

Evaluating Obesity and Cardiovascular Risk Factors in Children and Adolescents

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Obesity continues to be a growing public health problem. According to the 2003-2004 National Health and Nutrition Examination Survey, 17 percent of persons two to 19 years of age are overweight. The number of obese children and adolescents has tripled in the past 20 years. Obesity in adults is associated with cardiovascular risk factors including hypertension, dyslipidemia, and diabetes. The growing prevalence of overweight in children and adolescents is paralleled by the growth of its associated complications in that population: hypertension, diabetes, hyperlipidemia, and metabolic syndrome. A modification of the metabolic syndrome criteria designed for children and adolescents shows that as many as 50 percent of those who are severely overweight have the syndrome. The U.S. Preventive Services Task Force has not found sufficient evidence to support screening children for obesity or other cardiovascular risk factors. The American Academy of Pediatrics and the American Heart Association have adopted a more aggressive stance, based largely on consensus opinion. Current suggestions include focusing on children whose body mass indexes exceed the 85th percentile; who are rapidly gaining weight; who have a family history of type 2 diabetes or hypercholesterolemia; or who have hypertension or signs of insulin resistance. Physician advocacy for healthy communities and institutions that foster physical activity, good eating habits, and healthy lifestyles is also encouraged. (*Am Fam Physician*. 2008;78(9):1052-1058. Copyright © 2008 American Academy of Family Physicians.)

According to the Centers for Disease Control and Prevention (CDC), overweight in childhood and adolescence is defined as having a body mass index (BMI) at or above the 95th percentile for age and sex; a BMI between the 85th and 95th percentiles places a child in the at-risk-for-overweight category¹ (for a BMI calculator for children and teenagers see <http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx>). In the United States, obesity-related hospital costs among six- to 17-year-olds have increased threefold over the past 20 years, reaching \$127 million per year.² Data from the 2003-2004 National Health and Nutrition Examination Survey (NHANES) indicated that 17.1 percent of persons two to 19 years of age are overweight,³ up from 12 percent in the 1988-1994 report. The number of obese young persons in the United States tripled from 1980 to 2000,⁴ with similar trends in other countries. The implications of this increase are alarming and require special attention by health care professionals, parents, and the government.

Overweight children often become overweight adults.⁵ Obesity in adults increases

the likelihood of cardiovascular risk factors, including metabolic syndrome. According to the National Heart, Lung, and Blood Institute (NHLBI), metabolic syndrome is defined as having three of the five following cardiovascular risk factors: larger waistline, elevated triglyceride level, decreased high-density lipoprotein (HDL) cholesterol level, hypertension, and elevated fasting blood glucose level.⁶ The same associations are emerging in overweight young persons. Approximately 60 percent have at least one cardiovascular risk factor, and more than 25 percent have two or more risk factors.⁷

This article reviews how the obesity epidemic is shifting typically adult diseases (i.e., hypertension, dyslipidemia, diabetes, and metabolic syndrome) into childhood. Implications for practice, including screening, management, and prevention, will also be considered.

Adult Diseases Affecting Children HYPERTENSION

Childhood hypertension is defined by a systolic or diastolic blood pressure at or above the 95th percentile when adjusted for sex, age, and height. The incidence of persistent

SORT: KEY RECOMMENDATIONS FOR PRACTICE

<i>Clinical recommendation</i>	<i>Evidence rating</i>	<i>References</i>	<i>Comments</i>
Recommend a healthy diet and physical activity as prevention and treatment for overweight.	C	6, 28, 29, 32	According to the USPSTF, ²⁸ there is insufficient evidence to recommend for or against routine counseling in unselected patients in primary care.
Consider screening at-risk children and adolescents for hypertension, diabetes, and elevated lipid levels.	C	6, 29, 33-36, 38	According to the USPSTF, ³¹ there is insufficient evidence to recommend screening for these conditions.
Consider a multidisciplinary weight loss approach to improve cardiovascular risk factors.	C	42, 43	According to the USPSTF, ²⁸ there is insufficient evidence for effectiveness in the primary care setting or impact on outcomes.

