

# *AHA Medical/Scientific Statement*

## *Special Report*

### **Integrated Cardiovascular Health Promotion in Childhood**

#### **A Statement for Health Professionals From the Subcommittee on Atherosclerosis and Hypertension in Childhood of the Council on Cardiovascular Disease in the Young, American Heart Association**

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**C**oronary heart disease remains the leading cause of death in the United States, responsible for close to half a million deaths each year. Over 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 promotion of cardiovascular health that can be integrated into routine pediatric care. Five critical areas are reviewed: cigarette smoking, physical activity, obesity, hypertension, and levels of cholesterol.

Background information, methods of assessment, and means for intervention are discussed for each area. Brief sections on assessment of family history and interaction of risk factors are also included. A cardiovascular health schedule has been developed to help the practitioner implement these suggestions within the framework of regular pediatric care. Rather than labeling specific children as abnormal, strategies are directed toward promoting optimal cardiovascular health for all children.

#### **Cigarette Smoking**

##### *Background*

In 1984 Dr. C.E. Koop called smoking "the chief single avoidable cause of death in our society and the most important public health issue of our time." It is useful to consider cigarette smoking as a behavioral and

social illness that is widely prevalent and results in enormous morbidity and mortality. Because most smokers acquire their habit in the early teenage years, the solution of the problem must involve pediatricians and other health professionals who treat children.

Smoking is of great significance in a pediatric practice for four reasons: 1) If all smoking were eliminated from the United States, it is estimated that there would be 19% less abruptio placenta, 22% fewer infants born with low birth weights (less than 2,500 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 are evident in childhood, and smoking onset can be influenced by intervention. 4) The onset of smoking is usually in adolescence and has immediate social and medical consequences. Intervention that can prevent use, delay onset, or minimize smoking among adolescents is 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 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*

Patients and their parents should be asked if they have tried cigarettes, whether they smoke, and if they intend to quit if they have experimented or are regular smokers. Smoking levels of children, adolescents, and their parents should be documented in the medical charts. Silence on

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**TABLE 1. 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. 1. Ask about parents' smoking habits. 2. Motivate parents to quit smoking through immediate risks to infant, and 3. Set a date on which the smoker agrees to quit. 4. Reinforce exsmokers.
To teach children that smoking is a harmful and addictive behavior	Children in elementary school and the distal social environment	Promote nonsmoking by emphasizing 1. Harmful physical consequences of smoking 2. Addictive nature of cigarettes 3. Advertising techniques that mask real effects of smoking 4. Smokefree environments at home and 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 1. Immediate physiological and social consequences 2. Ways to deal with pressures to smoke 3. Commitment to nonsmoking 4. Alternatives

this subject by a physician is interpreted as an indication that smoking is not a significant health risk.

*What You Can Do*

Physicians 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 1.

*Infants*

With infants, intervention is not directed at the patient but at the parents. The infant whose parents smoke is not only exposed to the harmful effects of passive smoke inhalation but also observes smoking by the most powerful role models in his or her social environment.

Physicians who care for children play a unique role with a segment of the young adult population—parents. People between the ages of 18 and 35 years are less likely to visit physicians than are older people and are difficult to reach with a preventive message, yet young smokers, who have accumulated only a few pack-years of smoking, benefit most from cessation. Physicians can provide the effective intervention and counseling they need. 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 model of promoting smoking cessation among adults has four components: asking, motivating, setting a quit date, and reinforcing. Asking parents about smoking is the first crucial 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 frustratingly high: fewer than three of ten 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 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.

Four strategies for discussing smoking with children are suggested. First, it should be emphasized 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 stage, this advice could help delay or prevent that experimentation. Certain times in which physicians are likely to see children, such as for camp physical examinations, sports, or 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. Second, the harmful health consequences of smoking should be pointed out, for example, cancer, emphysema, and heart disease, as well as the addictive, habit-forming qualities of nicotine. Most adults who

smoke began doing so as adolescents without the knowledge that the effects of nicotine are so pernicious and the habit so tenacious. Third, 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. Finally, 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.

### *Adolescents*

Adolescents are clearly the group most at risk for beginning to smoke. At this stage, 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 pediatrician 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. An ecolyzer, which measures the amount of carbon monoxide in expired air, could be used by a physician to determine whether the adolescent is smoking. The immediate harmful effects of carbon monoxide could be used to encourage nonsmoking.

Peer influences appear to be the most important proximal factor for initiation. Learning to say no to peer pressure seems critical. The physician or nurse practitioner could review types of peer pressure situations and provide opportunities for the adolescent to practice refusal. Direct reinforcement for nonsmoking or commitments to nonsmoking could be used. A contract or a statement of intention not to smoke by the adolescent could be used by the physician. A letter to the patient commending his or her positive health behavior might be a powerful reinforcer. Finally, the physician can promote alternatives to smoking. Because adolescents smoke for particular reasons, for example 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.

