36 Obesity

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CHAPTER OUTLINE

Overview

Key Points

- The prevalence of obesity is a global concern.
- Obesity leads to increased health risks.
- Obesity is associated with increased economic burden on a nation's health care system.

The prevalence of obesity is a growing health concern globally (Swinburn et al., 2011). For the United States, data reported from the ongoing National Health and Nutrition Examination Survey (NHANES) suggest that more than one third of adult men and women age 20 years or older (35.7%, 78 million) and almost one fifth of young people age 2 to 19 years (17.9%, 12.5 million) are obese (Ogden et al., 2012, 2013). Overall, older adults (≥60 years), particularly older women, are more likely to be obese than younger adults. Among young people, a greater proportion of boys was found to be obese compared with girls (Ogden et al., 2012).

The high prevalence of obesity is of concern from several perspectives. Being obese increases the risk for developing chronic disorders such as heart disease, stroke, hypertension, type 2 diabetes, and some cancers, which in turn impairs an individual's quality of life. The economic burden to the United States of having a large percentage of the population with obesity can be measured in direct and indirect costs. The direct costs for obesity-related services such as inpatient and outpatient care, medical tests, and drug therapy have been reported to be $190 billion per year, with a per capita medical spending of $2741 higher (in 2005 dollars) for obese individuals than for those who are not obese (Cawley and Meyerhoefer, 2012). Indirect costs caused by workplace absenteeism, lost economic productivity, and higher insurance premiums are more difficult to estimate but are widely considered to be of equal concern (Dall et al., 2009).

A 2012 report projects that, over the next two decades, the prevalence of obesity in the United States will increase by 33% and 130% for severe obesity (Finkelstein et al., 2012). Just holding obesity prevalence at the 2010 level is estimated to save $549.5 billion in obesity-related direct medical costs alone. Family medicine physicians are well positioned to assist patients in attaining and maintaining a desirable weight. However, effective strategies and tools are needed. This chapter explores the approaches to caring for patients with excess weight and proposes a functional medicine approach to healthy weight management.

Defining Obesity

Key Points

- Obesity is derived differently for adults and children.
- In adults, obesity is defined as a body mass index (BMI) of 30.0 kg/m^2 or greater.
- Adult obesity is further categorized as class I, BMI of 30.0 to 34.9; class II, BMI of 35.0 to 39.9; and class III, BMI of 40.0 or greater.
- In children, obesity is defined as weight exceeding the 95th percentile on standard growth charts.

The BMI is derived from height and weight and expressed in kg/m^2. BMI is a convenient measurement used worldwide. For adults, BMI is age independent and the same for both sexes. In the United States, adults with a BMI of 18.9 to 24.9 are considered to be of normal weight. Overweight is a BMI of 25.0 or greater but less than 30.0, and obesity is defined as a BMI of 30.0 or greater. The World Health Organization (WHO) subdivides obesity into three classes according to BMI: 30.0 to 34.9 for class I, 35.0 to 39.9 for class II, and 40.0 or greater for class III, often referred to as extreme obesity (WHO Global Database, 2013) (Table 36-1).

In contrast to adults, weight for children varies with height but also age and sex. Growth charts issued in 2000 by the Centers for Disease Control and Prevention (CDC) for U.S. children provide sex- and age-specific reference values and allow determination of a BMI percentile (CDC, 2000; Kuczmarski et al., 2002). Obesity is defined as a BMI percentile at or greater than the 95th percentile on the sex-appropriate growth chart, and overweight is between the 85th and 95th percentiles (Krebs et al., 2007; Ogden and Flegal, 2010). Additional approaches to assessing the composition of the body mass of overweight and obese patients are discussed in the Assessment section.

Table 36-1 Classification and Types of Obesity

Class	BMI
I	30.0-34.9
II	35.0-39.9
III	≥40.0

Source: World Health Organization. http://apps.who.int/bmi/index.jsp?introPage=intro_3.html.

Determinants of Obesity

Key Points

- A number of factors have been found to affect weight regulation, including genes and their epigenetic modifications; maternal weight during pregnancy; metabolic imbalances; and environmental factors, including food intake, movement and physical activity, sleep, psychosocial stress, toxin exposure, and microbiome composition.
- These factors can provide leverage points for successful weight regulation.

Many factors contribute to a person's susceptibility to becoming overweight or obese (Barabas, 2007; NHLBNA, 2000). Overconsumption of calories and insufficient physical activity are two common contributors to weight gain, but several additional factors appear to be at play as well, including the quantity and quality of calories consumed; genetics and epigenetics; mother's weight gain during pregnancy; inadequate amount and quality of sleep; a wide variety of psychosocial stressors; exposure to environmental toxins; and the composition of the various body cavities in which microbiota exist, such as the intestinal, vaginal, respiratory, and oral cavities. Increasingly, no one component appears to be solely responsible for obesity. Rather, interactions among our genome, epigenome, and environment throughout our lifespan mutually influence weight regulation.

GENES AND THEIR EPIGENETIC MODULATION

There is general confusion as to contribution of genes in terms of developing obesity. A certain percentage is often assigned to the contribution of genes. This percentage reflects the balance between the relative contribution of genes and environment in the risk of someone becoming overweight or obese. It appears that the susceptibility for becoming obese is a continuum ranging from highly likely to highly unlikely, depending on one's particular genome (set of genes). Each of us has our individual genetic susceptibility with respect to becoming obese. There are genes that, when mutated, provide a high risk for developing obesity, even under environmental conditions that promote normal weight. These genes would contribute to the 100% (high risk) end of the spectrum. Fortunately, the prevalence of these genes appears to be rare, so only a minority of people have such a high risk for obesity. The vast majority of us appear to have a number of mutations (genetic variations) whose contributions are not strong enough in themselves to lead readily to obesity, but when these variants interact with particular environmental factors, the chance for weight gain increases. In this case, genetics would fall at the low-risk end of the spectrum, and the influence of the environment would fall towards the high end. It's the extent of interaction among various genes and environmental factors that appears to determine our susceptibility to gain and maintain excess weight.

Severe early-onset obesity results from a strong genetic influence on weight regulation and is typically accompanied by hyperphagia. In this case, single gene mutations (monogenic obesity) have been identified that, when present, tend to result in obesity that manifests in childhood. Although the genetic influence is much stronger than the environmental influence, excessive consumption of calories and insufficient physical activity can further exacerbate the situation. Examples of genes that have been identified as conferring a high risk for early-onset obesity include leptin (*LEP*) and the leptin receptor (*LEPR*) (Dubern and Clement, 2012), proopiomelanocortin (*POMC*) (Raffin-Sanson et al., 2003), and melanocortin-4 receptor (*MC4R*) (Panaro and Cone, 2013). These genes are collectively referred to as the leptin–POMC–melanocortin axis, a major hypothalamic circuit controlling energy homeostasis and food intake.

More recently, a number of gene variants have been described that, in the presence of an obesegenic environment, can promote overweight and obesity. These variants may influence any of the key components that factor into weight regulation, such as appetite control, energy metabolism, or physical activity, and interact with environmental factors such as dietary fats or carbohydrates. Examples of such variants include those that promote an increased absorption of dietary fat (e.g., *FABP2*); those involved with increased storage of fat in adipocytes (e.g., *ADRB2*, *ADRB3*); those that regulate transcription of key genes (e.g., *PPARG2*, *TCF7L2*); those that uncouple energy metabolism (e.g., the *UCP* gene family); and genes such as *FTO*, which is the most common weight-associated variant but whose function is not yet understood. Numerous other variants are being investigated for their role in weight regulation, including variants of genes involved with circadian rhythm (*CLOCK*, *REV-ERB-ALPHA*), which affect feeding behavior and weight regulation (Garaulet et al., 2013a, 2013b). Abete and colleagues (2012) provide a current review of the spectrum of genetic mutations associated with weight management.

Several of these variants form the basis of the weight management genetic tests that are presently on the market. However, these variants represent only a fraction of the many genes that are involved in the myriad of underlying biochemical mechanisms that can lead to obesity. As research continues to explore the numerous genes involved in all aspects of excessive weight, many more gene variants that influence weight management are expected to be identified.

Learn more about epigenetic regulation in eAppendix 36-1 online.

METABOLIC IMBALANCES

The adipocyte does more than store fat for future energy needs. It is a major endocrine organ that has a profound

EAPPENDIX

36-1 *Epigenetic Regulation*

Various environmental factors contribute to excess weight. Studies appear regularly that describe gene–environment interactions that influence individuals' phenotypes. Although our understanding of the underlying molecular mechanisms involved is still in the early stages, several intriguing findings have emerged. Perhaps the most intriguing is the finding that at least some, and likely most, environmental factors act epigenetically. Epigenetics relates to a set of instructions that influence gene expression without changing the nucleotide structure of the DNA so that the information expressed is not altered; only the ability to express the information is altered. One of the better understood mechanisms is the modification of DNA and histone proteins through the covalent attachment of chemical groups, which can activate or silence gene expression. Two of the more common types of modification involve the attachment (activation of expression) or removal (silencing of expression) of acetyl groups to the histone proteins around which DNA is wound in its compressed (nontranscriptional) state. Attachment of acetyl groups allows the DNA to relax and transcription to proceed. Removal leads to compression of the DNA into a tight coil, effectively blocking the transcription process. A second common mechanism is the attachment of methyl groups directly to the DNA, which silences the expression of the associated gene. These epigenetic "markings" or "tags" are responsible for tissue-specific gene expression. In some cases, epigenetic modification of DNA expression, either histone or DNA modification, is inherited transgenerationally. MicroRNA (miRNA)represents a third type of mechanism by which small sequences of noncoding RNA bind to the messenger RNA (mRNA) that contains the information that will direct the amino acid sequence of the protein being synthesized. Binding of miRNA to mRNA prevents translation of the message into protein, thereby controlling the amount of the protein synthesized. This mechanism is also cell type specific. Research into miRNA's influence on exercise-induced gene expression with human subjects, although limited at present, suggests that miRNA may be a contributing factor in epigenetic influence on weight regulation.

impact on the metabolism of other tissues, the regulation of appetite, insulin sensitivity, immunologic responses, and the risk of vascular disease (Ali et al., 2013). Adipocytes secrete multiple inflammatory cytokines such as interleukin-6 and tumor necrosis factor α, which can lead to increased systemic chronic inflammation. Weight gain furthers inflammation in the body, and when inflammation is present, losing weight is more difficult. Visceral adipose tissue is particularly active metabolically. Insulin resistance, present in the cardiometabolic syndrome (characterized by elevated waist circumference, low high-density lipoprotein cholesterol, elevated triglycerides, elevated blood pressure, and elevated blood sugar), is strongly associated with visceral adiposity. When insulin levels are high, as is the case in insulin resistance, the body is more likely to store calories. Weight gain in the abdominal area is associated with elevated insulin levels and inflammation. The elevated insulin levels can increase hunger levels and make it more difficult for a patient to lose weight. The interconnectivity of these metabolic factors promotes a vicious cycle that can make achieving a healthy weight difficult.

Other hormones influence weight and need to be considered when evaluating patients for weight gain and obesity. Hypothyroidism can result in weight gain. Other signs and symptoms of hypothyroidism include hair loss and hair thinning, cold intolerance, constipation, depression, arthralgias, elevated low-density lipoprotein cholesterol, dry skin, fatigue, memory impairment, menorrhagia, myalgias, and weakness (Gaitonde et al., 2012). Weight gain also influences hormone levels in the body. Estrogen can be produced in the adipocyte through the action of the enzyme aromatase. As an individual's percentage of body fat increases, dehydroepiandrosterone (DHEA) and testosterone are converted into estrogen by aromatase in adipose tissue. For men, this conversion can result in a lower testosterone level. This hormonal change has been associated with estrogen-related cancers, such as breast cancer, prostate cancer, and endometrial cancer (Williams, 2010).

MATERNAL WEIGHT DURING PREGNANCY

Maternal prenatal weight and weight gain during pregnancy have been associated with weight issues for the infant during childhood. A mother's prepregnancy weight and weight gain during pregnancy may also influence her children's weight. In a meta-analysis in which 45 studies met the researchers' selection criteria, Yu and coworkers (2013) found that children of mothers who were overweight or obese before pregnancy had a significantly increased risk of being overweight or obese during childhood. In a meta-analysis of 12 studies, Tie and colleagues (2014) found a significant association between excessive gestational weight gain and childhood overweight and obesity. Similarly, children of mothers who had gestational diabetes during pregnancy were found to have an increased risk of being overweight or obese later in life (Nehring et al., 2013). Undernutrition during pregnancy has also been associated with an increased risk of weight gain in children born to these mothers (Cunha et al., 2013). These reports suggest that maternal nutrition during pregnancy may be an important factor in weight management of offspring. Other contributing factors that should also be considered include features of infant feeding, the overall nutritional sufficiency during childhood, and how health promoting the eating patterns are within the home.

ENVIRONMENTAL FACTORS

Food Intake

Over the past 40 years, the tendency in the U.S. population has been to consume more calories than needed. Per capita consumption of calories increased from 2200 kcal in 1970 to 2680 kcal in 1997 (Putnam, 2000). Increased portion sizes, the energy density of today's commonly eaten foods, and the trend in consuming meals outside the home where food portions tend to exceed standard serving sizes all contribute to the increase in calorie consumption. Satiety helps determine food intake and is partially determined by the volume and weight of the food consumed. Foods that are high in calorie content for a given volume, such as highly processed, low-fiber foods, can lead to excessive calorie intake.

It is important to recognize that the reasons a person gains or loses weight are not always simple. In a laboratory setting, 3500 calories equals 1 lb, and so it has been assumed that if a person consumes 3500 fewer calories than his or her body requires, they will lose 1 lb. In the office setting, this calculation does not always hold, and it is important to recognize and accept this when working with patients. Why does someone overeat? Many factors contribute to overeating, including stress, boredom, nutritional insufficiencies, emotional lability, access to food, and the changing of our diet to one that is highly processed. In a randomized, blinded crossover design study by Lennerz and colleagues (2013), overweight or obese young men age 18 to 35 years ate test meals that differed only in glycemic index (GI). The high-GI meal contained rapidly digested carbohydrate; the low-GI meal contained slowly digested carbohydrate (see Glycemic Index and Glycemic Load).

Plasma glucose, serum insulin, and hunger were monitored after each test meal and compared between those who ate the high-GI meal and those who ate the low-GI meal. After the low-GI meal, plasma glucose initially rose and by 1 hour had dropped to a relatively steady plateau over the next 3 hours. In those who ate the high-GI meal, plasma glucose initially surged and then dropped steeply over the next 3 hours to a level lower than seen with the low-GI meal. A similar pattern was seen with serum insulin levels. At the 4-hour mark, subjects who had eaten the high-GI meal reported greater hunger, and brain imaging showed intense activation of the nucleus accumbens, the brain region considered "ground zero" for conventional addiction (e.g., involving drug abuse or gambling). Remarkably, every subject who ate the high-GI meal responded in exactly the same way on the brain scans, producing extremely strong confidence in the results ($P < 0.001$).

This study showed that highly processed carbohydrate foods can cause food cravings in susceptible individuals, providing qualified support for the notion of "food addiction." The findings suggest that limiting consumption of highly processed carbohydrates, such as white bread, white rice, white potato products, and products with concentrated sugar, could help weight gain–prone individuals avoid overeating.

