Overweight and obesity are pandemic health problems, not just among the adult population, but in children and adolescents as well. This article presents information on the prevalence, causes, prevention, and treatment of overweight and obesity in young people, with particular focus on the medical and psychological complications associated with the diseases. In addition, the challenges of imaging the obese pediatric population are discussed, and public policy changes that could help reverse obesity trends in children and adolescents are introduced.

Childhood obesity has become so pervasive that some now describe it as the most common chronic condition of childhood. Since the 1980s, the number of obese children and adolescents in the United States has tripled, and nearly one-third of American children and adolescents now are classified as either overweight or obese.

Obesity is a serious health concern, associated with shorter life spans, higher health care costs, and complications affecting nearly all of the body’s organ systems. Without intervention, obese children are likely to become obese adults; therefore, it is important for health care providers to recognize, treat, and prevent obesity in children and adolescents before obesity-related complications become severe and debilitating. Pediatric obesity is not consistently diagnosed by primary care providers or regularly noted by radiologists on imaging reports. Reversing the tide of overweight and obesity in children and adolescents requires the united efforts of health care professionals, parents, schools, community organizations, public policy makers, and children.

Defining and Measuring Obesity

In adults, overweight and obesity are determined using body mass index (BMI) categories. BMI is a measurement of body weight relative to height. The formula for calculating BMI is weight (kg)/height (m)^2. Converting to more familiar pounds and inches, the formula is weight (lb)/height (in)^2 × 703.
In addition to computing BMI and comparing the results to a population of children or adolescents the same age and sex, other simple and inexpensive means of assessing pediatric obesity are measuring waist circumference, hip circumference, or skinfold thickness and calculating waist/height ratio or waist/hip ratio. Other useful but more costly techniques for assessing the amount of body fat include bioelectrical impedance analysis and dual-energy x-ray absorptiometry (DXA). Bioelectrical impedance analysis is based on the rate at which a harmless electric current passes through components of the body, such as muscle, bone, fat, and water. It can be used to quickly and noninvasively determine lean and fat body mass. However, readings can

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**Table**

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<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>Weight Status</th>
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<tr>
<td>&lt; 18.5</td>
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<tr>
<td>18.5-24.9</td>
<td>Normal</td>
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<tr>
<td>25.0-29.9</td>
<td>Overweight</td>
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<tr>
<td>30.0-39.9</td>
<td>Obese</td>
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<tr>
<td>≥ 40.0</td>
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be affected by how recently a person has eaten, drunk, or exercised.\textsuperscript{11}

Whole-body DXA scanning is quick, taking less than 5 minutes, and delivers a low radiation dose of approximately 0.3 μSv.\textsuperscript{12} DXA images can be used to calculate percent body fat, fat mass, lean body mass, total tissue mass, and bone mineral content. A limitation of DXA scanning is its inability to distinguish visceral fat (ie, fat surrounding the internal organs) from subcutaneous fat. Another potential drawback is that some obese adolescents might be too heavy or too wide for the scanning equipment.\textsuperscript{15} However, Breihaupt and colleagues found no statistically significant differences between half-body DXA scan results vs full-body results in a study of 58 obese children and adolescents. They concluded that half-body scanning is a valid alternative for adolescents whose body width exceeded the 60-cm scan area of the DXA equipment used in their study.\textsuperscript{12}

Other imaging techniques can be used to assess body fat, but each is associated with drawbacks. Ultrasonography is a widely available tool but cannot assess the total volume of visceral fat.\textsuperscript{13} Computed tomography (CT) accurately depicts visceral fat but entails high levels of radiation exposure and therefore is not justifiable for obesity assessment in children and adolescents, particularly considering that multiple assessments might be required over time.\textsuperscript{13} Magnetic resonance (MR) imaging has proven effective for measuring total body fat as well as subcutaneous and visceral fat in the abdomen, but is costly.\textsuperscript{13}

**Prevalence**

**United States**

In the 1980s and 1990s, the prevalence of obesity among children and adolescents in the United States skyrocketed, doubling or even tripling in some age groups\textsuperscript{14,15} and prompting one researcher to call obesity “the most common chronic disorder in childhood” as well as “one of the most serious public health challenges” of our time.\textsuperscript{1} Recent data suggest that obesity rates might have begun to level, although overweight and obesity in young people remain common, with adolescents more likely to be affected than young children, boys more affected than girls, and some minority groups affected more than whites, particularly blacks, Hispanics, and Native Americans.\textsuperscript{14,15} Obesity also is more prevalent in children and adolescents with lower socioeconomic status.\textsuperscript{15}

Skinner and Skelton analyzed data from the National Health and Nutrition Examination Survey from the years 1999 to 2012. A total of 26 690 children and adolescents aged 2 to 19 years participated in the survey and were included in the analysis. The researchers determined that prevalence of all categories of obesity increased in most groups of study participants between 2009 and 2012, although the increases were not statistically significant.\textsuperscript{3} However, Skinner and Skelton found the prevalence of obesity and overweight increased significantly for certain subgroups in the study, particularly Hispanic girls and black boys.\textsuperscript{3} Similarly, Ogden and colleagues found no significant changes in the overall prevalence of obesity in youths between 2003 to 2004 and 2011 to 2012, also based on National Health and Nutrition Examination Survey data.\textsuperscript{16} Nevertheless, they cautioned, “Obesity prevalence remains high and thus it is important to continue surveillance.”\textsuperscript{16}

According to National Health and Nutrition Examination Survey data from 2011 to 2012, 32.2% of children and adolescents in the United States aged 2 to 19 years were either overweight or obese, and 17.3% were obese.\textsuperscript{3} In addition, 5.9% of children and adolescents qualified as type 2 obese, a category defined as 120% of the 95th percentile BMI for age and sex or a BMI of 35, whichever is lower. Finally, 2.1% were classified as type 3 obese, indicating a BMI greater than 140% of the 95th percentile BMI for sex and age or a BMI of 40, whichever is lower.\textsuperscript{3}

Overweight and obesity now affect even very young children, whereas formerly the condition was seen mostly in children 4 years and older.\textsuperscript{7} Ten percent of infants and one-quarter of toddlers and preschool-aged children in the United States qualify as overweight or obese.\textsuperscript{7}

**Regional Variations**

The prevalence of childhood overweight and obesity varies significantly among the states.\textsuperscript{19} Generally, obesity and overweight are more prevalent in the southeastern United States, particularly in Mississippi, Georgia, and Tennessee. Conversely, states in the Northwest...
and upper Midwest have the lowest prevalence of overweight and obesity. Geographical patterns of overweight and obesity in children and adolescents tend to mirror the patterns for adults.18

**Worldwide**

Although the United States might be the most severely affected nation, obesity and overweight are not limited to this country.1,9,10,19 Data from 2010 suggest that the problem is truly worldwide, with 38% of children and adolescents in Europe and 27% of children in the western Pacific region either overweight or obese.20 (Recall, however, that obesity and overweight are defined somewhat differently under different national and organizational criteria.) Maggio and colleagues reported a 20% prevalence of childhood obesity in Switzerland in 2014, adding, however, that the rate appeared to be stabilizing.21 A 2009 survey in Ireland showed that 25% of children aged 3 years and 9 years were either overweight or obese.1 In 2013, the estimated total number of overweight children worldwide was 155 million, with between 30 million and 45 million of these qualifying as obese.22

