Original Reports: Weight Control

Overweight as a Risk Factor in Children: A Focus on Ethnicity

The prevalence of overweight in youth is increasing dramatically in the United States. The intimate relationship of obesity and overweight with cardiovascular risk factors and diabetes in adults raises concern for the likelihood of subsequent disease development in children. Ethnic minorities are so disproportionately affected by overweight that a call to action is necessary. The International Society on Hypertension in Blacks convened this work group as part of a larger effort to focus on cardiovascular risk protection beginning in childhood and adolescence, entitled the ''Children are Our Messengers: Changing the Health Message'' initiative. This summary article reviews the data on cardiovascular risk factors and overweight in ethnic children and adolescents, and culminates in a practical algorithm for evaluating overweight children for cardiovascular risk. (*Ethn Dis.* 2003;14:94–110)

Key Words: Obesity, Overweight, Children, Adolescents, African American/Blacks, Hispanics, Ethnicity, Cardiovascular Disease, Hypertension, Diabetes, Insulin Resistance, Dyslipidemia

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Objective

During the past 2 decades, the prevalence of overweight has increased dramatically in the US adult population.[1] With that increase, there has been a concurrent increase in the prevalence of diabetes, and other well-known cardiovascular risk factors.[2] Subsequent to these trends in the adult population, similar trends of overweight are manifesting in US children and adolescents.[3] The rates of type 2 diabetes and insulin resistance are also increasing in the pediatric population.[4] Type 2 diabetes and cardiovascular disease are typically thought of as health problems affecting those of middle or older ages. This assumption is based on the appearance of risk factors in mid-to-late adult life. The current trends of increasing risk at earlier ages may signify an emerging trend toward earlier manifestation of clinical cardiovascular disease.

Overweight and obesity have direct links to adverse health outcomes; however, the more potent relationship may be their indirect association with a litany of other cardiovascular risk factors. While attention is focused on these risk factors, it is of paramount importance to address overweight as a pervasive and centralizing theme. The approaches to weight loss in adults often have limited success, because lifestyle patterns are set early in life. Perhaps a more effective strategy is to concentrate on overweight treatment and risk-factor assessment in childhood, when lifestyle habits are being formed.

Like other disease patterns, trends of overweight differ according to ethnicity and gender. However, the approach to treating overweight individuals has not been targeted accordingly. In this article, we review the literature on obesity and overweight in children and adolescents, as related to ethnicity, risk factors, and clinical disease; determinants of overweight; and clinical trials. Ethnic classifications are derived from region of descent, cultural origin, and cultural identification. In this paper, we have not sought to resolve the issue of clearly defining ethnicity, but to present current data published according to these classifications. Finally, this article reviews the optimal approach to treating an overweight child, and risk factor assessment.

Participants

The authors of this summary article are members of the "Children Are Our Messengers: Changing the Health Message" initiative sponsored and selected by the International Society on Hypertension in Blacks (ISHIB). The membership of this initiative was convened in October 2001, and the writing group first met in April 2002. Members of this group are from multi-specialty backgrounds, and include health service researchers, internists, and pediatricians, who share an interest in cardiovascular risk-factor assessment, and prevention of cardiovascular disease.

EVIDENCE

The work group identified a list of important issues relevant to the development of cardiovascular disease in obese children. The paper was divided into sections addressing key components of the subject of overweight ethnic children in the United States, including epidemiology, risk factors for obesity, hypertension, dyslipidemia, cardiovascular disease, diabetes, effectiveness of weight loss, and evidence-based treatment recommendations. The review focused on overweight or obese ethnic children in the United States, and the association of their condition with cardiovascular risk factors. A systematic review was not possible, due to the limited number of studies of ethnic children in the United States. The data review was conducted as follows: A Medline/PubMed search (from 1966–2002) was performed on each focus area, using key words such as "overweight children," "obesity," and "ethnicity or race," and reviewed by an assigned member of the work group. The papers collected were then summarized and presented to the work group. The data on cardiovascular risk factors in hypertension, dyslipidemia, and diabetes, were compiled into risk-factor epidemiology, pathophysiology, and treatment. These sections were compiled and reviewed by the entire work group. The drafted document was then read by 2 external reviewers with expertise in the focus areas of the manuscript, and returned for revision. The final draft was submitted to the ISHIB board of directors.

