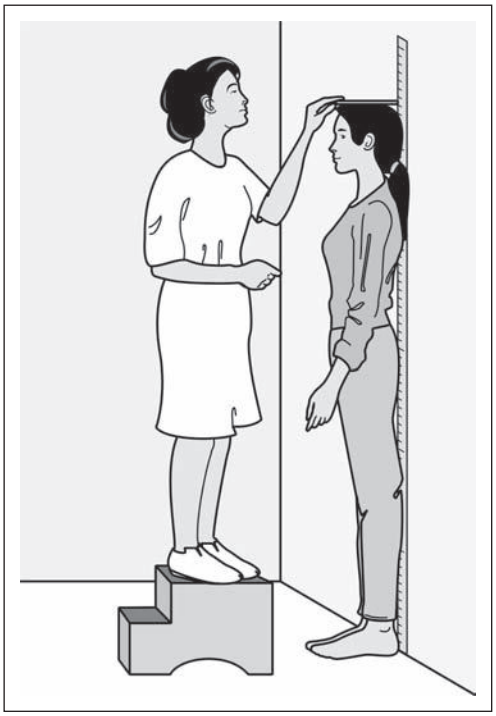


FIGURE 2-2 Measurement of height.

Source: © Cengage Learning®.

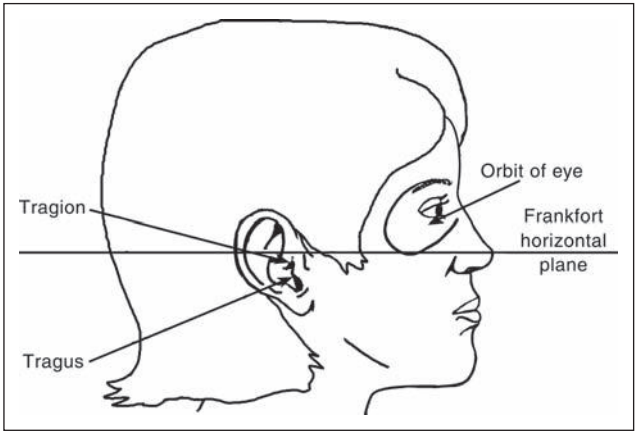


FIGURE 2-3 Frankfort Horizontal Plane aligns the lowest margin of the orbit of the eye with the tragion of the ear. The tragion is the deepest part of the notch just above the cartilage projection of the ear known as the tragus.

Source: © Cengage Learning®.

How Should the BMI Be Used in Assessment?

As you learned in Chapter 1, the BMI is an indicator of overweight and obesity that is derived from height and weight measures. For an accurate BMI, careful measures of height and weight are required. The BMI is calculated by dividing weight in kilograms by height in meters squared (kg/m^2). The BMI may also be figured by multiplying weight in pounds by 703 and dividing the total by height in inches squared (e.g., [weight in lbs $\times$ 703] $\div$ height in in^2). Alternatively, you may use the BMI calculator in Appendix A, Table 1.

The BMI is a very simple and inexpensive method for classifying people as underweight, overweight, or obese. A single formula works for children, adolescents, and adult men and women. It is not as good an indicator of fatness as some of the sophisticated methods of analyzing body composition summarized in Table 2-1, but a BMI can be useful in predicting health risks associated with excess weight and fat, including diabetes, hypertension, and coronary artery disease. In addition, a BMI of 17.5 or less is one diagnostic criterion for significant underweight in people with anorexia nervosa.

Limitations of the BMI

A person's body weight includes not just fat but also bone, water, and muscle. Any measure of obesity that relies primarily on weight, an indirect estimate of body fat, has limitations. While you can be confident that a BMI $>$ 30 indicates obesity, BMIs between 25 and 29 may be seen in some people who are not overfat, such as athletes who have a substantial lean body mass.