USPSTF = U.S. Preventive Services Task Force.

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to <http://www.aafp.org/afpsort.xml>.

hypertension in children has ranged from 1 to 3 percent,⁸ but a recent study of more than 5,000 children found that nearly 5 percent had persistent elevated blood pressure.⁹ The strongest risk factor was obesity (relative risk, 3.3; 95% confidence interval, 2.5 to 4.2), which has been confirmed by other studies.^{10,11} Childhood hypertension can lead to adult hypertension, an important risk factor for coronary artery disease and stroke,¹² and increases the risk of early signs of atherosclerosis, although the long-term implications of this are uncertain.¹³

DIABETES

The estimated prevalence of diabetes mellitus in persons younger than 20 years is about one in 400.¹⁴ Type 2 diabetes has become more common in six- to 19-year-olds, accounting for an estimated 8 to 45 percent of all new cases of diabetes in children and adolescents.¹⁵⁻¹⁷ The U.S. incidence of type 2 diabetes has also increased,¹⁸ paralleling the rise in obesity. Data from the 1994 NHANES showed that the absolute risk of increased fasting blood glucose was 17.6 per 1,000 children.¹⁸ The risk of diabetes of any type was four per 1,000 children, of whom approximately one third had type 2 diabetes.¹⁸

Three risk factors for diabetes in children have been identified¹⁹: BMI at or above the 85th percentile, fasting blood glucose level of 100 mg per dL (5.55 mmol per L) or more, and elevated fasting insulin level. A marked increase in insulin resistance and fasting blood glucose levels typically occurs during normal puberty in obese and nonobese persons. Obesity may cause a progression to impaired glucose tolerance and type 2 diabetes.

HYPERLIPIDEMIA

The 2003-2004 NHANES found that 10 percent of persons two to 19 years of age have serum total cholesterol levels greater than 200 mg per dL (5.18 mmol per L).³ The Bogalusa Heart Study, a multiracial longitudinal study, examined cardiovascular risk factors in 27,000 persons five

to 24 years of age via seven surveys.²⁰ According to their data, fatty streaks appeared by 10 years of age, and fibrous plaques by adolescence. The findings were exacerbated by the elevation of traditional adult risk factors: BMI, blood pressure, low-density lipoprotein cholesterol, and triglycerides. If three or four of the above factors were present, fatty streaks increased 8.5 times and plaques increased by a factor of 12. The results showed that BMI was the strongest predictor of high cholesterol levels. Black children had more extensive findings than white children.²⁰ The long-term clinical implications of these findings and their impact on morbidity and mortality are not yet known.

METABOLIC SYNDROME

The Third Report of the National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP III) defined metabolic syndrome as having three or more of the following: hypertriglyceridemia, low HDL cholesterol levels, elevated fasting blood glucose levels, excessive waist circumference, or hypertension.²¹

In the United States, metabolic syndrome has an estimated prevalence of 20 percent in adults 20 years and older and 40 percent in those older than 40 years.²² These adults are at greater risk of cardiovascular disease and diabetes. In children and adolescents, there is no standard definition for metabolic syndrome. Using a modified version of the NCEP-ATP III criteria outlined above, with BMI instead of excessive waist circumference, an estimated 6.4 percent of U.S. adolescents meet the diagnostic standards.²³ The prevalence of metabolic syndrome is 7 percent in at-risk-for-overweight adolescents, 29 percent in overweight adolescents,²⁴ and 50 percent in severely obese adolescents.²⁵ The syndrome is most common in Mexican Americans, followed by non-Hispanic whites and non-Hispanic blacks.²³ The increasing prevalence among children and adolescents has paralleled the rise in obesity. Metabolic syndrome has increased fourfold in overweight or at-risk-for-overweight adolescents who either smoke

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or are exposed to secondhand smoke.²⁶ The prevalence of adolescent smoking is reported to be between 7.4 and 17.9 percent.²⁷

Implications for Screening

What does this mean for the physician caring for children who are increasingly overweight and sedentary? Physicians may need to change their approach to risk stratification and screening to accommodate emerging morbidities. The existing guidelines address obesity and each component of the metabolic syndrome separately.