**Figure 2.** Abdominal magnetic resonance (MR) images (top row) and liver MR scans (middle row) of 3 obese adolescent boys. The Hispanic boy (right) had marked elevation in intramyocellular lipids (IMCL), hepatic fat fraction (HFF), and visceral fat. The African American boy (center) had low IMCL, undetectable liver fat, and low visceral fat and marked expansion of the total subcutaneous fat. The white boy (left) had a low IMCL and liver fat but significant visceral fat content. Extramyocellular lipids (EMCL) also differed significantly among the boys (bottom row). Reprinted from Liska D, Dufour S, Zern TL, et al. Interethnic differences in muscle, liver and abdominal fat partitioning in obese adolescents. PLoS ONE. 2007;2(6):e569. doi:10.1371/journal.pone.0000569.
**Racial and Ethnic Disparities**

Obesity appears to be more prevalent among black and Hispanic children and adolescents than among white, non-Hispanics. According to the 2009-2010 National Health and Nutrition Examination Survey, the prevalence of obesity was 24.3% among black non-Hispanic children and adolescents, compared with 21.2% among Hispanic youths and 14% for non-Hispanic white youths. Other studies have confirmed these disparities along ethnic and racial lines, although these findings are confounded by the effects of socioeconomic factors on overweight and obesity. Furthermore, an analysis of 1999 to 2012 National Health and Nutrition Examination Survey data indicated that all levels of overweight and obesity increased significantly among Hispanic girls and non-Hispanic black boys, prompting researchers to urge that future studies focus on whether specific risk factors for these groups could be addressed.

In addition to differences in the prevalence of overweight and obesity, the distribution of fat within the body also differs among racial and ethnic groups (see Figure 2). For example, African Americans typically have less visceral fat and more superficial subcutaneous fat than do whites or Hispanics with similar total body fat who are the same age and sex. African Americans also tend to have undetectable amounts of intrahepatic fat, even when overweight or obese. These observations are true for people of African descent generally, whether they live in the United States, the Caribbean, South America, or Europe. However, the reasons for these racial differences in fat distribution are unknown.

**Causes of Obesity in Children and Adolescents**

In most cases (95%-99%), childhood obesity is caused by caloric imbalance, meaning more calories are consumed than are expended. Caloric imbalance is affected by factors including diet, activity level, and genetic predisposition. Researchers are still investigating the genetic predisposition to obesity, and in many cases it appears likely that genetics, environmental factors, and personal behavior all play a role. Although the exact genetic mechanism is not clearly understood, it has been shown that having obese parents increases both the risk and severity of obesity in a child. Lifestyle factors linked to caloric imbalance in children and adolescents include increased television viewing and computer gaming, decreased physical activity levels, increased consumption of high-calorie beverages such as soft drinks, larger serving sizes, and increased consumption of high-fat foods.

In 1% to 5% of cases, the causes of obesity are organic, including a variety of endocrine and central nervous system disorders as well as certain genetic syndromes (see Box 1). Rare genetic syndromes can cause rapid onset of severe obesity, especially in young children. These disorders also tend to be associated with short stature, as well as developmental and intellectual delays, other abnormal clinical features, and a positive family history of the syndrome.

Certain drugs can contribute to weight gain and should be considered when evaluating overweight and obesity in children and adolescents. Besides some antihypertensives, antihistamines, tricyclic antidepressants, and anticonvulsants, these medications include:

- Insulin.
- Glucocorticoids.

**Box 1**

**Causes of Obesity Other Than Caloric Imbalance**

**Endocrine Disorders**
- Cushing syndrome
- Growth hormone deficiency
- Hypothyroidism

**Genetic Syndromes**
- Albright hereditary osteodystrophy
- Laurence Moon-Biedl
- Prader Willi
- Single gene mutations

**Central Nervous System Disorders**
- Hypothalamic tumors/lesions
Obesity in Children and Adolescents: Health Effects and Imaging Implications

- Hormonal contraceptives.
- Clozapine.
- Lithium.

Studies have implicated lack of adequate sleep as a possible contributor to obesity.\textsuperscript{24,25} About 20% of adolescents get the optimum amount of sleep for their age group.\textsuperscript{25} Factors that prevent adolescents from getting enough sleep include homework, sports and other extracurricular activities, part-time jobs, and use of the Internet, television, and mobile phones. In addition, parents are less likely to enforce bed times with adolescents than they are with younger children.\textsuperscript{24} Lack of sufficient sleep causes fatigue, bad moods, and psychological distress, which can affect eating patterns and contribute to weight problems.\textsuperscript{25}

In addition, adolescents as a group tend to be less physically active than younger children, which can contribute to weight gain during adolescence. Whereas more than 40% of children aged 6 to 11 years reportedly participated in one hour or more of physical activity daily, the figure drops to just 8% among those aged 12 to 15 years, and is slightly lower among older adolescents.\textsuperscript{4}

Arnold Slyper, MD, suggested that another cause of obesity in children and adolescents in recent decades is that their diets are now less “satiety inducing” than in the past, which is to say, less likely to produce a sense of being full.\textsuperscript{24} Many children eat only limited amounts of high-fiber foods that are associated with fullness such as whole grains, fruits, and vegetables. In addition, children and adolescents eat fewer eggs and drink less milk today, both of which are associated with satiety because of their high protein content. Instead, children and adolescents are consuming more soft drinks, fruit juices, and low-quality carbohydrates, which are not particularly filling but are high in calories.\textsuperscript{26}

Slyper traced this trend to the 1960s, when adults were urged to reduce the amount of saturated fat and cholesterol in their diets.\textsuperscript{26} However, the advice might have backfired by unintentionally encouraging consumption of less-filling, high-calorie foods. To combat childhood obesity, he suggested a new focus on choosing foods that induce satiety, such as whole-grain cereals, eggs, and whole milk, and limiting portion sizes and total caloric intake. “For children on Western-style diets, the calories from a moderate amount of dairy fat are preferable to those from the soda, juice, and highly refined starches that have often replaced them,” he explained.\textsuperscript{26}

In addition, increased television viewing and media exposure generally are directly correlated with overweight and obesity.\textsuperscript{27} Television and other forms of media expose children to advertising for less-healthy foods and prevent physical activity during viewing. Eating while watching television also is associated with overweight. The Children’s Nutrition Research Center and Baylor University studied eating habits of 287 4th through 6th grade children.\textsuperscript{27} They found that half the time, overweight children ate their dinners while watching television. By comparison, the children with a healthy weight ate their dinners while watching television only 35% of the time.\textsuperscript{27} The researchers pointed out that watching television while eating tends to tune out the body’s natural hunger and satiety cues, which encourages overeating.\textsuperscript{27}