Glycemic Index and Glycemic Load

- Two values are commonly used to describe how rapidly a food or meal is digested. The GI value of a food is measured by the rise in blood glucose after consumption of 50 g of that food. This is then compared with the rise in blood glucose after consumption of 50 g of sugar. Carbohydrates that break down quickly have high GI values. Carbohydrates that break down slowly have low GI values.
- The glycemic load describes the rise in blood glucose after an edible portion of that food is consumed along with other foods. For example, carrots may have a high GI, but because it is very difficult to consume 50 g of carbohydrate from carrots, they have a low glycemic load.
- Examples of foods with high GIs include candy, soda, and fruit juice. Broccoli is an example of a food with a low GI. A meal with a high glycemic load would be pancakes with syrup and orange juice; fish with ½ cup of brown rice and 2 cups of mixed greens would be a meal with a low glycemic load.

Movement and Physical Activity

In a recent review, Denham et al. (2013) summarized the ability of physical activity to influence epigenetic modifications of histones or DNA in the brain, skeletal muscle, and peripheral blood. Aerobic exercise over many weeks was the primary variable studied that led to activity-induced benefits. Several of the studies found benefits with 30 minutes of daily moderate activity.

Yoga also appears to be an effective type of movement activity for improving weight, mental well-being, and health in general. In a narrative review of yoga intervention clinical trials, Rioux and Ritenbaugh (2013) reported that overall therapeutic yoga programs were effective in reducing body weight and improving body composition. A community-based 12-week yoga and Pilates program was found to be helpful for weight loss in postpartum women (Ko et al., 2013). In a small 8-week randomized controlled trial of 20 obese adolescent Korean boys, yoga was found to significantly decrease body weight, BMI, body fat mass, and percentage of body fat and to significantly increase fat-free mass and basal metabolic rate (Seo et al., 2012). Although the trends appear positive in terms of yoga's health benefits, larger controlled trials are needed to explore the full potential of yoga for health promotion.

Sleep

There is an association between too little or too much sleep and overweight and obesity. In a survey of more than 54,000 U.S. adults age 45 years or older, sleeping too little (≤6 hours) and sleeping too much (≥10 hours) were significantly associated with obesity (Liu et al., 2013). Throughout the life cycle, a short sleep duration is independently associated with weight gain (Gillman and Ludwig, 2013; Patel and Hu, 2008). When sleep duration and BMI were followed for 7.5 years in more than 83,000 U.S. adults age 51 years or older, researchers found an inverse relationship between the length of sleeping and BMI (Xiao et al., 2013). Sleep deprivation is associated with elevated ghrelin, elevated cortisol, elevated insulin, decreased leptin, and increased hunger (Patel and Hu, 2008). These hormonal changes are associated with weight gain and can result in less than expected weight loss in patients who are sleep deprived, even when they are restricting their caloric intake (Nedeltcheva et al., 2010). In a longitudinal study of adolescents, sleep duration and BMI were followed at 6-month intervals between age 14 and 18 (Mitchell et al., 2013). Shorter sleep duration was associated with greater BMI. Mesarwi and colleagues (2013) found a correlation between short duration of sleep, obesity, and type 2 diabetes and recommended assessing sleep quantity and quality during patient visits.

We must assess our patients' sleep when addressing weight gain and obesity. In addition, we must be alert to signs of obstructive sleep apnea (OSA) because this process is proinflammatory. Patients with OSA have higher inflammatory markers than BMI-matched individuals without OSA (Steiropoulos et al., 2010). Insulin resistance, type 2 diabetes, obesity, and weight gain are frequently associated with sleep apnea, which can result from weight gain and can also cause weight gain through the increase in inflammation and changes in metabolism that result from inadequate sleep (Alam et al., 2007). Signs and symptoms of sleep apnea include elevated blood pressure, difficulty in controlling blood pressure, fatigue, hypersomnolence, retrognathia, snoring, mood changes, and attention issues. When a child is gaining weight, it is important to screen for sleep apnea by asking the parents about snoring and examining the tonsils and adenoids for enlargement.

PSYCHOSOCIAL STRESS

In addition to the negative influences of physiological stress from poor nutrition, insufficient appropriate activity, and inadequate sleep, psychosocial stress can also contribute to excess weight. Psychosocial stress can arise from a wide variety of environmental stressors, such as change in routine, difficult decisions, depression, chronic health issues, lack of access to health care, economic challenges, a dysfunctional home environment, an unsafe neighborhood, inadequate social support, abusive relationships, illiteracy, job dissatisfaction, poor adjustment to life-cycle transitions such as retirement, and legal problems.

This type of stress is often associated with weight gain, elevated BMI, and poor food choices. The amount of weight someone gains when exposed to stress depends on the intensity of the stress, the duration of the stress, and the type of food available for consumption during stressful times (Block et al., 2009). Increased cortisol levels can lead to weight gain around the abdominal region (central adiposity). It is important to screen for emotional stress with patients, identify how this stress may be negatively impacting their weight, and help them incorporate stress reduction programs to achieve their weight loss goals. Even when we are unable to control the existence of stressors, controlling our response to stress can positively influence our weight and our overall health.

Similarly, cultivating supportive relationships with oneself and with friends and family is particularly helpful when undergoing behavioral change, which is often necessary with weight loss. Persons of the same sex have a greater

influence on each other than those of the opposite sex (Christakis and Fowler, 2007). Our social networks can be a positive influence as well. People who exercise together are more likely to exercise. If you tell a friend, colleague or spouse that you are making a change in your lifestyle, you are more likely to maintain those changes.

TOXIN EXPOSURE

One environmental toxin in particular, the family of endocrine-disrupting chemicals (EDCs), is being investigated for its contribution to the high prevalence of obesity. Examples of EDCs include polychlorinated bisphenyls (PCBs), diethylstilbestrol (DES), bisphenol A, and persistent organic pollutants (POPs) such as tributyltin (TBT). This group of chemicals can interfere with the normal functioning of the endocrine system, which can affect development, reproduction, insulin production and utilization, and metabolic rate. Recent reviews of the literature suggest that exposure to EDCs during development is associated with excessive weight later in life and that these chemicals should be given serious consideration as potential contributors to obesity (Engel and Wolff, 2013; Newbold 2010; Tang-Péronard et al., 2011). Furthermore, these toxins have also been associated with insulin resistance and its associated obesity. An examination of selected POPs in the NHANES 1999 to 2002 data showed that elevated BMI and waist circumference were associated with POPs levels (Elobeid et al., 2010). BPA has also been linked to increased insulin levels and weight gain (Nadal et al., 2009).

MICROBIOME COMPOSITION

The microorganisms that inhabit the body cavities, such as the mouth, vagina, and respiratory and gastrointestinal tracts, appear to play an active role in our overall health. The gastrointestinal tract has been the subject of considerable interest in this regard. Multiple studies have suggested an association between our intestinal microbiota and weight. Fecal microbial cultures from healthy donors transplanted into recipients with metabolic syndrome were found to ameliorate the insulin resistance phenotype (Vrieze et al., 2012). High numbers of Bifidobacteria and low numbers of *Staphylococcus aureus* in the digestive tract in infancy may provide protection against the development of weight gain and obesity later in life. Bifidobacteria typify the gut microbiota composition of a healthy breastfed infant. Breastfeeding is associated with a 13% to 22% reduced likelihood of being overweight or obese in childhood (Kalliomäki et al., 2008).

However, just how the microbiota influence obesity remains unclear. What is clear so far is that the microbes are readily transmissible between individuals, after being transmitted can alter the outcome (obese vs. lean), and diet can further influence the outcome. The quality of the food we eat, as well as the influence our food has on our microbiota, have implications for the level of inflammation in our body and subsequent weight gain (Badman et al., 2005). Again, we see that all calories are not created equal.

See eAppendix 36-2 online to learn more about current research on how the microbiome can influence weight.

Assessment

Key Points

- Many of the environmental factors that lead to excess weight are lifestyle related.
- The patient's readiness to change is an important predictor of successful weight management.
- A thorough patient history provides important clues to the root cause of obesity.
- The patient assessment is conducted through a nutrition-oriented lens.
- Assessing percent body fat and its distribution helps inform the therapeutic intervention.
- Beyond nutrition, multiple modifiable lifestyle factors are also assessed.

Many of the environmental factors that lead to excess weight are lifestyle related. Typically, these factors are modifiable through an individual's actions, which provides the physician and patient with multiple leverage points in developing a personalized plan that can lead to successful weight management. The components of a thorough assessment are described in this section. Each of the chapter authors uses a nutrition-oriented approach to enhancing the standard patient health assessment, and key aspects are described here. Poetic license is taken with the term "nutrition" because it not only encompasses valuable clues as to nutritional status but also other lifestyle factors such as physical activity, sleep, thoughts and emotions, and relationships and system of meaning that can contribute to the root cause of overweight and obesity. Assessing your patient's readiness to change will help you decide where best to begin the journey toward attaining and maintaining a desirable weight.

READINESS TO CHANGE

The majority of the determinants of overweight and obesity are related to choices that can be modified. However, unless patients are ready to change their habits, successful weight management is not likely. Therefore, it is helpful to assess a patient's readiness to change. One particularly successful approach has been the transtheoretical or stages of change model pioneered by psychologist James Prochaska and colleagues (1992). This model describes the stages that a person passes through while changing a behavior: precontemplation, contemplation, preparation, action, and maintenance. Unless patients are ready to take action, they frequently are not able to sustain behavioral change. Validated questionnaires are available to help you determine the patient's stage (University of Rhode Island Change Assessment Scale, 2013). You can also get a quick feel for patient readiness with the question: "On a scale of 1 to 10, with 1 being not ready and 10 being very ready, how would you rate your readiness to change?"

In addition to using an open-ended questioning approach, motivational interviewing is particularly helpful when working with patients with chronic disorders in whom behavioral change is a key factor (Miller and Rollnick,

EAPPENDIX

36-2 Current Research on How the Microbiome Can Influence Weight

In work by Cani and associates (2007) using mice as a model to study mechanisms pertinent to human health, microbiota from obese mice transplanted into thin mice resulted in the thin mice gaining weight. Using adult female twin pairs that were discordant for obesity, Ridaura and colleagues (2013) took fecal cultures from the obese females and from their lean twins and transplanted the two sets of microbes into germ-free mice fed a low-fat diet or diets with varying amounts of saturated fat, fruits, and vegetables that were typical of the U.S. diet. Mice that received the obese twins' gastrointestinal tract microbiota had increased size and body fat as well as obesity-associated metabolic phenotypes. Mice that received the microbiota from the lean twin population became lean. When the mice transplanted with the microbiota from the obese females were co-housed with the mice transplanted with the microbiota from the lean females, the body composition and metabolic phenotype characteristic of obesity did not develop in the mice with the microbiota from the obese twins. This "rescue" phenomenon occurred when the mice were fed a low–saturated fat, high-fruit and high-vegetable diet but not with a high–saturated fat, high-fruit and high-vegetable diet. These results suggest that something in the lean twins' microbiota was transmissible and could prevent obesity from developing but that the diet could influence the degree to which the obesity phenotype could be prevented.

Identification of potential mechanisms by which the response of the mice with the obesity-related microbiota is being investigated by various research groups. In the study by Ridaura and colleagues (2013), the researchers found the expression of numerous genes, particularly those related to detoxification and stress, were increased in the microbes receiving the obese twins' microbiota. They also found an association with specific members of the Bacteroideae, gram-negative anaerobes readily found in the environment and in the respiratory and digestive tracts and skin of animals. The lipopolysaccharides released by gram-negative bacteria have been associated with metabolic endotoxemia and inflammatory disorders, such as type 2 diabetes, insulin resistance, nonalcoholic steatohepatitis, and obesity (Geurts et al., 2013). Proposed mechanisms include pattern recognition receptors in the innate immune system that can sense pathogens and influence the metabolic stress response. Activation of the pattern recognition receptors can cause a chronic low-grade inflammation throughout the body that can go on to promote fatty liver disease, insulin resistance, obesity, type 2 diabetes, and atherosclerosis (Jin and Flavell, 2013). Pathogen-associated molecular patterns (PAMPs) can come from viruses, bacteria, parasites, and fungi. Danger-associated molecular patterns (DAMPs) can sense stress signals and may be activated by certain components of our diet. PAMPs and DAMPs can go on to cause an inflammatory process in the body, which can establish a vicious cycle within the body.

Table 36-2 Antecedents, Triggers, and Perpetuators in Obesity

Antecedents (genetics)	*Ob* gene (chromosome 7) FTO (fat mass and obesity-associated gene) is located on chromosome 16 and is associated with being overweight or obese (Fawcett et al., 2010; Frayling et al., 2007) A defect in the melanocortin-4 receptor is the most common single gene mutation associated with severe obesity in 5% of the population (Chambers et al., 2008) Brain-derived neurotrophic factor (BDNF) gene has been shown to cause spontaneous mendelian obesity in humans (Fisler et al., 2013) Fatty acid binding protein gene (*FABP2*) is associated with fat absorption Peroxisome proliferator receptor-γ gene (PPAR-γ) plays a key role in the formation of fat cells Adrenergic β_2-receptor gene (*ADRB2*) mobilizes fat cells for energy Adrenergic β_3-receptor gene (*ADRB3*) regulates the breakdown of fat from tissues in response to exercise Glutamate decarboxylase 2 gene (*GAD2*) is released from pancreatic and brain cells coding for GABA neurotransmitter, which regulates food intake
Triggers	Food insecurity; supplemental nutrition programs with high–glycemic index foods (Leung et al., 2012; Ludwig et al., 2012; Nickols-Richardson et al., 2005); high fructose intake; infection (chronic, bacterial, viral, or parasitic); sources of injury and chronic inflammation; endocrine imbalance, adrenal insufficiency, thyroid hypofunction (consider autoimmune, radiation induced, chemical induced, or medication induced) (Hochberg et al., 2010; Thaler et al., 2013); food sensitivity or genetic overlap (celiac, food, and environmental hypersensitivity); environmental toxicity (bisphenol A; Dolinoy et al., 2007); and even cell phone use alters glucose metabolism in the brain, disrupting appetite-related chronobiology (Fragopoulou et al., 2012; Kohlstadt, 2013; Volkow et al., 2011)
Perpetuators	Altered sleep (disrupted chronobiology: shift work, jet lag) (Kohlstadt, 2013; Stempfer et al., 1989) and sleep apnea Minimal exercise (Jakicic et al., 2011; Sausse, 2013; Vincent et al., 2012; Warburton et al., 2006) Persistent stress (psychologic, physical, relationship, socioeconomic, environmental) Nutrition (high glycemic index [Ruottinen et al., 2008; Fava et al., 2013], poor vegetable or fruit intake)

GABA, γ-Aminobutyric acid.

2002). Motivational interviewing focuses on identifying, examining, and resolving the ambivalence that a patient feels about behavioral change. Key web resources are listed at the end of this chapter.

PATIENT HISTORY

A careful history helps identify common antecedents, triggers, and perpetuators of obesity (Table 36-2). Multiple factors can lead to overweight and obesity, and each patient will have his or her own path leading to excess weight. Determining some of the contributing factors will help you identify an intervention that is most likely to be successful for that patient. When gathering your patient's history, ask open-ended questions that will help identify the factors that may have predisposed them towards obesity: Was he or she overweight as a child? Did he or she gain weight all of a sudden or slowly over many years? Is there a family history of overweight or obesity? Is his or her activity level low because of pain or injury, inflammation, or fatigue? A slow, steady weight gain of 2 to 5 lb per year is typical for many adults who are not exercising adequately or eating too many calories. Alternatively, if your patient gained weight quickly, it is important to rule out thyroid disorders, hormonal changes, stress, family trauma, infection, and inflammation. A variety of clues such as these can come out during the information-gathering phase of the assessment if you ask open-ended questions and listen carefully (i.e., be "present" to the patient during this process).