### **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. Higher levels of physical activity in adults have been associated with a long life and decreased risk of cardiovascular disease.

A healthy level of physical activity requires regular participation in activities that increase energy expenditure above resting levels. An active child participates in

physical education classes, plays sports, performs regular household chores, spends recreational time outdoors, and regularly travels by foot or bicycle. A sedentary child minimizes opportunities for play or recreation at school, spends the majority of his or her leisure time watching television, and regularly travels by car. Many socioeconomic factors contribute to the diminished physical activity of American children. Schools have redistributed funding and time commitments in favor of academic programs and away from physical education programs because of costs and the recent emphasis on poor performance by American children in standard academic disciplines. Many children have either a single parent or two working parents, and supervision after school may not be as conducive to participation in peer-based recreational activities as in the past. Recent observations in children suggest increased obesity, television viewing, and playing of computer games, indicating that they are less physically active than in the past. Positive social values, including improved interpersonal skills, diffusion of tensions, and improved high school performance associated with regular participation in physical activity and sports, are less emphasized today.

### *Assessment*

A clinically useful assessment of a child's level of physical activity should be age related and take into account the following confounders: individual differences in physical fitness levels, physical ability, inclination to participate in various sports, and opportunity to participate. Assessment can begin as early as age 2–3. Asking parents to rate their child as more or less active than other children is an easy and reliable way to begin. Afterward, questions related to the physical activity standards listed below may be asked. The child's age, gender, and inclination toward activity as well as the season of the year, and parental attitudes toward activity should be considered.

*Healthy physical activity standards.* Some general guidelines for healthy physical activity are listed below.

- Regular walking, bicycling, and backyard play; use of stairs, playgrounds, and gymnasiums; and interaction with other children
- Less than 2 hours per day watching television or videotapes
- Weekly participation in age-appropriate organized sports, lessons, clubs, or sandlot games
- Daily school or day-care physical education that includes a minimum of 20 minutes of coordinated large-muscle exercise
- Regular participation in household chores
- Weekly 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*

Emphasis should be placed on play (rather than exercise) and on activities that are enjoyed by the child, that are consistent with the child's skill level, and that can be accomplished given the family's personal resources and interests (Table 2). Physical activity is important for all children, including those who are

TABLE 2. 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 in the media life-long participation in sports and the benefits of a physically active lifestyle.

clumsy and less coordinated. 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, including those who are less coordinated, are involved.
9. Teach parents the importance of being role models for active lifestyles and providing children with the opportunities for those activities.
10. Be an advocate for physical health in your community.

Changes in physical activity levels over time may be difficult to assess but the results of increased physical activity are easily documented. A decrease in the time needed to complete the 1-mile walk/run test administered in school is an objective measure of better cardiorespiratory endurance. An improved weight-for-height ratio, the family or patient's own admission of lifestyle change, fewer hours spent watching television, and favorable changes in blood pressure, total cholesterol level, and high density lipoprotein (HDL) cholesterol level can be related to an increasingly active lifestyle. The long-term benefit of physical activity counseling in

childhood may not be realized until adulthood, when the maintenance of a healthy lifestyle prevents the increase in weight, sedentary activity, blood pressure, and cholesterol levels characteristic of the third and fourth decades of life.

## Obesity

### Background

A preoccupation with body weight has become a characteristic of our adolescent and adult populations. This concern with weight is justified in a certain subset of both populations, because elevated body weight is a predisposing factor for hypertension, blood lipid level abnormalities, adult-onset diabetes, and coronary artery disease. Between 13% and 36% of 12–17-year-old Americans are obese. Depending on gender and race, an additional 4–12% may be considered super-obese. These data represent a 39% increase in the prevalence of obesity when compared with data collected between 1966 and 1970. Equally alarming, there has been a 54% increase in the prevalence of obesity among children aged 6–11 years. Obese children are at an increased risk for obesity as adults. Physicians are in a position to promote desirable body weight (Table 3).

### Assessment

It is important to discriminate between overweight and obesity. Overweight is defined as exceeding the population norm or average weight considering that person's gender, height, and frame. Obesity is defined as an excessive amount of body fat. It is possible to be obese and within the normal weight range, and to be overweight and of normal body fat. With children and adolescents, it is important to consider both weight and some measure of body composition; for example, skinfold fat thicknesses at selected sites. In adults, overweight and obesity, as distinct entities, have both been identified as risk factors for various chronic diseases such as hypertension, coronary heart disease, lipid abnormalities, and diabetes. Maintaining body weight below 120% of normal values and/or skinfold fat thicknesses less than the 85th percentile appear to be reasonable guidelines for children and adolescents who may be at increased risk for cardiovascular diseases.