OBESITY

Because obesity is a common denominator in all of the previously described risk factors for cardiovascular disease, a child's weight status is the obvious starting point for screening and risk assessment. However, evaluating children for overweight is not universally supported. The U.S. Preventive Services Task Force (USPSTF) has stated that it is unable to determine the potential benefits and harms for routinely screening children and adolescents for overweight and that there is insufficient evidence for the effectiveness of behavioral counseling or other preventive interventions that can be done in primary care settings.²⁸

The American Academy of Pediatrics (AAP) has issued a policy statement on goals for weight management, diet, and physical activity in children and adolescents; the policy is directed at health care professionals, parents and caregivers, schools, and legislators to facilitate lifestyle changes.^{29,30}

According to the AAP Expert Committee, among children younger than seven years with a BMI at or above the 95th percentile, those without secondary complications should maintain their weight, whereas those with complications should pursue weight loss to achieve a BMI at or below the 85th percentile. Among children seven years and older, those with a BMI between the 85th and 95th percentiles should lose weight to achieve a BMI at or below the 85th percentile.²⁹ From the physician's perspective, a BMI at or below the 85th percentile achieved through weight loss or weight maintenance, depending on the age of the child, is the desired outcome.

Parental responsibility for the development of childhood eating behavior includes controlling food availability and portion size; teaching other caregivers what to feed the child; counteracting messages from media and other sources; sitting down to regular family meals; and serving as role models. The AAP also recommends 60 minutes of vigorous play or moderate activity per day, limiting all forms of sedentary behaviors to one to two hours per day, removing televisions from children's

bedrooms, and discouraging snacking during sedentary activity or in response to boredom. Suggestions for school and government initiatives are also summarized in the same policy statement.^{29,30}

HYPERTENSION

The USPSTF concluded that there is insufficient evidence to recommend for or against screening for hypertension in children to prevent cardiovascular disease, given the absence of clinical outcomes studies and the low risk of cardiovascular disease in this age group.³¹ However, screening for hypertension, starting at three years of age, has traditionally been recommended by the AAP based on consensus guidelines and expert opinion. Using an appropriately sized cuff is imperative to obtain accurate readings. Normal values are referenced according to age, sex, and height.³² Elevation of blood pressure in children 10 years and older is likely to be essential hypertension and, as in adults, is often associated with obesity.

DIABETES

The USPSTF found insufficient evidence to recommend for or against diabetes screening in adults, and does not address screening in children.³³ The American Diabetes Association suggests that children with a BMI at or above the 85th percentile and two additional risk factors (i.e., family history of type 2 diabetes; Native American, Mexican American, Hispanic American, or Asian/South Pacific Islander ancestry; or signs of insulin resistance or associated conditions, such as acanthosis nigricans, hypertension, hyperlipidemia, or polycystic ovary syndrome) have a fasting blood glucose test every other year starting at 10 years of age.³⁴ Measurement of fasting insulin and glucose levels is recommended by the American Heart Association (AHA).³⁵ The AAP advises that glucose and insulin be measured when screening those at risk of diabetes.

HYPERLIPIDEMIA

The USPSTF carefully reviewed the literature and found insufficient evidence to recommend screening for hyperlipidemia in children based on a lack of proven long-term benefits.³⁶ Despite this lack of evidence, many physicians were performing selective lipid screening in their practices according to the Second NHLBI Survey of Primary Care Physicians.³⁷ Consensus guidelines from the AAP Expert Committee and the NCEP have recommended criteria for selective screening and have created an algorithm for the management of hyperlipidemia in children and teenagers (*Figure 1*).³⁸ Such practice guidelines have been criticized because they ignore the lack of quality evidence³⁹; there have been no studies measuring clinical

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outcomes of hyperlipidemia treatment in adolescents. Given the low risk of heart disease in this population, it is likely that the number needed to treat to prevent one premature death is extremely high and involves years of treatment for many persons who would not benefit. Yet, in a 2008 clinical report, the AAP designated overweight in children as a special risk category requiring cholesterol screening regardless of family history or lack of other risk factors.⁴⁰ The report suggested that physicians screen these children between two and 10 years of age and reinforced weight management as the treatment of choice for nonhereditary hyperlipidemias.