During the patient history, evaluate the timeline of the weight gain. When did the weight gain begin? When did it markedly increase? Through the identification of environmental triggers as well as epigenetic and metabolic drivers for the obesogenic environment, therapeutic interventions can be developed. These environmental pressures, from the prenatal period through adulthood, are associated with weight gain and obesity (Table 36-3).

Obese patients frequently have comorbidities that often require therapeutic medications. These therapeutic drug regimens for diabetes, depression, hypertension, seizures, and HIV disease can trigger weight gain and worsen obesity (Table 36-4). Additionally, many of the most commonly prescribed medications can alter nutritional biochemistry and the obesogenic environment by multiple mechanisms (Table 36-5).

THE ABCDs OF NUTRITION EVALUATION

The ABCDs of nutrition evaluation of the obese patient include anthropometrics, biochemical markers, clinical indicators, and diet and lifestyle evaluation (Institute for Functional Medicine, 2010). Anthropometrics and vital signs include the height; weight; BMI; waist circumference; hip circumference; waist-to-hip ratio or waist-to-height ratio; percent body fat (fat mass); percent fat-free mass (lean body mass); extracellular water content; intracellular water content; blood pressure; respiratory rate; temperature; pulse; and for patients with diabetes, microfilament testing of the feet to test for feeling sensation. Biochemical markers typically include the comprehensive metabolic panel that includes a fasting lipid panel, thyroid panel or at least thyroid-stimulating hormone, 25-hydroxy vitamin D, high-sensitivity C-reactive protein, hemoglobin A_{1c}, complete blood count, urinalysis, and other laboratory analyses as needed (e.g., fasting insulin). The physical examination is a standard comprehensive examination with the assessment of additional clinical indicators as seen through a nutrition lens, such as including an examination of the mouth; evaluation of the nails, skin, and hair; and peripheral sensation using monofilament, 128 Hz tuning fork, and a reflex hammer.

The ABCDs of the nutrition-oriented evaluation of the obese patient should be completed and will help clarify the role of lifestyle in the root causes of the underlying chronic condition (Jones et al., 2010; Minich et al., 2013).

Table 36-3 Environmental Influences on Obesity

Environmental Influences	Behavior, Condition, or Exposure	Associated Impact
Prenatal	Maternal smoking Higher maternal BMI at conception Maternal diabetes	Increase odds of adult obesity by 50% by age 33 Increase body weight of child Increase overweight as a child and adult
Breastfeeding	Primarily breast fed (vs. formula)	Less likely to be obese as a child Each additional month of breastfeeding can result in a 4% decrease in risk of obesity
Viruses (e.g., adenovirus-36 antibody)	Increased glucose uptake, decreased leptin secretion	Associated with increased body weight in twin studies
Toxins (e.g., endocrine-disrupting chemicals)	Bisphenol A, organotins, phytoestrogen exposure during development	Higher serum toxin levels can lead to greater obesity in children
Smoking cessation	People who discontinue smoking	Increased odds ratio of obesity by at least twofold
Sleep deprivation	Associated with increased food intake, decreased physical activity, and decreased body temperature with fatigue	Consistently associated with development of obesity in children and young adults
Movement	Increased leisure time Declining work activity Declining walking, biking, etc. as a means of transportation Declining activity at home Increased electronic interface (computers, games, TV time) High risk of inactivity	A low level of physical activity decreases total energy expenditure and unless matched by a decrease in energy intake can lead to weight gain

BMI, Body mass index.

Adapted from Polsky S, Catenacci VA, Wyatt HR, Hill JO. Obesity: epidemiology, etiology and prevention. In Ross AC, Caballero B, Cousins RJ, et al, eds. *Modern nutrition in health and disease.* 11th ed. Baltimore: Wolters Kluwer/Lippincott Williams and Wilkins; 2014:771-785.

Table 36-4 Concomitant Pharmacology That Promotes Weight Gain and Influences Body Weight

Steroid hormones	Glucocorticoids, estrogens, progestins, testosterone, tamoxifen
Diabetes therapies	Some insulins, sulfonylureas, thiazolidinediones; metformin, glucagon-like peptide agonists, sodium glucose cotransporter 2 inhibitors
Certain antiretroviral protease inhibitors	Lipodystrophy during treatment with protease inhibitors, lipohypertrophy after successful suppression of viral load
Certain β-adrenergic blockers	Propranolol
Certain antihistamines	Diphenhydramine
Certain antidepressants	Tricyclic antidepressants, MAO inhibitors, some SSRIs (paroxetine), antiserotonin agents (pizotifen)
Certain antiseizure medications	Valproate, gabapentin, carbamazepine
Certain antipsychotropic drugs	Clonazepine, olanzapine, risperidone, thioridazine

MAO, Monoamine oxidase; *SSRI,* selective serotonin reuptake inhibitor.

Anuurad et al., 2010; Polsky et al., 2014; Seger, 2013.

Table 36-5 Many Commonly Used Medications Promote Weight Gain

Rank in Prescriptions Written (Million)	Medication	Mechanism
2 (94.1)	Simvastatin	Reduces exercise tolerance, promotes insulin resistance, depletes CoQ10
5 (57.2)	Amlodipine besylate	Increases appetite centrally in some patients
6 (53.4)	Omeprazole	Contributes to vitamin B_{12} deficiency and diet indiscretion
9 (48.3)	Metformin	Lowers absorption of vitamin B_{12}
10 (47.8)	Hydrochlorothiazide	Increases appetite, reduces cardiac response to exercise
By Sales (Billions)	**Medication**	**Mechanism**
1 (7.2)	Lipitor	Reduces exercise tolerance, promotes insulin resistance, depletes CoQ10 within muscle cells in genetically susceptible patients
2 (6.3)	Nexium	May contribute to vitamin B_{12} deficiency, fatigue, altered methylation, diet indiscretion
4 (4.7)	Advair Discus	Potentially protects against weight gain by reducing need for corticosteroids
5 (4.6)	Abilify	Increases appetite centrally
6 (4.4)	Seroquel	Increases appetite centrally
8 (3.8)	Crestor	Reduces exercise tolerance, promotes insulin resistance, depletes CoQ10
9 (3.5)	Actose	Associated with weight gain

CoQ10, Coenzyme Q10.

Adapted from Kohlstadt I. Obesity-primary care approaches to weight reduction. In Kohlstadt I, ed. *Advancing medicine with food and nutrients.* 2nd ed. Boca Raton, FL: CRC Press; 2013: 349-372 and Report of the IMS Institute for Healthcare Informatics. The use of medicines in the United States: review of 2010. Parsippany, NJ: IMS Health; 2011. http://www.imshealth.com/imshealth/Global/Content/IMS%20Institute/Documents/IHII_UseOfMed_report%20.pdf.

Table 36-6 Anthropometric Evaluation

Quantitative direct measurements	**COMMONLY USED** Weight, height (length) Waist circumference (<35 in women; <40 in men) Hip circumference Skinfold thickness measurements (three sites) Reactance/resistance (BIA)
Calculations	BMI (normal, 18.5-24.9; overweight, >25; obese, >30) Waist-to-hip ratio (<0.8 in women; <0.9 in men) Waist-to-height ratio (<0.5) Deurenberg Equation (BMI, Age, Gender) % Body fat = (1.2 × BMI) + (0.23 × Age [yr]) − (10.8 × G) − 5.4 G = 1 for male; G = 0 for female Bioelectrical imepdance analysis Fat mass, fat-free mass, extracellular water, intracellular water, phase angle, BMR (weight, height, and activity dependent)
Quantitative testing	**LESS COMMONLY USED** BOD POD Quantitative magnetic resonance Underwater weighing Deuterium dilution

BIA, Bioelectrical impedance analysis; *BMI,* body mass index; *BMR,* basal metabolic rate; *BOD POD,* whole-body air displacement plethysmography (Deurenberg et al., 2003; Srikanthan et al., 2009; Wang et al., 2010).

Anthropometrics

Assessing anthropometrics is the first step in the nutritional evaluation of the patient. Starting with birth, the weight and height are determined and then routinely checked throughout the lifespan. The use of these basic measurements and associated ratios that can be calculated, such as waist-to-hip ratio, are commonly used in clinics. The initial stratification is by BMI calculation from height and weight (underweight, <18.5; normal, 18.5-24.9; overweight, 25-29.9; obese, >30), waist circumference (women, <35 in; men, <40), and waist-to-hip ratio (women, <0.8; men, <0.9) or waist-to-height ratio (<0.5 ideal). BMI is the primary parameter used to categorize weight for height (Weight/Height/Height × 703) and, in fact, has recently been mandated to be included in all patient charts. The BMI is bimodal. There is increased risk of mortality and morbidity when BMI is below 18.5 and above 24.9. The risk of inflammatory disease, including cardiovascular disease, occurs at both ends of the bimodal curve.

Body mass index is a quick and easy screening tool to use in the office setting but is imperfect. For muscular individuals, the BMI overestimates risk. For patients with too little lean muscle mass (sarcopenia), the BMI underestimates risk. Table 36-6 lists the many ways to assess body composition. A comparison of the various assessment methods is provided by Saltzman et al. (2013).

A more informative assessment of adiposity as well as risk for disease than BMI is body fat percentage. Table 36-7 lists the fat percentage in healthy individuals. Although underwater (hydrostatic) weighing and dual-energy X-ray absorptiometry (DXA) scan are considered the preferred methods for measuring percent body fat, these methods are not readily available in most clinics. Each method has its own confounders and advantages (Carroll et al., 2008; Kushner and Blatner, 2005; Wang et al., 2010). Bioelectrical impedance analysis (BIA) has emerged as a more convenient technique for in-office measurements of body fat and fat-free mass, of particular interest in detecting malnutrition. The inclusion of BIA in the NHANES with comparison with the more traditional multisite skinfold measurements has validated the use of this tool. BIA is best used as a tool for tracking a patient's progress from one time point to another rather than as a precise measurement of any one component of body composition. Many practitioners use sequential BIA analysis to follow the progression of treatment, which allows for determining that the weight loss is the desired fat mass and not muscle mass loss or excessive water loss.

Table 36-7 Classification by Percentage Body Fat

Classification	Female (%)	Male (%)
Essential fat	10-13	2-5
Athletes	14-20	6-13
Fitness	21-24	14-17
Acceptable	25-31	18-24
Obesity	>32	>25

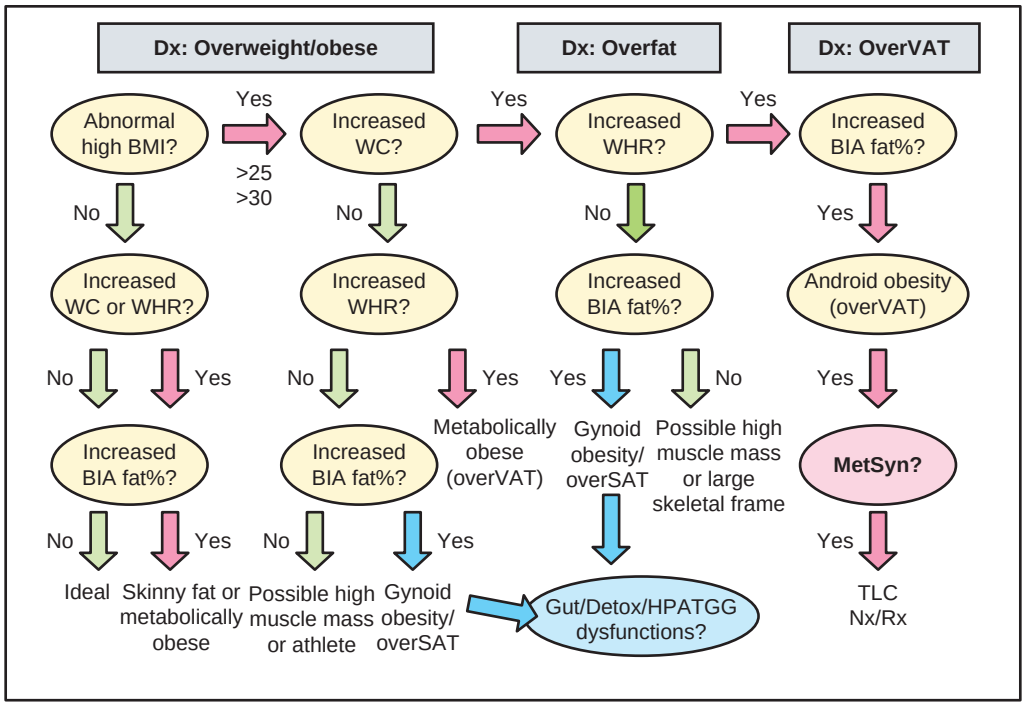
Adapted from ACE Pro. Percent body fat calculator: skinfold method. http://www.acefitness.org/acefit/healthy_living_tools_content.aspx?id=2.

Additional anthropometric measurements, waist and hip circumference, and the calculated waist-to-hip ratio help to further stratify obesity by location of fat accumulation (Figure 36-1). If a man's waist circumference is greater than 40 inches (102 cm) and a woman's abdominal circumference is greater than 35 inches (>89 cm), then they are considered obese. The presence of android obesity (visceral adiposity) with a waist-to-hip ratio of greater than 0.8 in women and greater than 0.9 in men portends of a more inflammatory metabolism and is characterized by the apple shape. The gynoid obesity (increased BMI, increased body fat percentage) hallmark is subcutaneous obesity with a waist-to-hip ratio of less than 0.8 for women and less than 0.9 for men and a characteristic pear-shaped body type. Android obesity (increased BMI, increased percentage of body fat with an elevated waist-to-hip ratio) correlates with adiposopathy and with metabolic disease (insulin resistance, metabolic syndrome). Those with android obesity have an increased visceral adipose tissue percentage. The waist measurement accuracy depends on the use of the same landmarks. Some suggest the waist at the top of the iliac crest (Anderson and Hensrud, 2011); others use the waist as the midpoint between the bottom of the 10th rib and the superior iliac crest at the midaxillary line.

Figure 36-2 provides a case example in which the combined used of multiple anthropometric measures, including BIA, is helpful in following treatment progression.

After the pattern of fat distribution has been determined (android or gynoid distribution), the necessary biochemical indicators are ordered to help determine drivers of the obesity-promoting condition (Table 36-8). This approach helps improve the metrics for health risk analysis (Ahima and Lazer, 2013).

