# 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

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AHA Scientific Statement

# 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

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Coronary heart disease remains the leading cause of death in the United States, responsible for close to half a million deaths each year. During the past two decades, convincing evidence has emerged that links defined risk factors in adults with an accelerated atherosclerotic process. Pathological data have shown that atherosclerosis begins in childhood and that the extent of atherosclerotic change in children and young adults can be correlated with the presence of the same risk factors identified in adults. It thus seems eminently reasonable to initiate healthful lifestyle training in childhood to promote improved cardiovascular health in adult life.

The goal of this document is to provide strategies for promoting cardiovascular health that can be integrated into the comprehensive pediatric care of children. The following critical areas are reviewed: physical activity, obesity, insulin resistance and type II diabetes mellitus, hypertension, high blood cholesterol, and cigarette smoking.

Background information, methods of assessment, and means for intervention are discussed for each major area. A cardiovascular health schedule has been developed to help the practitioner implement these suggestions within the framework of comprehensive pediatric care. Rather than labeling specific children as abnormal, strategies are directed toward promoting optimal cardiovascular health for all children.

## Physical Activity

### Background

The health benefits associated with a physically active lifestyle in children include weight control, lower blood pressure, improved psychological well-being, and a predisposition to increased physical activity in adulthood. Increased physical activity has been associated with an increased life expectancy and decreased risk of cardiovascular disease (CVD).

Healthy levels of physical fitness require regular (4 to 5 times per week) participation in activities that generate energy expenditures significantly above the resting level and ideally ≥50% to 60% of maximal exertion. Activities that result in significant energy expenditures in children may include both recreational and organized or competitive sporting activities.

Physical activity in American children has diminished for a variety of reasons. Children tend to walk or bicycle less and increasingly rely on cars for transportation. A trend away from active leisure pursuits and recreational sports has been evident, and reliance on sedentary entertainment, including television, video games, and computers, has increased. Participation in organized athletics diminishes greatly after middle school. Although this is true for both sexes, it is a very important problem for girls.

Although these trends are nationwide, socioeconomic factors place certain subpopulations of children at greater risk. Lack of safe outdoor play areas in many portions of large cities limits children's ability to engage in active physical play or recreational sports. Tightening school budgets and changing curriculum priorities have resulted in a deemphasis on regular physical education programs in many schools. Changing family makeup, with increasing numbers of households with two working parents or a single parent, limits the ability of parents to encourage participation and provide access to regular after-school physical activities.

### Assessment

Assessment of physical activity in children should be tailored to the individual child. Factors that must be considered include but are not limited to age, sex, race, level of sexual maturity, and physical and mental disabilities that may affect exercise participation (ie, chronic diseases or medical condi-

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**TABLE 1. Methods Physicians Can Use to Promote Physical Activity**

| Objective | Target | Strategy |
|---|---|---|
| Incorporate physical activity counseling into medical practice | Children, parents, and physicians | Ask about physical activity patterns, encourage parents to be more active, and recommend activities specific to the child's age, family circumstances, and environment. |
| Universal participation in increased physical activity | All children, including those who are clumsy, overweight, or handicapped. | For older children, emphasize sports in which they can participate all their life, deemphasize the competitive and achievement-oriented nature of sports programs, and increase emphasis on participation and teamwork; encourage an active lifestyle at a young age. |
| Improve children's access to physical activity programs | Schools, media, and local, state, and national government | Improve physical education programs in schools and day care; encourage the maintenance of high-quality and safe public play spaces; and promote life-long participation in sports and the benefits of a physically active lifestyle. |

tions). In addition familial, socioeconomic, and environmental factors should be addressed. Familial attitudes toward exercise and sport participation should be explored. The child's access to regular convenient places of exercise and the ability of the family to encourage regular activity must be assessed. The health professional should also determine the amount of time the child spends in sedentary leisure activities, such as television viewing and video game playing. Assessment of activity level should begin as early as preschool and continue through adolescence. Asking questions about changes in physical activity may help the health professional identify children at risk for decreasing physical activity. Some general topics for such questions are listed below.

- Amount of time regularly spent walking, bicycling, and in backyard play; use of stairs, playgrounds, and gymnasiums; and interactive physical play with other children
- Number of hours per day spent watching television or videotapes and playing video or computer games
- Time spent participating in age-appropriate organized sports, lessons, clubs, or league games
- Amount of time spent in school or day-care physical education that includes a minimum of 30 minutes of coordinated large-muscle exercise (for children >2 years of age)
- Participation in household chores
- Time spent in family outings that involve walking, cycling, swimming, or other recreational activities
- Positive role modeling for a physically active lifestyle by parents, other caretakers, physicians, and school personnel

### What You Can Do

When addressing physical activities with children, emphasis should be placed on play and activities rather than "exercise." In sporting events, participation should be stressed and competition deemphasized. The health professional (Table 1) should help direct children with special needs or limitations to appropriate types of physical activity and sports.

The following are some general suggestions: (1) Formally address the subject of exercise in your practice. (2) Advise parents to include planned activities instead of food as part of the family's reward system for positive accomplishments. (3) Advise parents to establish time limits for sedentary activities and encourage a daily time for physical activity. (4) Emphasize the benefits of regular physical activity: an improved cardiovascular risk factor profile, increased energy expenditure, improved weight control, a general sense of physical well-being, improved interpersonal skills, and an outlet for psychological tension. (5) Do not include or exclude a child from activities because of physical or mental limitations. Tailor suggestions for exercise to the child's physical ability. (6) Encourage participation in pick-up games, noncompetitive activities, and organized sports. Emphasize sports that can be enjoyed throughout life, participation in summer camp, and school physical education programs. (7) Make suggestions appropriate to the age of the child. (8) Incorporate advocacy of physical education into your role as a school health professional, if applicable. Make sure all children are involved. (9) Teach parents the importance of being role models for active lifestyles and providing children with opportunities for increased physical activity. (10) Be an advocate for physical health in your community.

Changes in physical activity levels over time are difficult to assess in the office setting. The benefits of increased physical activity, however, are often apparent in routine health assessments. The health professional will be able to assess changes in weight-for-height ratio and body mass index (BMI), skinfold thickness as an index of subcutaneous fat, and child and family reports of everyday lifestyle changes, including hours spent in physical activities versus sedentary activities (eg, watching television). The long-term benefits of providing physical activity counseling to children in a healthcare setting may not be realized until later in life. Maintenance of a physically active lifestyle helps prevent the development of obesity, elevated blood pressure, insulin resistance, and elevated blood cholesterol levels, all of which are CVD risk factors that frequently are present as early as childhood or adolescence.

## Obesity

### Background

Recent data have documented dramatic increases during the past two decades in overweight among children and adolescents. Rates of obesity have increased 2- to 4-fold, with the highest rates among African-American and Latino youth. This trend is of particular concern because overweight in

childhood and adolescence has been associated with increased risks of hypertension, adverse lipid profiles, type II diabetes, and early atherosclerotic lesions, as well as increased risks of adult obesity and obesity-related morbidities and mortality in adulthood. Overnutrition and insufficient physical activity associated with obesity have been estimated to account for at least 300 000 deaths and ≈$99 billion in economic costs per year in the United States. Recent research has confirmed that the pathogenesis of obesity may be, in part, inherited, though genetics cannot account for the rapid increases in overweight in the US population. Thus, health professionals caring for children and adolescents are in a key position to help prevent and treat obesity by promoting behavioral and environmental changes. Although the evidence base is insufficient to provide specific, generalizeable guidelines for assessment and treatment of child and adolescent obesity, the following recommendations reflect critical reviews of the literature and are consistent with the recommendations of a recent consensus panel.

## Assessment

The first step in assessment is identifying the overweight child who is most likely to benefit from an intervention. For clinical purposes, obesity should be defined as a level of overweight that is associated with adverse physical or psychological health problems. The risk of overweight relates, however, to health outcomes in a continuous manner, with no clear threshold or cutoff associated with dramatically increased risks. As a result, most definitions of obesity have been based on population distributions of relative weight or body fatness. With these cutoffs used as a starting point, clinicians can then weigh other factors in making decisions about whether to treat and how to treat any individual child and family.

The BMI is a reliable and valid measure of relative weight in children and is recommended for clinical use. The BMI is calculated as the weight in kilograms divided by the square of the height in meters. Age- and sex-specific BMI standards for the US population have recently been published as percentile growth curves by the Centers for Disease Control and Prevention. Clinicians are encouraged to use these curves to replace the older weight-for-height curves. According to epidemiological data and extrapolation from adult definitions, it is reasonable to use the 85th percentile to identify those who are mildly to moderately overweight (a group at increased risk of obesity) and the 95th percentile to identify those with more significant overweight (a group likely to benefit from additional assessment and treatment). The 95th percentile is also likely to correspond to ≈130% of the ideal weight percentile, which corresponds to the child's age- and sex-specific height percentile. For example, a child whose height is at the 50th percentile for age and sex should ideally have a weight around the 50th percentile for age and sex as well. If the 50th percentile is 100 pounds, and the child actually weighs 130 pounds, this is 130% of ideal weight for height (or 30% overweight). It is particularly important to calculate BMI for children and adolescents in the upper percentiles (75th percentile and above) for height and weight because they are at greater risk of obesity. Children and adolescents above the 95th percentile for BMI are significantly more likely to remain overweight as adults and suffer health complications of obesity. Health professionals should plot BMI percentiles for children during ongoing pediatric care. Children who are crossing BMI percentiles in an upward direction also may be at risk of overweight.