Consider the following when using the BMI:

- The BMI will overestimate overweight/obesity and health risk in lean, muscular athletes or people with high bone densities.
- Individuals with **edema**, in which fluid accumulates in the tissues, may gain enough weight to increase their BMI to levels suggesting obesity.
- Postmenopausal women who have lost height due to osteoporosis will have higher BMIs but not necessarily excess fat.
- In general, BMI may be less accurate in adults who are under 5 ft tall.[4] Researchers do not find BMI as predictive of health risk among short-statured adults as among adults of average height.[5]
- The BMI typically underestimates body fatness in older adults because fat mass increases with age while lean body mass decreases, yet weight may not increase enough to significantly increase BMI.
- The relationship between BMI and fatness probably differs among various racial and ethnic groups, yet there are not currently ethnic- or racially-specific BMI tables. Some researchers have begun using a World Health Organization–proposed classification of 23.0–24.9 kg/m^2 to designate overweight among Asians.[6]
- The BMI does not provide information about fat distribution, which may have a more profound effect on health than weight alone.

edema *Fluid accumulation in the tissues, which may result from congestive heart failure, kidney disease, corticosteriod therapy, liver diseases, or other metabolic conditions.*

Because BMI cannot account for differences in body build, level of fatness, or fat distribution, it needs to be interpreted carefully with all other available health data.

Interpretation of BMI

Table 2-2 provides the BMIs that classify adults as underweight, overweight, obese, or extremely obese. An adult BMI below 18.5 indicates underweight, and a BMI of 25 or greater indicates overweight. Notice also that the table relates disease risk to both BMI and waist circumference, which is discussed in the next section. BMI values that suggest health risk in adults should not be applied to children and adolescents. The Centers for Disease and Prevention (CDC) provides age-and gender-specific BMI charts for 2- to 20-year-olds, which may be found in Tables 8 and 9 in Appendix A. Using these charts, an Expert Committee of the American Academy of Pediatrics defines obesity in children and adolescents as a BMI at or above the 95th percentile and overweight as at or above the 85th percentile.

Little is served by simply telling someone that they are "underweight" or "obese" based on BMI. It is more important to inform individuals about potential health risks associated with their BMI and to conduct further screening to assess fat distribution, fat mass and FFM, activity level, dietary patterns, cardiovascular risk factors, and risk of other health problems. While these additional assessments are not as simple as height and weight, they can help to overcome some of the limitations of the BMI. Later in this chapter, the evidence linking BMI to health issues are discussed.

Should We Use Height–Weight Tables?

The Metropolitan Life Insurance Company published its table of Desirable Weights for Men and Women in 1959. This particular table was derived from data collected on 4.5 million life insurance policies issued to 25- to 59-year-olds from 1935 to 1954. Later, data from 4.2 million additional policies issued from 1950 to 1972 were analyzed to create a revised

TABLE 2-2 Classification of Adult Overweight and Obesity by BMI, Waist Circumference, and Associated Disease Risk

	BMI (kg/m^2)	Obesity Grade	Disease Risk* (Relative to Normal Weight and Waist Circumference)	
			Men ≤ 40 in (≤102 cm) Women ≤ 35 in (≤88 cm)	Men > 40 in (>102 cm) Women > 35 in (>88 cm)
Underweight	<18.5			
Normal**	18.5–24.9			
Overweight	25.0–29.9		Increased	High
Obesity	30.0–34.9	I	High	Very high
	35.0–39.9	II	Very high	Very high
Extreme Obesity	≥40	III	Extremely high	Extremely high

*Disease risk for type 2 diabetes, hypertension, and cardiovascular disease.
**Increased waist circumference can be a marker for increased risk even in persons of normal weight.

Source: National Heart, Lung, and Blood Institute. (2000). *The practical guide: Identification, evaluation, and treatment of overweight and obesity in adults.* Washington, DC: U.S. Department of Health and Human Services, p. xvii.

Available online at http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf

table called the 1983 Metropolitan Height and Weight Tables for Men and Women. In the Metropolitan tables, the weight ranges given for each height correspond with the lowest death rates among the company's life insurance holders. Both the 1959 and 1983 tables may be found in Appendix A, Tables 2 and 3.

The general public may be more familiar with height–weight tables than with the BMI. However, height–weight tables are problematic for many reasons:

- Because the tables were originally created using data from 25- to 59-year-old purchasers of personal life insurance, the data are not representative of the population as a whole and underrepresent older adults, minorities, and people in lower socioeconomic groups.
- Information used to develop the height–weight tables is of uneven quality. Some people self-reported their heights and weights; people were weighed at different times of the year, wearing varying amounts of clothing; and there was an overall lack of standardization in collecting the data.
- Weights included in the tables are weights obtained when the person purchased insurance. Changes in weight that might have occurred before death are not reflected.
- There is an overall presumption that weight is equated with fat. In fact, a lean person may weigh more than the desirable weight yet have a low percentage of fat. In contrast, an overfat person may be close to healthy weight.
- The inclusion of smokers in the population used to construct tables complicates interpretation of the relationship between weight and health. Cigarette smokers tend to be lower in weight than nonsmokers, yet smokers have higher morbidity and mortality. This correlation might give the appearance that lighter weights are less healthy and heavier weights more healthy. Some experts suggest that the cumulative effect of cigarette smoking and the impact of smoking on weight invalidate tables published after 1959.[7]

What Do Circumference Measures Tell Us about Body Composition?