**TABLE 3. Methods Physicians Can Use to Promote Desirable Body Weight**

Objective	Target	Strategy
To identify children who are obese rather than overweight	Physicians, health promoters, physical education teachers	Use skinfold calipers or other indirect measures of body composition
To encourage a healthier selection of foods, i.e., those with reduced fat and salt content	Child, adolescent, parent	Promote the understanding of food labels and explain how to determine the relative fat content of food
To encourage a more active lifestyle	Child, adolescent	Promote daily school physical education, emphasizing moderate to vigorous activity, and encourage after-school and weekend outdoor activity when possible

### *What You Can Do*

To help patients prevent overweight and obesity, physicians may recommend the following tips.

1. Selection of a healthy diet—For cardiovascular health, cancer prevention, and optimum athletic performance, a diet low in fat and high in complex carbohydrates (e.g., fruit, vegetables) is the diet of choice. This is also true of the optimum diet for either weight loss or weight maintenance. People tend to consume more calories per day on higher-fat diets. Most scientists and clinicians recommend a diet in which fat provides no more than 30% of total calories.

2. Dietary moderation, not restriction—A nutrition plan sure to fail is one in which favorite foods are forbidden. It is important to practice moderation when dieting. The occasional dish of ice cream or piece of pie is all right as long as it really is occasional (e.g., not more than once or twice a week).

3. First helpings but no seconds—Advise your patients to eat as much healthy food as they want with their first plate, but to take no second helpings. This will generally reduce the overall intake of calories but not leave them feeling deprived.

4. Snack food—Snacks are acceptable, but the type of food eaten at snack time is important. The number of calories consumed during snacking add up quickly, so low-calorie, healthy snack food like fruit and vegetables should be selected. Snacking should be limited.

5. Food as an inappropriate reward—Too often high-fat and high-sugar foods are used to reward desired behavior; food should not be used as a reward.

6. Increased levels of daily physical activity—It is surprising how even a small change in daily activity helps to maintain optimum weight. Encourage your patients to walk or ride their bikes rather than taking the car, to stand up when talking on the telephone, and to take the stairs, avoiding elevators and escalators. Help them be creative, adding to this list to increase their daily activity.

7. Formal exercise program—Adding a formal exercise program to the daily schedule can help control weight. Not only are more calories expended but the number of calories consumed may even decrease. Bicycling, walking or jogging, and participation in games and sports are examples of exercise patients can do regularly.

8. An enjoyable exercise routine—Exercise should not be punishment, despite what some persons may have experienced in school physical education classes (e.g., extra laps for tardiness). However, people do not

all enjoy the same activities. Thus, individuals should find activities that they can enjoy and perform successfully. Aerobic activity uses calories quickly, and muscle-building exercise increases the metabolically active fat-free mass.

9. Exercise time as a priority—One thing is true of almost all individuals: everyone is busy. However, a busy schedule should never leave out time for activity. Once that starts to happen, it is difficult to get back into the habit.

10. Parents as important role models—By modeling appropriate dietary and activity habits, parents can have a significant positive influence on the health of their children.

11. Realistic expectations—The media has convinced most people that they can look like popular movie stars or athletes. Ask patients to look at their brothers and sisters, parents, uncles and aunts, and grandparents to get a realistic idea of the role genetics plays in body shape or type. Remind them that there is little one can do to change that. It is also important to remember that weight gains are necessary in the growing child and adolescent, and only unusual gains should be of concern.

## **Hypertension**

### *Background*

Elevated blood pressure accelerates the development of coronary artery disease and contributes significantly to the pathogenesis of cerebrovascular accidents, heart failure, and renal failure. Among all the risk factors cited by the landmark Framingham Study, hypertension has been identified as the most potent antecedent of cardiovascular disease. Because hypertension is usually silent, physicians have a responsibility to identify individuals at risk. Blood pressure rises with age, but hypertension begins in childhood. Physicians therefore have an important role to play in educating children and families about blood pressure and the preventive measures useful in reducing hypertension.

### *Assessment*

The AHA's Council on Cardiovascular Disease in the Young supports the recommendation of the Second Task Force on Blood Pressure that all children 3 years of age and older should have their blood pressure measured in a physician-monitored setting. The measurement should be performed with a mercury sphygmomanometer, with the child sitting and his or her right

