Obesity in Children and Adolescents

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Objectives

After completing this article, readers should be able to:

1. Describe the appropriate use of the body mass index.
2. Delineate the relationship between sedentary activities such as television/video viewing and overweight.
3. Explain when clinicians should screen for impaired glucose tolerance in overweight children and adolescents.
4. Explain the expected results of thyroid studies in tall-for-age obese children.
5. List the psychiatric disorders for which obese children and adolescents should be screened.
6. Describe the management approach to obesity in overweight children and adolescents.

Introduction

Obesity has grown to epidemic proportions in children and adults. The medical consequences of obesity, including heart disease, hypertension, and diabetes, also have increased. Hospital costs from obesity-related diseases in youth have increased from $35 million (0.43% of total hospital costs) during 1979 to 1981 to $127 million (1.79% of total costs) during 1997 to 1999. Thus, it has become increasingly important to identify the risk factors predisposing to obesity and to identify youth who are overweight and at risk for becoming overweight. To prevent both the medical and psychological complications of obesity, treatment should be started as early as possible

Definitions and Epidemiology

Although there are several methods of describing overweight, body mass index (BMI), defined as weight in kilograms divided by height in meters squared (kg/m^2), has become the acceptable format for children, adolescents, and adults. The correlation of BMI with measures of adiposity is excellent in adults, but slightly less reliable for children, whose BMI changes with age during childhood and adolescence. Adiposity is influenced by several factors, including age, sex, pubertal stages, waist-to-hip ratio, and race. Boys have less body fat than do girls at the same BMI. Maturational level is more important than age, with those who are further along in puberty having more body fat. Those who have a higher waist-to-hip ratio at the same BMI have more body fat. With increasing age, blacks ultimately have more adiposity than whites. Although BMI is not perfect, it is the most acceptable gross screening measure for overweight. In 2000, the Centers for Disease Control and Prevention (CDC) released new growth curves, including BMI curves for boys and girls from ages 2 to 20 years (www.cdc.gov/growthcharts). Overweight has been defined by experts in the field as a BMI greater than the 95th percentile for age on the 2000 CDC growth curves. Children whose BMIs fall between the 85th and 95th percentile for age are considered "at risk" for becoming overweight. The adult definition of obesity is a BMI of 30 or more.

Data on overweight have been collected as part of the National Health and Nutritional Examination surveys (NHANES). To date, there have been four NHANES surveys:

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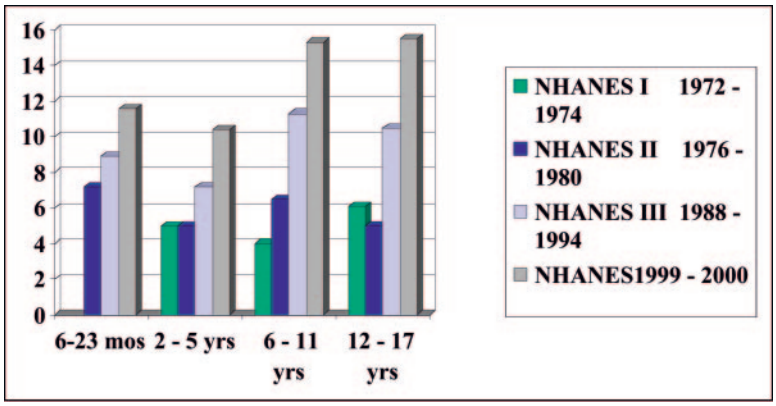

Figure 1. Prevalence of overweight as percent of age group from the NHANES studies.