Prevention and Management

Because eating habits are established in childhood and weight loss has proved difficult to achieve and maintain, prevention should start early. Family physicians often have a relationship with parents before the arrival of their children; therefore, guidance from the family physician can be invaluable.

Breastfeeding is associated with lower rates of childhood obesity⁴¹ and should be actively supported. Parents must be taught to recognize satiety cues in their children to facilitate development of self-regulated eating behavior. Using food to control or reward behavior should be discouraged. "Supersized" portions and foods high in fat and sugar should be discouraged in favor of alternatives that are low in fat and sodium and higher in fiber. Cultural preferences should also be considered when making dietary recommendations. The AHA proposed a schedule for integrated cardiovascular health promotion in children (Table 1³⁵) as part of its Atherosclerosis, Hypertension, and Obesity in the Young committee report.³⁵ AAP Policy Statements^{29,30} also provide practical suggestions for the busy physician (Table 2²⁹).

Once established, obesity and its comorbidities represent multifaceted problems that are often resistant to simple interventions. A consensus panel on childhood obesity recommended that treatment begin before adolescence and that the entire family focus on gradual, sustainable changes rather than rapid weight loss.⁴² Improvement has been shown

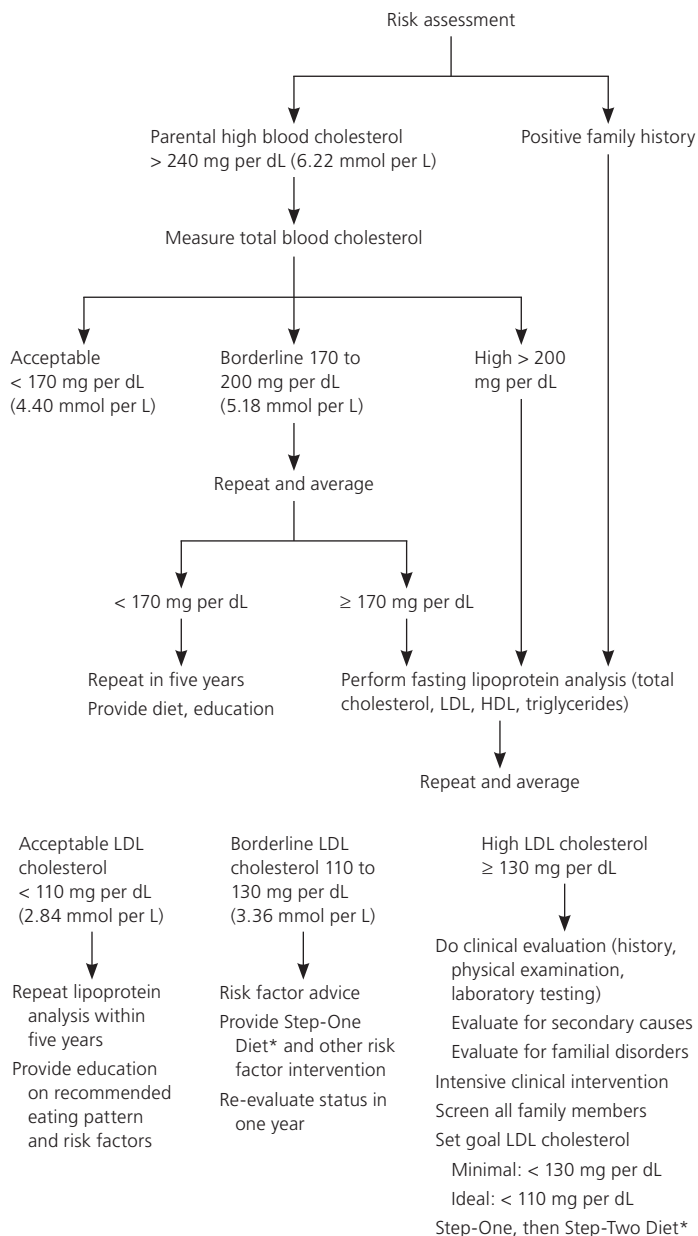


Figure 1. Algorithm to screen for and manage high cholesterol in children and adolescents.