The decline of family meals is another possible contributor to overweight and obesity in children and adolescents. “The once-traditional pattern of the family having dinner together at the table has changed,” noted the Academy of Nutrition and Dietetics in 2014.\textsuperscript{14} “However, children who eat meals with their families at home have better diet quality than those who do not, and they are also more likely to have healthy body weights.”\textsuperscript{14} Specifically, children who eat at least 3 meals per week with their families tended to have higher intakes of fruits and vegetables and were more likely to eat breakfast regularly.\textsuperscript{14} Researchers suggested that parents might be modeling healthy eating habits when families eat together, and that children might be more likely to abide by family rules regarding eating at family meals.\textsuperscript{14}

At the same time the number of family meals eaten together has declined, food eaten away from home has increased significantly. In 1977, less than a quarter of all food consumed was eaten away from home; as of 2006, the figure was more than one-third.\textsuperscript{14} Moreover, the single largest category of food eaten away from home is fast food.\textsuperscript{27} Foods eaten at home but prepared elsewhere (ie, take-out meals) also are increasing. Foods not prepared at home tend to be higher in calories and fat than home-prepared foods.\textsuperscript{14} Fast-food restaurants usually
do not provide many fruits, vegetables, whole grains, or dairy foods on children’s menus.\textsuperscript{14}

Another factor that might contribute to overweight and obesity in children and adolescents is beverage consumption trends. Fewer children drink milk now than in the 1970s, while more are drinking fruit juices. The American Academy of Pediatrics recommends only a small amount of fruit juice per day (4 to 6 ounces), for example, but infants aged 1 year are reportedly consuming an average of 10 to 12 ounces per day.\textsuperscript{14} Children are consuming more soft drinks as well.\textsuperscript{14}

The number of snacks eaten per day by children and adolescents also has increased.\textsuperscript{28} Snacking per se is not necessarily associated with overweight or obesity,\textsuperscript{28} but research has shown that desserts and sugary drinks are major sources of snack-associated calories.\textsuperscript{14} Some of the most commonly chosen snacks among adolescents include chips, ice cream, candy, and cookies.\textsuperscript{28}

Emotional difficulties are another suspected contributor to obesity.\textsuperscript{1} Children and adolescents who are depressed, anxious, or frustrated might overeat as a coping mechanism.\textsuperscript{1} This sets up a negative cycle because overweight and obesity can contribute to children’s depression and thus exacerbate overeating.\textsuperscript{1}

Finally, prenatal factors and diet during infancy are known to influence overweight and obesity in childhood. For example, women who were undernourished during pregnancy tend to give birth to infants with low-for-gestational-age birth weights who are at higher risk for becoming obese later in life.\textsuperscript{22} Conversely, high birth weight also is associated with risk for obesity.\textsuperscript{22} Breastfeeding during the first year of life is associated with a lower risk of obesity later, possibly because of slower growth rates in the first weeks of life among breastfed infants compared with formula-fed infants.\textsuperscript{22,29}

**Positive Trends in Adolescent Behavior**

Although there are many possible factors contributing to overweight and obesity in children and adolescents, there also has been some progress among American adolescents in terms of activity levels and healthier diets, according to a study of 11- to 16-year-olds across the United States.\textsuperscript{30}

Iannotti and Wang studied nationally representative samples of students in 6th to 10th grades during 3 time periods: 2001 to 2002, 2005 to 2006, and 2009 to 2010.\textsuperscript{30} Participants were surveyed about their physical activity levels, sedentary behaviors, and diet. The researchers found improvements among all racial and ethnic groups. Specifically, the number of students who ate fruits and vegetables daily improved, as did the number of days on which participants were physically active for at least 60 minutes. In addition, television viewing and consumption of sweets decreased, and more students reported eating breakfast regularly.\textsuperscript{30} Another positive finding was no significant change in participants’ average BMI from the 2005-2006 survey to the 2009-2010 survey.\textsuperscript{30}

Based on these findings, Iannotti and Wang suggested that public health efforts aimed at reducing obesity might be beginning to pay off. However, they cautioned that there still is room for improvement in adolescents’ obesogenic (obesity-promoting) behaviors.\textsuperscript{30} Most of the adolescents surveyed were not physically active for the recommended 60 minutes per day and did not consume the recommended 5 or more servings of fruits and vegetables daily. In addition, most of the participants indicated that they watched television or engaged in another sedentary behavior, such as video gaming, for 2 or more hours daily.\textsuperscript{30}

**Health Problems Associated With Obesity**

Obesity in childhood or adolescence is strongly associated with adult obesity: One-third of obese preschool-aged children, one-half of obese school-aged children, and 80% of obese adolescents become obese adults.\textsuperscript{1} Of further concern is that obese adults who were obese as children experience more rapid and serious obesity-related complications than do people who were normal weight during childhood but become obese as adults.\textsuperscript{1}

Numerous studies have confirmed that being obese or overweight as a child or adolescent is associated with risk of chronic disease in adulthood, especially cardiometabolic dysfunction. This includes type 2 diabetes, hypertension, and coronary heart disease.\textsuperscript{19} However, weight loss in adulthood has many positive effects and appears to mitigate these risks.\textsuperscript{19}

In addition to suffering from obesity-related health problems when they reach adulthood, obese children and
Box 2

Possible Complications of Obesity in Children and Adolescents

Accelerated puberty
Asthma
Blount disease
Cardiovascular disease, including atherosclerosis
Continuing obesity into adulthood
Depression and anxiety
Dyslipidemia
Eating disorders such as binging and purging
Gastroesophageal reflux disease
Hypertension
Insulin resistance/type 2 diabetes mellitus
Low self-esteem
Metabolic syndrome
Nonalcoholic fatty liver disease
Obstructive sleep apnea syndrome and other breathing problems
Osteoarthritis
Polycystic ovary syndrome
Slipped capital femoral epiphysis
Some types of cancer
Reduced quality of life

adolescents also are at risk for obesity-related conditions before they become adults (see Box 2 and Figure 3). Maggio and colleagues attempted to quantify certain obesity complications in a cohort of 774 patients aged 1.7 to 17.9 years who attended a pediatric obesity care center in Switzerland.\textsuperscript{21} The patients were classified as overweight, obese, or extremely obese based on their BMIs and World Health Organization categories.\textsuperscript{21} Maggio et al found that 23% of the study participants had systolic or diastolic hypertension, with the heaviest patients at highest risk. Also, 40% of participants had dyslipidemia (abnormal concentrations of lipids in the blood), and 27% had increased liver enzymes suggestive of fatty liver disease.\textsuperscript{21} More than half (54%) had orthopedic abnormalities associated with obesity, and 79.4% complained of quality-of-life issues related to their weight such as bullying and shortness of breath.\textsuperscript{21}

Cardiovascular Disease

Obesity is a major modifiable risk factor for cardiovascular disease, along with hyperlipidemia, hypertension, hyperglycemia, and smoking.\textsuperscript{9} The link between obesity and cardiovascular disease, especially accelerated atherosclerosis, is particularly strong.\textsuperscript{9,35} A primary goal of identifying and treating obese children and adolescents is to prevent future cardiovascular disease or to stop it early in its course.\textsuperscript{9}