NHANES I (1971 through 1974), NHANES II (1976 through 1980), NHANES III (1988 through 1994), and NHANES 1999 through 2000. The percent of children and adolescents who were overweight has increased substantially from NHANES II to III and again to NHANES 1999 to 2000 (Fig. 1). According to the NHANES 1999 to 2000 data, 15% of children and adolescents ages 6 to 19 years of age were considered overweight; an additional 15% were "at risk" for becoming overweight. Thus, 30% of children and adolescents ages 6 to 19 years were either overweight or at risk of becoming overweight. Among males ages 6 to 11 years, the prevalence of overweight increased from 3.8% to 16% from the NHANES I to NHANES 1999 to 2000 surveys. For females in the same age group, the prevalence of overweight increased from 3.6% to 14.5%. For males ages 12 to 17 years, the prevalence rate of overweight increased from 5.4% to 15.5%, and for females in the same age bracket, the prevalence of overweight increased from 6.4% to 15.5%. For younger children (ages 2 to 5 y), the prevalence of overweight doubled from the NHANES I to the NHANES 1999 to 2000 data set at 5% and 10%, respectively.

Interestingly, no racial differences in overweight were found in the NHANES III data, but there was an increase in overweight among non-Hispanic black and Mexican-American adolescents on the NHANES 1999 to 2000 data. The respective prevalences of overweight were 19.5% and 23.7% in the 6- to 11-year-old group and 23.6% and 23.4% in the 12- to 19-year-old age group. This increase was specific to older children and adolescents and was not seen in those ages 2 to 5 years. In the National Heart, Lung and Blood Institute's Growth and Heart Study, differences between black and white females were delineated. Adiposity in all females increases nonlinearly, with the largest increases at the onset of puberty and menarche. Blacks entered puberty earlier than whites, so for the same chronologic age, blacks had more adiposity than their white counterparts. However, even after adjusting for pubertal maturation, after age 12 years, blacks had greater adiposity than whites. The accumulation also increased more in blacks than in whites among teens ages 17 to 19 years. Other racial groups also have been examined. In Native Americans, such as the Pima Indians, the prevalence of overweight in children and adolescents is 30% to 40%. More data on ethnic groups are needed.

Pathogenesis

The pathogenesis of overweight most likely is a combination of genetic, environmental, and behavioral factors that still are being clarified. Predictors of overweight and increased adiposity include early childhood obesity, elevated parental BMI, and increased fasting blood insulin (and associated decreased insulin sensitivity) and blood leptin levels.

Over the past decades, children have become less physically active, spending more time in sedentary entertainment activities, including viewing TV and playing computer and video games. Fewer children walk to school. Physical education requirements also have changed, such that those not involved in athletic team sports may be less physically active in school. A 2% increase in the prevalence of obesity has been documented for each extra hour per day of TV viewing by those 12 to 17 years of age. Blacks spend more time than whites watching TV. Those who have a TV in their room are likely to spend more time watching compared with those who do not. Less parental education and more poverty also have been correlated with increased TV viewing and adiposity.

Food choice and availability have been associated with increased BMI. The availability of high-fat fast foods and the decreased number of family meals result in less fruit and vegetable consumption and higher fat food consumption. Children from lower socioeconomic groups have a higher saturated fat intake. Parents' level of adiposity and food preferences also affect children's preferences.

Overweight runs in families. Parental obesity more

than doubles the risk of adult obesity in children younger than age 10 years, whether or not they are obese at that age. Although birthweight per se is not predictive of obesity in adulthood, obesity in children older than age 3 years predicts obesity in adulthood and is compounded if there is an obese parent. The contribution from genetics versus environment has been addressed by studies of adopted children and twins. Studies of adopted children reveal that their BMIs resemble more closely those of the biologic parents than of the adoptive parents. Studies of twins suggest the heritability of obesity to be between 40% and 70%, with concordance of 0.7 to 0.9 for monozygotic twins and 0.35 to 0.45 for dizygotic twins. Many genes have been identified that can cause obesity. Mutations in leptin, leptin receptor, neuropeptide Y, pro-opiomelanocortin, prohormone convertase 1, and melanocortin receptor MC4R all have been identified and linked to obesity. Genome-wide scans have localized obesity loci on many chromosomes, including 2, 5, 10, 11, and 20. The most common forms of obesity are believed to be polygenic. The field of the genetics of obesity is expanding and changing rapidly, but genetic influence, as important as it is, does not explain the rapid temporal increase in obesity over the past 30 years.