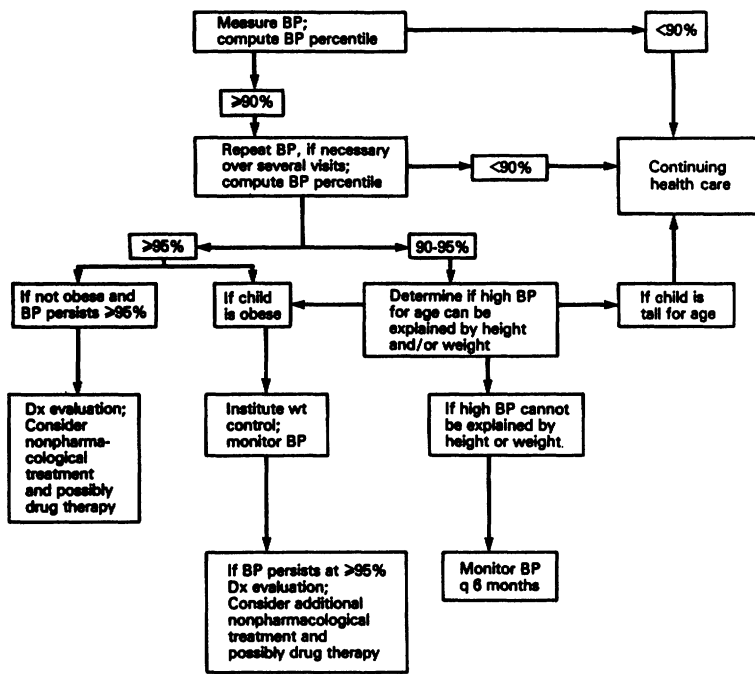


FIGURE 1. Flow chart for identifying children with high blood pressure in need of diagnostic evaluation and treatment. BP, blood pressure; Dx, diagnosis; q 6 months, every 6 months. From Report of the Second Task Force on Blood Pressure Control in Children. Reprint of the Task Force Report by the National Heart, Lung, and Blood Institute. Dallas, Tex, American Heart Association, 1987.

arm resting on a supporting surface at heart level. The width of the blood pressure cuff should be at least two thirds the length of the upper arm, and the bladder should be long enough to almost encircle the arm. The recommendations of the AHA should be followed, including inflation of the cuff to a pressure of 20–30 mm Hg above systolic blood pressure and cuff deflation at 2–3 mm Hg/sec. Korotkoff fourth and fifth sounds have both been suggested as being representative of diastolic blood pressure in children. Electronic instruments are convenient and accurate for measurement of systolic blood pressure. It is this committee’s belief that true diastolic blood pressure is not accurately assessed by indirect methods in infants and children. Therefore, caution should be used in interpretation of diastolic blood pressures in these patients.

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 Second Task Force developed a flow chart for the identification of children with elevated blood pressure (Figure 1). Elevated blood pressure in children is defined as systolic blood pressure consistently 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 graphs developed by the Second Task Force should be used to interpret and track blood pressure measurements. It is useful to review the blood pressure graphs with the child and parent indicating 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. Tall youths may have a

blood pressure at the top of, or just above, the normal range for age but within the normal range for weight. Obese youths are more likely to be hypertensive than leaner ones. Values for the 95th percentile for height and weight for each age group are shown in Table 4. If resting blood pressure equals or exceeds the 95th percentile on three separate occasions and the elevation cannot be explained by height or weight, the diagnosis of hypertension should be made and an appropriate evaluation undertaken. In Table 4 hypertension is classified by age group. The Second Task

TABLE 4. Classification of Hypertension by Age Group

Age group	Significant hypertension (mm Hg)	Severe hypertension (mm Hg)
Newborn		
7 days	Systolic BP ≥ 96	Systolic BP ≥ 106
8–30 days	Systolic BP ≥ 104	Systolic BP ≥ 110
Infants (<2 years)	Systolic BP ≥ 112 Diastolic BP ≥ 74	Systolic BP ≥ 118 Diastolic BP ≥ 82
Children (3–5 years)	Systolic BP ≥ 116 Diastolic BP ≥ 76	Systolic BP ≥ 124 Diastolic BP ≥ 84
Children (6–9 years)	Systolic BP ≥ 122 Diastolic BP ≥ 78	Systolic BP ≥ 130 Diastolic BP ≥ 86
Children (10–12 years)	Systolic BP ≥ 126 Diastolic BP ≥ 82	Systolic BP ≥ 134 Diastolic BP ≥ 90
Adolescents (13–15 years)	Systolic BP ≥ 136 Diastolic BP ≥ 86	Systolic BP ≥ 144 Diastolic BP ≥ 92
Adolescents (16–18 years)	Systolic BP ≥ 142 Diastolic BP ≥ 92	Systolic BP ≥ 150 Diastolic BP ≥ 98

BP, blood pressure.

From Report of the Second Task Force on Blood Pressure Control in Children. Reprint of the Task Force Report by the National Heart, Lung, and Blood Institute. Dallas, Tex, American Heart Association, 1987.

TABLE 5. Methods Physicians Can Use to Promote Prevention of Hypertension in Children

Objective	Target	Strategy
To reduce the risk of high blood pressure and obesity	Parents, children less than 2 years old	Education of the parent about the use of salt as well as healthy eating patterns
To measure blood pressure in all children 3 years of age and older	Physicians, clinics, parents, children	To measure the blood pressure of all children during health visits

Force report presents a succinct diagnostic evaluation for the child whose blood pressure is elevated.