Signs of cardiovascular disease are evident even in young people, and particularly in obese young people. For example, the Pathologic Determinants of Atherosclerosis in Youth study examined a large cohort of adolescents and young adults aged 15 to 34 years who died of trauma.\textsuperscript{36} Postmortem examinations of the study subjects focused on their coronary arteries and aortas. The subjects’ cardiovascular risk factors were recorded as well. In this study, obesity in male subjects was associated with raised lesions and fatty streaks in the right coronary artery as well as microscopic atherosclerosis and stenosis in the left anterior descending artery.\textsuperscript{9,36} One author concluded that the evidence “suggests that the process of accelerated atherosclerosis begins in adolescence, and that risk factors present in youth predict adult cardiovascular disease.”\textsuperscript{9}

In particular, the effect of BMI on lesions in the right coronary artery was more pronounced in young men and adolescent boys with a central or visceral pattern of adiposity, as opposed to peripheral adiposity.\textsuperscript{9} Interestingly, no association between BMI in the female study subjects and atherosclerosis was reported,\textsuperscript{9} although a weak association was seen between BMI and fatty streaks in the arteries of women with central-pattern adiposity.\textsuperscript{36}

Another study, the Muscatine study, used electron beam CT to evaluate coronary artery calcification in children and young adults with risk factors for coronary artery disease. This study demonstrated a strong association between high BMI and calcification of the coronary arteries, particularly in young men.\textsuperscript{9}

In addition, the Bogalusa Heart Study, a long-term study that has tracked a group of Louisiana children into adulthood, showed a strong relationship between BMI in youths and increased carotid intima-media thickness in adulthood.\textsuperscript{9} Carotid intima-media thickness is assessed using ultrasonography, which measures the thickness of the inner 2 layers of the carotid
Furthermore, obese children and adolescents have a subclinical, proinflammatory state that can be quantified by measuring levels of C-reactive protein in their blood.\textsuperscript{16} Severely obese children (ie, those with a BMI $\geq 40$) have markedly increased inflammation markers.\textsuperscript{35} This condition further contributes to atherosclerosis.

**Metabolic Syndrome**

Metabolic syndrome in childhood or adolescence is a proven predictor of metabolic syndrome in adults, as well as a predictor of type 2 diabetes mellitus and cardiovascular disease.\textsuperscript{9} In adults, metabolic syndrome includes a combination of at least 3 of the following conditions:  
- High waist circumference.  
- High systolic or diastolic blood pressure.  
- Increased blood glucose or triglyceride levels, or both.  
- Low high-density lipoprotein cholesterol.

However, there is no consensus about what constitutes metabolic syndrome in children or adolescents, and different definitions have been proposed.\textsuperscript{9} For example, Choudhary et al defined pediatric metabolic syndrome as “a group of risk factors in one person that includes obesity, insulin resistance, and other metabolic abnormalities.”\textsuperscript{2} Under this definition, almost 50\% of morbidly obese children have metabolic syndrome.\textsuperscript{2} Morandi and Maffeis, alternatively, suggested a definition of adolescent metabolic syndrome that more closely mirrors the adult definition.\textsuperscript{37}

**Type 2 Diabetes Mellitus**

The association between type 2 diabetes and obesity is well established.\textsuperscript{22} Previously, the disease was mostly limited to adults and was sometimes known as adult-onset diabetes. However, it is now increasingly diagnosed in children and adolescents, and is especially...
prevalent in obese children and adolescents who are African American, Native American, Hispanic, or Asian/Pacific Islanders. A common sign in obese children and adolescents with type 2 diabetes is acanthosis nigricans, an abnormally darkened, thick, and velvety area on the skin, often on the neck, armpit or groin, that might itch or smell bad. Up to 90% of pediatric patients with type 2 diabetes have acanthosis nigricans. Other symptoms and signs include abnormal thirst and frequent urination.

The American Diabetes Association recommends regular screening for type 2 diabetes in overweight and obese children and adolescents if they have 2 of the following risk factors:

- A family history of type 2 diabetes.
- Native American, African American, Hispanic, or Asian/Pacific Islander heritage.
- Signs of insulin resistance (eg, excessive thirst and frequent urination).

Diabetes screening in at-risk overweight and obese children should begin at age 10 years or at puberty, whichever is earlier, and should be repeated every 2 years.

Onset of type 2 diabetes during childhood or adolescence is particularly concerning because diabetic complications are related to the duration of the disease. In addition to cardiovascular disease, complications of type 2 diabetes can include damage to the kidneys, nerves, and eyes, among other conditions.

Shah and colleagues studied obese adolescents with prediabetes (n = 102) and obese adolescents with normal glucose tolerance (n = 139) to assess the effects of prediabetes on cardiovascular health. Specifically, they measured carotid intima-media thickness and arterial stiffness. Shah et al found that the obese youths with prediabetes had greater arterial thickness and stiffness than did the non-diabetic obese youths in the control group. The researchers encouraged interventions to prevent diabetes and prediabetes in obese adolescents as a way to reduce arterial disease early in life.

Liver Disease

Nonalcoholic fatty liver disease is the most common type of liver disease in children, as well as one of the more common complications of childhood obesity. The disease is characterized by unusual amounts of fat in the liver and generally is asymptomatic, although some patients have mild upper abdominal discomfort. Technically, fatty liver disease is defined as fat infiltration in more than 5% of hepatocytes. Autopsy data indicate that the overall prevalence of fatty liver disease is 13% among children in the United States. However, in overweight and obese children and adolescents, the prevalence is as high as 46%.

Nonalcoholic fatty liver disease sometimes is detected incidentally on abdominal imaging examinations ordered for other indications. On sonograms, the disease is characterized by a bright-appearing liver with increased echo texture and blurring of the liver's vasculature. It is definitively diagnosed with liver biopsy. In some patients, fatty liver disease progresses to cirrhosis and end-stage liver disease, which requires liver transplantation.

Besides obesity, insulin resistance is a primary risk factor for fatty liver disease in children and adolescents. Boys are more likely to develop the disease than are girls, by a ratio of 2:1. This difference might be due to estrogen's protective effects on the liver. In addition, prevalence is highest among Hispanics and lowest among African Americans, with a middle prevalence for whites. Multiple genes are thought to contribute to individual genetic susceptibility to developing fatty liver disease. Dietary risk factors include high consumption of carbohydrates, fructose, sucrose, and omega 6 polyunsaturated fatty acids.

The current treatment strategy for pediatric nonalcoholic fatty liver disease is increased physical activity and improved diet, leading to gradual weight loss or slower weight gain. For example, decreasing fructose and sucrose consumption by eliminating foods such as soft drinks from the diet is beneficial. However, patient compliance with diet and lifestyle changes often is poor, and other potential treatments are under investigation, including Vitamin E (an antioxidant), metformin (an insulin-sensitizing drug), and probiotics (live microorganisms added to the digestive system).

Asthma

Asthma is one of the most common chronic diseases in children and the leading cause of school absences in the United States. Obese children are known to be at
higher risk for developing asthma than nonobese children, although the nature of the link between asthma and obesity is not clearly understood. One hypothesis is that obesity is a proinflammatory state associated with low-grade inflammation throughout the body, including airway inflammation. However, this might not be the only mechanism involved, and more research is needed to understand the connection between obesity and asthma in children and adolescents, as well as to determine the optimum asthma treatment in this patient population.