HDL = high-density lipoprotein; LDL = low-density lipoprotein.

*—Cholesterol-lowering diet from the American Heart Association.

Adapted with permission from National Cholesterol Education Program (NCEP): highlights of the report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. *Pediatrics*. 1992;89(3):497-498.

in some studies when a multidisciplinary approach is used^{34,42,43} and referral is required.

Physicians should be alert to the signs of obesity and its comorbidities among their younger patients; familiarize themselves with the current, albeit sometimes

Table 1. Schedule for Integrated Cardiovascular Health Promotion in Children

Age (years)	Family history*	Cholesterol	Obesity	Blood pressure	Diet
Zero to two	Early heart disease† (55 years or younger) Parental total cholesterol ≥ 240 mg per dL (6.22 mmol per L)	Parental cholesterol screening	Plot height and weight on growth charts Parental obesity	Family history of hypertension	Diet history <i>Early foods influence future food preferences</i>
Two to six	Update family history Early heart disease† (55 years or younger) Parental total cholesterol ≥ 240 mg per dL	Fasting lipids screening Total cholesterol screening	Plot height, weight, and BMI on growth charts BMI percentiles	Start routine blood pressure measures at three years of age (determine if child is above the 90th or 95th percentile for sex, age, and height)	Diet history <i>Diet low in saturated fat,‡ including 1% or nonfat milk Moderate salt intake</i>
Six to 10	Update family history Early heart disease† (55 years or younger) Parental total cholesterol ≥ 240 mg per dL	Fasting lipids screening Total cholesterol screening	Plot height, weight, and BMI on growth charts BMI percentiles	Blood pressure measures Blood pressure percentiles	Diet history <i>Diet low in saturated fat,‡ including 1% or nonfat milk Moderate salt intake</i>
Older than 10	Update family history Early heart disease† (55 years or younger) Parental total cholesterol ≥ 240 mg per dL	Fasting lipids screening Total cholesterol screening	Plot height, weight, and BMI on growth charts BMI percentiles	Blood pressure measures Blood pressure percentiles	Diet history <i>Diet low in saturated fat,‡ including 1% or nonfat milk Moderate salt intake</i>

NOTE: Assessment items are in normal typeface; counseling items are in italic.

BMI = body mass index.

*—Includes parents, grandparents, and blood-related aunts and uncles.

†—Documented myocardial infarction, coronary artery disease, angina pectoris, or sudden cardiac death at 55 years or younger or family history not available.

‡—The diet should average less than 30 percent (but not less than 20 percent) of calories from total fat, less than 10 percent of calories from saturated fats, 10 percent or less of calories from polyunsaturated fats; and the lesser of 300 mg per day or 100 mg cholesterol per 1,000 kcal energy intake.

§—Includes immediate physical, social, and physiologic effects of smoking, risk of addiction, counter-arguing techniques, and resisting social and environmental pressures to smoke.

Table 2. AAP Recommendations for the Prevention of Childhood Overweight and Obesity

Health supervision recommendations

Calculate BMI annually in children two years and older
Encourage and educate parents/caregivers to promote healthy eating patterns
Encourage and support breastfeeding
Identify and track children at risk via family history; birth weight; and socioeconomic, ethnic, cultural, or environmental factors
Monitor change in BMI percentile to identify rapid or excess weight gain
Recognize and monitor obesity-associated risk factors: dyslipidemia, hyperinsulinemia, hypertension, impaired glucose tolerance, obstructive sleep apnea
Recommend limiting screen time (e.g., television, computer, video games) to one to two hours per day
Routinely promote physical activity at home and in school, child care settings, and the community

Advocacy recommendations

Encourage funding sources to direct research money toward effective prevention strategies and to maximize limited resources to achieve healthy outcomes
Enlist policy makers to support healthy lifestyles for all children
Help those who influence children to encourage healthy habits
Support social marketing to promote healthy food choices and increase physical activity

AAP = American Academy of Pediatrics; BMI = body mass index.