All overweight children should be assessed for the possibility of underlying causes. Screening for developmental delay, short stature (most overweight children are average height or tall for their age), dysmorphic features, and abnormal genitalia will help rule out most genetic and endocrine causes of childhood obesity. Children with obesity secondary to acquired hypothyroidism often present with lack of energy, dry and yellowish skin, decelerating linear growth, and sometimes thyroid enlargement. Obesity related to hyperinsulinemia generally is accompanied by signs and symptoms of hypoglycemia. Although these findings are rare, they often require referral to an endocrinologist, geneticist, or obesity specialist for additional evaluation.

Children and adolescents with a BMI greater than the 95th percentile should undergo blood pressure measurement, lipoprotein analysis, and fasting insulin and glucose determination. These children and adolescents should also receive additional evaluation for other obesity-related complications. History and physical examination should include assessments for headaches and blurred optic disk margins, which may indicate pseudotumor cerebri; nighttime snoring, breathing difficulties, or daytime somnolence, which may indicate obstructive sleep apnea or obesity hypoventilation syndrome; hip or knee pain, which may be manifestations of slipped capital femoral epiphysis; oligomenorrhea, amenorrhea, striae, or hirsutism, which may indicate polycystic ovary disease or Cushing's syndrome; acanthosis nigricans, which is associated with type II diabetes; hepatomegaly associated with hepatic steatosis; thyromegaly associated with hypothyroidism; abdominal pain or tenderness associated with gallbladder disease; and leg bowing as found in Blount's disease. Specific findings would lead to additional diagnostic tests as indicated, and the presence of any of these complications warrants consultation with appropriate pediatric subspecialists and a pediatric obesity specialist. These children should also be assessed for signs of depression, bulimia nervosa, binge-eating disorder or other serious psychological disorders that would require further evaluation and treatment by a child psychiatrist or psychologist.

## What You Can Do

Essentially all children, adolescents, and families can benefit from counseling to prevent excess weight gain and obesity (Table 2). This counseling should include strategies on how to eat a healthy diet and be more physically active. A diet low in saturated fat and cholesterol that includes 5 or more daily servings of vegetables and fruits and 6 to 11 servings of whole-grain and other complex-carbohydrate foods is the diet of choice for prevention of CVD and cancer. It may be helpful for parents and children to visualize a "healthy plate" of which half is filled with salad and vegetables, one fourth with starch (potatoes, rice, etc), and one fourth with a protein source (meat, poultry, fish, soy, etc). Similarly, children >2

**TABLE 2. Methods Physicians Can Use to Promote Desirable Body Weight**

| Objective | Target | Strategy |
|---|---|---|
| To identify obese children and adolescents and those at high risk of becoming obese | Children, adolescents, and parents | Plot height, weight, and BMI on growth charts.<br>Assess obesity in the family as a risk factor for child and adolescent obesity. |
| To encourage a healthful diet to maintain desirable weight | Children, adolescents, and parents | Take a diet history.<br>Promote an AHA Step I diet, low in saturated fat and cholesterol and rich in vegetables, fruits, and grains for children >2 years of age.<br>Educate parents on appropriate portion size.<br>Suggest nutritious lower-calorie snacks.<br>Advocate for school meals that meet AHA Step I guidelines for fat, saturated fat, and cholesterol.<br>Discourage the use of high-calorie snacks as rewards<br>. |
| To encourage a more active lifestyle | Children, adolescents, parents, schools, and community leaders | Take a physical activity history.<br>Promote daily moderate to vigorous physical activity that is part of the child's and family's lifestyle.<br>Promote reducing the time spent in sedentary behaviors such as watching TV and playing computer and video games.<br>Advocate for daily school physical education and safe and convenient community facilities and programs for child and adolescent physical activity. |

years of age should participate in at least 30 minutes of moderate physical activity most days of the week, and preferably every day. They should also be encouraged to build more physical activity into their lifestyle, such as walking or biking to school instead of driving, taking stairs instead of elevators, and helping with active chores inside and outside of the house. Parents should be encouraged to help their children reduce excessive time spent on sedentary behaviors such as watching television and videotapes, playing on a computer, listening to music, and talking on the phone. Health professionals and parents can also advocate in their communities for school meals and snacks that meet dietary guidelines, more frequent and effective physical activity programs in school, and more after-school and summer programs that include heart-healthy food choices and physical activity.

Children and adolescents with overweight parents are at increased risk of being or becoming overweight themselves and may benefit from more intensive counseling. Assessment of usual diet and activity patterns will highlight simple preventive measures to increase physical activity, decrease inactivity, and encourage healthier food choices and portion control. Utilization of a clinical dietitian may also be beneficial for this purpose. In younger children, most of the recommendations will be targeted at parents. As children age, more teamwork is needed between the parent and child. For most adolescents, the advice is targeted directly to the adolescent himself or herself. Even at young ages, however, the child should be included in identifying feasible and desirable goal behaviors and strategies for change.

The goal for obesity treatment in children should be to establish long-term weight control through adoption of healthy eating and activity patterns. Weight-loss goals should be realistic and should not necessarily attempt to fully normalize weight. The achievement of the median BMI for age and sex is usually an unrealistic goal for treatment. Substantial reductions in CVD risk may result from a modest weight loss of 5 to 10 pounds. In contrast to adults, children have the advantage that they are still growing in height. As a result, maintenance of weight or modest weight loss, while children continue to grow in height, reduces their degree of overweight. Children with complications of obesity (eg, hypertension, hyperlipidemias, insulin resistance, hepatic steatosis) should attempt to lose enough weight to correct those complications.

Treatment of obesity can be frustrating and difficult for clinicians as well as patients and families. Behavioral treatments with overweight children, however, have produced long-term benefits. Some programs have resulted in sustained weight control lasting 10 years in up to 30% of participating children, although most children remained overweight but to a lesser degree than at baseline. More complete descriptions of the principles of behavioral treatments are available elsewhere. Essentially, all successful programs include interventions to reduce calorie intake and increase physical activity. Because healthy linear growth must be promoted during treatment, calorie intake is moderately reduced while maintaining a well-balanced diet.

A recent consensus panel of pediatric obesity treatment specialists identified a number of components of successful treatments, including (1) beginning treatment before adolescence, if possible; (2) willingness on the part of both child and family to participate; (3) education of families about the medical complications of obesity; (4) involvement of the entire family and other caregivers in the treatment; (5) promotion of long-term permanent changes in behavior patterns instead of rapid weight loss; (6) emphasis on small and gradual behavior change goals; (7) inclusion of activities to help families monitor their eating and physical activity behaviors; and (8) clinical empathy and encouragement rather

than criticism and penalties. In addition, many treatment programs promote specific skills for parents, including parent role modeling of healthful dietary and activity habits for their children and appropriate use of praise, contracting, and rewards. Most programs also promote changes in the family environment to help children and families change their behaviors. These may include removing high-calorie foods from the home, reducing the number of meals eaten outside of the home, serving portion-controlled meals to the child instead of allowing children to serve themselves, or establishing a formal routine exercise program at a scheduled time each day or evening.

Clinicians should also counsel their patients to avoid fad diets or other programs or products that promise a quick fix. At best, they produce short-term weight losses, and some may produce serious harm. No currently available pharmacological agent for weight control has been shown to be safe and effective for use in children and adolescents. Additional pharmacological agents for weight loss may become available in the future. Experience with existing agents, however, suggests that pharmacological treatments are only effective as long as they are taken. For children and adolescents, this may translate into lifelong treatment, and, at present, most agents are not fully tested in children and adolescents before their approval by the Food and Drug Administration. As a result, clinicians must carefully investigate the efficacy and side effects of these agents before recommending or prescribing them. Consultation with a pediatric obesity specialist before using pharmacological agents for weight control in severely obese children or adolescents is recommended.

## Insulin Resistance and Type II Diabetes Mellitus

### Background

The resistance of the body to the actions of insulin results in overproduction of this hormone by the pancreas and ensuing hyperinsulinemia. The insulin resistance syndrome with its components—hyperinsulinemia, obesity, hypertension, and hyperlipidemia—recently has been recognized as a major precursor of atherosclerotic CVD and type II diabetes in adults. The role of obesity in the insulin resistance syndrome may be particularly relevant. Obese adults are insulin resistant when compared with normal control subjects, and obesity has been strongly and independently correlated with cardiovascular risk. A direct association between obesity and insulin resistance also has been reported in children, as has the association between insulin resistance and lipids. Being overweight during childhood and adolescence is associated with high levels of fasting insulin, lipids, and blood pressure in young adulthood. Weight loss in these individuals results in a decrease in insulin concentration and an increase in insulin sensitivity toward normal in adults and adolescents. In children, the relations between the components of the insulin resistance syndrome and its role as a predictor of adult CVD and type II diabetes are not entirely clear. An increasing body of evidence suggests a strong connection between insulin resistance, overweight, abnormal lipids, and high blood pressure in childhood and adolescence. Recent reports point to an alarming increase in the incidence of type II diabetes in children.