Table 1. Etiologic Considerations for Overweight Children and Adolescents

Endocrine Disorders
• Cushing syndrome
• Hypothyroidism
• Pseudohypoparathyroidism
• Type 2 diabetes
Genetic Syndromes
• Prader-Labhard-Willi syndrome
• Bardet-Biedel syndrome
• Cohen syndrome
Central Nervous System Disorders
• Hypothalamic tumor
• Trauma
• Inflammation
Miscellaneous
• Drug-induced (eg, risperidone, tricyclic antidepressants)
• Binge eating disorder
• Bulimia nervosa

Clinical Assessment

Because the prevalence of obesity is increasing, it is imperative that clinicians learn to recognize and define the problem by performing an appropriate history and physical examination, followed by selected laboratory studies. Although most overweight children and adolescents have exogenous or primary obesity, genetic syndromes, hypothalamic tumors, or endocrinopathies can present with overweight as the initial symptom. Selected causes of secondary obesity are listed in Table 1.

The initial history should include a thorough review of systems, with attention to respiratory difficulties, endocrine disturbances, and orthopedic complaints (Table 2). Relevant family history should identify relatives who are obese and those who have premature coronary artery disease, elevated lipid levels, diabetes, or hypertension. Family members who have such conditions at young ages are especially significant. Social history should include family and peer activity, cooking routines, frequency of family meals, and levels of both physical and sedentary activity. Additionally, the clinician should screen the patient for issues of self-esteem, depression, and eating disorders during this part of the history.

The physical examination provides objective data about body size and screens for comorbid diagnoses. As described earlier, most authorities use the BMI as a clinical screening tool for overweight and risk for overweight. Accurate assessment of height is important because most exogenously obese patients are tall for their age. The obese patient who is short for age is more likely to have an endocrine or genetic syndrome accompanying the condition. Height, weight, and BMI should be plotted on the growth curve. Comparison to other points in time is very helpful in tracking the problem. Other, more complex measurements of body fat determination, such as triceps skinfold testing or bioelectric impedance testing, probably are too labor-intensive for most busy practitioners.

Once the BMI has been evaluated, blood pressure should be measured and compared with age-matched norms. Use of the appropriate blood pressure cuff, in which the bladder of the cuff covers two thirds of the upper arm and completely encircles the arm, is essential to avoid errors in diagnosing hypertension. General appearance is assessed for distribution of adiposity and presence of syndromic features. Funduscopic examination screens for blurring of optic disc margins, which could indicate pseudotumor cerebri. The neck is examined for thyromegaly. Each patient should have thorough Sexual Maturity Rating staging for evaluation of pubertal status. Examination of the skin may reveal stria or acanthosis nigricans (Figure).

Table 2. Components of a Clinical History for Overweight Children and Adolescents

Family History

- Presence of obesity in siblings/parents/grandparents
- Hypertension
- Thyroid disease
- Premature atherosclerosis
- Hyperlipidemia
- Diabetes, type 2
- Cancers (eg, colorectal, breast)

Social History

- Composition of the home nuclear family
- Attendance and grades in school
- Location of meals and snacks
- Participation in organized sports
- Hours per week of physical education
- Home exercise equipment
- Hours of television viewing per day plus location of TVs in home
- Computer/video game activity
- Formation of appropriate peer group
- History of depression
- Symptoms of bulimia nervosa or binge eating