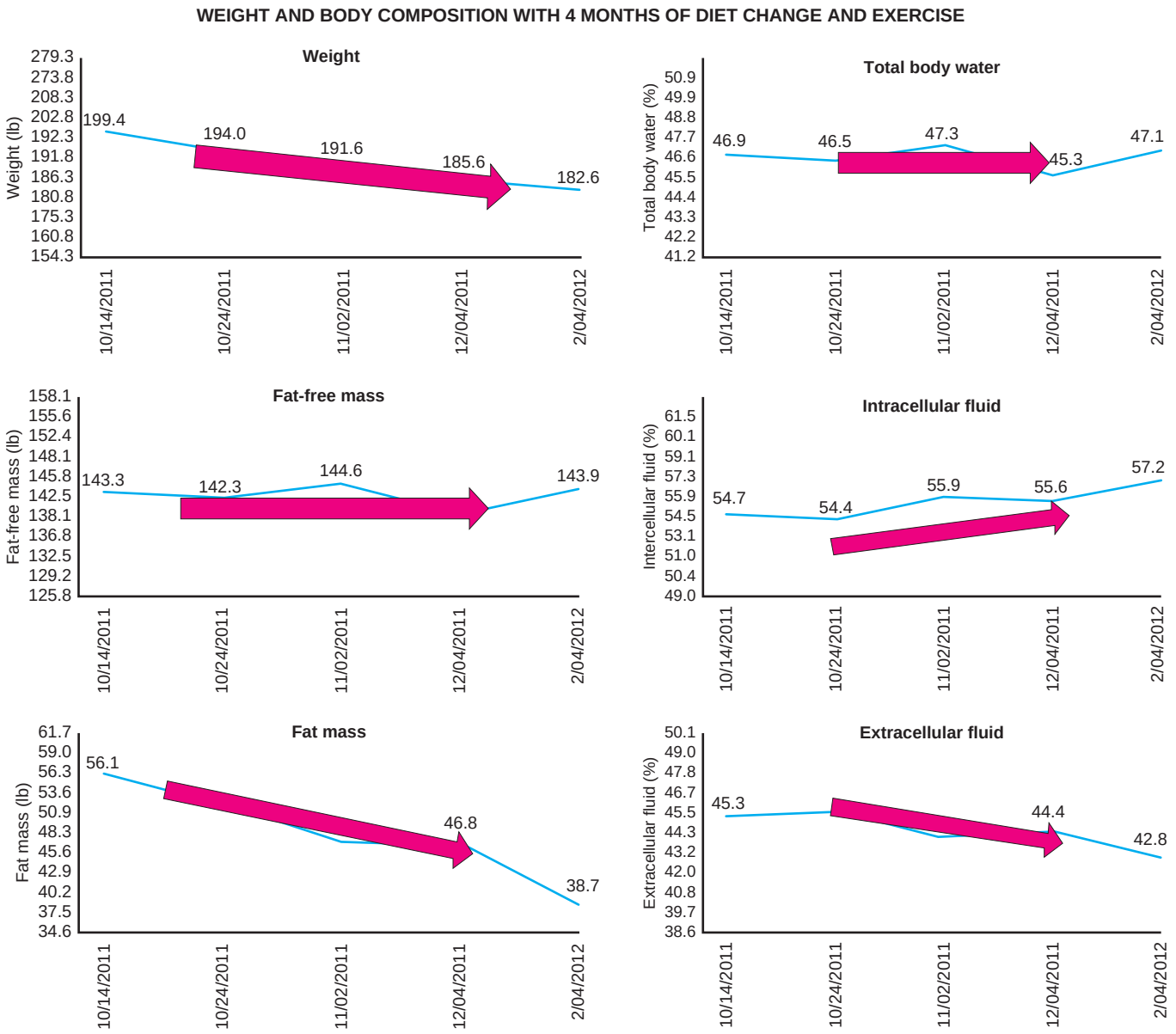
The pattern of morbidity in an obese patient is influenced by whether the patient has the sequel of adiposopathy (dysmetabolic syndrome), which is associated with elevated



Abnormal BMI	Increased Waist Circumference	Increased Waist-to-Hip Ratio	Increased % Body Fat	Obese/Fat Distribution	Workup
No	No	No	No	No	Ideal normal health monitoring
No	No	No	Yes	Skinny fat—sarcopenic adiposity	Metabolically obese inflammatory workup; workup for causes of sarcopenia or sarcobesity (Parr et al., 2013)
Yes	No	No	No	No	High-muscle athlete; normal health monitoring
Yes	No	Yes	Yes	Yes: android obesity,visceral adiposity	Inflammatory workup; root causes of inflammation associated with weight gain and adiposopathy (e.g., infection, glucose dysregulation, toxins)
Yes	No	No	Yes	Yes: gynoid obesity, subcutaneous fat adiposity	Gastrointestinal, biotransformation, HPATGG dysfunction, toxicity, and endocrine evaluations
Yes	Yes	No	No	No: large frame; high muscle mass	No intervention; normal health monitoring
Yes	Yes	No	Yes	Yes: gynoid obesity subcutaneous fat adiposity	Gastrointestinal, biotransformation, HPATGG dysfunction, toxicity, and endocrine evaluations
Yes	Yes	Yes	Yes	Yes: android obesity, visceral adiposity	Therapeutic lifestyle change, nutritional and inflammatory workup, root causes of inflammation associated with weight gain and adiposopathy (e.g., infection, glucose dysregulation, toxins)

Figure 36-1 Assessing body composition by body mass index (BMI), waist circumference, waist-to-hip ratio, and percent fat mass. *BIA,* Bioelectrical impedance analysis; *fat %,* bioelectrical impedance analysis fat percentage; *HPATGG,* hypothalamic–pituitary–adrenal–thyroid–gonadal–gastrointestinal axis; *METSyn,* metabolic syndrome; *overSAT,* high percentage of subcutaneous adipose tissue; *overVAT,* high percentage of visceral adipose tissue; *TLC Nx/Rx,* therapeutic lifestyle change and intervention, nutritional and pharmacologic treatment; *WC,* waist circumference; *WHR,* waist-to-hip ratio. (From Saxena S: Cardiovascular advanced practice module, *Institute for Functional Medicine,* 2012, Federal Way, WA, and Stone PM: Functional nutrition–head to toe. Toolkit, *Institute for Functional Medicine,* 2013, Federal Way, WA.)

Case Study:
Anthropometrics: height, 72 in; weight, 202 lb
BMI: 27.4
Waist circumference: 39 in
Hip circumference: 38 in
Waist-to-hip ratio: 10.02; **waist-to-height ratio:** 0.54
BIA: fat mass, 28.1%; **fat-free mass:** 71.9%
Assessment: android body type, increased abdominal visceral body fat, grade 1 obesity
Treatment: low glycemic impact diet



Case Study:
Anthropometrics: height, 72 in; weight, 182.3 lb
BMI: 24.7
Waist circumference: 33 in
Hip circumference: 37.5 in
Waist-to-hip ratio: 0.88; **waist-to-height ratio:** 0.45
BIA: fat mass, 20.9%; **fat-free mass:** 78.1%

Figure 36-2 Case Study: Case example using sequential bioelectrical impedance analysis (BIA) to follow treatment progression. The patient was a 56-year-old man with hyperlipidemia and erectile dysfunction taking prevastatin and Viagra. BIA was used over the 4-month period of increased exercise, food choice, and quantity intervention to follow anthropometric changes in weight, fat-free mass, and fat mass to confirm that the weight loss was composed of fat mass loss and not loss of muscle mass or total body water. The shift in extracellular fluid to intracellular fluid is considered a healthy sign.

Table 36-8 Physical Examination Findings in the Obese with Associated Comorbidities

System	Condition
Body composition	Monitoring fat and muscle mass with weight, waist circumference, waist-to-hip ratio, BIA, and resting metabolic rate; DEXA assesses bone densitometry and body composition (Heber et al., 1996; Kohlstadt, 2013) Age of onset in adolescence: increased BMI (23-25) strongly associated with obesity in adulthood Age 25-40 yr: increases in BMI associated with worse profile biomarkers later in adulthood
Hydration	Dry mucous membranes, pedal edema, poor skin turgor, dry mouth generally indicative of intracellular dehydration; need corroboration with urine specific gravity Poor hydration is associated with less favorable BIA and alters accuracy of skinfold measurements (Kohlstadt et al., 2013)
Oral cavity	Xerostomia, periodontal disease, tooth decay, amalgam fillings, and odor may indicate barriers to weight reduction, inducing dehydration unfavorable microbiota, inadequate mastication, undermethylation, and insulin resistance (Kohlstadt, 2013)
Neck circumference	Predictor of OSA and severity which is obesogenic (men, >17 in [43 cm]; women, >16 in [41 cm]) (Pinto et al., 2011)
Cardiovascular	Hypertension, CAD, essential hypertension, LVH, CHF, cor pulmonale, obesity-associated cardiomyopathy, accelerated atherosclerosis, pulmonary hypertension of obesity, thromboembolic pulmonary emboli Peripheral vasculature: venous varicosities, thrombophlebitis, lower extremity venous and or lymphatic edema, lower limb circulatory stasis
Pulmonary	Predisposition to respiratory infections, increased bronchial asthma, obesity hypoventilation syndrome (Pickwickian syndrome), dyspnea, OSA, hypoventilation syndrome, Pickwickian syndrome, asthma
Neurologic	Cranial nerve I: olfactory nerve function loss is associated with altered food choices, including oversalting and oversweetening of food (Hirsch and Whitman, 2013; Kohlstadt, 2013) Intracranial hypertension caused by increased abdominal pressure, sleep apnea, and so on Stroke, nerve entrapment (meralgia paresthetica, carpal tunnel syndrome)
Gastrointestinal	Gallbladder disease (cholecystitis, cholelithiasis), NASH, fatty liver infiltration, reflux esophagitis, hernias
Genitourinary	Urinary stress incontinence, nephrotic syndrome, focal glomerulosclerosis, erectile dysfunction
Reproductive	Obstetric and perinatal complications: pregnancy-induced hypertension, increased risk of gestational diabetes, shoulder dystocia, fetal macrosomia, pelvic dystocia Women: anovulation, early puberty, infertility, hyperandrogenism, polycystic ovaries Men: hypogonadotropic hypogonadism
Musculoskeletal	Musculoskeletal: general: abdominal hernias, ventral and inguinal, immobility Musculoskeletal and orthopedic: osteoarthritis of major joints, coxa vera, slipped capital femoral epiphysis, Blount disease, Legg-Calvé-Perthes disease, chronic lumbago Pain with moderate pressure over adult patients' shin bones or ribs: associated with osteomalacia; vitamin D deficiency, which perpetuates insulin resistance; can lower mood and limits physical activity, increasing fall risk (Brady et al., 2013; Holick, 2006; Kimmons et al., 2006; Wicherts et al., 2007)
Integument	Intertrigo (bacterial or fungal), acanthosis nigricans, hirsutism, increased risk of cellulitis and carbuncles, skin tags (epiliths) secondary to insulin resistance, stasis dermatitis, ulcerations, stria distensae (skin stretch mark), stasis pigmentation, venous stasis ulcers
Metabolic and endocrine	Type 2 diabetes mellitus, prediabetes, metabolic syndrome, dyslipidemia
Psychologic	Social stigmatization and depression
Malignant	Associations with endometrial, prostate, colon, breast, gallbladder, and lung cancer
Lifestyle	Sleep duration <5 hr to >8 hr associated with increased visceral and subcutaneous body fat with decreased leptin hormone and increased ghrelin hormone levels
Obesity in women	Being overweight contributes to menstrual disorders, infertility, miscarriage, poor pregnancy outcome, impaired fetal well-being, and type 2 diabetes; changes in sensitivity to insulin may occur Pregnant women who are obese are more at risk for pregnancy-induced hypertension and preeclampsia (Escott-Stump, 2012)
Age of onset	History of rapid weight gain in infancy, childhood, or early puberty, and excessive weight gain in pregnancy increase the risk for obesity (Johnson et al., 2006) Total energy expenditure and physical activity level declines progressively in both overweight and normal weight men and women, falling ≈150 kcal/decade; the thermic effect of food does not change (Roberts and Dallal, 2005)
Obesity in elderly adults	Increasing prevalence along with related macro and micronutrient deficiencies (Flood and Carr, 2004)

BIA, Bioelectrical impedance analysis; *BMI,* body mass index; *CAD,* Coronary artery disease; *CHF,* congestive heart failure; *DEXA,* dual-energy x-ray absorptiometry; *LVH,* left ventricular hypertrophy; *NASH,* nonalcoholic steatohepatitis; *OSA,* obstructive sleep apnea.
Hamby and Griffing, 2013; Kushner and Roth, 2003.

blood sugar, elevated blood pressure, and dyslipidemia. Fat mass disease is associated with stress on the weight-bearing joints, immobility, tissue compression (sleep apnea, gastrointestinal reflux, high blood pressure), and tissue sheer forces (intertrigo) (Allende-Vigo 2010; Bays et al., 2005, 2008; Bays, 2009, 2012; Seger et al., 2013).

Bioelectrical impedance analysis provides additional information on fat-free mass (lean body and muscle mass), extracellular water, and intracellular water. Being able to monitor whether body fat, rather than lean muscle mass, is being lost is a particularly valuable contribution of BIA testing. There is often a lower than predicted metabolic rate

observed in extremely obese individuals (Livingston and Kohlstadt, 2005). This is because muscle caloric burn rate per pound per day is 6 calories for muscle and 2 calories for fat. The coincident loss of muscle and replacement weight fat leads to a 66% decrease in resting burn rate per pound of tissue (Kohlstadt, 2013).

In morbidly and super obese individuals, there is a shift in percentage of body water, and body fat percentage increases. Whereas an adult with a healthy weight is 60% to 65% body water, someone who is extremely obese tends to have a total body water of 35% to 45%. This shift places the obese at an increased vulnerability for volume depletion (dehydration), which is a common problem in obese individuals (Batmanghelidj and Kohlstadt, 2006; Kohlstadt, 2013; Livingston and Kohlstadt, 2005).

Biochemical Indicators

The distribution of fat, percent body fat, and associated muscle mass help the clinician determine which laboratory and biochemical indicators would be most revealing and helpful for determining interventions (see Figure 36-1 and Table 36-9). Using this sorting of fat distribution determined by BMI, waist circumference, waist-to-hip ratio, and bioimpedance analysis, the laboratory tests considered extend beyond the evaluation of simply thyroid function. See Table 36-9 for further clarity on how body fat percent and distribution inform the intervention.

Clinical Indicators

The clinical indicators (see Table 36-8) uncovered during the physical examination of the obese patient help identify comorbidities and physical examination features unique to the patient with android or gynoid obesity caused by adiposopathy or fat mass disease (see Table 36-9). The pathology of cardiovascular, pulmonary, rheumatologic, neurologic, and endocrinologic comorbid disease drives the obesogenic metabolic environment within the patient. The physical examination is a key component to the nutritional evaluation of the obese patient.

Diet and Lifestyle Evaluation

At a minimum, include a food diary in your patient information packet and, preferably, a broader diet and lifestyle assessment to assess your patient's risk of becoming overweight or obese. The diet and lifestyle evaluation should include a diet record from the patient that ranges from 1 to 7 days in length. The diet is evaluated for adequacy of protein; essential fats; and complex carbohydrates, including fiber. The overabundance of any major nutrient or the imbalance of saturated or transaturated fats, simple carbohydrates, or incomplete protein is identified. Also assess whether your patient has adequate intake of water and a wide variety of colorful vegetables and fruits, which are rich in phytonutrients. Assuring that these aspects of the diet are adequate will increase the likelihood of sufficiency of minerals and vitamins.

The diet and lifestyle assessment helps uncover and improve understanding of the obesogenic drivers. During the gathering of the patient history, the antecedents, triggers, and perpetuators combine with the anthropometrics, biochemical indicators, and clinical findings to direct the development of an intervention and its treatment plan.

If possible, make the information packet available so the patient can complete it in advance. You can create a simple 7-day diet and lifestyle assessment form by listing the days of the week across the top and down the left side listing food intake (breakfast, snack, lunch, snack, dinner, optional snack), water intake (cups or ounces), physical activity (time, type), sleep (quality), emotional stress (thoughts and emotions), and one thing patients did for themselves each day that brought them joy. If, however, you use only a food and activity log, include room to note activity for each day of the week and at least 3 days of food intake that includes two weekdays and one weekend or nonwork day because people tend to eat differently when their schedules are more flexible. Have patients indicate the type of activity and length as well as which foods and beverages and how much was consumed.