### Assessment

Our understanding of the syndrome of insulin resistance in children is still evolving, and clear recommendations are presently unavailable for the overall assessment and treatment of this syndrome. Because the first step in assessment is identifying those children who would clearly benefit from intervention, and because insulin resistance is often associated with type II diabetes, fasting plasma glucose testing has been recommended for children at risk for the presence or development of type II diabetes. These are children who (1) are overweight; (2) have a family history of type II diabetes; (3) have a predisposition according to race/ethnicity (American Indian, African American, Hispanic, or Asian/Pacific Islander); and (4) have signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, or polycystic ovary syndrome). This is an easy and relatively inexpensive tool for office screening by the clinician. Even in the face of a normal fasting glucose level on a simple test, the child at risk remains at high potential for developing type II diabetes later in life. Children who do not show signs of type II diabetes may exhibit other morbid features of the insulin resistance syndrome, such as obesity, hypertension, and high cholesterol, and remain at risk for future CVD and diabetes. Body size measurements with BMI or other methods (as described in the section on obesity) and determination of blood pressure and cholesterol should become part of the evaluation of any child with the risk profile described above. Insulin resistance per se is assessed by a rather complicated method: the euglycemic insulin clamp. This technique involves continuous intravenous administration of insulin and glucose over a period of 3 hours; insulin sensitivity is calculated by measuring the amount of glucose required to maintain normal glucose levels (euglycemia). The euglycemic clamp currently is used in children for research purposes only. Although less accurate than the euglycemic clamp method, assessment of hyperinsulinemia by measuring fasting plasma insulin levels may provide a reasonable clinical alternative for evaluating insulin resistance (range: *normal* $<$15 mU/L, *borderline high* 15 to 20 mU/L, *high* $>$20 mU/L).

### What You Can Do

After identifying children who are at risk for developing the syndrome of insulin resistance, clinicians should evaluate some of the clinical entities associated with this. A thorough history is essential in detecting those who are at risk according to race/ethnicity or familial predisposition. Physical examination can reveal specific findings such as overweight, acanthosis nigricans, subcutaneous fat deposits, and signs of endocrine disease (eg, polycystic ovary syndrome, Cushing's syndrome). Periodic measurements of blood pressure, fasting plasma glucose, and lipids are easily accessible in most practices and can aid in early diagnosis of the above conditions.

Because of its major role in the syndrome of insulin resistance, emphasis needs to be placed on the detection,

assessment, prevention, and treatment of overweight/obesity, as described in the section on obesity. The syndrome of insulin resistance is complex and, once identified, may require consultation with several pediatric subspecialists (including endocrinologists; specialists in lipid disorders, hypertension, or obesity; and mental health providers).

On the basis of current knowledge, weight control, lifestyle modification in childhood, and early detection of type II diabetes could alter the incidence of the syndrome of insulin resistance and improve the risk profiles for CVD and type II diabetes as children make the transition toward adolescence and young adulthood.

## High Blood Pressure

### Background

Elevated blood pressure accelerates the development of coronary artery disease (CAD) and contributes significantly to the pathogenesis of cerebrovascular accidents, heart failure, and renal failure. Among all the risk factors cited by the Framingham Study, hypertension has been identified as one of the most potent antecedents of CVD. Because hypertension is usually asymptomatic, healthcare providers have a responsibility to identify individuals at risk by measuring blood pressure. In childhood, blood pressure normally rises with age. Elevated blood pressure at a young age is a predictor of blood pressure elevation later in life. Elevated blood pressure may begin in childhood or adolescence. Clinicians therefore have an important role to play in educating children and families about blood pressure and the approaches that are useful in preventing and treating hypertension.

### Assessment

The American Heart Association (AHA) Council on Cardiovascular Disease in the Young supports the recommendation of the Second National Heart, Lung, and Blood Institute Task Force on Blood Pressure and the update published by the National High Blood Pressure Education Program that all children ≥3 years of age should have their blood pressure measured in the course of routine health care. The measurement should be performed with a mercury sphygmomanometer or a calibrated aneroid device with the child sitting and his or her right arm resting on a solid supporting surface at heart level. It is important to consider the cuff size when measuring blood pressure in children and adolescents. Choosing a cuff that is too small will result in a false elevation of the blood pressure reading. An appropriate size cuff (cuff width 40% of mid-arm circumference) will be a cuff bladder that covers 80% to 100% of the arm circumference and approximately two thirds of the length of the upper arm. The lines printed on the cuff by the manufacturer facilitate the correct choice of a cuff. The recommendations of the AHA for measurement of blood pressure should be followed, including inflation of the cuff to a pressure of 20 to 30 mm Hg above systolic blood pressure and cuff deflation at 2 to 3 mm Hg/s. The onset of the fifth Korotkoff phase has been suggested as being representative of diastolic blood pressure in children. Electronic instruments are convenient but may provide measurements that are different from measurements made by sphygmomanometer. It is this committee's belief that caution should be used in interpretation of blood pressure measured by these devices. Ambulatory blood pressure monitoring devices may be helpful for evaluating diurnal patterns of blood pressure and persistence of blood pressure elevation.

Blood pressure measurements in noncooperative, agitated children are misleading. Attempts must be made to obtain reliable resting measurements. If the child is not quiet, his or her status should be recorded with the blood pressure. The National High Blood Pressure Education Program recommends using blood pressure standards based on sex, age, and height to determine blood pressure elevation in children ≥1 year of age and adolescents. Elevated blood pressure in children is defined as systolic or diastolic blood pressure persistently above the 95th percentile. In adults, elevation of systolic blood pressure is as important as elevated diastolic blood pressure as a risk factor.

### What You Can Do

Blood pressure tables developed by the National High Blood Pressure Education Program based on sex, age, and height should be used to interpret and track blood pressure measurements. It is useful to review the blood pressure tables with the child and parent and to indicate how the child's blood pressure compares with that of his or her peers. Attention to the child's height and weight is important because blood pressure is directly related to both. Obese youths are more likely to be hypertensive than are leaner ones. In order to use the table, the physician should first measure the patient's height and determine the height percentile from the standard growth charts. The correct row in the table is determined by the child's age, and the correct column is determined by the child's height percentile. Finding the intersection between the correct row and column provides the 95th percentile for children of similar sex, age, and height. Values for the 95th percentile for blood pressure for sex, age, and height groups are shown in Table 3. If the blood pressure exceeds the 95th percentile, the measurement should be repeated at a subsequent visit. If resting blood pressure equals or exceeds the 95th percentile on three separate occasions, the diagnosis of hypertension should be made and an appropriate evaluation undertaken. If hypertension is severe or if there is a strong suspicion of secondary hypertension, the appropriate work-up should be initiated after the primary assessment and referral to a recognized specialist in hypertension should be made.

The approach to evaluation of blood pressure in children and adolescents is presented in Figure 1. Most blood pressure elevation in children above age 6 years and in adolescents is due to primary hypertension. Obesity has been found to be an important correlate of blood pressure elevation in children and adolescents with primary hypertension. Secondary causes of hypertension, such as renal parenchymal disease and coarctation of the aorta, are more important to consider in young patients who have substantial elevation of blood pressure (often above the 99th percentile) and have little family history of hypertension, but they can also occur in older children and adolescents.

The AHA Council on Cardiovascular Disease in the Young recommends early detection of blood pressure elevation.

**TABLE 3. 95th Percentile Blood Pressure Values for Children by Sex, Age, and Height**

| | Boys | | | | | | | | | | Girls | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Systolic Blood Pressure | | | | | Diastolic Blood Pressure | | | | | Systolic Blood Pressure | | | | | Diastolic Blood Pressure | | | | |
| Age, y | 5th HP | 25th HP | 50th HP | 75th HP | 95th HP | 5th HP | 25th HP | 50th HP | 75th HP | 95th HP | 5th HP | 25th HP | 50th HP | 75th HP | 95th HP | 5th HP | 25th HP | 50th HP | 75th HP | 95th HP |
| 1 | 98 | 101 | 102 | 104 | 106 | 55 | 56 | 57 | 58 | 59 | 101 | 103 | 104 | 105 | 107 | 57 | 57 | 58 | 59 | 60 |
| 3 | 104 | 107 | 109 | 111 | 113 | 63 | 64 | 65 | 66 | 67 | 104 | 105 | 107 | 108 | 110 | 65 | 65 | 66 | 67 | 68 |
| 5 | 108 | 110 | 112 | 114 | 116 | 69 | 70 | 71 | 72 | 74 | 107 | 108 | 110 | 111 | 113 | 69 | 70 | 71 | 72 | 73 |
| 7 | 110 | 113 | 115 | 116 | 119 | 74 | 75 | 76 | 77 | 78 | 110 | 112 | 113 | 114 | 116 | 73 | 73 | 74 | 75 | 76 |
| 9 | 113 | 116 | 117 | 119 | 121 | 76 | 78 | 79 | 80 | 81 | 114 | 115 | 117 | 118 | 120 | 75 | 76 | 77 | 78 | 79 |
| 11 | 116 | 119 | 121 | 123 | 125 | 78 | 79 | 80 | 81 | 83 | 118 | 119 | 121 | 122 | 124 | 78 | 79 | 79 | 80 | 81 |
| 13 | 121 | 124 | 126 | 128 | 130 | 79 | 81 | 82 | 83 | 84 | 121 | 123 | 125 | 126 | 128 | 80 | 81 | 82 | 82 | 84 |
| 15 | 127 | 129 | 131 | 133 | 135 | 81 | 83 | 83 | 84 | 86 | 124 | 126 | 128 | 129 | 131 | 82 | 83 | 83 | 84 | 86 |
| 17 | 132 | 135 | 136 | 138 | 140 | 85 | 86 | 87 | 88 | 89 | 126 | 127 | 129 | 130 | 132 | 83 | 83 | 84 | 85 | 86 |

HP indicates height percentile.