FOCUS AREA 1: EPIDEMIOLOGY OF OVERWEIGHT AND OBESITY IN CHILDREN AND ADOLESCENTS

Definitions of Overweight and Obesity

Obesity is defined as excess adipose tissue or body fat, in relation to lean body mass, while overweight refers to increased body weight compared to height. Body mass index (BMI), a measure of body weight related to height (calculated as weight in kilograms divided by height in meters squared [kg/m^2]), is gender- and age-specific for children and adolescents, but not for adults. Body mass index (BMI) growth charts developed by the Centers for Disease Control and Prevention (CDC) were derived using National Health and Nutrition Examination Surveys (NHANES) data, and serve as guidelines for assessing BMI cut points expressed as percentiles.[5] Children and adolescents with BMI values at, or above, the 95th percentile of the sex-specific BMI growth charts are classified as overweight, while those with BMI between the 85th and 95th percentile are considered to be at risk for becoming overweight.[6] Because obesity is defined as excessive adiposity, this term should only be used in children when the high BMI is confirmed by assessment of adiposity (see http://www.cdc.gov/growcharts for the CDC growth charts). The standards for these growth charts are based on large data sets collected in children during the 1960s and 1970s. Several of the studies referred to in this manuscript actually assessed obesity, as they measured adiposity, in addition to weight and height. Therefore, it is appropriate to use "overweight" in some parts of the manuscript and "obese" elsewhere.

The current trends of increasing risk at earlier ages may signify an emerging trend toward earlier manifestation of clinical cardiovascular disease.

Prevalence

The epidemic of childhood obesity is an issue of global importance. Worldwide, approximately 22 million children under 5 years of age are overweight.[7] In the United States, overweight and obesity have been recognized as leading health indicators in *Healthy People 2010,* a national health promotion and disease prevention initiative seeking to reduce the prevalence of overweight and obesity among children and adolescents to ≤5%.[8] The 1999–2000 NHANES data indicate that the prevalence of overweight is now 15.3% and 15.5% in children and adolescents, respectively (Figure 1). In addition, the 2001 Youth Risk Behavior Surveillance System (YRBSS), a self-reported, school-based survey conducted by the CDC to track health-risk behaviors and prevalence trends among youth and young adults, found that 10.5% of US high school students reported being overweight, and 13.6% are at risk for overweight.[10]

Trends and Disparities

Trends in the United States over the past 4 decades indicate a worsening picture. The prevalence of pediatric overweight has increased 3-fold since the 1960s, and doubled since the early 1970s. From 1963 to 2000, the prevalence of overweight rose from 4% to 15.3% in children [aged 6–11 years], and from 5% to 15.5% in adolescents [aged 12–19 years], respectively (Figure 1). This increase in overweight prevalence extends across racial and ethnic groups; however, there are some differences by gender and ethnicity. At younger ages, boys have a higher prevalence of overweight than girls (16% vs 14.5%, respectively), while adolescent boys and girls have similar prevalence rates of overweight (15.5%).[9]

In the YRBSS, male students (14.2%) were significantly more likely than female students (6.9%) to report being overweight. Across grades 9 to 12, prevalence among all students ranged from 9.6% to 10.8%, with adolescents