Sleep Apnea

Obstructive sleep apnea syndrome is marked by repeated partial or complete blockages of the upper airway during sleep. People with the syndrome might wake up suddenly with a gasping or choking sensation, or they might not experience any symptoms. More than 12 million people in the United States are affected, and half of these are overweight. Excess body fat is thought to cause sleep apnea by decreasing the tone of the airway, which then tends to collapse during sleep, or by reducing the diameter of the airway. Because sleep apnea impairs the quality of sleep and interferes with the body’s oxygen supply, it can be associated with neurocognitive deficits.

Treatment for obstructive sleep apnea syndrome varies. Many patients use continuous positive airway pressure equipment, which blows air into the nose or mouth through a mask to keep the airway open during sleep. In overweight and obese individuals, a moderate weight loss (ie, 10% of total body weight) often can improve sleep apnea symptoms.

Orthopedic Problems

Overweight and obese children and adolescents are more prone to skeletal disorders than are their normal-weight peers. One of these disorders is slipped capital femoral epiphysis, a painful hip condition in which the head of the femur is displaced posteriorly and inferiorly. Symptoms include hip or knee pain, intermittent limping, and inability to bear weight on the affected leg. When the condition is a result of obesity, it is more likely to be bilateral. Slipped capital femoral epiphysis occurs more commonly in boys than in girls and requires surgical fixation with pins or screws. Serious complications such as avascular necrosis can occur.

Childhood obesity also is associated with Blount disease, a growth disorder of the tibia caused by excessive force on the growth plate. Blount disease causes the lower leg to turn inward; treatment might require bracing or surgery. In addition, obese children and adolescents are more likely to suffer fractures despite having greater bone density than normal-weight peers as demonstrated on DXA scans. Also, obesity causes osteoarthritis from excess loads on joints, and osteoarthritis has been demonstrated in obese adolescents.

Idiopathic Intracranial Hypertension

Obese people are more likely than those of normal weight to develop idiopathic intracranial hypertension, or high pressure of the cerebrospinal fluid in the brain. Obese women of childbearing age are particularly at risk, for unknown reasons. This condition also is known as pseudotumor cerebri because increased spinal fluid pressure often accompanies brain tumors. The etiology of idiopathic intracranial hypertension is not well understood. Headaches are a common symptom, and the condition can lead to vision problems including blindness. Medication, repeated lumbar punctures, and shunting of excess spinal fluid can reduce pressure; weight loss is an effective treatment in some patients.

Polycystic Ovary Syndrome

Polycystic ovary syndrome is an endocrine disorder that primarily affects women of childbearing age. Signs and symptoms include menstrual irregularities, difficulty getting pregnant, excessive body hair, acne, and cysts in the ovaries. Although the syndrome is most commonly diagnosed in women aged 20 to 40 years, adolescent girls also are affected. Polycystic ovary syndrome is associated with excess weight. Half of all patients with the syndrome are either obese or overweight, and girls and women with excess abdominal fat are at higher risk. Weight loss is a recommended treatment for these patients, and some are prescribed an insulin-sensitizing agent such as metformin.
Cancer

In adults, the link between obesity and many types of cancer is well established. These include cancers of the breast, ovary, colon, esophagus, kidney, pancreas, gall bladder, thyroid, and prostate, as well as multiple myeloma and Hodgkin lymphoma. The relationship between childhood obesity and cancer is not as well understood. However, in obese girls, puberty is believed to occur earlier than in nonobese girls, and early puberty is associated with a higher risk of cancers that are influenced by hormones, such as breast cancer. Patients with high BMIs tend to have poorer outcomes when they develop cancer. Therefore, the relationship among childhood obesity, cancer prevalence, and cancer survival merits further research.

Mental Health and Health-related Quality of Life

Studies have demonstrated a reduced quality of life among obese adults compared with normal-weight adults, particularly in terms of physical functioning. To assess the effects of obesity on children’s and adolescents’ quality of life, Schwimmer and colleagues studied a group of 106 obese children and adolescents, mean BMI 34.7, who had been referred for treatment to an academic children’s hospital. For control purposes, they administered the same quality-of-life questionnaire to a group of healthy, normal-weight children and adolescents, as well as to a group of pediatric patients with cancer who were undergoing chemotherapy. The questionnaire assessed 5 quality-of-life domains: psychosocial, physical, emotional, social, and school functioning.

The severely obese children and adolescents showed significant impairment in total quality-of-life scores and in each of the 5 domains. The study subjects were 5.5 times more likely than the healthy subjects to report impaired quality of life, and had a similar likelihood of impairment as the children and adolescents undergoing cancer treatment. In addition, they experienced impaired quality of life even when they did not have comorbidities associated with obesity.

These results are concerning because previous studies have shown that pediatric cancer patients have lower quality-of-life scores than do children and adolescents with serious medical conditions such as congenital heart disease, type 1 diabetes, and juvenile rheumatoid arthritis. Therefore, Schwimmer et al concluded, parents, teachers, and physicians should be alert to the likelihood and possible severity of impaired quality of life in severely obese children and adolescents.

Similar to Schwimmer et al, Walders-Abramson and her colleagues concluded that the degree of obesity is more relevant to adolescents’ level of psychological distress than the presence or absence of obesity-related comorbidities. Walders-Abramson et al assessed comorbidities and psychological distress in a group of 166 obese adolescents aged 11 to 18 years. Based on their findings, the researchers suggested that clinicians might have more success motivating obese adolescent patients to change their dietary and physical activity habits by focusing more on the emotional difficulties associated with obesity, rather than on the potential for medical complications.

Depression and anxiety also are known to affect obese children and adolescents disproportionately compared with their normal-weight peers. To assess the prevalence of depression and anxiety among obese adolescents, Herget and colleagues conducted a systematic review of the literature on adolescent patients’ psychological health before and after bariatric surgery. They found that about one-third of obese adolescents were moderately to severely depressed presurgery and one-quarter had symptoms of an anxiety disorder. After surgery, patients’ depression improved.

Imaging Obese Children and Adolescents

Imaging obese children and adolescents poses special challenges. Obese patients might have difficulty with standard positioning for some examinations because of their size; they might need extra assistance transferring to the examination table, or they might be too large or heavy for some imaging equipment. Transporting obese adolescents to the imaging department might require special stretchers or wheelchairs designed specifically for obese patients. Also of concern is the higher doses of radiation necessary to penetrate larger amounts of soft tissue and produce diagnostic-quality images.

Radiologic technologists should know the apertures and weight limits for the equipment in their department.
and should ensure that a patient’s body weight and diameter do not exceed equipment limitations before beginning an examination. Attempting to image a patient whose weight exceeds the limit can damage the table, its motor, or both. Fluoroscopy equipment typically has the lowest weight limit (350 lb) and the smallest equipment aperture (45 cm); CT and MR scanners might have larger apertures and accommodate heavier patients. For example, vertical-field open MR equipment typically can image patients weighing up to 550 lb.