Appropriate management for primary hypertension includes the initiation of nonpharmacological therapies, such as active dietary counseling and physical activity prescriptions. Because pharmacological agents require appropriate compliance and may be associated with side effects, such intervention is reserved for children whose blood pressure is consistently very high, for those with substantial secondary hypertension, and for children with evidence of target-organ effects such as left ventricular hypertrophy. Because the development of obesity in childhood and adolescence is strongly related to

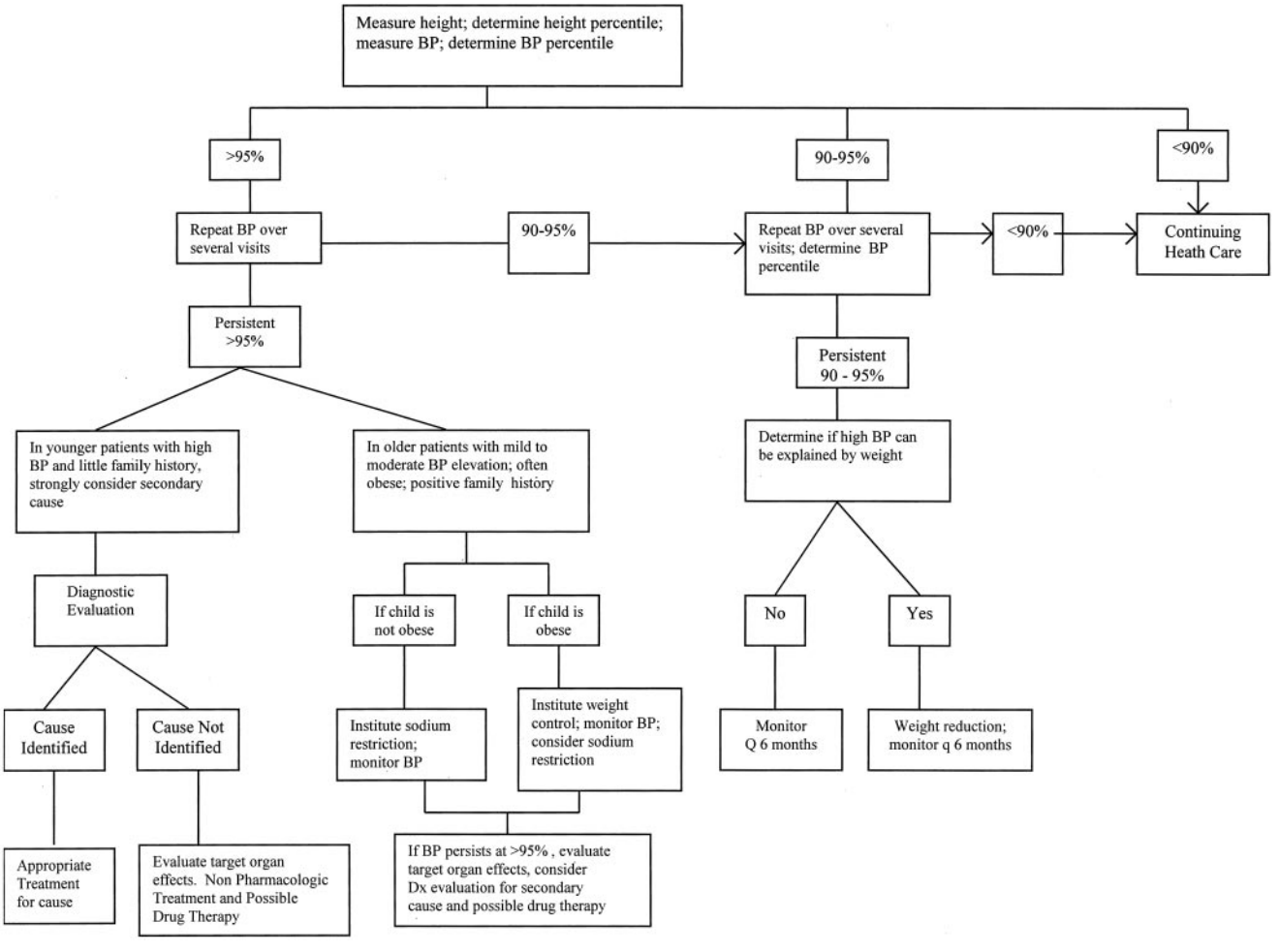


**Figure 1.** Flow chart for identifying children with high blood pressure in need of diagnostic evaluation and treatment. BP indicates blood pressure; Dx, diagnosis; and q 6 months, every 6 months. Modified from *Pediatrics*. 1987;79:1–25.

hypertension in adult life, weight control, prevention of obesity, and a physically active lifestyle are strongly encouraged. Even in early childhood, significant differences in blood pressure can be accounted for by fitness and body fatness. Weight loss and improved cardiovascular conditioning have been demonstrated to lower blood pressure in hypertensive adolescents.

The council also believes that it is prudent to recommend moderation in the use of salt in the diet of children. The diet of the average American child contains much more sodium than is required. Most studies suggest that increased salt intake over time increases blood pressure in individuals who are salt sensitive. The desire for salt may be an acquired taste, and salt should be used with moderation in childhood. There are few, if any, adverse effects of lowering sodium in the diet. Sodium restriction can lower blood pressure in some individuals.

The goals of blood pressure control in childhood and adolescence are: (1) to prevent the acquisition of lifestyle factors (obesity, excessive salt intake, and sedentary activity patterns) that contribute to an excessive rise in blood pressure with increasing age; and (2) to identify children and adolescents with secondary hypertension and those with severe primary hypertension who require evaluation and therapy. Health professionals should support the following approaches:

- Encourage appropriate diet and physical activity to maintain appropriate weight.
- Use appropriate techniques for measurement of blood pressure in children.
- Learn to interpret blood pressure levels in children and adolescents with the use of tables based on sex, age, and height.
- Measure blood pressure after age 3 at all routine healthcare visits.
- Identify children with persistent blood pressure elevation.
- Institute nonpharmacological treatment with sodium restriction and weight reduction when appropriate.
- Refer children with severe blood pressure elevations to a hypertension specialist.

## High Blood Cholesterol

### Background

Major epidemiological studies in adults have established a strong positive association between total and low-density lipoprotein (LDL) cholesterol levels and the incidence of CAD morbidity and mortality. Among adults dying of CAD, more than one third have a total cholesterol level >240 mg/dL, a level at which the rate of CAD is twice that when total cholesterol is <200 mg/dL. Low levels of high-density lipoprotein (HDL) cholesterol also are associated with an increased risk of CVD in adults. Studies in adults over time periods as short as 3 to 7 years have shown that lowering elevated LDL cholesterol levels lowers the risk of coronary heart disease. Cholesterol levels track over time, which means that children with high levels of LDL cholesterol are likely to become adults with high levels. Evidence linking higher blood cholesterol levels in children and adolescents with atherosclerotic lesions in coronary and other arteries is accumulating. Because the atherosclerotic process antedates clinical manifestations by years and even decades, it seems prudent to minimize or reduce known adult risk factors in younger as well as older age groups. Such an approach is even more justified when reductions in risk are not associated with adverse side effects. Public, physician-based, and family-based education is likely to affect lifestyles in such a way that lower blood cholesterol levels will be present in later years. An important aspect of addressing blood cholesterol levels in children should be positive emphasis on promotion of cardiovascular health and the avoidance of negative approaches, like labeling children with higher cholesterol levels as being at risk.

### Assessment and Intervention

Two strategies are recommended by the National Cholesterol Education Program (NCEP): (1) the population strategy of maintaining lower blood cholesterol levels in all children, and (2) the individual strategy of identifying children at higher risk for premature heart disease due to high blood cholesterol levels so targeted intervention can lead to lower blood cholesterol levels in these children.

### Population Strategy

This strategy is recommended for all children >2 years of age and has an overall goal of introducing nutritional patterns in childhood that, when maintained throughout life, will lower blood cholesterol levels of the adult population as a whole. These recommendations are consistent with those of the AHA and the NCEP report of the Expert Panel. The recommendations emphasize implementation of a diet low in saturated fat (<10% of energy) and cholesterol (<300 mg/d) to lower blood cholesterol levels and promote cardiovascular health in all children >2 years of age, as well as adolescents and adults.