The Council on Cardiovascular Disease in the Young recommends early detection of blood pressure elevation. Appropriate management includes the initiation of nonpharmacological therapies such as active dietary counseling and physical activity prescriptions. Because pharmacological agents cannot lower blood pressure without side effects, such intervention is reserved for children whose blood pressure is consistently very high and for those with significant secondary hypertension. Because obesity in childhood and the development of obesity in adolescence are strongly related to 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. 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 it seems reasonable to initiate moderate salt use in childhood, which might preclude its subsequent overuse.

In Table 5 the objectives, target groups, and strategies to optimize blood pressure awareness in childhood and the preventive measures that may be helpful in reducing hypertension are identified. The goal of children's blood pressure assessment and follow-up is twofold: to identify children with secondary hypertension and those with severe primary hypertension who require evaluation and therapy, and to prevent in all children the acquisition of lifestyle factors (obesity, excessive salt intake, and sedentary activity patterns) that contribute to excessive rise in blood pressure with aging.

### Levels of 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 coronary artery disease morbidity and mortality. Among adults dying of coronary artery disease, more than one third have a total cholesterol level higher than 240 mg/dl, a level at which the rate of coronary artery disease is twice that when total cholesterol is less than 200 mg/dl. Equally important, studies of adults carried out over time periods as short as 3–7 years have shown that lowering elevated cholesterol levels lowers the risk of coronary artery disease. 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 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 seen 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: the population strategy of maintaining lower blood cholesterol levels in all children, and the individual strategy of identifying children at higher risk for premature heart disease because of 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 older than 2 years and has an overall goal of introducing nutritional patterns in childhood that when maintained in adulthood will lower blood cholesterol levels of the adult population as a whole. These recommendations are consistent with those of the AHA, the National Cholesterol Education Program (NCEP) report of the Expert Panel on Population Strategies for Blood Cholesterol Reduction, and the NCEP Expert Panel on Blood Cholesterol Levels in Children and Adolescents. The recommendations emphasize implementation of the AHA's Step 1 diet to lower blood cholesterol levels and promote cardiovascular health in all adults and children more than 2 years of age

- Adequate nutrition should be achieved by eating a wide variety of foods.
- Total calories sufficient to support normal growth and development and maintain desirable body weight should be consumed.
- Total fat should provide an average of no more than 30% of total calories.
- Saturated fatty acids should provide less than 10% of total calories.
- Polyunsaturated fatty acids should provide up to 10% of total calories.
- Less than 300 mg cholesterol should be consumed per day.

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. Government and communities can provide guidance to make school lunches more heart healthy. Instruction on preparation of school lunches, alternate low-fat food choices (e.g., 1% or skim milk rather than whole milk), and substitutions and understanding of food labels are examples of programs that can be developed. Children should be encouraged to consume 1% or skim milk and other low-fat dairy products, which are major sources of calcium, an important constituent of bone. Bone mass appears to be related to intakes of calcium during the years of bone mineralization, which peaks at about age 20.

### *Individual Strategy*

With increasing public awareness of the link between cholesterol and heart disease, cholesterol screening is an acceptable method for introducing children and families to heart-healthy life patterns. The AHA recommends monitoring the cholesterol levels of children in families or environments in which adverse cardiovascular health factors are present, including premature coronary artery disease (at or below age 55) in parents, grandparents, aunts, or uncles; family history of hypercholesterolemia (parents with blood cholesterol levels higher than 240 mg/dl), or children for whom family history is not available. 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 (e.g., oral contraceptives or anti-convulsives), or disease states such as diabetes mellitus or nephrotic syndrome.

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. LDL cholesterol levels can be measured in either serum or plasma but are usually determined indirectly by using the Friedewald formula:  $\text{LDL cholesterol} = \text{total cholesterol} - (\text{HDL cholesterol} + [\text{triglycerides}/5])$ .

In population studies, childhood cholesterol level is a good predictor of cholesterol levels as a young adult, 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 labeling the child hypercholesterolemic.

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 less than 170 mg/dl and less than 110 mg/dl, respectively; borderline levels, 170–199 mg/dl and 110–129 mg/dl; and high levels, higher than 200 mg/dl and higher than or equal to 130 mg/dl.

The levels of 170 mg/dl and 200 mg/dl approximate the 75th and 95th percentiles, respectively, for total cholesterol levels in American children. A long-term goal is to identify children whose cholesterol levels put

them at increased risk of coronary artery disease as adults. The screening protocol varies according to the reason for testing (Figure 2). The initial test for young people with at least one parent with high blood cholesterol (higher than 240 mg/dl), should be a nonfasting measurement of total cholesterol level. The NCEP pediatric panel suggests that a fasting lipoprotein profile be obtained in two clinical situations: when the child's or adolescent's total cholesterol level is higher than 200 mg/dl, and when young people are tested because of a documented history of premature cardiovascular disease in a parent, grandparent, aunt, or uncle (in some instances cardiovascular disease occurs in individuals with low HDL cholesterol levels but normal total blood cholesterol levels).