Below are recommendations for ways to assess each of the key modifiable lifestyle factors that contribute to disease.

Food Diary. Key information you can obtain from the food diary includes whether the patient eats breakfast, snacks at night, or drinks an excessive amount of sugar-sweetened beverages. Skipping breakfast has been associated with increased calories eaten later in the day and with weight gain. Nighttime snacking is a common pattern that you want to fully assess and help curtail. How much soda, juice drinks, 100% fruit juice, or sweetened caffeinated beverages are drunk most days? Drinking your calories through high soda or juice intake is associated with obesity. An easy recommendation that you can make during many office visits is to have your patients stop drinking all sugar-sweetened beverages. It is important to ask about all sugar-sweetened beverages, including soda, sports drinks, juice drinks, and coffee and tea (Han and Powell, 2013) (see Figure 36-1). Table 36-9 reviews key diagnostic nutritional tests that can be considered in weight loss therapy. The calories from these beverages can add up quickly and should not be included on a daily basis.

A food diary can also help determine the quality of the carbohydrates eaten, which may come from foods with a high GI or from sugar-sweetened beverages. There is compelling evidence that carbohydrate quality has important influences on obesity as well as on comorbidities associated with obesity, such as cardiovascular disease, metabolic syndrome, and type 2 diabetes. Dietary fiber is an important determinant of satiety and weight gain and helps protect against hyperlipidemia and hyperglycemia. Vegetables and fruits are excellent sources of fiber and phytonutrients and help protect against cardiovascular disease, diabetes, and cancer. Assess the record for high-GI carbohydrates (see Glycemic Index and Glycemic Load earlier in the chapter). It is common for patients to replace saturated fat with high-GI carbohydrates, which may increase the risk of developing type 2 diabetes and cardiovascular disease. As noted earlier, soft drink consumption is a proven cause of weight gain, which may relate to the lack of satiation provided by these drinks. In large amounts, the fructose contained in these drinks leads to greater adverse metabolic changes than equivalent amounts of glucose (Slyper, 2013).

Another aspect of food intake that can lead to excess weight (not necessarily excess body fat) is the presence of food sensitivities, as measured by elevated IgG antibodies

Table 36-9 Nutritional Diagnostic Tests to Guide Weight Loss Reduction

Testing	Interpretation	Mechanism	Treatment	Relevance to Weight Loss
Albumin (serum)	Low level suggests protein malnutrition	Inadequate intake, malabsorption	Dietary protein, supplemental amino acids, digestive enzymes	Maintain lean body mass, avoid sarcopenia (Kohlstadt, 2008)
C-reactive protein (CRP)	High-sensitivity CRP should be <10 mg/L	Inflammation from various sources, including food allergies, infection, autoimmune issues, and weight reduction	Supplemental fiber, alkaline diet, avoidance of food allergens, multiple vitamin, supplemental curcumin 2-4 g/d	Inflammation exacerbates sarcopenia
Carnitine	Deficiency if low plasma carnitine or elevated urinary adipic, suberic, and ethylmalonic acids	Impaired absorption; decreased synthesis, associated with Fe deficiency, high demand during fat metabolism	L-acetyl carnitine 2 g/day	Fat metabolism increases demand for carnitine; carnitine drop is associated with fatigue in pregnancy; carnitine is needed to transport free fatty acids into the mitochondria
Carotenes	α-Carotene, 9-101 mcg/L β-Carotene, 42-373 mcg/L, lutein, 50-250 mcg/L, zeaxanthin, 8-80 mcg/L	Nutrient deficiencies (i.e., Zn) and medications can interfere with synthesis	Green leafy vegetables; cooking with spices, phytonutrient-rich supplements	Obesity is a risk factor for reduced fat-soluble nutrients
Coenzyme Q10 (CoQ10)	Low serum CoQ10 signifies depletion of tissue CoQ10; high levels of pyruvate, succinate, fumarate, and malate in the urine suggest insufficient CoQ10 to meet energy needs	Nutrient deficiencies and medications can interfere with synthesis	Supplemental CoQ10 up to 300 mg/day	Fat metabolism increases demand for CoQ10
Fatty acid profile	RBC fatty acid profiles can identify omega-3, omega-6, trans, very long chain, and saturated fatty acids	Skewed dietary intake; inappropriate supplement use; reduced delta 6 desaturase enzyme activity; fat malabsorption	Balance mono- and polyunsaturated fatty acids with diet and supplements	Guides strategic use of dietary and supplemental fatty acids for weight reduction; fatty acid imbalances may stem from prior medical or surgical treatment for obesity
Homocysteine	Elevation signifies deficiency in vitamin B_{12}, folate, vitamin B_6, or interactive insufficiencies of riboflavin, niacin, and thiamine	Impaired absorption and inadequate intake of the B vitamins (B_1, B_2, B_3, B_6, B_{12}, folate)	Supplementation of methyl folate, folacin, and vitamin B_{12} can improve methylation	Maintain energy metabolism and harvest of calories through intermediary metabolism of carbohydrates and proteins
Iron studies	Low ferritin and percent saturation ≤15 suggest iron-deficient erythropoiesis even when HCT is normal; elevation suggests hemochromatosis	Deficiency from impaired absorption; inadequate intake excess from primary hemochromatosis, a nutrient–gene interaction	Treat deficiency with supplemental minerals, dietary iron, and cooking with an iron skillet with citrus; hemochromatosis is managed medically and by minimizing dietary iron intake	Deficiency tends to coexist with other mineral deficiencies, exacerbated by some diets; iron, zinc, and chromium alter food preferences; hemochromatosis contributes to the inflammatory component of obesity
Magnesium	RBC magnesium below laboratory-specified range	Impaired absorption, inadequate dietary intake, competitive absorption with calcium	Increase fruit and vegetable intake; supplement calcium and magnesium in a ratio of 2:1	Optimizing magnesium supports hydration, fat metabolism, and extracellular–intracellular fluid flux
Triglycerides	Fasting values >100 mg/dL or even 75 mg/dL suggest impaired fat metabolism	Steatosis, increased oxidative stress, consumption of synthetic fats, and refined carbohydrates	Diet low in refined carbohydrates and no trans or highly processed fats; liver support; supplemental L carnitine 2 g/d	Elevated triglycerides represent a treatable impairment in fat metabolism; also may indicate increased intestinal production of lipids from simple carbohydrates

Continued on following page

Table 36-9 Nutritional Diagnostic Tests to Guide Weight Loss Reduction (Continued)

Testing	Interpretation	Mechanism	Treatment	Relevance to Weight Loss
Vitamin D	25-OH vitamin D: 30-50 ng/mL throughout the year <10 ng/mL deficient, <30 ng/mL insufficient, <36 ng/mL associated with insulin resistance, <50 ng/mL associated with double the solid cancer incidence; when associated with a high normal or high 1,25–DHCC, associated with underlying infection	Low vitamin D associated with decreased innate immunity function, increased insulin resistance; impaired absorption is associated with certain medications, sunblock use, or inadequate outdoor sunlight exposure Obesity increases the demand for preactivated vitamin D	Food rich in vitamin D; augment digestive enzymes if postsurgical or pancreatic insufficiency; consider supplementation as needed to address deficiency states Dietary sources include cold water fish, dairy (if supplemented), mushrooms (ergocalciferol)	Obesity is associated with lower serum levels of vitamin D and plays a role in the mechanism of hyperparathyroidism and bone loss in obesity; low vitamin D levels are associated with increased musculoskeletal pain, increased fall risk, and increased insulin resistance Optimizing vitamin D may facilitate weight loss
Vitamin B_{12}	Serum concentration <540 mg/mL and elevated urine methyl malonate, homocysteine, and mean cell volume suggest deficiency	Impaired absorption partly from drug interactions; reduced intake from some diets Impaired absorption caused by age-related decrease	Oral, sublingual, or IM supplementation	Maintain energy metabolism
Uric acid	Serum uric acid >5.9 mg/dL needs further evaluation	If increased TG, LDL, homocysteine, platelets >385,000 consider atherosclerotic disease	Quercetin and folic acid inhibit xanthine oxidase	Consider low-purine diet; address oxidative stress; look for confounders (fructose intake >100 g/day) associated with metabolic syndrome; chronic inflammation promotes weight gain via insulin resistance
Hemoglobin A_{1c}	<5.4, good; 5.5-6.0, increased oxidative stress, age; >6.0, insulin resistance; and >6.5, diabetes	Low–glycemic index diet change; consider adequacy of protein intake; evaluate root causes	Consider adequacy of vitamin D; evaluate and treat root pathology, oral hypoglycemia, and insulin if necessary Low–glycemic index foods; reduce simple sugars; increase exercise	Elevated HgA_{1c} as an advanced glycosylation endproduct is a marker of prolonged oxidative stress and can decrease as BMI drops into normal range if diabetes is under control Hypertriglyceridemia artificially raises HgA_{1c} readings (Xavier and Carmichael, 2013)
Thyroid-stimulating hormone	>2 mIU/L requires further evaluation	Lowered metabolic rate and marked decrease in exercise tolerance	Consider appropriate treatments for diminished thyroid function; nutritional evaluation of zinc, iodine, selenium, and protein adequacy should be considered	Maintain optimal metabolic rate; reduce myalgias, fatigue, and gastrointestinal symptoms
Urinalysis	Specific gravity >1.025 suggests inadequate hydration; the presence of protein may require additional evaluation	Medical barriers to adequate hydration may be present; urinary protein losses can suggest chronic kidney disease	Address medical barriers to hydration; diet may need to be modified if chronic kidney disease	Hydration facilitates weight reduction; urine protein loss may require modifying the patient's diet

1,25-DHCC, 1,25-Dihydroxycholecalciferol; *BMI,* body mass index; *HCT,* hematocrit. *IM,* intramuscular; *LDL,* low-density lipoprotein; *RBC,* red blood cell; *TG,* triglyceride.
Adapted from Escott-Stump, 2012; Kohlstadt, 2013; Lysen et al., 2012; Xavier and Carmichael, 2013; Cunningham et al., 2005.

against foods. Elevated levels of food sensitivities have been associated with obesity in children. Obese children have been found to have higher serum C-reactive protein values, more IgG food sensitivities, and higher carotid intimal thickness on ultrasonography (Wilders-Truschnig et al., 2008). Could it be that the inflammation resulting from the immune response is a trigger or perpetuator in the development of obesity? A food diary and careful questioning of the patient can detect gastrointestinal dysfunction. Sometimes the patient can associate symptoms such as bloating, gas, cramping, or increased motility to particular foods, but often the effects of food sensitivities are delayed and appear 24 to 48 hours after ingesting the problem food. In the authors' opinion, there is no one test that provides unequivocal identification of foods that cause delayed hypersensitivity, but many practitioners have found IgG4 testing, mediator release testing, and the antigen leukocyte cellular antibody test helpful in identifying problem foods. Often an elimination diet is the best test to determine if food sensitivities or allergies are present.

As discussed earlier, modifiable lifestyle factors, including sleep and relaxation, exercise and movement, and stress and relationships, need to be assessed as well to determine the causes of the individual patient's weight gain.

Intervention

Key Points

- The 5 A's of obesity treatment provide a useful framework for approaching long-term weight management.
- Lifestyle therapy offers numerous opportunities to engage the patient and to personalize the intervention.
- Specific modifiable lifestyle factors are addressed within the intervention, such as food intake, movement and physical activity, sleep, psychosocial stress, toxin exposure, the microbiome, pharmacotherapy, and surgery.

How best to counsel a patient about long-term weight management is as individual as each patient. Many patients are uncomfortable discussing their weight. They may be ashamed of their size if they believe that it reflects weak self-control. Often speaking with patients about the role of a healthy weight in overall health as simply another valuable component of a multipronged approach to being healthy in the same way that not smoking, regular seatbelt use, and washing hands regularly help protect one's health can be nonthreatening. Asking patients whether they would like to discuss weight management also helps to establish a nonjudgmental environment in which patients will feel comfortable voicing their concerns. Ask patients what has worked for them in the past. Help patients identify their strengths and discuss ways to build on these strengths from a weight management perspective. Alexander and colleagues (2011) have proposed the 5A's of obesity treatment as a recommended framework for approaching weight management with overweight and obese patients (Table 36-10).

LIFESTYLE THERAPY

Interventions for overweight and obese patients are tailored to each patient's needs and include lifestyle therapy, either alone or in combination with pharmacotherapy, and when appropriate, bariatric surgery. Lifestyle therapy, including behavioral change, is the cornerstone of evidence-based weight control. Using a slow, steady approach, as many of the modifiable lifestyle factors as possible are addressed so that patients come to adopt health-promoting habits and eliminate health-detracting ones. This process can be challenging for patients and, ideally, the physician and patient will work together as partners in this endeavor. The physician or other team members supply the guidance, tools, and encouragement, and the patient supplies the long-term commitment to achieving a healthy weight. Health care practitioner support and peer group support are powerful modalities for effecting behavioral change.

Table 36-10 The 5 A's of Obesity Treatment

Ask	Ask for permission to discuss body weight and explore readiness for change.
Assess	Assess body mass index, waist circumference, and obesity stage; explore drivers and complications of excess weight.
Advise	Advise the patient about the health risks of obesity, the benefits of modest weight loss, the need for a long-term strategy, and treatment options.
Agree	Agree on realistic weight-loss expectations, targets, behavioral changes, and specific details of the treatment plan.
Arrange or assist	Assist in identifying and addressing barriers, provide resources, assist in finding and consulting with appropriate providers, and arrange regular follow-up.

Adapted from Alexander SC, Cox ME, Boling et al. Do the five A's work when physicians counsel about weight loss? *Fam Med*. 2011;43:179-184.

The most successful treatments for obesity incorporate nutrition professionals in the care and counseling of the patient. The diet and lifestyle evaluations are most frequently completed by a nutrition professional, lifestyle educator, or counselor involved in the team approach to helping the obese patient successfully intervene in his or her condition. When the physician partners with the nutritionist and other treatment team members, the patient is more successful in addressing the multifactorial aspects of obesity (Table 36-11).

DIET

A health-promoting diet is an integral part of weight management. Numerous diets are available; the challenge is to select one that meets the individual nutritional needs and food preferences of each patient. In general, the food plan should include adequate quantity (i.e., sufficient calories) and quality, which includes macronutrients (protein, fats, and carbohydrates) and micronutrients (minerals, vitamins, and phytonutrients). Basic principles of a health-promoting diet include consuming sufficient calories to support a healthy weight; eating a variety of foods to maximize nutritional value; meeting macronutrient needs with food selections of high nutritional value; consuming at least one and preferably two servings of each of the six categories of richly colored foods each day (6-10 total servings/day); and drinking adequate amounts of clean, filtered water. Protein content should range from 10% to 25% of calories, fats 30%, and carbohydrates 40% to 55%. A diet high in fiber and low in sodium is commonly recommended as part of a health-promoting eating plan. For starters, however, virtually all of these details can be rolled into the following simple guidelines: become familiar with serving size so as not to overeat; select whole foods rather than processed foods; choose plant foods over animal foods as often as possible; and drink clean, filtered water (measured in ounces) equal to approximately half your desirable weight (in pounds).

For patients who meet criteria for dysmetabolic syndrome or android obesity, a low glycemic impact diet has been show to result in more weight loss (Pittas et al., 2005) and improvement in blood sugar, insulin, and lipids. In this population, limitation of refined carbohydrates is especially important.