- Adequate nutrition should be achieved by eating a wide variety of foods low in saturated fat and cholesterol.
- Total caloric intake should be sufficient to support normal growth and development and maintain desirable body weight.
- Saturated fatty acids should provide <10% of total calories.
- Total fat should provide an average of no more than 30% and no less than 20% of total calories.
- Polyunsaturated fatty acids should provide up to 10% of total calories.
- Less than 300 mg of cholesterol should be consumed per day.
- Children should consume 5 or more daily servings of vegetables and fruits.
- Children should consume 6 to 11 daily servings of whole-grain and other grain foods.
- Children should consume adequate amounts of dietary fiber (Age +5 g/d).

Dietary guidelines can be implemented by easily understood educational programs for the public; by marketing, industrial cooperation through the media, and emphasis on

preparation of appropriate foods by the food service industry; and in physicians' offices. Governments and communities can provide guidance to make school lunches more heart healthy. Instruction on preparation of school lunches, alternative low-fat food choices (eg, 1% or fat-free milk rather than whole milk), and understanding of food labels are examples of programs that can be developed. Children >2 years of age should be encouraged to consume low-fat (1%) or nonfat (skim) milk and other low-fat dairy products, which are major sources of calcium, an important constituent of bone. Bone mass seems to be related to intakes of calcium during the years of bone mineralization, which peaks at ≈20 years of age.

### Individual or High-Risk Strategy

The AHA recommends monitoring the cholesterol levels of children in families in which adverse cardiovascular health factors are present (including premature CAD [at or below age 55 years in parents, grandparents, aunts, or uncles] or family history of hypercholesterolemia [parents with blood cholesterol levels >240 mg/dL]), children who have other CVD risk factors, and children for whom family history is unavailable. Family history should be reviewed at the initial assessment and updated annually. The physician may elect to screen the child for high blood cholesterol levels if one or more of the following risk factors are observed: hypertension, smoking, sedentary lifestyle, obesity, excessive alcohol intake, certain medications associated with hyperlipidemias (eg, retinoic acid, oral contraceptives, or anticonvulsants), or disease states such as diabetes mellitus or nephrotic syndrome. In population studies, childhood cholesterol level is a good predictor of cholesterol level in young adulthood, particularly at the high and low extremes of distribution. However, because the correlation is imperfect, it cannot be definitely stated that a child with high cholesterol levels will have high cholesterol levels as an adult. Multiple measurements through puberty are therefore recommended before diagnosing the child as hypercholesterolemic. Total cholesterol levels can be measured at any time of day in nonfasting patients because levels of total cholesterol do not vary appreciably with eating. A fasting lipid profile provides more complete information about the child's cholesterol status. For a fasting lipid profile, the child should have nothing to eat or drink except water for 12 hours. LDL cholesterol levels can be measured in either serum or plasma but usually are determined indirectly by using the Friedewald formula: LDL cholesterol − total cholesterol − (HDL cholesterol + [triglycerides/5]).

The AHA endorses the guidelines of the NCEP Expert Panel on Blood Cholesterol in Children and Adolescents in setting the following definitions for acceptable, borderline, and high total and LDL cholesterol levels in children and adolescents between 2 and 19 years: Acceptable levels of total cholesterol and LDL cholesterol are <170 mg/dL and <110 mg/dL, respectively; borderline levels, 170 to 199 mg/dL and 110 to 129 mg/dL; and high levels, ≥200 mg/dL and ≥130 mg/dL. The levels of 170 mg/dL and 200 mg/dL approximate the 75th and 95th percentiles for total cholesterol levels, respectively, in American children. A long-term goal is the identification of children whose cholesterol levels put them at increased risk of CAD as adults.

The most complete approach to screening is to obtain a fasting lipid profile. This will provide measurement of total cholesterol, triglycerides, and HDL cholesterol. When the fasting triglycerides level is <400 mg/dL, LDL cholesterol can be calculated. Nonfasting total cholesterol measurements can be obtained, but these may miss children and adolescents with isolated low HDL cholesterol and need to be verified by a fasting lipid profile if the total cholesterol is elevated above 170 mg/dL. When abnormal values are detected, it is useful to repeat the test and to consider the average value of the two tests for clinical decision-making (Figure 2). Depending on the cholesterol concentration, appropriate interventions can be started.

Two children with the same total cholesterol level but different levels of HDL cholesterol also will have different levels of LDL cholesterol; the children with the higher HDL cholesterol level will have a lower LDL cholesterol level, and the child with the lower HDL cholesterol level will have a higher LDL cholesterol level. In the Framingham Study, low HDL cholesterol levels were correlated with a higher risk of CAD in adults. Members of some families with isolated decreases in plasma HDL cholesterol levels are at risk of developing premature CAD. The NCEP considers an HDL cholesterol level of <35 mg/dL a risk factor in children and adolescents. Other factors associated with low HDL cholesterol include smoking and obesity. Hypertriglyceridemia is often associated with lower HDL levels.

The significance of elevated triglyceride levels measured in childhood for cardiovascular risk in adulthood is unknown. Triglyceride levels >200 mg/dL, which are related to obesity, respond to weight reduction. Dietary modifications such as decreasing consumption of fat and simple sugars and increasing intake of omega-3 fatty acids (eg, fish oil, flaxseed oil) also help to decrease triglycerides. Triglyceride levels >500 mg/dL may suggest a genetic disorder of triglyceride metabolism.

### What You Can Do

The above indications for determining cholesterol levels represent a minimum. As more is learned about the relation between elevated cholesterol and atherogenic lipoproteins, wider and more precise screening strategies may become apparent. Because elevated cholesterol level is in part an inherited characteristic, it is of concern that a relatively small number of parents currently know their cholesterol level. Therefore, primary care providers should obtain information on parental and grandparental health history. They should encourage parents and other family members to have their cholesterol measured. This process should be assisted by cardiologists who care for adults with coronary heart disease. When an adult patient with atherosclerotic heart disease is treated, the cardiologist should ask about other family members, including children and grandchildren. Then the primary care physician of these younger patients should be notified so appropriate screening can be accomplished. If family history information is unavailable, then primary care providers may wish to obtain parents' cholesterol measurements so a deter-

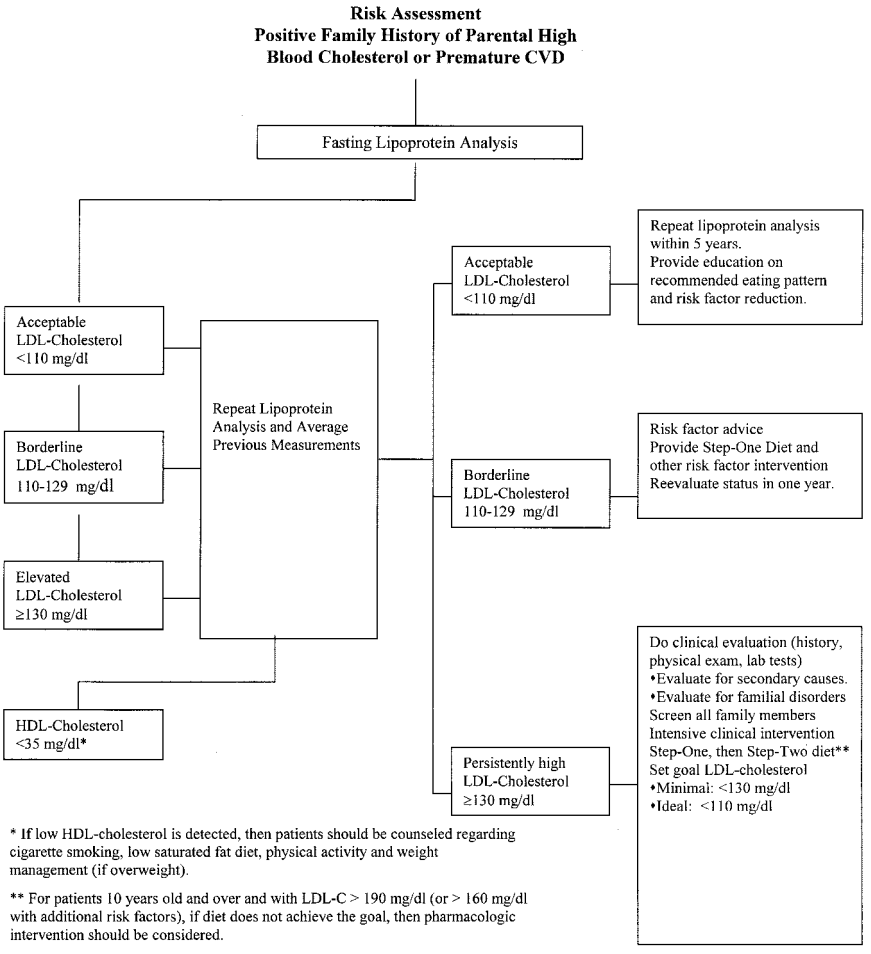


**Figure 2.** Flow chart of classification, education, and follow-up of children based on LDL cholesterol levels. Modified from Highlights of the Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents.

mination about the need for screening the child can be made. This may assist in identifying adults who are at increased risk of CVD but are unaware of it.

All children with an LDL cholesterol level >130 mg/dL should receive targeted intervention and follow-up (see Figure 2). As previously recommended by the AHA and, more recently, the NCEP pediatric panel, a diet low in saturated fat and cholesterol is the first approach to lowering elevated blood cholesterol levels. Dietary education benefits the general population, but it is also the primary focus for intervention in children with hypercholesterolemia. Good aspects of a child's current diet should be used as the initial building block of a healthier nutritional intake.