The full assessment of the patient following the physical examination includes laboratory analysis to screen for comorbidities and alternate causes for the overweight condition. Most clinicians base laboratory testing on family history and findings on examination. The recommended laboratory testing includes fasting lipid protein analysis and a metabolic profile, particularly fasting glucose levels and liver and kidney function testing. Some authors recommend thyroid function screening for all overweight children; others select only those who are of relatively short stature, are female, or have a family history of thyroid disease. Further screening for type 2 diabetes and insulin resistance often is pursued if acanthosis nigricans is found on physical examination or if a strong family history is revealed. The test that best detects insulin resistance remains controversial. The usual recommendation is a 2-hour glucose tolerance test. Impaired glucose tolerance is defined as a 2-hour blood glucose level of 140 mg/dL (7.8 mmol/L) after a 75-g glucose load; diabetes is strongly considered if the postprandial level is greater than 200 mg/dL (11.1 mmol/L). In addition, clinical data support the use of fasting glucose/insulin ratios to determine the degree of insulin resistance. A glucose/insulin ratio of less than 7 has been found to predict insulin resistance in young girls who have had premature adrenarche. Fasting insulin levels may be used as a screen for type 2 diabetes mellitus, as well. Hopefully, better standardized tests for diagnosing insulin resistance will become available in the near future.

Figure. Acanthosis nigricans.

Patients who have exogenous obesity are at risk for several complications that often require referral to subspecialists for assistance in management (Table 3). These include respiratory conditions such as obstructive sleep apnea, asthma, Pickwickian syndrome, and chronic snoring. Pediatric pulmonologists can provide resources such as sleep study evaluations and prescription of bilateral intermittent positive airway pressure or continuous positive airway pressure to allow for positive airway pressure during sleep. Surgical interventions such as tonsillectomy or adenoidectomy also may be indicated.

Orthopedic disorders in overweight children may go unrecognized. Hip pain may indicate slipped capital femoral epiphyses, seen in early puberty, or Legg-Calvé-Perthes disease in younger children. Blount disease due to overgrowth of the proximal tibial metaphysic, seemingly from excess mechanical stress on the knees leading to tibial bowing, is common.

Gastrointestinal problems include steatohepatitis and gallbladder disease. Cardiovascular complications of obesity include hypertension and dyslipidemias. Hyperinsulinism, insulin resistance, impaired glucose tolerance, and type 2 diabetes mellitus are endocrinologic complications of obesity. The combination of obesity, insulin resistance, dyslipidemia, and hypertension recently has been named "metabolic syndrome X." Having this syndrome seems to increase the risk for both type 2 diabetes and coronary heart disease.

Gynecologic conditions that often accompany obesity

Table 3. Complications of Obesity

Respiratory	
• Sleep apnea	
• Snoring	
• Pickwickian syndrome	
• Asthma	
Orthopedic	
• Blount disease	
• Slipped capital femoral epiphysis	
Gastrointestinal	
• Gallbladder disease	
• Steatohepatitis	
Cardiovascular	
• Dyslipidemias	
• Hypertension	
Endocrinologic	
• Insulin resistance	
• Hyperinsulinism	
• Impaired glucose tolerance	
• Type 2 diabetes	
• Polycystic ovarian syndrome	
• Menstrual irregularity	
Psychological	
• Depression	
• Eating disorders	
• Social isolation	

include menstrual irregularity, polycystic ovarian syndrome (PCOS), or ovarian hyperandrogenism, and early initiation, although usually not precocious, puberty. PCOS often presents with irregular menses, acne, and hirsutism and is accompanied by insulin resistance in about 30% of cases. Management of PCOS must address the protean presentations of the condition and proceed in conjunction with adolescent medicine specialists, endocrinologists, or gynecologists.

Finally, the psychosocial concerns that accompany overweight are ubiquitous. Poor self-image and social isolation are the rule, especially in severely overweight individuals. In younger children, obesity may isolate them from opportunities to participate in sports and other physical activities, thus producing a vicious cycle of inactivity and overeating. Low self-esteem has been found in obese children as young as 5 years of age. Problems of self-esteem may manifest in adolescence as depression, eating disorders (including binge eating and bulimia nervosa), and poor performance in school. This effect has been magnified in girls, especially in Hispanics and whites. The work of Strauss and others has documented reduced self-esteem in cohorts of obese children from ages 9 to 10 years to 13 to 14 years and significantly higher rates of sadness and loneliness and of smoking and alcohol use in those whose self-esteem declined.