CALCULATING IDEAL WEIGHT

We caution against using the life insurance tables of weight for height. These values are observational and reflect what

Table 36-11 Interventions

Dietary	Moderately energy-deficit diets Low-calorie diets Very-low-calorie diets Low-carbohydrate, high-protein diets Low-fat, low-energy-dense diets Low–glycemic index diets Balanced-deficit/portion-control diets Meal replacement diets	Requires a nutrition professional partnering with the patient and medical provider
Physical activity	Moderate intensity: 30 min 5 days a wk Vigorous activity: 30 min 3 days a wk (>6 MET) >200 min a wk (moderate exercise) 90 to 150 min a wk (vigorous activity) Resistance training	Often requires partnering for accountability and persistent change
Behavior therapy	Readiness to change Setting goals Reliable support system Building in maintenance Making gradual changes Keeping records Making it enjoyable Being flexible	Often requires counselors, lifestyle educators, awareness and desire to change health trajectory
Pharmacologic	Orlistat Phentermine–topiramate ER Lorcaserin	Requires monitoring from informed physician
Surgical	LAGB Vertical sleeve gastrectomy Roux-en-Y gastric bypass Distal-roux-en-Y gastric bypass Duodenal switch with biliopancreatic diversion Jejunoileal bypass	Requires surgical and bariatric specialty BMI >40 kg/m^2 BMI 35-40 kg/m^2 with significant obesity-related comorbidities such as hypertension or type 2 diabetes Unsuccessful attempt at weight loss by nonoperative means Clearance by dietitian and mental health professional No contraindications for surgery

BMI, Body mass index; *LAGB,* laparoscopic adjustable gastric band; *MET,* metabolic equivalent.
Adapted from Cheskin and Poddar, 2014.

the people surveyed actually weighed rather than derived through research studies of what desirable weight for height would be. Typically, these tables overestimate desirable weight. Instead, use the Hamwi formula, which is a quick method that has been in use clinically since it was introduced in 1964 by the American Diabetes Association (Hamwi, 1964). It is a handy way to get an estimate of desirable weight during a brief office visit. For women, assign 100 lb to the first 60 in and 5 lb for each additional inch of height (for those under 60 inches, subtract 2.5 lb for each inch under 60 in). This calculation will yield an approximate ideal weight. Adjust this weight to a desirable weight by discussing with the patient what she believes has been a comfortable weight for her in the past, her goal weight (which may be much lower than her comfortable weight), and your clinical judgment. If she is 64 in and 200 lb and wants to get down to 140 lb, talk with her about the advisability of losing 1 to 2 lb per week for a healthy approach and to increase the success for long-term maintenance of weight lost and then stage the weight loss using 1 to 2 lb per week weight loss. Perhaps discuss a first goal of losing 20 lb and be sure she understands that will take approximately 3 months. To estimate desirable weight for men, use 106 lb for the first 60 inches and 6 lb for each additional inch. These are estimates for medium frames and can be adjusted ±10% to accommodate small or large frames as needed.

CALCULATING CALORIES

To calculate an appropriate calorie level, the Mifflin–St. Jeor modification of the Harris-Benedict equation (Mifflin et al., 1990) is commonly used because it takes into account age, sex, and activity level (including metabolic needs resulting from medical conditions). It does, however, underestimate calories needed for muscular individuals and overestimates calories for obese individuals. For office visit purposes of arriving at a reasonably good estimate of calorie levels, use the rule of thumb of 10 calories per pound of desirable weight as being the least amount of calories to recommend to keep metabolism humming along. A range of 12 to 13 calories per pound is appropriate for active women and 13 to 15 calories per pound for an active man. This approach guards against recommending calorie levels below 1200 for women and below 1500 for men. Again, the nutrition professional will make any needed adjustments and develop a longer-term plan.

Address weight and healthy eating at each office visit, even if only briefly. Success with weight management is associated with the patient making behavioral changes in small steps. For most physicians, the goals will be to point the patient in the right direction; provide basic guidelines of healthy eating (and physical activity); and refer the patient to a nutrition professional who can personalize the diet to the patient's weight loss needs, comorbid conditions, food preferences, economic status, family requirements

Table 36-12 Centers for Disease Control and Prevention's Physical Activity Guidelines for Americans

Age	Duration and Frequency (Total Time Includes All Three Types of Activity)	Weekly Time (Includes All Three Types of Activities)		
		Aerobic Activity*	Muscle-Strengthening Activities*	Bone-Strengthening Activities*
Children, 6-17 yr	60 min at least 3 days per wk	Moderate or vigorous	Push-ups, gymnastics	Jumping rope, running
Adults, 18-64 yr	Regular activity throughout the week rather than as a single session	150 min per wk of moderate activity, 75 min of vigorous activity, or an equivalent mix of moderate and vigorous activity	2 or more days per week	Not specifically addressed
Older adults, ≥65 yr	Regular activity throughout the week rather than as a single session	150 min per wk of moderate activity, 75 min of vigorous activity, or an equivalent mix of moderate and vigorous activity	2 or more days per week	Not specifically addressed

*Examples of *moderate activities* include brisk walking, water aerobics, riding a bike on level ground or with few hills, playing doubles tennis, pushing a lawn mower, and dancing. Examples of *vigorous activities* include running, swimming laps, riding a bike fast or on hills, playing singles tennis, and playing basketball. *Muscle-strengthening activities* work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms). Examples include lifting weights (machines or hand weights), working with resistance bands, exercises that use your body for resistance (sit-ups, push-ups, pull-ups, gymnastics), heavy gardening (digging, shoveling), climbing wall, and yoga. Bone-strengthening activities include hopping, skipping, jumping, running, jumping rope, tennis, basketball, and gymnastics

From Centers for Disease Control and Prevention. http://www.cdc.gov/physicalactivity/everyone/guidelines/children.html.

(e.g., whether there are children, elders, or other family members with specific health requirements in the home), and overall lifestyle. It is common today for patients not to be skilled in planning, shopping for, and preparing healthy meals. Many need education concerning basic nutrition and the role of food in health. The nutrition professional will be able to address each of these issues and help the patient plan meals appropriate to his or her needs.

If you have reason to believe the patient has food sensitivities, an elimination diet is an inexpensive way to help identify which foods are problematic for the patient. This type of food plan typically eliminates the most common food sensitivities (e.g., dairy, gluten, nuts, citrus, seafood, beef) and environmental toxins for a 21-day period. Each eliminated food category is then added back systematically and the patient's response noted. After suspect foods have been identified, these foods can be removed from the diet or rotated so they are infrequently eaten. If symptoms persist with a food or food grouping, these foods are eliminated for a longer period (e.g., 6-9 months), and reintroduction is again tested and recorded by the patient. If no symptoms are noted, these foods are added back to the diet. If symptoms are noted, the foods are eliminated and may need to be avoided indefinitely.

MOVEMENT AND PHYSICAL ACTIVITY

Physical activity is a key component of a healthy lifestyle for reasons ranging from stress reduction to decreased risk of cardiovascular disease. It is also an important component of preventing and treating overweight and obesity. Movement should be a normal part of life, from a formal exercise program to becoming more physically active in daily routines. Exercise itself burns calories but also promotes the development of lean muscle mass that in turn can increase the amount of calories used even when we are at rest. In general, the goal should be 30 minutes of moderately vigorous physical activity most days of the week. To promote weight loss, a goal of 60 minutes per day may be more appropriate and, to maintain weight loss, up to 90 minutes a day may be necessary. A popular program promoting physical activity encourages people to walk 10,000 steps each day or at least an initial increase of 2000 steps over baseline. A pedometer is a great way for patients to track their progress. The National Weight Control Registry, which was started in 1993, is the longest ongoing study of individuals who have lost at least 30 lb and have kept it off for a minimum of 1 year. Registry participants who have been successful at weight loss maintenance report exercising at least 1 hour per day every day (Phelan et al., 2007).

Physical activity has three key components: aerobic activity, muscle strengthening (resistance) activity, and bone-strengthening activity. Table 36-12 shows guidelines from the CDC for duration and frequency for physical activity and recommendations for the types of activities to engage in while physically active.

In addition to traditional aerobic and resistance exercise, many people are turning to yoga as a way to strengthen muscles and bones and to combat stress, improve feelings of self-worth, and develop a sense of community with others. See previous discussion on yoga under the heading Environmental Factors.

SLEEP

As discussed earlier, too little sleep, too much sleep, and poor-quality sleep in adults and children have been associated with weight gain, overweight, and obesity (Liu et al., 2013; Mesarwi et al., 2013; Xiao et al., 2013).

The amount of sleep needed varies with the individual. Recommendations for the amount of sleep needed per day are typically given by age and are intended to be guidelines only. The National Sleep Foundation's recommendations for sleep durations across the lifespan are shown in Table 36-13.

Many patients are counseled to lose weight to help their sleep-disordered breathing. Although this approach can be helpful, it is important to remember that for some patients, sleep apnea is the cause or at least a contributing factor for their weight gain. As a result, these patients will have a difficult time losing weight if they have untreated sleep apnea.

Table 36-13 National Sleep Foundation Recommendations for Sleep Durations across the Lifespan

Age	Duration (hr/day)	Schedule
Infants, 1-2 mo	10.5-18	As needed (irregular schedule)
Infants, 3-11 mo	9-12	Naps of 0.5-2 hours
Toddlers, 1-3 yr	12-14	Nap of 1-3 hours
Preschoolers, 3-5 yr	11-12	Nap up to 5 years
School-age children, 5-10 yr	10-11	Nighttime
Teens, 10-17 yr	8.5-9.25	Nighttime
Adults, ≥18 yr	7-9	Nighttime

Adapted from information provided by the National Sleep Foundation. http://www.sleepfoundation.org.

A referral to a sleep specialist is often necessary to help patients reach their goals.

Additionally, the discussion of good sleep hygiene should be included in the office visit. Remind patients to stop work and turn off their computers, phones, and TV an hour before bedtime and keep to a similar schedule to go to bed and to get up. Yoga is being examined as a beneficial modality to improve sleep quality (Afonso et al., 2012; Innes and Selfe, 2012; Taibi and Vitiello, 2011). Add in relaxation exercises such as breathing, yoga, or a calming bath before bedtime to help quiet the mind and body and assist with the transition to sleep.

PSYCHOSOCIAL STRESS

Many patients would benefit from assistance with identifying their stressors, reducing the intensity and number of stressors experienced, learning skills for coping with stressful situations, and changing their maladaptive perceptions. As with improving nutrition, the behavioral changes needed require a slow, steady approach to changing long-term perceptions and behaviors. Most patients are likely to be more successful making these changes for the long term if they are able to work with a behavioral medicine professional, either individually or in a group setting. If you do not have such a professional available to your practice, either as a member of the health care team or on contract, there may be hospital- or community-based programs that host stress management programs. These programs can be quite effective when the patient is at the action stage of the readiness to change continuum.

Mindfulness programs are showing promise for long-term weight management as well as stress reduction. A mindful approach to each of the modifiable lifestyle factors can help overweight and obese patients identify the root cause of their excess weight and develop effective strategies for building resiliency in multiple areas of their lives. The mindfulness approach to behavior change originated in 1985 at the University of Massachusetts Medical Center under the guidance of Jon Kabat-Zinn. Mindfulness means paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally. Mindfulness has been used successfully for therapeutic applications for more than 30 years. Among the better researched mindfulness programs are mindfulness-based stress reduction (MBSR) (Kabat-Zinn et al., 1985), mindfulness-based cognitive therapy (MBCT) developed by Segal and colleagues (Bieling et al., 2012), and mindfulness-based eating (MB-EAT) (Kristeller and Wolever, 2011).

In a recent overview, Kabat-Zinn and colleagues discuss the current state of MBSR and the neuroscience underlying mindfulness (Paulson et al., 2013). The MBSR program was adapted by Zindel Segal, Mark Williams, and John Teasdale to develop a MBCT program that focuses on thoughts and emotions, particularly in reference to recurring depression and unhappiness. The approach has been incorporated into the clinical guidelines established by the American Psychiatric Association (2000). Although rooted in the Buddhist philosophy, mindfulness programs have been carefully developed as secular programs designed to be acceptable to everyone, regardless of religious orientation.

As with many emerging modalities, mindfulness-based programs originally lacked strong scientific documentation for their efficacy. However, more recently, the studies have used rigorous scientific methodology and integrated the latest in understanding the neuroscience principles that underlie mindfulness. In a review of the current status of mindfulness programs, Marchand (2012) reviewed the studies conducted to date and concluded that the research was of very high quality and published in journals with very high impact factors. Mindfulness approaches singled out as particularly efficacious included conditions commonly seen in primary care, such as depression, anxiety, and pain.

More recently, the field of positive psychology has emerged, founded by Martin Seligman at the University of Pennsylvania (Seligman and Csikszentmihalyi, 2000). This approach came from the realization that the field of psychology focused primarily on what was wrong, identifying and repairing damage to human functioning within a disease model, rather than on what made individuals and communities thrive and flourish. Seligman and his colleagues have worked to turn this orientation around and created a strong movement within academia and clinical practice. Clinicians are particularly subject to focusing on what's wrong as patients tend to come to them when they have a problem. Rather than asking, "What are your concerns?" try asking, "What's going well for you today (or in your life)?" Simple changes such as this one change the tenor of the physician–patient interaction. Focus on what works. Similarly, identify positive psychology-based programs in your community that can assist patients in becoming more positive in spite of their medical challenges.

The physician should also encourage patients to rethink their relationships with themselves and others. Are they comfortable with themselves? Are they able to tap into and trust their own inner wisdom? Do they feel worthy and able to set aside time each day to do one thing that brings them joy? Do they have a strong social support network? If not, what is one thing they could do today that would begin to strengthen existing relationships or develop a new one? Again, mindfulness practice can help significantly in developing relationships with oneself and others. You can find helpful resources at Dr. Seligman's website (http://www.pursuit-of-happiness.org) and the Wholebeing Institute (http://www.wholebeinginstitute.com).

ENVIRONMENTAL TOXIN EXPOSURE

As discussed previously, the environment presents numerous toxins that can enter our bodies through the food we eat, the water we drink, and the air we breathe. Toxins are potential triggers for harmful effects within the body. Help patients identify the sources of potential toxins and ways to eliminate them. In parallel, consider ways to lower the level of toxins that already exists within the patient. Here, nutrition is key. The detoxification and biotransformation process that occurs in the gut and the liver is dependent on nutrients as cofactors for the various reactions. If you are able to assess whether the patient has one or more genetic variants in the phase I cytochrome P450s (*CYP* genes) or phase II glutathione-S-transferase (*GST)* or N-acetyltransferase (*NAT*) genes, use nutrition therapy to compensate for any genetic limitations that in turn affect activity of the key biotransformation enzymes coded for by these gene variants. Use the cruciferous (cabbage family) vegetables to upregulate other GST genes that are unimpaired. Examples of appropriate foods are broccoli, Brussels sprouts, cabbage, greens (e.g., beet, collard, kale, mustard, turnip), and horseradish root.