If careful adherence to this diet for at least 3 months fails to achieve LDL cholesterol levels of <130 mg/dL, then a more aggressive dietary approach is warranted. This entails further reduction of the saturated fat intake to <7% of total calories and dietary cholesterol to <200 mg/d. This diet requires careful planning to ensure a balanced and adequate intake of calories, vitamins, and minerals. A registered dietitian or other qualified nutrition professional should be consulted at this stage, if this has not been done previously.

In general, as recommended by the NCEP pediatric panel, drug therapy to lower blood cholesterol levels is reserved for those 10 years of age or older who, while on a strict diet, either have LDL cholesterol levels persistently >190 mg/dL or have LDL cholesterol levels >160 mg/dL and either a strong family history of premature CAD or ≥2 adult CVD risk factors (eg, low HDL cholesterol level, smoking, high blood pressure, obesity, or diabetes). Children who require drug therapy to lower blood cholesterol levels should be treated by physicians experienced in the management of lipid disorders in children. Children with hypercholesterolemia require nutritional intervention, long-term follow-up of cholesterol levels, nutritional guidance, and identification and amelioration of other risk factors. It is important to emphasize interactions among the different risk factors (eg, the associations between obesity and increased LDL cholesterol levels and between smoking and decreased HDL cholesterol levels) as well as the ability of single interventions to modify multiple risk factors simultaneously (eg, exercise as a means of decreasing obesity, lowering blood pressure, and increasing HDL cholesterol levels). The physician's office or community clinic where cholesterol testing of patients and their families can reliably be performed is the perfect setting for the introduction of comprehensive risk factor assessment and treatment. An integrated approach involving the entire family will likely be more successful.

## Cigarette Smoking

### Background

Cigarette smoking has been called the chief single avoidable cause of death in our society and the most important public

**TABLE 4. Methods Physicians Can Use to Promote Nonsmoking**

| Objective | Target | Strategy |
|---|---|---|
| To reduce the amount of passive smoking by the infant | Parents and others close to the infant | Encourage cessation of smoking among parents and/or nonsmoking near the infant. |
| | | Ask about parents' smoking habits. |
| | | Motivate parents to quit smoking by stressing the immediate health risks to infants and young children. |
| | | Set a date on which the smoker agrees to quit. |
| | | Reinforce the commitment of ex-smokers. |
| To teach children that smoking is a harmful and addictive behavior | Children in elementary school and the distal social environment | Promote nonsmoking by emphasizing the harmful physical consequences of smoking. |
| | | Discuss the addictive nature of cigarettes. |
| | | Describe advertising techniques that mask the real effects of smoking. |
| | | Advocate a smoke-free environment at home and enforce a smoke-free environment at the doctor's office. |
| To encourage adolescents to remain or become nonsmokers through social skills development | Adolescents in secondary schools | Promote nonsmoking by emphasizing the immediate physiological and social consequences. |
| | | Describe ways to deal with pressures to smoke. |
| | | Urge commitment to nonsmoking. |
| | | Recommend healthier alternative behaviors. |

health issue of our time. Cigarette smoking has also been characterized as a behavioral and social illness that is widely prevalent and results in enormous morbidity and mortality. Because most smokers first acquire their habit in the preteen or teenage years, prevention of the problem necessitates the active involvement of pediatricians, family practice physicians, and other health professionals who care for children.

Smoking is of great significance in a primary care practice for four reasons: (1) If all smoking were eliminated from the United States, it is estimated that there would be 19% less placental abruption, 22% fewer infants born with low birth weights (<2500 g), 33% less heart disease, 41% fewer childhood deaths between 1 month and 5 years of age, 50% less bladder cancer, and 90% less lung cancer. (2) Many children are, in effect, already smoking on a regular basis by breathing the residual smoke from cigarettes lit and inhaled by their parents. Even indirect and passive smoking incurs substantial health consequences and causes a significant percentage of minor and major illnesses among children. (3) The precursors to the adoption of cigarette smoking onset can be influenced by intervention. (4) The onset of smoking is usually in adolescence and has immediate social and medical consequences. Interventions that can prevent use, delay onset, or minimize smoking among adolescents are likely to prevent habitual use. The predictors of smoking are numerous, and a consistent antismoking message from key health-related role models may lower smoking rates in all age groups and subcultures. The message about cigarette smoking, in contrast to that of many other risk-related behaviors, is unequivocal. The child's physician should explicitly support the concept of not smoking. In the office, this includes promotion of smoking cessation among adults and adolescents, as well as overt reinforcement for not smoking.

## Assessment

A smoking history should be obtained on all children >8 years of age during routine health assessments. Children should be asked if they have ever tried cigarettes, if they have siblings or friends who smoke, and if they are currently smoking. Children who are current smokers should be asked about age of onset of smoking; number and type of cigarettes currently smoked per day, week, or month; and whether they want to quit smoking and need help to quit the habit.

A smoking history should also be obtained for parents and other household members and updated periodically. Parents who smoke should be encouraged to quit and should be actively referred to community smoking cessation programs. Smoking behaviors of children, adolescents, and their parents should be documented in the medical charts and followed up at each successive clinic visit. Silence on this subject by a physician is interpreted as an indication that smoking is not a significant health risk.

## What You Can Do

Clinicians who treat infants, children, and adolescents deal with vastly different levels of intellectual and social maturity. Both the theory and practical details of smoking interventions differ among these groups. Behavioral prescriptions to use for each age group are summarized in Table 4. Physicians who care for children and adolescents should have patient information ready to distribute to parents and children in the office setting that describes the health hazards of smoking and provides specific information on smoking cessation methods and contact information for community agencies that sponsor smoking cessation programs.

### *Infants and Toddlers*

For infants and very young children, intervention is not directed at the child but at the parents and other cigarette smokers in the home. The young child with parents or other family members or caretakers who smoke not only is exposed to the harmful effects of passive smoke inhalation but also is influenced by the daily experience of watching the most influential role models in his or her life practice the unhealthy

smoking habit. Studies have shown that preschool children with a parent who smokes cigarettes are much more likely to think cigarette smoking is "cool" and to say that they intend to smoke cigarettes "when they get bigger." Thus, health professionals who care for young children play a key role in urging smoking parents to quit the habit.

Health professionals who care for children also play an important role in positively influencing the health of young parents. Individuals between 18 and 35 years of age are less likely to visit physicians than are older adults and are difficult to reach with preventive messages. Because young smokers who have accumulated only a few pack-years of smoking benefit most from cessation, it is critical for health professionals to provide effective intervention and counseling toward smoking cessation. Smokers rate physicians as providing the greatest motivation to quit smoking, ahead of urging by friends and relatives, legal restriction of smoking at work and in public places, higher taxes, and antismoking advertising.

One smoking cessation model has four basic components: *ask*, *motivate*, *set a quit date*, and *reinforce*. *Asking* parents of infants and young children about smoking is the first step, which should occur during each office visit. *Motivating*, the second component of promoting smoking cessation, occurs on two levels: The physician must motivate the parent to attempt to quit smoking, and the physician must motivate himself or herself to deliver a cessation message. When parents who smoke have been identified and then motivated to quit by discussion of the immediate health and social consequences, the actual cessation attempt can be negotiated. An effective way to do this is to *set a date* in the near future on which the smoker agrees to quit and enter it into the child's medical chart. This third component may increase both the number of attempts to quit and the success of those attempts. The final component is *reinforcement.* Although smoking cessation manuals and specialized clinics can now achieve reliably high initial rates of cessation, recidivism is also very high: Fewer than 3 of 10 smokers who quit will remain abstinent after 1 year.

### *Children*

When children are asked from whom they learn most about health, the second most frequent response, after their mothers, is doctors. Children see physicians as both medical experts and role models for appropriate health behavior. The messages delivered by physicians are interpreted as facts and translated into evidence for or against particular habits. The physician serves a unique role in being able to provide information at critical times in a child's development as well as being an alternative health role model for the child.

Five strategies for discussing smoking with children are suggested. First, encourage young children to actively avoid environmental cigarette smoke whenever possible. Second, emphasize to children that not starting to smoke—"not even a puff"—is the best way to avoid becoming a regular smoker. Because some experimentation does occur during this age, this advice could help delay or prevent that experimentation. Certain times at which physicians are likely to see children (eg, for camp physical examinations, sports, and school changes) may be particularly significant occasions for physicians to discourage smoking. School transitions, for example from elementary to junior high school, are times of marked acceleration in smoking onset rates. Third, point out the harmful health consequences of smoking (eg, cancer, emphysema, and heart disease) and the addictive, habit-forming qualities of nicotine. Many adults began smoking as adolescents without the knowledge that the effects of nicotine are so pernicious and the habit so tenacious. Fourth, smoking advertisements should be shown to children, with an emphasis on how little is written about the well-known harmful effects of smoking and how advertising falsely portrays the smoking habit to be enjoyable. Fifth, the physician should provide a nonsmoking environment in the office, one without ashtrays and with signs indicating that smoking and a physician's office are incompatible. In addition, a nonverbal but effective antismoking message can be delivered through posters, pamphlets, and videos in the waiting room and through casually displayed educational models of healthy and diseased arteries or lungs in the examining room.