Management

Treatment of obesity is viewed best as managing a chronic disease, rather than expecting a "cure." Thus, the clinician should set reasonable goals for the patient and family. As with the management of other chronic diseases, a team of practitioners should provide multidisciplinary guidance to the patient and family. The first step in evaluating any obese patient is to assess his or her readiness for change. Clearly, if the child or family is not acknowledging a problem, treatment will be difficult. Yet, many children and adolescents are motivated to lose weight and don't have the tools to accomplish the task. The three primary components of therapy are dietary modification, increased physical activity, and behavioral modification for both the patient and the family.

Several options exist for dietary management. Except in dangerously obese children, the child's growth and development should not be compromised by an excessively restrictive diet. In fact, weight maintenance over a period of time can change the BMI in a growing child significantly. Often, just eliminating snacking and reducing high-sugar/high-fat foods or drinks can result in some weight loss. Many dietitians recommend keeping a food journal because both children and families tend to underreport intake. The process of journaling often provides insight into the source of additional calories. One diet that is popular is the "traffic light" diet. This categorizes food into "green foods" that can be eaten in unlimited quantities (nonfat or low-fat foods such as fish, most fruits and vegetables, fat-free milk, and fat-free cheeses), "yellow foods" that are eaten with more caution (low- to moderate-fat foods such as whole grain breads/pastas, beans, barley, sweet potatoes), and "red foods" that are eaten rarely (high-fat foods such as nuts, butter, margarine, chocolate, candy, fried foods, salami). Some data support this diet for school-age and preadolescent age groups, with a reduction in "red food" consumption even after treatment has concluded. This diet has shown long-term success when combined with both behavioral and exercise components.

For more severe obesity, a high-protein, low-fat, ketogenic diet has been studied, usually with intensive medical and nutritional support. Willi and associates treated six morbidly obese teenagers for 20 weeks:

8 weeks with a very low-calorie ketogenic diet, followed by 12 weeks with a small amount of carbohydrate added. The patients lost approximately 15 kg during the ketogenic phase and an additional 2 to 3 kg once some carbohydrate was added. Blood chemistries remained normal, and serum cholesterol decreased. Sleep abnormalities improved as weight loss was achieved.

Exercise regimens are intended to increase calorie expenditure, increase muscle mass, and assist in weight control, but exercise alone rarely is successful in achieving meaningful weight loss. When combined with diet, however, exercise can be a powerful tool to enhance well-being and self-esteem. Aerobic activity often is recommended. Some programs use a 1-mile walk as an initial benchmark of fitness, gradually increasing the distance and speed. Others provide weekly supervised sessions with exercise physiologists and prescribe home aerobic activity, as well. Another exercise concept includes lifestyle exercise, which attempts to build in more exercise to regular activity, such as walking up and down stairs and parking further away from a destination. Some data show that this less structured approach may be easier to sustain long term but that modification must account for age and developmental abilities of the child.

The behavioral intervention may be the most important facet of obesity treatment. Ideally, it is provided through frequent group or individual treatment sessions. Frequent monitoring and feedback produce better outcomes. The treatment should be long term because of the chronicity of the condition and frequent recidivism. A behavioral program initially should screen for readiness to change and consists of three primary components: controlling the environment, self-monitoring, and contracting for reasonable goals. The home environment can be altered by removing high-risk foods and developing shopping and cooking routines geared toward the prescribed diet. The patient is taught how to regulate his or her behavior, such as reducing vending machine snacking at school. The goals need to be realistic and achievable, such as losing 1 to 2 lb per month. Any behavioral program should screen for psychiatric conditions, such as depression and eating disorders, particularly binge eating and bulimia nervosa. Referral for psychotherapy and, perhaps, pharmacotherapy may be necessary.