Circumferences are used to estimate FFM, fat mass, and fat distribution. Circumference measures may be preferable to skinfolds in some situations. They are certainly easier to obtain than skinfolds, and there is better agreement about the precise location of circumference sites than skinfolds.[8] Circumferences are more sensitive than skinfolds or bioelectrical impedance analysis (BIA) to changes in body composition that result from weight loss.[9]

The client being measured should wear underwear, a bathing suit, or a lightweight gown. Two measurements at each site are taken to the nearest 0.1 cm or 0.25 inch using a nonstretch, flexible tape. When the two measurements are within 5 mm of each other, they can be averaged. Circumferences most commonly used in calculating body density are of the abdomen, hip, thigh, calf, and midarm.

Prediction Equations

Equations are available to convert circumference measures into estimated percent fat. The only equations that should be used are those derived from studies of people similar to those being assessed. Age, gender, and race are important characteristics to consider when choosing equations. Prediction equations for calculating body density from circumference

measures are given in Table 7 in Appendix A for older women, obese individuals, and female athletes.

Limitations of Circumferences in Determining Body Composition

subcutaneous fat
Fat stored directly under the skin, which is measured with skinfolds.

The biggest limitation of circumference measures is that girth represents not only **subcutaneous fat** but also muscle, bone, blood vessels, nerves, and internal fat. People with large musculature may be erroneously classified as obese. In addition, clinical edema and even simple fluid retention after sitting or standing for a prolonged period increases girth measurements. However, circumferences are of great value in determining the pattern of fat distribution.

Use of Circumferences in Determining Body Fat Distribution

Internal abdominal visceral fat
Fat stored deep in the abdomen, sometimes called visceral, central, truncal, or intra-abdominal fat.

Fat is stored both subcutaneously and internally. Two people with the same BMI might store fat quite differently. Internal fat consists of visceral and nonvisceral fat. **Internal abdominal visceral fat**, fat stored in the abdominopelvic region, is thought to be more harmful to health than subcutaneous fat (you may also hear this type of fat referred to as central, truncal, or intra-abdominal). This is pictured in Figure 2-4. So-called love handles are usually made up of subcutaneous, not visceral, fat.

Because of the high association between internal fat and health problems, determination of fat distribution is an important component of assessment. The waist-to-hip ratio (WHR) has been used for many years as an indicator of fat distribution. The WHR is calculated by dividing waist circumference by hip circumference. Upper body fat deposition

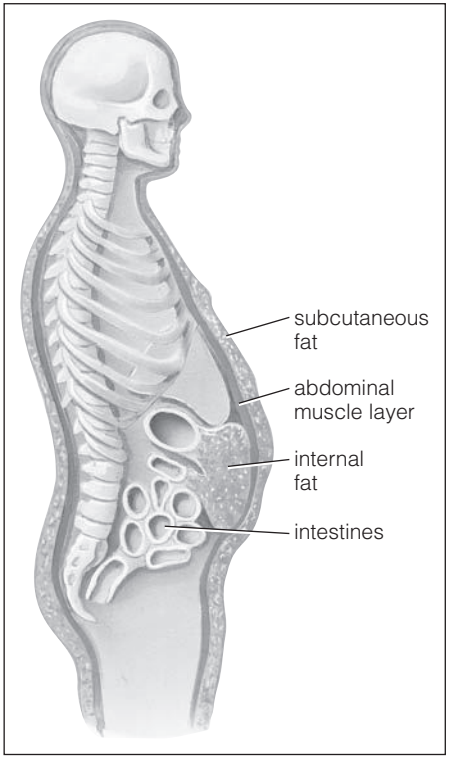


FIGURE 2-4 Internal fat and subcutaneous fat. The fat lying deep within the abdominal cavity may pose an especially high risk to health.

Source: © Cengage Learning®.