### *Adolescents*

Adolescents are the group most at risk for beginning to smoke. At this age, the long-term harmful effects of smoking should be deemphasized; adolescents recognize the health consequences of smoking but see them as remote and irrelevant. Instead, smoking is seen as having more immediate positive consequences, such as becoming part of a group or being more mature. The primary care provider should concentrate on more proximal methods to discourage smoking for adolescent smokers and nonsmokers. Consequences like bad breath, smelling like smoke, and nicotine stains on the fingers are of concern to self-conscious adolescents. The effects of nicotine on heart rate, blood pressure, and steadiness are evident after a single cigarette and, once pointed out to a young smoker, can serve as a repeat warning every time a cigarette is smoked.

Peer pressure seems to be the most important proximal factor for initiation. Learning to say no to peer pressure is critical to prevention. The physician or nurse practitioner should review types of peer pressure situations and provide opportunities for the adolescent to practice refusal. Direct reinforcement for nonsmoking or commitments to nonsmoking should be used. A contract or a statement of intention not to smoke by the adolescent can also be used by the physician. A letter to the patient commending his or her positive health behavior might be a powerful reinforcer. Finally, health professionals should promote alternatives to smoking. Because adolescents smoke for particular reasons (eg, to fit in with a group, to lose weight, or to appear older), smoking serves important functions. Attention to the lifestyle of the adolescent and the needs that smoking fulfills can help the physician generate alternative behavioral prescriptions for the adolescent and maintain nonsmoking as the ideal.

## Smoking Cessation

Because >1 in 5 US adolescents smokes cigarettes on a daily basis by the time he or she is a senior in high school, a large proportion may need assistance with smoking cessation.

Physicians and other health professionals who care for adolescents should obtain a tobacco history on each adolescent patient and be familiar with effective methods of smoking cessation. Physicians also need to be prepared to provide ongoing support to teens who require professional counseling for smoking cessation, either personally or through referral to an appropriate community-based smoking cessation program. Some adolescents will quit smoking on the advice of their physician, and cessation messages as brief as 3 minutes may be effective. Studies show, however, that the more intense the treatment, the more effective it is in producing long-term abstinence from smoking. Many adolescents will require repeated efforts to quit smoking, especially if they are nicotine dependent. The physician should encourage the adolescent to set a quit date and to gradually decrease the number of cigarettes smoked before that date. The quit date should be clearly noted in the patient's chart, and the physician (or other staff) should call the night before to remind the adolescent of the impending date and offer assistance as needed. Because adolescent smokers who try to quit experience withdrawal symptoms similar to adults, those who regularly smoke a pack a day or more may require use of nicotine replacement systems such as the nicotine patch or gum, especially if nonpharmacological techniques have been tried without success. These therapies seem safe and well tolerated when applied under appropriate professional supervision.

## Prevention of CVD in Children and Adolescents

### Family History of CVD

An important part of assessing a child's or adolescent's risk of CVD later in life is evaluation of the occurrence of CVD due to atherosclerosis in the child's immediate and extended family. CAD is familial; that is, CAD tends to cluster in families. In some studies, a history of premature CAD in a first-degree relative (parents or siblings) has been found to be the single best predictor of risk even when patients with an inherited dyslipidemia are excluded. Therefore, a family history of CAD should be documented early in childhood. Because parents of infants and young children may be too young to have CAD themselves, a positive family history is defined as documented myocardial infarction, angiographic documentation of CAD, angina pectoris, or sudden cardiac death in first- or second-degree relatives (parents, siblings, grandparents, or blood-related aunts and uncles) $\leq$55 years of age.

If a positive family history is identified, information about CVD risk and about strategies to reduce risk should be introduced. Parents with significant CVD risk factors need to be referred for evaluation if this has not been done previously. Because the health status of family members is still evolving in young families, family history must be updated annually. If the family history becomes positive for CAD at any time, a review of CVD risk and referral of the parents by the child's doctor may be appropriate. This process should be reciprocal; physicians making the diagnosis of heart disease in young adults should refer children and grandchildren for further evaluation.

### Interaction of CVD Risk Factors

Identification of a child with multiple risk factors is important. The risk associated with any single identified factor is markedly affected by the intensity of coexistent risk factors. Epidemiological and clinical studies have shown that individuals with multiple risk factors have substantially increased CVD risk compared with those with a single risk factor and that risk factors tend to cluster in individuals.

As an approach to identifying multiple risk factors, a cardiovascular health profile can be completed for each child. Personal family history, smoking history (including passive smoking), blood pressure percentiles, BMI percentile chart, serum cholesterol level, and level of fitness can be used to develop a composite estimate of CAD risk and to direct management. This profile graphically demonstrates to children and their families their risk factors for future CAD.

### Cardiovascular Health Schedule

The childhood years provide a unique opportunity for promotion of cardiovascular health. Parents actively seek advice and support from primary care providers, particularly when their children are in infancy. Information provided at this vulnerable time can have an important impact on future lifestyle. Plotting growth, BMI, and blood pressure and following other health factors over time allows for early identification of lifestyle elements that may contribute to the risk of CVD later in life. Health promotion begins by focusing intervention at the child's developmental level.

At the same time, it is important to educate and encourage parents to personally adopt and practice a heart-healthy lifestyle at home, especially with regard to diet, physical activity, and avoidance of tobacco use. In this way, parents become positive role models for their children and at the same time improve their own cardiovascular health. Many parents can be persuaded to adopt healthier personal lifestyles for the sake of their children, even if they were not previously motivated to make the same changes for themselves.

The schedule for Integrated Cardiovascular Health Promotion in Children, described in Table 5, provides recommendations for CVD risk factor identification, education, intervention, and follow-up at specific times during routine pediatric care. This table was designed to be copied and included in each child's medical record to guide and document CVD health promotion screening and counseling activities as part of child health supervision.

#### *Birth*

At either the prenatal or first neonatal visit, the primary care practitioner should obtain a careful family history for CVD in the expanded first-degree relative group. Family history is dynamic and therefore should be updated regularly. As noted previously, identification of a family history positive for CVD should initiate a pattern of management for the parent and child.

At the initial pediatric visit, a parental smoking history should be obtained. Information about the negative impact of

parental smoking on children and the risk associated with passive smoking should be communicated to parents, and smoking cessation should be strongly recommended. Information about smoking cessation should be available.

### *First 2 Years of Life*

During the first 2 years of their child's life, parents have many questions about feeding. Issues like the introduction of solid foods provide openings for teaching parents about a healthy diet for children, one that is nutritionally adequate, low in salt, and low in saturated fat and cholesterol. When children begin eating independently, recommendations can be made about good snacks. At ≈1 year of age, when the switch is usually made from breast milk or formula to cow's milk, the importance of whole milk as a source of calories at this age can be emphasized.

### *From 2 to 6 Years of Age*

After 2 years of age, the change can be made from whole milk to low-fat (1% or fat-free) milk and dairy products with the goal of keeping saturated fat below 10% of energy intake. Calories previously derived from saturated fat may be replaced with complex carbohydrates and with monounsaturated fats (eg, olive oil, canola oil, peanuts, and peanut butter) in order to maintain adequate energy intake. The heart-healthy, prudent diet can be gradually implemented after the second birthday. Parents should be encouraged to include a variety of vegetables and fruits and grains in the preschooler's diet so that young children can acquire taste preferences for healthy foods. Adults in the home should serve as role models for young children, following a healthy eating pattern consistent with the US Department of Agriculture Food Guide Pyramid. Routine clinical charting of weight, height, and BMI will identify children with deviant growth patterns. Early identification of preschool children who are becoming overweight is important so that appropriate primary prevention steps may be initiated. Because children with one or both obese parents are at increased risk of developing obesity, these children should be monitored carefully. Formal review of a child's growth chart is often revealing for a parent and can be very helpful in supporting recommendations for dietary change.

During the preschool years, when many physical skills are required, parents should be encouraged to participate in regular play with their children to enhance development of these skills. Family activities allow children to see their parents as models for an active lifestyle and to learn activities they can enjoy throughout life: A link is established between fun and exercise. At ≈3 years of age, formal recording of blood pressure should begin. Blood pressure needs to be interpreted in light of age, weight, and height, and charting is recommended to allow identification of those children with blood pressure at or higher than the 90th percentile. Recording blood pressures and reviewing the blood pressure course with patients and families leads naturally into discussion of avoidance of obesity and reduced salt intake, which are important for all patients. Three or more systolic and/or diastolic blood pressures higher than the 95th percentile for age and height should initiate an investigation for secondary causes of hypertension as outlined by the Second National Heart, Lung, and Blood Institute Task Force on Blood Pressure in Children.

Although the diagnosis of a dyslipidemia can be made in infancy, intervention is not usually recommended before age 2; a reasonable age for this assessment therefore seems to be 2 to 6 years. At this time, if the parents' lipid levels are unknown, parental lipid profiles should be obtained to identify those children who need lipid evaluation. Two determinations that show LDL cholesterol levels above the 95th percentile and/or HDL cholesterol levels below the 5th percentile strongly imply a genetic dyslipidemia.