If nonfasting total cholesterol level is borderline (170–199 mg/dl), a second measurement of total cholesterol should be taken and if the average is borderline or high, a fasting lipoprotein analysis should be obtained (Figure 2).

Two children with the same total cholesterol level but different levels of HDL cholesterol will also have different levels of LDL cholesterol; the child 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 coronary artery disease in adults. Members of some families with isolated decreases in plasma HDL cholesterol levels are at risk of developing premature coronary artery disease. The NCEP considers an HDL cholesterol level of less than 35 mg/dl a risk factor in children and adolescents. Other risk factors associated with low HDL cholesterol include smoking and obesity. Hypertriglyceridemia is often associated with lower HDL levels.

Because the correlation between HDL cholesterol levels in the prepubertal and the postpubertal years is not very good, and significant problems remain in the laboratory standardization of the measurements of HDL cholesterol, determining HDL cholesterol levels to assess risk is not recommended in children at present. However, HDL cholesterol levels much lower than 35 mg/dl or much higher than 70 mg/dl are, at least in part, genetically determined and may have some predictive significance.

The significance of elevated triglyceride levels measured in childhood for cardiovascular risk in adulthood is unknown. In general, triglyceride levels higher than 200 mg/dl are often related to obesity and will respond to weight reduction or decreasing fat content of the diet. Triglyceride levels higher than 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 large part an inherited characteristic, it is of concern that a relatively small number of parents currently know their cholesterol level. Therefore, it seems reasonable for pediatric primary care providers



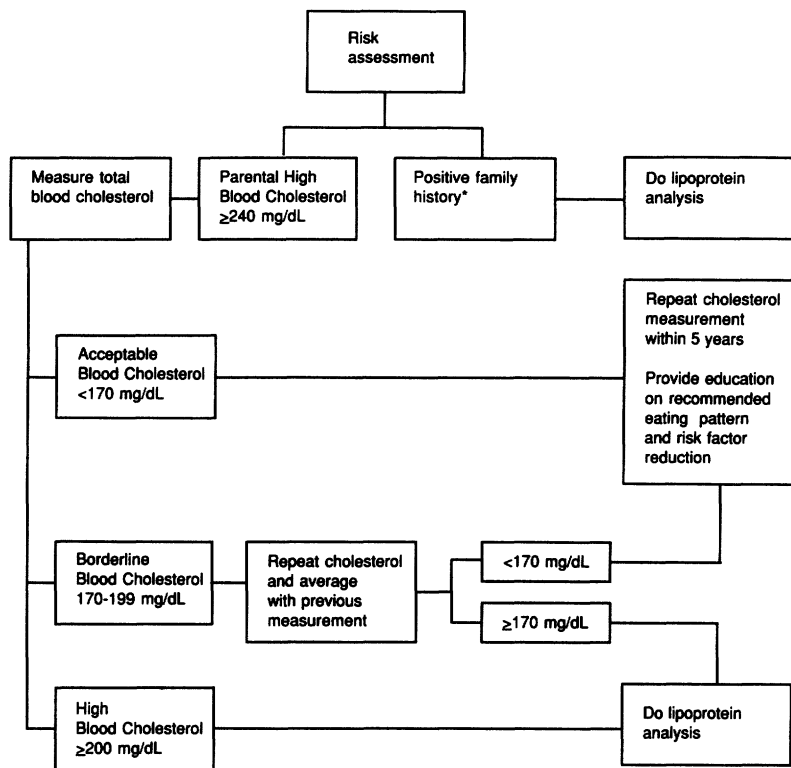


FIGURE 2. Flow chart of assessment of risk to determine need for second measurement or lipoprotein analysis. Positive family history is defined as a history of premature (before age 55) cardiovascular disease in a parent or grandparent. From Highlights of the Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. Reprint of the Pediatric Panel Report by the National Heart, Lung, and Blood Institute. Dallas, Tex, American Heart Association, 1991.

to obtain parents' cholesterol measurements so a determination about the need for screening the child can be made.

All children with LDL cholesterol levels higher than 130 mg/dl should receive targeted intervention and follow-up (see Figure 3). As previously recommended by the AHA and, more recently, the NCEP pediatric panel, an AHA Step 1 diet 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 less than 130 mg/dl, the Step 2 diet should be prescribed. This entails further reduction of the saturated fat intake to less than 7% of calories and of the cholesterol intake to less than 200 mg/day. Adoption of the Step 2 diet requires careful planning to ensure adequacy of the nutrients, 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 higher than 190 mg/dl or have LDL cholesterol levels higher than or equal to 160 mg/dl and either a strong family history of premature coronary artery disease or two or more adult cardiovascular disease risk factors (i.e., low HDL cholesterol level, smoking, high blood pressure,

obesity, or diabetes). The AHA endorses the recommendations of the NCEP pediatric panel report with respect to drug therapy. Children requiring drug therapy to lower blood cholesterol levels should be treated by physicians experienced in the management of lipid disorders in children.