In cases of obesity where the patient is more than 100% ideal body weight, bariatric surgery has emerged as an option. Both gastroplasty, the formation of a 15- to 30-mL stomach pouch, or gastric bypass, the creation of a larger pouch that bypasses the duodenum to deliver food contents directly into the jejunum, have been gaining popularity in adults. One small study in adolescents found a plethora of complications, including renal disorders, gallstones, and nutritional deficiencies. Most experts do not recommend surgery for a pediatric population. Similarly, drug intervention with anorectic agents is associated with significant adverse effects and has shown only limited benefit in adults; these are not recommended for children.

Prognosis

Several clinical trials have examined obesity treatments, and many have had positive results. A study of overweight early adolescents compared a group treated with exercise (50 min of supervised aerobic activity three times a week), the American Dietetic Association diet, and behavioral change with a group treated with the same diet and behavioral change therapy without exercise, and a control group. The group with dietary and exercise interventions showed the most weight loss and improvement in lipoprotein levels; the control group gained weight. A recent study examining behavioral modification in children ages 8 to 13 years of age compared child self-regulation training with no additional training in two groups given nutrition and exercise information. Although both groups initially lost weight, the group that had been taught self-regulation skills continued to lose weight on follow-up, and the control group gained weight. Additional studies have compared exercise, various behavioral modification modalities, and the benefit of parental training. Many have shown great success, even in long-term follow-up.

Barriers to treatment include lack of parental involvement, motivation, and time and training to deal with complex psychosocial issues that may be prominent in these families. Poor insurance reimbursement remains a tremendous disincentive for hospitals and clinics to provide the multidisciplinary services needed to treat overweight and obese patients effectively. Accordingly, primary care practitioners are in the position of being the entire multidisciplinary team, which can be overwhelming. Helping to motivate a young person to make changes and being supportive and encouraging of the ensuing ups and downs are key in filling this role. Clinicians have accomplished meaningful results by using a combination of diet, exercise, and behavioral therapy. Given the epidemiology of this condition, more specific methods need to become available for creative and safe treatment of obese patients in local care settings. In addition, more support programs aimed at prevention are paramount.

Suggested Reading

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PIR Quiz

Quiz also available at www.pedsinreview.org.

1. In addressing a group of residents on the topic of obesity in childhood and adolescence, you would want to emphasize that adiposity is:

   A. Directly related to sexual maturity rating.
   B. Independent of ethnic background.
   C. Independent of genetic sex.
   D. Inversely related to age.
   E. Inversely related to waist-to-hip ratio.

2. Among the following, the *best* predictor of adult obesity in a 5-year-old child is:

   A. Birthweight.
   B. Distance from home to school.
   C. Parental obesity.
   D. Saturated fat intake.
   E. Television viewing habits.

3. A 10-year-old girl has a BMI of 29. Her height has been increasing along the 90th percentile since age 2 years. Of the following, she is *most* likely to have:

   A. A hypothalamic tumor.
   B. An abnormal karyotype.
   C. An ACTH-secreting pituitary adenoma.
   D. An elevated thyroid-stimulating hormone level.
   E. Increased insulin resistance.

4. You have begun to provide care for a 15-year-old boy who has exogenous obesity. He is currently asymptomatic. Aside from a BMI of 32, his physical examination findings are normal. Among the potential complications of obesity, at this time you should especially focus on:

   A. Coronary artery disease.
   B. Sleep acidosis.
   C. Slipped capital femoral epiphysis.
   D. Social isolation.
   E. Stroke.

5. A 14-year-old girl has exogenous obesity. Her BMI is 28. She is interested in losing weight. To *best* ensure long-term success, you would recommend:

   A. A high-protein, low-fat, ketogenic diet.
   B. An anorectic agent.
   C. Behavioral intervention.
   D. Gastroplasty.
   E. Intense aerobic training.

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