Adapted with permission from Krebs NF, Jacobson MS, for the American Academy of Pediatrics Committee on Nutrition. Prevention of pediatric overweight and obesity. *Pediatrics*. 2003;112(2):427-428.

Physical activity	Smoking
Parental physical activity <i>Discourage television and video viewing</i>	Parental/household smoking? If yes, counsel to quit; referral for smoking cessation
<i>Encourage active child-parent play</i> <i>Limit sedentary behaviors such as television and video viewing</i>	Parental/household smoking? If yes, counsel to quit; referral for smoking cessation
Physical activity history <i>Lifestyle and family activities</i> <i>Limit sedentary behaviors such as television and video viewing</i>	Parental/household smoking? If yes, counsel to quit; referral for smoking cessation <i>Antismoking counseling§</i>
Physical activity history <i>Lifestyle and family activities</i> <i>Daily moderate to vigorous activity</i> <i>Limit sedentary behaviors</i>	Parental/household smoking? Assess child smoking If yes, counsel to quit; referral for smoking cessation <i>Antismoking counseling§</i>

Adapted from Williams CL, Hayman LL, Daniels SR, et al. Cardiovascular health in childhood: a statement for health professionals from the Committee on Atherosclerosis, Hypertension, and Obesity in the Young (AHOY) of the Council on Cardiovascular Disease in the Young, American Heart Association [published correction appears in Circulation. 2002;106(9):1178]. Circulation. 2002;106(1):157.

conflicting, recommendations; and decide how best to incorporate prevention into their daily practice. Developing a network of local professionals to support a family approach to treatment, when necessary, might prove useful in halting this evolving health issue. *Table 3* provides a list of online resources for physicians and parents of overweight children and adolescents.

Final Comments

Family physicians should be advocates in their communities for changes that promote building physical activity into daily life. Such changes include programs that encourage children to walk and bike to school; efforts to build sidewalks, greenways, and bike paths; planning for healthy, walkable neighborhoods; and support for the development of parks and playgrounds.

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Table 3. Resources for Physicians and Parents of Overweight and Obese Children and Adolescents

Physicians

American Academy of Pediatrics
<http://www.aap.org/obesity/>
and
<http://pediatrics.aappublications.org/cgi/content/full/117/5/1834> (policy statement on preventing childhood obesity through lifestyle changes)
2005 Dietary Guidelines Advisory Committee Report
<http://www.health.gov/dietaryguidelines/dga2005/report/>
Promoting Better Health for Young People Through Physical Activity and Sport
http://www.cdc.gov/healthyyouth/physicalactivity/promoting_health/pdfs/ppar.pdf
Resources, state programs, information about childhood obesity and comorbidities
<http://www.cdc.gov/nccdphp/dnpa/obesity/childhood/>
Weight Control Information Network
<http://win.niddk.nih.gov/resources/index.htm>

Parents

American Academy of Pediatrics
<http://www.aap.org/obesity/>
American Dietetic Association. Eating Healthfully and Affordably
http://www.eatright.org/cps/rde/xchg/ada/hs.xml/home_9567_ENU_HTML.htm
President's Council on Physical Fitness and Sports (ideas for physical fitness activities)
<http://www.fitness.gov>
Small Step Kids
<http://www.smallstep.gov/kids/flash/index.html>
We Can! (a way to enhance children's activity and nutrition)
<http://www.nhlbi.nih.gov/health/public/heart/obesity/wecan/>
Weight Issues in Children
<http://familydoctor.org/online/famdocen/home/healthy/food/kids/343.htm>

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