Children with hypercholesterolemia will require nutritional intervention, long-term follow-up of cholesterol levels, nutritional guidance, and identification and avoidance of other risk factors. It is important to emphasize interactions among the different risk factors (e.g., the associations between obesity and increased LDL cholesterol levels and between smoking and decreased HDL cholesterol levels) as well as the ability of simple interventions to modify multiple risk factors simultaneously (e.g., 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. An integrated approach involving the entire family will likely reduce the current high morbidity and public cost of coronary artery disease in the United States.

### Family History

Coronary artery disease is familial; manifest CAD clusters in families. In some studies, a history of premature CAD in a first-degree relative 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

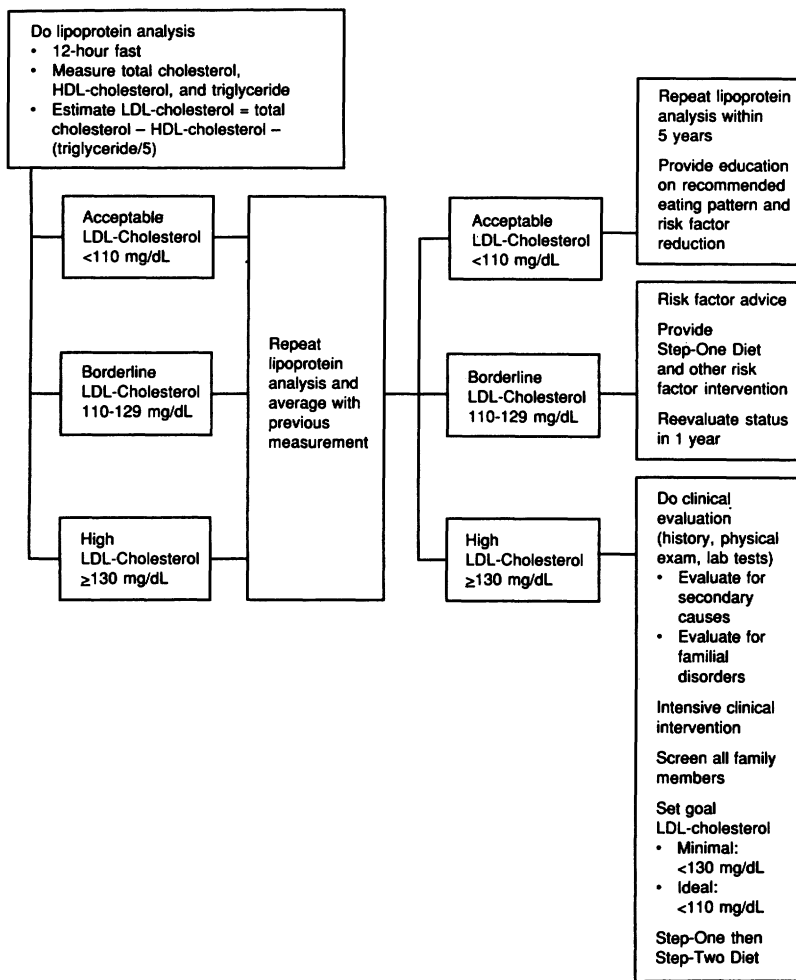


FIGURE 3. Flow chart of classification, education, and follow-up of children based on low density lipoprotein cholesterol levels. HDL, high density lipoprotein; LDL, low density lipoprotein. From Highlights of the Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. Reprint of the Pediatric Panel Report by the National Heart, Lung, and Blood Institute. Dallas, Tex, American Heart Association, 1991.

childhood. Because parents of infants and young children may be too young to have coronary artery disease themselves, a positive family history is defined as documented myocardial infarction, angiographic documentation of coronary artery disease, angina pectoris, or sudden cardiac death in parents, grandparents, aunts, or uncles at age 55 or younger.

If a positive family history is identified, information about cardiovascular risk and its modifiability should be introduced. The involved parent needs to be referred for evaluation if this has not been done previously. Because family history is still evolving in young families, it must be updated regularly, and if the family history becomes positive for coronary artery disease at any time, a review of cardiovascular risk and referral of the parents by the child's doctor are necessary. 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 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 any coexistent risk factors. Cross-sectional studies in adults have shown that patients with multiple risk factors have substantially increased cardiac risk compared with those with a single risk factor. In adults, it has also been

shown that risk factors tend to cluster in an individual patient.

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, weight-for-height chart, serum cholesterol level, and level of fitness can be used to develop a composite estimate of coronary artery disease risk and to direct management. This profile graphically demonstrates to children and their families their risk factors for future coronary artery disease.