MICROBIOME

Although it is not yet clear whether the intestinal microbiome plays a significant role in the risk of becoming overweight or obese, it is becoming clear that the human microbiome does contribute to our overall health status. Clues that an overweight or obese patient's microbiome may be unbalanced include gastrointestinal distress, such as gas, bloating, cramping, or motility issues, and a strong history of antibiotic use. Promoting a healthy microbiome through attention to sufficiency of both prebiotics and probiotics would seem to be prudent. Microorganisms enter the digestive tract primarily through the food we eat. Whether the overall microbial composition is pathogenic or beneficial depends in large part on the types of foods eaten. Consuming fermented foods that contain live active cultures is one approach. Examples of such foods include various dairy foods (yogurts, kefir) and nondairy foods (fermented soy, kim chi, natto, miso, sauerkraut, tempeh, and various pickled vegetables). How much of a food containing live active cultures will be needed depends on the patient's beginning microbiome, but a serving a day can be helpful for maintaining a healthy microbial community in the gut. When it is clear that the patient needs to eliminate pathogenic organisms and recolonize the gut with beneficial ones, it is typically more efficient to use a concentrated form of live active cultures, called a "probiotic," available in dietary supplement form. A probiotic will provide a higher titer of microorganisms and appears to colonize the gut more quickly than most food sources. Probiotics come in liquid and capsule forms and may or may not need to be refrigerated, depending on the brand selected. Also depending on the brand, products can be obtained that are dairy free and do not contain ingredients such as wheat, gluten, soy, egg, peanuts, tree nuts, fish, crustacean shellfish, colors, artificial sweeteners, artificial flavors, or preservatives for patients with food sensitivities. A probiotic should contain titers in the billions of organisms per serving. All of this information can be found on the Dietary Supplement Facts panel on the product. These live organisms thrive on soluble fiber, which is often referred to as a "prebiotic." One or more prebiotic ingredients may be included in the probiotic, but they can also be obtained through a health-promoting diet that includes daily servings of foods such as fruit, vegetables, legumes, and grains.

Caution your patients that they may initially experience some gas and bloating as the microbial population expands within the digestive tract but that the situation will usually fade away within 1 week or so. Allow approximately 1 month for a healthy microbiome to become established and then cut back on the therapy. Daily use of live active cultures of probiotics can be continued because this practice appears to have no known adverse effects. Alternatively, patients may wish to reseed their guts periodically or after antibiotic use with the same protocol they used initially to support the ongoing health of their gut microbiome.

INTERVENING WITH OUR PEDIATRIC POPULATION

Of increasing concern is the growing excessive weight in children. Research shows that children who are obese or overweight rate their well-being as similar to that of children with cancer. Helping our families with prevention of weight gain is of utmost importance. The American Heart Association recently analyzed NHANES data and discovered that fewer than 50% of our adolescents exhibited more than five of seven ideal cardiovascular markers. Markers analyzed included blood pressure, blood sugar, cholesterol, level of physical activity, weight, use of tobacco, and health of their diet (Shay et al., 2013). Poor diet and lack of physical activity in adolescents increases their risk of obesity throughout their lives. Prevention is key, and a family physician is the ideal person to help our children get set up for a healthy life. A good resource for families is *Ending the Food Fight* by David Ludwig, MD, PhD. It is important that we encourage parents to act as good role models and that the family become active together.

In an infant, breastfeeding should be encouraged up to the age of 1 year. Restriction or elimination of sweetened beverages such as soft drinks and sports drinks can greatly reduce caloric consumption in children. The American Academy of Pediatrics (AAP) recommends that even 100% fruit juices be limited to 4 to 6 oz daily for children age 1 to 6 years.

For children age 2 to 5 years, whether they are overweight or obese, the goal is weight maintenance and not weight loss. They will have improvement in their BMI as they grow taller. For overweight children between the ages of 6 and 11 years old, the goal is also weight maintenance. If they meet the criteria for obesity, the goal is 1 lb of weight loss every 2 weeks. For overweight or obese children between the ages of 12 and 18, up to 2 lb of weight loss per month is an acceptable goal (Rao, 2008). It is important to focus on long-term behavioral patterns and lifestyle change with a slow, steady weight loss that can be maintained. Healthy lifestyle modification should be the goal. Overly restrictive diets have the potential of interfering with growth rate, bone mineralization, and menstruation. For a child with a BMI above the 95th percentile (obesity), a more structured

and aggressive approach may be appropriate. Many children and families benefit from working with nutrition professionals. It is very important that the whole family is involved in the lifestyle change to prevent the overweight child from feeling uncomfortable. When the whole family focuses on eating more vegetables and incorporating 60 minutes of exercise every day, it is more likely that the child will be successful. Small, specific, measurable goals will make everyone more successful.

Also encourage parents to make meal time be family time, a time when the family gathers to eat together without distractions, such as television or electronic devices. This practice can help to improve the nutritional status of parents and children alike, encourages interpersonal connections among family members, and provides space for each member to share his or her successes and concerns. Establishing a positive environment is essential for many reasons, including optimal digestion as well as providing a safe space for children to express their concerns and feel heard. Avoiding squabbles over the child's food choices is essential to preserving the positive environment sought. Table 36-14 provides meal time guidelines for parents and children that can promote harmony along with good nutrition.

Prevention is key and can be implemented in every primary care office. Encourage your families to remember the 5-2-1-0 rule recommended by the AAP as part of the White House Obesity Initiative:

- Five servings of fruits and vegetables per day
- Two hours or less of screen time per day
- One hour of physical activity per day
- Zero sweetened beverages per day

The AAP provides prescription forms for the 5-2-1-0 program for use in the clinic (http://www.aap.org/en-us/professional-resources/practice-support/Patient-Management/Pages/Healthy-Active-Living-Prescriptions.aspx).

Table 36-14 A Suggested Division of Responsibility at Meal Time

3 Ps for parents	1. Plan healthy meals and snacks. Have healthy food options in the home. 2. Prepare and serve meals. 3. Provide support so your child can make healthy choices.
3 Cs for the children	1. Choose to eat or not. The child chooses whether to eat the healthy meal the parent has prepared and does not have the option to eat other foods not served. 2. Choose what to eat from what is served. It is healthier for the child to choose, and often the child will take a smaller portion than the parent would serve. 3. Choose how much to eat. The child eats until full. The parent should not instruct the child to clean the plate or restrict the quantity of food.

Adapted from Dunlop A, Blount B. Childhood obesity: management. FP Audio 405 (AAFP). Feb 2013.

Weight loss targets depend on many factors, such as the age of the patient and his or her health status. Even small amounts of weight loss can have a profound impact on a patient's health. In multiple studies, 5% to 10% of weight loss has been associated with a reversal of metabolic syndrome, type 2 diabetes, heart disease, and cancer (Liebermeister, 2003). This is important when counseling patients to make changes. When obesity is approached nonjudgmentally from the perspective of health risk, patients may be more accepting of the need to change and more willing to partner with the physician in addressing the problem. A patient does not need to lose weight to reach a normal BMI in order to achieve the health benefits. It also may not be possible for some patients to achieve a normal BMI. That does not mean that they cannot be successful. Have many markers to follow your patient outside of weight, including waist circumference, fasting blood glucose, blood pressure, fasting insulin and triglyceride levels as well as their energy level and how clothes fit for them. If we just focus on weight, patients may feel that they failed if the scale does not decrease enough, when in fact they may have made substantial changes in biomarkers and health risk. What we eat and how active we are is often more important than the amount we weigh. Include more markers to follow so you can motivate your patients with their improvements. Readiness to change should be addressed, and addressing barriers to success is key in weight loss and maintenance. Barriers may include emotional factors (stress, depression) or time constraints that limit exercise or proper food preparation. A support system can be helpful for someone attempting weight loss, including friends, a spouse, or an organized program put together by a local nutritionist.

WHEN LIFESTYLE THERAPY IS NOT SUFFICIENT

Treatment interventions of adult patients with overweight or obesity as a disease are multifactorial depending on the underlying causes and the timeline of weight excess onset. Patients are weighed every day in clinic, and certain weight markers should trigger nutrition and lifestyle counseling and intervention (Table 36-15). For the best results, the interventions should include many aspects of personal lifestyle: nutrition, physical activity, behavior therapy, pharmacotherapy, and, in certain cases, bariatric surgery. The pharmacologic and bariatric treatments for obesity are discussed here.

Pharmacotherapy

Adding weight loss medication to lifestyle counseling increases average weight loss (Carvajal et al., 2013; Garvey et al., 2012), but they have been approved for only short-term use. Until the mid 1990s, diet, physical activity, and behavior modifications were the key components of a weight loss program, but the pharmacotherapy option was added as the understanding of the metabolic risks of disease that occurred when the BMI was greater than 27 (Seagle et al., 2013). Many medications have appeared on the market and have been subsequently withdrawn because of side effects. Three classes of medications continue to be available in the United States approved by the U.S. Food and Drug Administration: (1) decreasing fat digestion and absorption (e.g., Orlistat, a gastric and pancreatic lipase

Table 36-15 Nutritional Biomarkers to Check before Bariatric Surgery, 6 Months after Surgery, then Annually

Nutrient	Biomarker	Primary Symptoms/Signs
Thiamin (vitamin B_1)	Serum thiamin	Ophthalmoplegia, nystagmus, ataxia, rapid vision loss, Wernicke encephalopathy, peripheral neuropathy with proximal weakness
Folate	RBC folate, homocysteine	Megaloblastic anemia, glossitis
Vitamin B_{12}	Serum vitamin B_{12}, methylmalonic acid	Megaloblastic anemia, neuropathy, memory loss, vision loss, darkening of the skin, decreased vibratory and position sense
Iron	Serum ferritin, TIBC, CBC	Microcytic anemia, fatigue, pallor, koilonychias, glossitis
Vitamin D	25-OH vitamin D, calcium, phosphorus, parathyroid hormone	Decreased bone density, secondary hyperparathyroidism, tender anterior tibia, increased inflammation, periodontal disease
Protein	Serum albumin, plasma amino acids	Edema, excessive alopecia, poor wound healing, sarcopenia, neurotransmitter inadequacy, poor biotransformation
Vitamin A	Plasma retinol	Reduced night vision, hyperkeratosis pilaris, poor immune function
Vitamin E	Plasma α-tocopherol	Neuropathy, ataxia
Vitamin K	PT, serum uncarboxylated osteocalcin	Bleeding tendency, easy bruising, osteoporosis

CBC, Complete blood count; *PT,* prothrombin time; *TIBC,* total iron-binding capacity.
Adapted from Xanthakos SA. Nutritional deficiencies in obesity and after bariatric surgery. *Pediatr Clin North Am* 2009;56:1105-1121 and Stone PM. Physical signs indicative or suggestive of undernutrition. In Jones DS, ed. *Textbook of functional medicine.* Gig Harbor, WA: Institute for Functional Medicine; 2005:786-788.

inhibitor for long-term use and available over the counter), (2) norepinephrine reuptake inhibitor as an appetite suppressant (e.g., phentermine), and (3) 5-hydroxytryptamine agonist (e.g., Lorcaserin, also used as a centrally acting appetite suppressant).

Orlistat works by inhibiting lipases in the gastrointestinal tract, which partially blocks fat absorption. It is approved for up to 2 years of continuous use and has been shown to improve weight loss and lipids, lower blood pressure, and enhance glucose metabolism. In a combined lifestyle intervention study involving Orlistat, the study treatment for 4 years delayed development of type 2 diabetes in obese subjects by 37% (Nicolai et al., 2012).

Phentermine as a norepinephrine reuptake inhibitor is a schedule 4 medication. It is has been approved for use for up to 12 weeks since its release in 1959. A continuous off-label use pattern in bariatric medicine has validation in the international literature (Nicolai et al., 2012). The side effect precautions include dry mouth, palpitations, hypertension, constipation, and insomnia.

Phentermine HCl–topiramate extended release is also a schedule 4 medication. It is a combination shorter- and longer-acting medication that combines a shorter-acting sympathomimetic amine and a longer-acting neurostabilizer approved as monotherapy for seizure disorders and migraine headache prevention. Phentermine is metabolized by the liver and excreted by the kidney; topiramate is excreted by the kidney (Garvey et al., 2012; Seger et al., 2013). This combination has been associated with up to a 10% weight loss in phase 3 trials (Garvey et al., 2012).

Lorcaserin is a 5-hydroxytryptamine 2c receptor agonist weight management agent that is a schedule 4 medication used twice a day. Serotonin (5-HT) has been implicated as a critical factor in the short-term (meal-bymeal) regulation of food intake. Its safety profile with coadministration with other serotonergic, antidopaminergic agents has not been established. The drug has multiple multisystem potential side effects (Seger et al., 2013) and should not be used in pregnancy. When combined with a 600-kcal decrease in food intake, lorcaserin twice a day was associated with a 10% weight loss in 20% of patients compared with 7% in the placebo group in phase 3 trials (Redman and Ravussin, 2010).

Indications for consideration of pharmacotherapy include obesity with a BMI greater than 30; overweight patients (BMI >27) with presence of obesity complications, including type 2 diabetes, hypertension, and dyslipidemia; and no improvement in a 12-week program of therapeutic lifestyle change, including consultation and routine evaluation with a behavioral therapist, nutritionist, and exercise program specialist. When used as an isolated therapy, pharmacotherapy to reduce obesity is not cost effective (Veerman et al., 2011).

Surgery

Indications. Bariatric surgery for patients with BMIs of greater than 40 or patients with BMIs greater than 35 with multiple comorbid conditions is now endorsed by different groups (Buchwald et al., 2004; Buchwald 2005). Over the past 2 decades, the prevalence of severe obesity (BMI >40 kg/m^2) has increased from 1 in 200 to 1 in 50 Americans. A new category of the extremely obese (BMI >50) was developed by the CDC to better inform the spectrum of disease and varies in frequency from state, gender, and ethnic background (Kushner and Herrington, 2013). Nearly 6% of adult Americans are severely obese, with the highest prevalence (nearly 14%) in adult African American women. Weight loss surgery has been found to be effective in carefully selected patients and has been reviewed elsewhere (Anderson and Hensrud, 2011; Medical Advisory Secretariat, 2009).

Evaluation for a patient with a BMI greater than 30 and one or more adverse health conditions caused by excessive fat or a BMI greater than 40 with or without adverse health conditions caused by fat mass disease or excessive body fat are the basic considerations now outlined for bariatric surgery (Seger et al., 2013). A thorough medical evaluation, including a bariatric surgery specialty consultation, with cardiology, pulmonary, gastroenterology, nutrition, and mental health evaluations, should be completed (Mechanick et al., 2013). Surgery alters the morbidity of obese patients with diabetes by varying mechanisms

(Cummings et al., 2004). There has been a recent meta-analysis review noting that after bariatric surgery, there was 76.8% complete resolution of type 2 diabetes in the 1846 patients evaluated (Medical Advisory Secretariat, 2009). The patients with gastric banding had a 47.9% resolution of their diabetes; gastroplasty, 71%; gastric bypass, 83.7%; and biliopancreatic diversion or duodenal switch, 98.9% (mean change in HbA_{1c} was −2.7%; Medical Advisory Secretariat, 2009).

Techniques and Procedures

PREOPERATIVE. The guidelines for weight loss surgery suggest that patients who cannot comprehend the nature of the surgical interventions and the lifelong measures required to maintain an acceptable level of health should be excluded from surgery (Consensus Development Conference Panel, 1991). Often the patient must show documentation of a 6 to 18 month supervised diet program before insurance authorization for the bariatric procedure (Brethauer, 2011). Exclusion criteria usually include previous weight reduction surgery; previous gastric operations, including gastric or duodenal ulcer, in the past 6 months; active malignancy in the past 5 years; myocardial infarction in the past 6 months; bulimic eating pattern; abuse of alcohol or drugs; psychological problems resulting in poor cooperation; regular use of cortisone or nonsteroidal anti-inflammatory drugs; and other severe illness, including certain autoimmune conditions (Sjostrom et al., 2004).