When performing radiographic examinations, technologists should use multiple, overlapping image receptors if a single one does not cover the patient’s body surface. Also, because the x-ray beam might not adequately penetrate an obese body, increasing the kilovoltage peak (kVp) and milliampere seconds (mAs) might be necessary. For example, Uppot suggested increasing kVp to 100 and mAs to 4 for a chest radiograph of an obese adult, compared with typical settings of 90 kVp and 2 mAs for normal-weight adult patients. Use of a grid also is recommended.

Ultrasoundographic imaging also is affected by obesity. The ultrasound beam has poor penetration beyond its focal depth, and beam attenuation increases as the beam passes through body fat. Using a low-frequency transducer, such as 2 MHz, can improve image quality in obese patients. When possible, a sonographer should review an obese patient’s previous imaging examinations to determine the thickness of subcutaneous fat. This can help ensure that the area of interest is within the transducer’s focal length range.

With CT imaging, inadequate beam penetration can increase image noise. Increasing the kVp to 140 as well as increasing the effective mAs can reduce noise. This can be accomplished, for example, by slowing the gantry rotation speed to one rotation per second instead of one rotation per half-second. However, because this tactic increases patient radiation dose, the decision to use the higher dose must be weighed against the improved image quality. Another possible limitation of CT imaging of obese adolescent patients is that beam-hardening artifacts can occur when the patient’s body is larger than the field of view. To minimize this problem, the patient should be positioned so that the area of interest lies within the field of view. Although it is possible to crop subcutaneous fat from CT images to focus on internal organs, this is not recommended; cropping subcutaneous tissue can interfere with diagnoses such as certain malignancies.

When performing MR examinations, radiologic technologists should use the smallest field of view appropriate for the area of interest because larger fields of view are associated with lower image resolution. Technologists also can improve MR image quality for obese patients by using a body coil instead of a phased-array multicoil. Another helpful technique is using saturation bands to reduce noise from subcutaneous fat. Some imaging facilities provide padding where an obese patient’s body contacts the bore to prevent possible skin burns.

Preventing Obesity in Children and Adolescents

Parents, schools, health care providers, and communities can help prevent overweight and obesity in children and adolescents, although there are inherent challenges. For example, in 2003, Arkansas mandated annual BMI assessment for public school students, with reporting of results to parents. However, it is not yet clear whether this type of public health program is effective for preventing or reducing obesity. Well-child checkups are another opportunity for intervention and prevention. The American Academy of Pediatrics recommends annual evaluation of children’s weight using BMI, as well as discussion about diet and exercise habits for early intervention if a weight problem begins to develop. The 3 periods during childhood that are particularly associated with changes in the rate of adipose tissue gain are the first year of life, ages 3 to 7 years, and menarche in girls. These periods might represent the best windows of opportunity for intervention.

In addition, an expert committee of clinicians and scientists convened by the American Academy of Pediatrics made the following recommendations to help parents and families prevent overweight and obesity in children and adolescents:

- Limit screen time to 2 hours per day.
- Engage in one hour of moderate to vigorous physical activity every day.
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**Box 3**

**School Lunch and the Healthy Hunger Free Kids Act**

The Healthy Hunger Free Kids Act of 2010 was designed to ensure access to healthy foods for children in low-income families. One of its objectives is to improve the nutritional quality of meals served in schools, including preschools. As a result of the act, nutrition standards for school meals were updated to require more whole grains, fruits, vegetables, lean protein, and low-fat dairy foods. The new standards also call for less sugar, fat, and sodium.

The U.S. Department of Agriculture reported that more than 90% of schools are now in compliance with the new standards, and that the healthier meals have been well received in many schools. However, the changes also have generated controversy. Some school officials reported that students don’t like some of the new foods introduced to meet the updated standards, and that food waste and costs have both gone up. Unwanted fruits and vegetables, in particular, tend to end up in trash cans. In addition, some students have complained that the new lunches have left them feeling hungry.

Furthermore, a meta-analysis by the Cochrane Collaboration suggested that schools have an important role to play in preventing obesity. The analysis included 37 studies of obesity prevention programs involving 27,946 children, mostly aged 6 to 12 years. The researchers concluded that some of the more helpful preventive strategies were:

- Including healthy eating, physical activity, and body image education in the school curriculum.
- Increasing the amount of physical activity during the school day.
- Serving healthier food in schools.

For more on the federal government’s recent efforts to improve the nutritional quality of meals served in schools, see **Box 3**.

One of the main challenges for children in learning to eat healthfully is the marketing of low-nutritional-value foods to children and adolescents, which includes not only television advertisements, billboards, and product placements in games, toys, movies, and music, but also Internet ads and mobile phone text messages. Half of the foods marketed to children are candy, gum, or similar items; one-quarter are other sugary or salty snack foods; and one-quarter are healthier foods such as bottled water. In addition, fast-food restaurant ads are ubiquitous in children’s television programming and on Web sites aimed at children. A meta-analysis of 123 studies suggested a likely link among food marketing to children, children’s food choices, and overweight and obesity among children. Moreover, the harmful effects of advertising food to children are more pronounced among children who are already overweight or obese and in younger children.

Another difficulty is that programs intended to teach children and families about healthy eating might not have long-term effects. For example, a randomized controlled trial examined the effectiveness of a 5-session pilot program for parents and their children. The program, intended to prevent overweight and obesity in the children, included sessions on nutrition, cooking skills, taste testing, meal preparation, and parent discussion groups. Although the program’s participants showed improvements in terms of choosing healthier foods compared with the control group, the improvements were not maintained 6 months later.

**Treatment**

Treating overweight and obesity in children and adolescents is problematic for several reasons. Many pediatricians do not suggest treatment unless an obese
loss, such as 1 lb to 2 lb per month, might be advised for some older adolescents.  

An expert committee convened by the American Academy of Pediatrics endorsed a staged approach to obesity treatment. The committee outlined 4 stages, with increasing intensity. For many patients, starting with the least-intensive stage is appropriate, then switching to a more-intensive stage if needed and if patient and family motivation allow. Other patients might begin at a higher treatment stage. The stages are as follows:

- **Prevention Plus** – Focuses on healthy eating and activity habits, with increased physician monitoring.
- **Structured Weight Management** – Provides more support and structure than Prevention Plus, including a diet or daily eating plan developed by a dietician, as well as planned, supervised physical activity. This stage might include monthly office visits with a pediatrician and family counseling sessions, if needed.
- **Comprehensive Multidisciplinary Intervention** – Involves a team of specialists, more frequent office visits, and more intense behavioral changes. For example, a behavioral counselor, dietician, exercise specialist, and pediatrician might collaborate to support the patient and his or her family. Weekly office visits might be planned for 2 to 3 months, followed by monthly visits.
- **Tertiary Intervention** – Reserved for severely obese pediatric patients who already have attempted weight control with a comprehensive multidisciplinary intervention. Medication, meal replacements or a very-low-calorie diet, and surgery might be included at this stage.