**Cardiovascular Health Schedule**

The childhood years provide a unique opportunity for promotion of cardiovascular health. Parents actively seek advice and support from pediatric care providers, particularly when their children are in their infancy. Information provided at this vulnerable time can have an important impact on future lifestyle. Plotting growth and blood pressure and following other health factors over time allows for early identification of lifestyle elements that may contribute to the risk of cardiovascular disease later in life. Health promotion begins by focusing intervention at the child's developmental level. At the same time, educational intervention with the parents can be initiated so parents can serve as role models for their children while improving their own

**TABLE 6. Cardiovascular Health Schedule**

Birth	<ul style="list-style-type: none"> <li>• Family history for early coronary heart disease, hyperlipidemia → if positive, introduce risk factors; parental referral</li> <li>• Start growth chart</li> <li>• Parental smoking history → smoking cessation referral</li> </ul>
0–2 years	<ul style="list-style-type: none"> <li>• Update family history, growth chart</li> <li>• With introduction of solids, begin teaching about healthy diet (nutritionally adequate, low in salt, low in saturated fats)</li> <li>• Recommend healthy snacks as finger foods</li> <li>• Change to whole milk from formula or breast feeding at approximately 1 year of age</li> </ul>
2–6 years	<ul style="list-style-type: none"> <li>• Update family history, growth chart → review growth chart* with family (concept of weight for height)</li> <li>• Introduce prudent diet (&lt;30% of calories from fat)</li> <li>• Change to low-fat milk</li> <li>• Start blood pressure chart at approximately 3 years of age**; review for concept of lower salt intake</li> <li>• Encourage active parent–child play</li> <li>• Lipid determination in children with positive family history or with parental cholesterol &gt;240 mg/dl (obtain parental lipid levels if necessary) → if abnormal, initiate nutrition counselling</li> </ul>
6–10 years	<ul style="list-style-type: none"> <li>• Update family history, blood pressure and growth charts</li> <li>• Complete cardiovascular health profile with child; determine family history, smoking history, blood pressure percentile, weight for height, fingerstick cholesterol, and level of activity and fitness.</li> <li>• Reinforce prudent diet</li> <li>• Begin active antismoking counseling</li> <li>• Introduce fitness for health → life sport activities for child and family</li> <li>• Discuss role of watching television in sedentary lifestyle and obesity</li> </ul>
>10 years	<ul style="list-style-type: none"> <li>• Update family history, blood pressure and growth charts annually</li> <li>• Review prudent diet, risks of smoking, fitness benefits whenever possible</li> <li>• Consider lipid profile in all patients</li> <li>• Final review of personal cardiovascular health status</li> </ul>

\*If weight is >120% of normal for height, diagnosis of obesity should be considered and the subject addressed with child and family (see page 1641).

\*\*If three consecutive interval blood pressure measurements exceed the 90th percentile and blood pressure is not explained by height or weight, diagnosis of hypertension should be made and appropriate evaluation considered (see page 1642).

cardiovascular health. The cardiovascular health schedule described here (Table 6) calls for identification of and education about known risk factors at a variety of times during routine pediatric care.

### *Birth*

At either the prenatal or first neonatal visit, the primary care practitioner should obtain a careful family history for cardiovascular disease 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 cardiovascular disease 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 Two Years*

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 fats. When children begin eating independently, recommendations can be made about good snacks. At approximately 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 Two to Six Years*

At 2 years of age, the change can be made from whole milk to skim milk. This often promotes discussion of an appropriate diet. The prudent diet (AHA Step 1) can be formally introduced at this time. Routine charting of weight and height allows early identification of children who are becoming overweight. The risk of obesity needs to be identified and the problem addressed early. 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 approximately 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, important for all patients. Three or more systolic and/or diastolic blood pressures higher than the 90th percentile for age uncorrected by weight and height should initiate a workup for hypertension as outlined by the Second Task Force on Blood Pressure.

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 appears to be 2–6 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 Six to Ten Years

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, weight-for-height chart, fingerstick cholesterol, and level of fitness, is an 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 exercise 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 antismoking counseling for the patient should also begin in this age group and be reinforced regularly.

#### More Than 10 Years

In this age range, when pediatric visits are generally limited to sports and camp physicals, the setting itself can be conducive to reviewing the benefits of fitness and smoking avoidance in preventing heart disease. A pre-college or employment physical of a patient returning for a final pediatric visit is 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 of the teenage years has ended by the late teens, the patient may be better able to incorporate some of the informa-

tion 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 over the next 10–20 years, strong recommendations for cardiovascular health promotion at this time can have an important effect.

#### Conclusion

The AHA's approach to cardiovascular health promotion in children, based on the identification of modifiable lifestyle factors through routine pediatric care, is integrated with the child's developmental level. Smoking, hypertension, cholesterol, obesity, and physical activity have been reviewed in this article. 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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