TYPES OF PROCEDURES. The types of bariatric procedures are illustrated in Figure 36-3. The procedures create one of three post–bariatric surgical states: malabsorptive (Figure 36-3, *A* to *C*), restrictive (Figure 36-3, *D* and *E*), or a combined malabsorptive and restrictive state (Figure 36-3, *F* and *G*). The malabsorptive conditions are more effective at weight loss, but they have a higher morbidity complication rate. The goal of the restrictive procedures is to limit food intake capacity and to slow the rate of stomach emptying. These include the laparoscopic adjustable gastric banding (LAGB) versus the vertical banded gastroplasty. Because of the ease of procedures and the lack of effectiveness of the vertical banding in trials, gastric banding is common and routinely completed. The adjustable gastric band involves the placement of the banded sleeve that can band a reservoir around the upper quarter of the upper stomach. Gastric banding is followed by the gastric sleeve and finally the roux-en-Y gastric bypass (RYGB) procedure for the lowest cost effectiveness (Seger et al., 2013).

The laparoscopic adjustable gastric band is a silicone ring placed around the proximal portion of the stomach and inflated to create a small proximal gastric pouch and a narrowed opening between the proximal and distal stomach with the gastric pouch holding approximately 30 cc (DeLegge et al., 2013; Shikora et al., 2007). This has been advocated for obese adolescents and those with a lower obese BMI (DeLegge et al., 2013). The lap band procedure is less complicated and is the most often performed in the United States. Weight loss occurs more slowly. Most patients can expect to lose 30% to 50% of their excess weight over 3 to 5 years, with an average of 47% (Buchwald et al., 2004; DeLegge et al., 2013). Laparoscopic adjustable banding is generally an outpatient procedure (Seger et al., 2013). The recovery is usually 1 week, and the contraindications include being a poor surgical candidate because of nutritional status or having severe comorbidities, severe psychiatric disorder, intolerance to general anesthesia, pregnancy, untreated esophagitis, or drug or alcohol

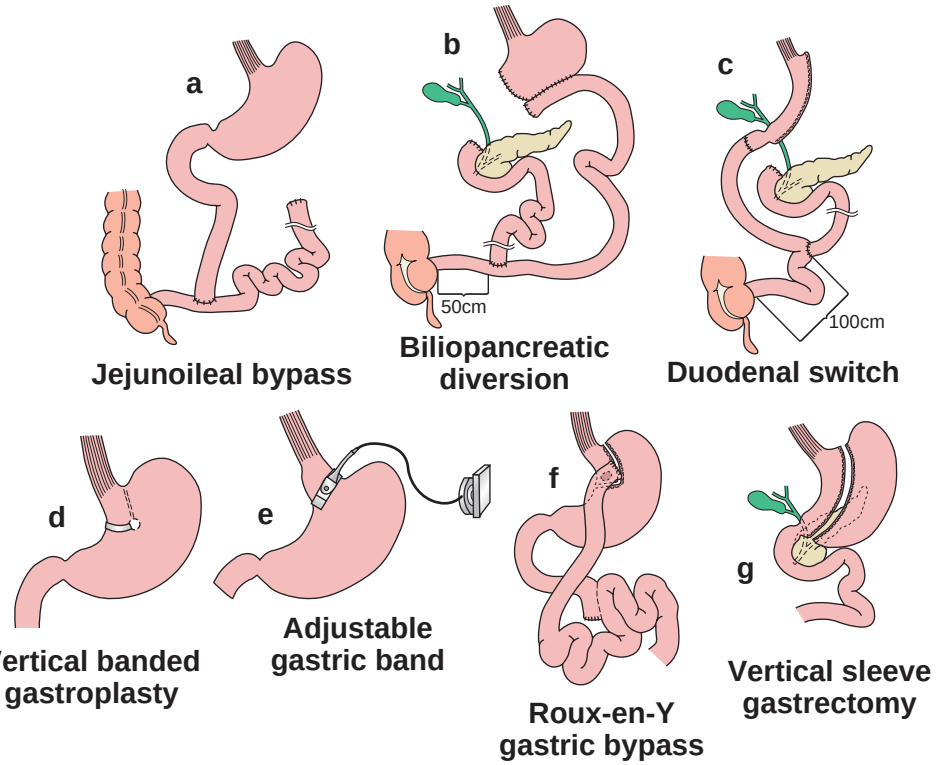


Figure 36-3 Malabsorptive, restrictive, or combined restrictive, and malabsorptive bariatric procedures. (Reprinted with permission from Xanthakos SA. Bariatric surgery for extreme adolescent obesity: indications, outcome and physiologic effects on the gut-brain axis. *Pathophysiology.* 2008;15:135.)

addiction. The acute complications include the band being too tight with gastrointestinal obstruction symptoms, leakage of gastric contents into the abdomen, hemorrhage, gastrointestinal bleeding, infection, cardiac dysrhythmias, atelectasis and pneumonia, deep vein thrombosis (DVT), and occasional death. The chronic complications can include weight regain with no weight loss, band slippage erosion, ulceration, port infection, disconnection, and displacement. The patients may develop esophageal dilation, and there are rarer nutrient deficiencies that can occur if persistent vomiting is marked and there is a sustained decrease in nutritional intake. Depression may also develop.

The sleeve gastrectomy involves surgically reducing the stomach to about 25% of its original size with the surgical removal of a large portion of the stomach along the greater curvature, resulting in a narrower sleeve or tube like structure. The vertical sleeve gastrectomy removes 85% of the stomach, leaving a narrow, tubular, banana-shaped portion of the stomach (stomach capacity, 50-150 cc), and is sometimes advocated for those with a very high BMI (>55 kg/m^2). The detached section of the stomach is primarily responsible for production of ghrelin, and weight loss is further enhanced by the lower levels of this hormone that result after the surgery (Frezza, 2007). In general, the hospital stay is 1 to 2 days, with recovery in 1 to 2 weeks. The contraindications are similar to those for the LAP-BAND with the additional contraindications of Barrett esophagus, severe gastroparesis, achalasia, previous gastrectomy, and gastric bypass surgery. The acute complications are similar with addition of pulmonary emboli, rhabdomyolysis, or dehydration. Long-term complications may include marginal ulcers, dumping syndrome with reactive hypoglycemia, and small bowel obstruction caused by internal hernias or adhesions. Additional documented complications include luminal stenosis, anastomotic staple line leak, fistula formation, gallstones, calcium deficiency, secondary hyperparathyroidism, iron deficiency, protein malnutrition, and nutritional and mineral deficiencies (including vitamins A, C, D, E, K, B, and B_{12}, folate, zinc, magnesium, and thiamin). Anemia related to mineral and nutrition deficiencies, metabolic acidosis, bacterial overgrowth, and kidney stones (oxalates) may also develop. Increased frequency of neuropathies, osteoporosis, and depression is seen in this post-surgical population without ongoing assessment and appropriate interventions (Seger et al., 2013; Xanthakos, 2009).

The purely malabsorptive procedures such as the biliopancreatic diversion with or without the duodenal switch (stomach capacity, 50-150 cc) are not commonly performed because of the significant nutritional complications that develop after the procedure, including significant protein, essential fat, vitamin, and mineral deficiencies (DeLegge et al., 2013). The RYGB, the combined malabsorptive and restrictive procedure, usually leaves a gastric pouch of 20 to 30 cc. The patient generally has a hospitalization of 2 to 4 days, with a recovery 2 to 4 weeks or longer. The contraindications are poor surgical candidate, severe psychotic disorder, intolerance to general anesthesia, pregnancy, drug or alcohol addiction, untreated esophagitis, and unwillingness or inability for appropriate long-term follow-up. The acute complications include gastrointestinal obstruction, hemorrhage, gastrointestinal bleeding, anastomotic leaks, infection, cardiac dysrhythmia, atelectasis and pneumonia, DVT, pulmonary emboli, rhabdomyolysis, dehydration, and death. Chronic complications can include weight regain, marginal ulcers, esophageal dilation, dumping syndrome with reactive hypoglycemia, small bowel obstruction caused by internal hernias or adhesions, anastomotic stenosis, gallstones, calcium deficiency, secondary hyperparathyroidism, iron deficiency, protein malnutrition, other nutritional mineral deficiencies, anemia, metabolic acidosis, bacterial overgrowth, kidney stones (oxalates), neuropathies resulting from nutritional deficiencies, osteoporosis (often caused by calcium deficiency and chronically elevated parathyroid hormone levels), and depression (Seger et al., 2013). The efficacy of the more aggressive surgeries is partially tied to the gastrointestinal endocrine system effects, which are significant. Gut hormones (glucagon-like peptide 1, peptide YY, leptin, and ghrelin) are not affected by restrictive operations such as LAGB and therefore do not contribute to weight loss. The adiposity hormones (leptin and insulin) are elevated in obese individuals and decrease with weight loss. It is suggested that RYGB surgery restores leptin sensitivity (DeLegge et al., 2013). Ghrelin is a known appetite stimulant produced by the stomach and duodenum and increases before eating and decreases afterward (DeLegge et al., 2013). It stimulates mealtime hunger associated with initiation of a meal. Successful weight loss surgery is not associated with lowering of the ghrelin levels.

Dumping Syndrome. Dumping syndrome following RYGB or other gastric surgeries that bypass the pylorus or interfere with gastric innervation is common. Up to 70% of RYGB patients report dumping in the postoperative period (DeLegge et al., 2013), but a minority will have an ongoing problem. It is categorized into early or late dumping syndrome. The early dumping syndrome is handled with low-volume, high-protein, carbohydrate-controlled mini meals (DeLegge et al., 2013) and the addition of soluble fiber from guar gum, glucomannan, or pectins to delay gastric emptying and alter the transit time in the bowel (DeLegge et al., 2013). A host of medications have been used to help alleviate the issue. Octreotide has been used to improve the symptoms of dumping syndrome (Ukleja, 2006)

A successful outcome from bariatric surgery is the loss of 50% of excess weight. A meta-analysis of 22,000 patients demonstrating outcomes reported a weight loss of 61.6% for RYGB and 47% for LAGB. Weight regain occurs in 30% to 50% of the patients, with significant weight regain of 15% to 30% (DeLegge et al., 2013; Hsu et al., 1998; Magro et al., 2008). There is significant success with the correctly selected patient in undergoing a significant body composition change and reductions in type 2 diabetes, hypertension, and dyslipidemia (Table 36-16). The morbidity and mortality from the procedures are markedly affected by the discernment and preoperative screening of the potential surgical patient (Table 36-17). The advantages and disadvantages of the different procedures have been reviewed elsewhere (Anderson and Hensrud, 2011; DeLegge et al., 2013; Medical Advisory Secretariat, 2009; Xanthakos, 2009).

Postprocedure Treatment and Monitoring

There is no doubt that the success of continued weight loss after bariatric surgery requires multiple team members,

Table 36-16 Summary of Findings on Excess Weight Loss and Resolution of Comorbid Conditions

Procedure	Excess Weight Loss (%)*	Resolution of Comorbid Conditions (Range %)†
MALABSORPTIVE		
Roux-en-Y gastric bypass	60-90	Diabetes mellitus: 74-99 Hypertension: 67-93 Dyslipidemia: 73-99
RESTRICTIVE		
Adjustable gastric banding	42-60	Diabetes mellitus: 29-92 Hypertension: 29-40 Dyslipidemia: 24
Vertical banded gastroplasty	58-67	Diabetes mellitus: 100 Hypertension: 50-60 Dyslipidemia: 14-72

*Percentage of excess weight loss = (Weight loss/Excess weight) × 100 (where Excess weight = Total preoperative weight – Ideal weight)
†Defined as the stopping of medication taken for comorbid condition.
From Medical Advisory Secretariat. Bariatric surgery: an evidence-based analysis. *Ont Health Technol Assess Ser.* 2005; 5(1).

Table 36-17 Mortality and Adverse Effects from Bariatric Surgery

Procedure	Mortality Range (%)	Adverse Effects Range (%)
MALABSORPTIVE		
Roux-en-Y gastric bypass	0.1-4.1	0.1-70
RESTRICTIVE		
Adjustable gastric banding	0-0.9	1.1-18
Vertical banded gastroplasty	0-0.8	1.0-30.4

Medical Advisory Secretariat. Bariatric surgery: an evidence-based analysis. *Ont Health Technol Assess Ser.* 2005;5(1).

including the patient with the will for prolonged lifestyle and nutrition habit change; the nutrition professional for continued counseling and education about diet and nutritional interventions; often input from a counselor involved in behavior change; the primary care physician, who continues to be alert to monitor nutrition and disease-associated laboratory and physical examination findings suggestive of under- or malnutrition; and the surgeon, who is involved in any procedural issues associated with the ongoing monitoring and adjustment of the postsurgical patient. Nutrition-directed biomarker tracking needs to be completed before bariatric surgery, at 6 months, and annually after bariatric surgery (see Table 36-15). It is noted that the increased use of malabsorptive and restrictive bariatric surgical procedures has increased the incidence of nutrition deficiency signs and symptoms in the treated obese population (Kumar, 2010; Xanthakos, 2009). Depending on the procedure location in the patient, the full range of nutritional mineral, vitamin, and major nutrient deficiencies can develop over time. The routine and consistent application of the ABCDs of nutrition assessment of obese and postoperative obese patients will aid in their healthful recovery.

Summary

Overweight and obesity and their reduction in quality of life and increase in economic burden are global concerns. Family medicine physicians can make a valuable contribution to decreasing the prevalence of weight-related diseases by addressing weight issues at each office visit. Through the evaluation of the basis for the patient's overweight or obesity and the patient's readiness to change, the physician can identify appropriate ways to move patients in a positive direction along their journey to achieving and maintaining a healthy weight. A number of environmental factors contribute to why a patient is overweight or obese, and a number of modalities are available. It is critical that patients not be overwhelmed with the magnitude of the journey ahead. Help them to take one step at a time. For example, have patients identify one modifiable lifestyle factor each day and ask, "What can I do for myself today that would move me in the direction of the goals I set in partnership with my physician?" Alternatively, if addressing each of the modifiable lifestyle factors is overwhelming, have patients focus on just one domain and select a different one tomorrow. Help them to think in terms of small steps. For example, have them think about making just a small change: eating 5% less today than they typically eat, increasing their physical activity by 5% today, increasing their sleep time by 5% tonight, keeping a gratitude journal for 30 days, or making a commitment to phoning a friend today or attending their church social hour this week to strengthen relationships.

Summary of Additional Online Content

The following content is available at www.expertconsult.com:

eAppendix 36-1 Epigenetic Regulation

eAppendix 36-2 Current Research on How the Microbiome Can Influence Weight

References

The complete reference list is available at www.expertconsult.com.

Web Resources

www.calculator.net/calorie-calculator.html Calorie calculator based on Mifflin-St. Jeor modification of the Harris-Benedict equation.

www.cellinteractive.com/ucla/physcian_ed/interview_alg.html UCLA Center for Human Nutrition helpful algorithm for motivational interviewing.

www.heartmath.org/free-services/solutions-for-stress/gps-for-the-soul.html GPS for the Soul measures your heart rate and heart rate variability. This is helpful to assess the parasympathetic nervous system, calm the body, and make better lifestyle choices.

www.loseit.com Lose It application. A great app that helps patients track their calories and activity against a goal.

www.motivationalinterviewing.org Clinical resources for motivational interviewing.

www.myfitnesspal.com MyFitnessPal is a free website that allows for calorie tracking along with a food diary. It helps individuals track their progress and lifestyle habits toward achieving and maintaining their ideal weight.

www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm Standard body mass index calculator.

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