The American Academy of Pediatrics recommends weight-reducing diets that provide fewer calories than are needed to maintain weight, but in no case less than 1200 calories per day. Another approach is to consume 300 to 400 fewer calories than needed for weight maintenance. Long-term studies show no differences in the effectiveness of various diets based on their macronutrient content. Low-carbohydrate, high-protein diets, for example, have not been well studied in children. However, one study demonstrated that this approach can be as effective as a conventional...
portion-controlled diet, although adherence rates were lower with the low-carbohydrate diet. 25

One popular program for improving children’s diets and controlling weight is the “traffic light” approach developed by Leonard Epstein, PhD. 26 In this system, foods are classified as red, yellow, or green. Red foods are high in calories and sugar or fat and should be considered occasional treats. Children are taught to stop and think before consuming these foods and might be instructed to consume them only a few times a week. 26 Yellow foods include lean meats and whole-grain foods that are moderately high in calories. Although these foods make up an important part of a healthy diet, children should slow down with yellow foods and think about appropriate portion sizes. Green foods include fruits, vegetables, water, and nonfat milk. Children should be encouraged to eat as much of these as they like, ideally at least one serving of fruit, one serving of vegetables, and water or nonfat milk at each meal. 41

The goal of the traffic light system is to provide maximum nutrition with minimal energy intake. 24 In studies involving children on the traffic light diet, caloric intake ranged from 900 to 1500 calories per day, and participants demonstrated modest, sustained decreases in BMI even 5 and 10 years after the intervention. 28,33 One possible limitation of the traffic light approach is that it has been studied primarily with white, middle-class children aged 6 to 12 years 28 and might not be as effective in adolescents or children of other races, ethnic groups, or socioeconomic statuses.

One strategy shown to be ineffective is parental control or restriction of children's and adolescents' food intake. 25 This approach increases the risk of overweight and obesity later in life, possibly because it interferes with children's sense of satiety and their ability to regulate their own eating. Children who are subjected to dietary control by their parents might be more likely to snack, to choose less healthy foods, and to eat when they are not hungry. 25

Rather than controlling or restricting what their children eat, parents should instead focus on the following 25:

■ Eat family meals together.
■ Stock plenty of fruits and vegetables at home.
■ Encourage children to drink more water.
■ Help children and adolescents form a self-identity that includes their accomplishments and personal characteristics other than physical appearance.

■ Provide a safe haven at home from weight-related teasing at school or in other settings.

Interventions that increase physical activity have had mixed results in terms of decreasing BMI. 27 Studies have shown that increasing activity decreases BMI in both children and adolescents. 28 For example, one randomized controlled trial examined results of a 2-month program in which children and their parents participated in a weekly physical activity that lasted 2 hours and was designed to be fun. 24 Children who participated in the program showed improvement in their BMI, waist circumference measurement, body composition, cardiovascular fitness, and other measurements compared with the control group. 24 Conversely, another randomized controlled trial of a physical activity program for preschool-aged children failed to show improvement in BMI at 6-month and one-year follow-up. 25

Generally, a nonpharmaceutical approach is preferred for treating obesity in children and adolescents, but in some cases medication can be helpful. Antiobesity medications suppress the appetite, impair absorption, or raise energy expenditure. 5,33 Orlistat, for example, is a lipase inhibitor that prevents absorption of fat. 20,33 Currently, orlistat is the only drug approved by the U.S. Food and Drug Administration for weight loss in children 12 years and older. 33 Although it has been shown to be slightly effective when used in combination with lifestyle changes, orlistat also is associated with adverse effects that include abdominal pain, fecal incontinence, and cholelithiasis (gallstones). 20

In a randomized controlled trial comparing orlistat with a placebo in a group of adolescent patients, the patients taking orlistat decreased their BMIs by an average of 0.55 compared with a BMI reduction of 0.31 in patients assigned to take a placebo. 33 However, the patients taking orlistat were more likely to report gastrointestinal symptoms (up to 50% of patients) than were the patients taking a placebo (up to 13%). 33 Consequently, drug treatment typically is recommended for adolescent patients only when obesity is severe and comorbidities have been diagnosed. 10

Weight-loss surgery is the only treatment for obesity that has proven, long-term effectiveness, 62 and it is being
performed more commonly on obese adolescents. Specifically, bariatric surgery might be considered for patients with severe obesity and comorbidities who have completed puberty. For instance, Han suggested that only patients with a BMI of 50 or greater, or 40 or greater with significant comorbidities, should be considered for bariatric surgery and then only with caution. Because the long-term adverse effects in adolescents have not been well studied, these patients should have long-term follow-up care.

There are 2 types of bariatric surgery: procedures that restrict the stomach’s capacity, such as gastric banding, and procedures that interfere with absorption, such as gastric bypass. Both are associated with potentially serious complications including nutritional deficiencies. However, bariatric surgery can improve quality of life for some obese adolescents and resolve obesity-related comorbidities in many patients.

For example, Nadler and colleagues evaluated a group of 50 obese adolescents, aged 14 to 18 years, who underwent gastric banding surgery with the Lap-Band device (Inamed Corporation). All of the patients had BMIs greater than 40 (mean weight 299 lb) and unsuccessful attempts to lose weight with medical supervision. The patients were evaluated before surgery and at follow-up for a number of comorbid conditions associated with obesity, including dyslipidemia, back pain, hypertension, and depression. Patients also were evaluated presurgery and postsurgery for impaired glucose tolerance, dyspnea, osteoarthritis, obstructive sleep apnea, asthma, and gastroesophageal reflux.

Among patients who completed follow-up at one year, the mean weight was 227 lb and the average percentage of excess weight lost was 46%. More fat mass than lean mass was lost, although the patients also lost a significant amount of lean mass. In addition, 55% of the patients’ comorbid conditions resolved completely after surgery, and 29% of the comorbidities improved compared with presurgical assessments. Among patients with dyslipidemia, however, some showed improvement but others worsened or had no change. No complications occurred during the surgeries, although 2 patients subsequently dropped out of the study because of adverse events including gastric perforation. Nonetheless, the authors concluded that the surgery is “an excellent option” for weight loss in certain extremely obese adolescents.

Public Policy Recommendations

Battling the obesity epidemic might require more than individual, family, school, and community efforts. Changes in public policy also might be necessary. An HBO documentary series on obesity in America, for example, discussed the need for changes in the way government supports the farming industry, such as reducing subsidies that keep the cost of fast food artificially low and increasing support for small and medium-sized farms that produce fruits and vegetables. Another policy recommendation is restricting advertising for less-healthy foods and beverages while increasing public funding for efforts aimed at improving eating habits and physical activity levels. In addition, some public health experts have called for mandatory physical education for students of all ages and health insurance premium structures that include incentives for maintaining a healthy weight.

Changing the patterns that contribute to overweight and obesity is an enormous, long-term societal challenge. But as one obesity expert suggested, it seems less daunting when considered in light of similar public health challenges already being confronted successfully. For example, seat belt laws have reduced traffic fatalities and injuries, antismoking campaigns are helping to prevent lung cancer, and education about safer sex and sexually transmitted disease screening has slowed the spread of AIDS. The same resources and commitment can help reverse the pandemic of childhood obesity.