### *From 6 to 10 Years of Age*

In this age range, when children are still somewhat responsive to authority figures, the primary care physician can complete a cardiovascular health profile of the child. As stated previously, this composite estimate of CAD risk, based on family history, smoking history, blood pressure percentile, BMI percentile chart, fingerstick cholesterol, and level of fitness, is a potentially effective teaching instrument. The profile can be used to emphasize all the important elements of cardiovascular health, including the prudent diet that should be reinforced for this age group.

Because several studies indicate that physical activity patterns established in childhood persist into adult life, reinforcing the need for regular exercise is important. To facilitate this, the subject of fitness can be formally introduced with the parent and child in this age range. Age-appropriate activities for the child can be recommended and increased family participation in regular activities of all kinds can be encouraged. The association of television watching with sedentary lifestyle and obesity should be addressed.

Active smoking prevention counseling for children in this age group should be a routine part of health assessments and should be reinforced at each encounter. Parents who smoke should repeatedly be urged and assisted to quit smoking.

### *Preteens and Adolescents*

In this age range, when physician visits generally are limited to sports and camp physicals, the setting itself can be conducive to reemphasizing the benefits of heart-healthy nutrition, daily physical activity, maintenance of ideal weight, and smoking avoidance in preventing heart disease. Because about one quarter of adolescents will be regular smokers by their senior year in high school, active smoking prevention and cessation counseling must be a routine part of adolescent health care. It is helpful if the primary care provider reviews the family history with older adolescents, emphasizing prevention of health conditions and chronic diseases that have affected first- and second-degree family members (eg, atherosclerosis and coronary heart disease, hypertension, hyperlipidemia, obesity, type II diabetes, and tobacco-related diseases).

For adolescents, precollege or employment physicals provide an ideal opportunity to review all the risk factors for heart disease. In epidemiological studies of children, the best correlation of adult cholesterol levels was with cholesterol levels obtained in the late teen years, so a lipid profile obtained at this age will be even more predictive than earlier ones of adult cholesterol levels. Because most of the turmoil

**TABLE 5. Schedule for Integrated Cardiovascular Health Promotion in Children**

| Age, y | Family History* | Cholesterol | Obesity | Blood Pressure | Diet | Physical Activity | Smoking | Actions Taken |
|---|---|---|---|---|---|---|---|---|
| 0–2 | Early heart disease† (age ≤55 y)<br>Parent's total cholesterol ≥240 mg/dL | Parent cholesterol screening | Plot height and weight on growth charts<br>Parent obesity | Family history of hypertension | Diet history<br>*Early foods influence future food preferences* | Parent physical activity<br>*Discourage television and video viewing* | Parental/household smoking?<br>If yes, counsel to quit; referral to smoking cessation | ... |
| 2–6 | Update family history<br>Early heart disease† (age ≤55 y)<br>Parent's total cholesterol ≥240 mg/dL | → Fasting lipids screening<br>→ Total cholesterol screening | Plot height, weight, and BMI (kg/m$^2$) on growth charts<br>BMI percentiles | Start routine blood pressure measures at 3 y of age (determine if >90th or 95th percentile for sex, age, and height) | Diet history<br>*Low-saturated-fat diet‡ including 1% or nonfat milk*<br>*Moderate salt intake* | *Encourage active child-parent play*<br>*Limit sedentary behaviors such as television and video viewing* | Parental/household smoking?<br>If yes, counsel to quit; referral to smoking cessation | ... |
| 6–10 | Update family history<br>Early heart disease† (age ≤55 y)<br>Parent total cholesterol ≥240 mg/dL | → Fasting lipids screening<br>→ Total cholesterol screening | Plot height, weight, and BMI (kg/m$^2$) on growth charts<br>BMI percentiles | Blood pressure measures<br>Blood pressure percentiles | Diet history<br>*Low-saturated-fat diet‡ including 1% or nonfat milk*<br>*Moderate salt intake* | Physical activity history<br>*Lifestyle and family activities*<br>*Limit sedentary behaviors such as television and video viewing* | Parental/household smoking?<br>If yes, counsel to quit; referral to smoking cessation<br>*Antismoking counseling§* | ... |
| >10 | Update family history<br>Early heart disease† (age ≤55 y)<br>Parent's total cholesterol ≥240 mg/dL | → Fasting lipids screening<br>→ Total cholesterol screening | Plot height, weight, and BMI (kg/m$^2$) on growth charts<br>BMI percentiles | Blood pressure measures<br>Blood pressure percentiles | Diet history<br>*Low-saturated-fat diet‡ including 1% or nonfat milk*<br>*Moderate salt intake* | Physical activity history<br>*Lifestyle and family activities*<br>*Daily moderate to vigorous activity*<br>*Limit sedentary behaviors* | Parent/household smoking?<br>Assess child smoking<br>If yes, counsel to quit; referral to smoking cessation<br>*Antismoking counseling§* | ... |

Assessment items are in normal typeface; counseling items are in italics.

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

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

‡The diet should average <30% (but not <20%) of calories from total fat, <10% of calories from saturated fats, ≤10% of calories from polyunsaturated fats; and the lesser of 300 mg/d or 100 mg cholesterol per 1000 kcal energy intake.

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

of the teenage years has ended by the late teens, the patient may be better able to incorporate some of the information provided at this time. It is particularly important to review the significance of cardiovascular fitness because young adults often become much less active once they leave school. Because many young people seek no routine medical care during the next 10 to 20 years, strong recommendations for cardiovascular health promotion at this time can have an important effect.

## The Multidisciplinary Team

A major goal of this document is to provide effective strategies for cardiovascular health promotion that can be integrated efficiently into routine pediatric care. A developmental, family-based, profile approach to the assessment and management of cigarette smoking, physical activity, obesity, hypertension, and levels of cholesterol is suggested and emphasized in the cardiovascular health schedule presented in Table 5. Information provided suggests a multidisciplinary team approach and is applicable across healthcare settings, including the physician's office and hospital- and community-based clinics. Physicians, nurses, and other healthcare professionals can be involved in the assessment of the child and family cardiovascular health profile and in designing and implementing developmentally appropriate interventions. Cardiovascular health promotion, as defined in Table 5, emphasizes the acquisition and maintenance of health behaviors. Nurses and dietitians can be particularly instrumental in providing this information and in counseling children and families about the adoption of and adherence to a heart-healthy lifestyle.

## Cardiovascular Health Promotion in Schools

Health and education are strongly linked. To maintain good health and avoid preventable disease throughout their lives, children must acquire knowledge about health risks and acquire the skills that are needed to avoid or reduce those risks. Moreover, because a growing number of children

attend preschool, and the vast majority attend elementary through high school, the schools are an especially effective and efficient system for providing health education for children. Many of the risk factors for chronic diseases during adulthood, such as CVD, have their roots in childhood. Lifetime patterns of diet and physical activity, for example, often are established and reinforced in childhood, and three fourths of adult cigarette smokers tried their first cigarette before age 18. A wide variety of school health education curricula and programs are available in both comprehensive and categorical models. All seek to help students acquire the knowledge and develop the skills needed to make positive health choices and practice healthful lifestyle behaviors. Comprehensive programs cover a wide range of health education areas, including nutrition, exercise, fitness, disease prevention, cigarette and drug use prevention, growth and development, social and emotional health, dental health, consumer health, environmental health, and health and safety. Categorical programs specific for cardiovascular health are valuable supplements for schools and provide more in-depth education and skill-building in areas targeting reduction of CVD risk. These include curricula developed by the AHA; the National Heart, Lung, and Blood Institute of the National Institutes of Health; and others. Guidelines for physical activity, nutrition, and smoking prevention/cessation programs for schools have been developed by the Centers for Disease Control and Prevention. These guidelines provide in-depth recommendations for educational content, school policy and environment, physical activity and sports programs, school food service, and program evaluation.

Physicians in the community can play an important role in encouraging the adoption and implementation of effective health education programs in their community schools. In addition, active professional support is important in related activities such as membership on school health committees, input into school no-smoking policies, encouragement of heart-healthy school lunch programs, provision for high-quality physical education programs, and inclusion of teacher training institutes in areas related to health education.

## Conclusion

The AHA's approach to cardiovascular health promotion in children and adolescents, which is based on the identification of modifiable lifestyle factors through routine pediatric care, is integrated with the child's developmental level. Smoking, hypertension, cholesterol, obesity, physical activity, and diet have been reviewed in this statement. The cardiovascular health schedule provides developmentally specific education to be implemented during routine pediatric visits. Cardiovascular health promotion linked to regular pediatric care has the potential to reduce the risk of atherosclerotic disease in both the individual child and the population at large.

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KEY WORDS: AHA Scientific Statements ■ pediatrics ■ atherosclerosis ■ cardiovascular diseases ■ prevention ■ risk factors

# Correction

In the AHA Scientific Statement, "Cardiovascular Health in Childhood," by Williams et al, which appeared in a previous issue of the journal (*Circulation*. 2002;106:143–160), an error appeared in the section on obesity. The next-to-last sentence in the third paragraph of the Assessment section read: "Obesity related to hyperinsulinemia generally is accompanied by signs and symptoms of hypoglycemia."

The sentence should read: "Obesity related to hyperinsulinemia generally is accompanied by signs and symptoms of hyperglycemia."

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