Conclusion

Obesity among children and adolescents is an international problem, and is particularly severe in the United States. Obese and overweight children and adolescents suffer from an array of weight-related problems, including psychological and quality-of-life concerns as well as cardiovascular, metabolic, orthopedic, and other complications. Recent evidence suggests that the prevalence of childhood obesity in the United States might be leveling, although it remains high in some ethnic and racial groups and in some areas of the country. Obesity can create special imaging challenges and might require
a customized approach, so radiologic technologists and radiologist assistants need to be knowledgeable about caring for this patient population. Experts recommend that obesity treatment for children and adolescents follow a staged approach, beginning with lifestyle changes and progressing to medication or surgery only under certain circumstances. Preventing and reducing obesity among young people requires the united efforts of parents, schools, health care professionals, communities, and public policy makers.

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References


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1. According to guidelines from the American Academy of Pediatrics, a pediatric patient should be categorized as _______ if his or her body mass index (BMI) is between the 85th and 94th percentiles for children or adolescents of the same sex and age.
   a. high-normal weight
   b. at risk for obesity
   c. overweight
   d. morbidly obese

2. Which of the following are advantages of whole-body dual-energy x-ray absorptiometry scanning for assessing obesity?
   1. low radiation dose
   2. can be used to calculate fat, lean, and total tissue mass
   3. distinguishes between visceral and subcutaneous fat
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

3. Recent data suggest that overall obesity rates might have begun leveling among children and adolescents in the United States.
   a. true
   b. false

4. According to the 2009-2010 National Health and Nutrition Examination Survey, prevalence of obesity was highest among children and adolescents of which racial or ethnic group?
   a. non-Hispanic whites
   b. non-Hispanic blacks
   c. Hispanics
   d. Asian/Pacific Islanders

5. African Americans typically have less _______ fat than whites and Hispanics with similar total body fat, although the reasons for this difference are unknown.
   a. subcutaneous
   b. peripheral
   c. visceral
   d. abdominal
6. In most cases, childhood obesity is caused by:  
   a. genetic syndromes.  
   b. endocrine disorders.  
   c. prescription medications.  
   d. caloric imbalance.  

7. Which of the following have been identified as possible contributors to overweight and obesity in adolescents?  
   1. inadequate sleep  
   2. less-satiating diets  
   3. eating meals while watching television  
   a. 1 and 2  
   b. 1 and 3  
   c. 2 and 3  
   d. 1, 2, and 3  

8. Which of the following was not one of several positive trends identified by Iannotti and Wang in their surveys of 6th to 10th grade students between 2001 and 2010?  
   a. More students ate fruits and vegetables daily.  
   b. Consumption of sweets decreased.  
   c. More students ate meals with their families.  
   d. Television viewing decreased.  

9. According to the study by Maggio and colleagues of overweight, obese, and extremely obese children and adolescents, which of the following was the most common complication, affecting nearly 80% of study participants?  
   a. hypertension  
   b. dyslipidemia  
   c. orthopedic abnormalities  
   d. quality-of-life issues such as bullying  

10. All of the following were findings of the Pathological Determinants of Atherosclerosis in Youth study that examined young trauma victims’ coronary arteries and aortas postmortem except:  
   a. Obesity was associated with right coronary artery lesions and fatty streaks in young men.  
   b. Obesity was associated with stenosis in the left anterior descending artery in young men.  
   c. Obesity was not associated with atherosclerosis in young women.  
   d. Arterial lesions were more pronounced in study subjects with peripheral adiposity vs central adiposity.  

11. Acanthosis nigricans is:  
   1. an abnormally darkened, thick area of skin.  
   2. often located on the neck, armpit, or groin.  
   3. very common in obese children and adolescents with type 2 diabetes.  
   a. 1 and 2  
   b. 1 and 3  
   c. 2 and 3  
   d. 1, 2, and 3  

12. Dietary risk factors for nonalcoholic fatty liver disease include high consumption of all of the following except:  
   a. sucrose.  
   b. carbohydrates.  
   c. saturated fats.  
   d. fructose.  

13. A growth disorder of the tibia caused by excessive force on the growth plate is called:  
   a. slipped capital femoral epiphysis.  
   b. Blount disease.  
   c. Osgood-Schlatter disease.  
   d. Paget disease.
14. One study of obese children and adolescents found that they have a similar likelihood of impaired quality of life as children and adolescents with:
   a. asthma.
   b. type 1 diabetes mellitus.
   c. congenital heart disease.
   d. cancer.

15. Because the x-ray beam might not adequately penetrate an obese body, increasing the kilovoltage peak and milliampere seconds might be necessary to obtain diagnostic-quality images.
   a. true
   b. false

16. According to the article, which techniques improve computed tomography (CT) imaging of obese adolescent patients?
   1. Slow the gantry rotation speed.
   2. Position the patient so that the area of interest lies within the field of view.
   3. Crop subcutaneous body fat from the images to focus on internal organs.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

17. According to the article, which techniques improve magnetic resonance imaging of obese adolescent patients?
   1. Use the smallest field of view appropriate for the area of interest.
   2. Use a phased-array multicoil instead of a body coil.
   3. Use saturation bands to reduce noise from subcutaneous fat.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

18. Half of the foods marketed to children are:
   a. fast-food restaurant menu items.
   b. candy, gum, or similar items.
   c. soda and other sugary beverages.
   d. salty snacks such as chips.

19. A randomized, controlled study revealed that one problem with programs intended to prevent obesity by teaching children and families about healthy eating is that:
   a. parents say they do not have time to participate.
   b. children have difficulty understanding and remembering the information.
   c. effects might not be long term.
   d. the programs are prohibitively expensive to develop and administer.

20. In the staged approach to obesity treatment proposed by an expert committee, which is the initial, least-intensive treatment stage for obesity and overweight in the pediatric population?
   a. Tertiary Intervention
   b. Comprehensive Multidisciplinary Intervention
   c. Structured Weight Management
   d. Prevention Plus

21. According to the traffic light approach to weight control, which of the following would most likely be considered yellow-light foods?
   a. candy and soda
   b. French fries and hamburgers
   c. whole-wheat bread and tuna fish
   d. nonfat milk and apples

22. Which parenting practice is not recommended to help children manage their weight?
   a. parental control of children’s food intake
   b. regularly eating meals together as a family
   c. stocking fruits and vegetables in the home
   d. encouraging children to drink more water

continued on next page
23. Orlistat, a weight-loss drug approved for use in adolescents aged 12 years and older, has been shown to be slightly effective when combined with lifestyle changes. However, orlistat also is associated with adverse effects such as:
   1. fecal incontinence.
   2. abdominal pain.
   3. hypoglycemia.
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3

24. In Nadler et al’s study of 50 obese adolescents who underwent gastric banding surgery, which comorbidity did not consistently improve postsurgery and worsened in some patients?
   a. back pain
   b. depression
   c. dyslipidemia
   d. hypertension

25. According to the article, which public policy changes might help reverse trends in childhood obesity?
   1. restricting advertising for less-healthy foods
   2. increasing government support for farms that produce fruits and vegetables
   3. mandating physical education for students at all levels
   a. 1 and 2
   b. 1 and 3
   c. 2 and 3
   d. 1, 2, and 3