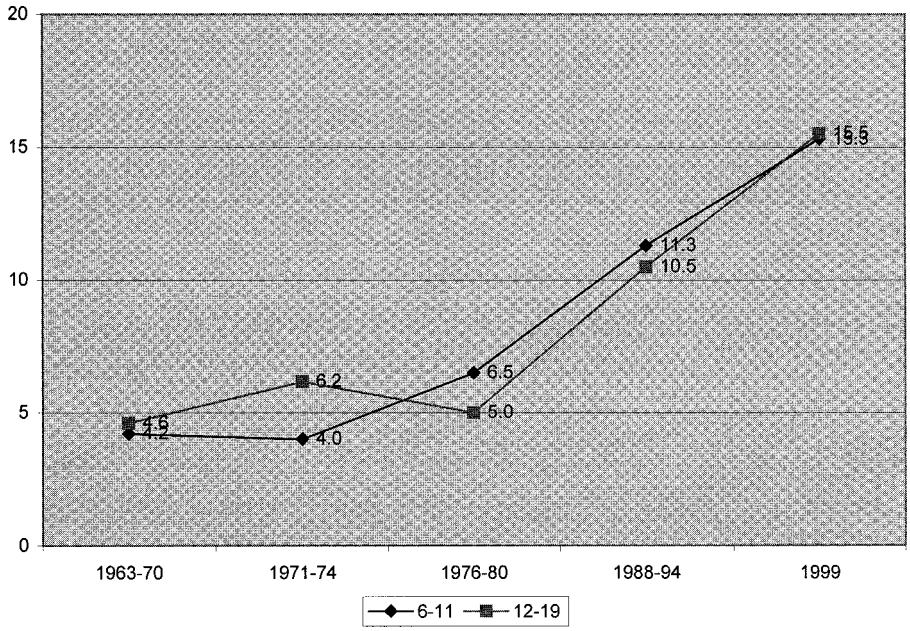

Fig 1. Trends in the prevalence of overweight among children and adolescents, United States. 1963–2000

Source: Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS); National Health Examination Survey (NHES II/III [1963–70]), National Health and Nutritional Examination Surveys NHANES I [1971–74]; NHANES II [1976–80]; NHANES III [1988–94]; NHANES (1999–2000)

exhibiting the highest prevalence in tenth grade, and the lowest in twelfth grade. This survey is useful in monitoring trends, yet the accuracy of self-reported data suffers due to under-reporting.[11,12] In ethnic comparisons from 1999–2000 NHANES data, among boys, Mexican Americans had the highest rates of overweight (27.3% at ages 6–11 years, and 27.5% at ages 12–19 years). Among girls, non-Hispanic Blacks have the highest rates of overweight (22.2% at ages 6–11 years, and 26.6% at ages 12–19 years)[2] (Figure 2). Strauss and Pollack, using data from the National Longitudinal Survey of Youth (NLSY), have documented racial and ethnic differences, with the greatest increase in overweight found among African Americans and Hispanics.[2] Although there is no nationally representative study of obesity in Native American children to date, this ethnic group also appears to have an increased risk for obesity.[13] Data are still sparse on Asian-American, Pacific Islander, or Alaska Native children. Also not well researched are prevalence rates of obesity among children of recent immigrants to the United States from Latino countries (other than Mexico), or from Caribbean, Asian, European, Middle-Eastern, or African countries.

The high prevalence rates of obesity in children and adolescents of minority populations underscore the need for timely intervention in this population. In developing approaches to this public health issue, it is critical to identify those at greatest risk for obesity.

FOCUS AREA 2: RISK FACTORS FOR OBESITY IN CHILDHOOD

Energy Balance

In children, obesity and overweight results from failure to balance energy intake with energy expenditure.[14] The main component of energy expenditure is resting energy expenditure, which is closely associated with body composition and size. Therefore, much inter-individual variability in metabolism and resting energy expenditure is probably explained by differences in body composition.[14–16] The component of energy expenditure exhibiting the greatest variability is physical activity energy.[14] For example, compared to watching television, energy expenditure is about 15% higher for doing school work, 20%–30% higher for creating arts and crafts projects, and 150% higher for engaging in mild-to-moderate physical activity.[17] Therefore, the time spent in these various activities is an important determinant of the overall energy balance. For instance, a 4-year-old child who increased his energy intake by ~30 kcal (~2.5 oz of soda), or who spent ~15 minutes more per day watching television, rather than playing, could potentially develop obesity, if this trend continued for 1 to 2 years.[14] While comprehensive reviews of factors associated with energy imbalance have been published[18]; the focus in this report is on US minority children.

Unusual Underlying Conditions

In the United States, most cases of childhood obesity are primary or exogenous. A small percentage of cases are due to co-existing medical conditions, such as hypothyroidism, Cushing's syndrome, Down's syndrome, Turner's syndrome, Prader-Willi syndrome, excessive tube feeding, cancer survival, or steroid therapy. Most underlying conditions are easily recognizable, and obese children who do not exhibit short stature, developmental delay, dysmorphic signs, or abnormal genitalia, are unlikely to have an underlying medical condition. Energy balance is regulated by leptin, ghrelin, neuropeptides, and other hormones.[19] Only a few cases of leptin insufficiency have been documented, but

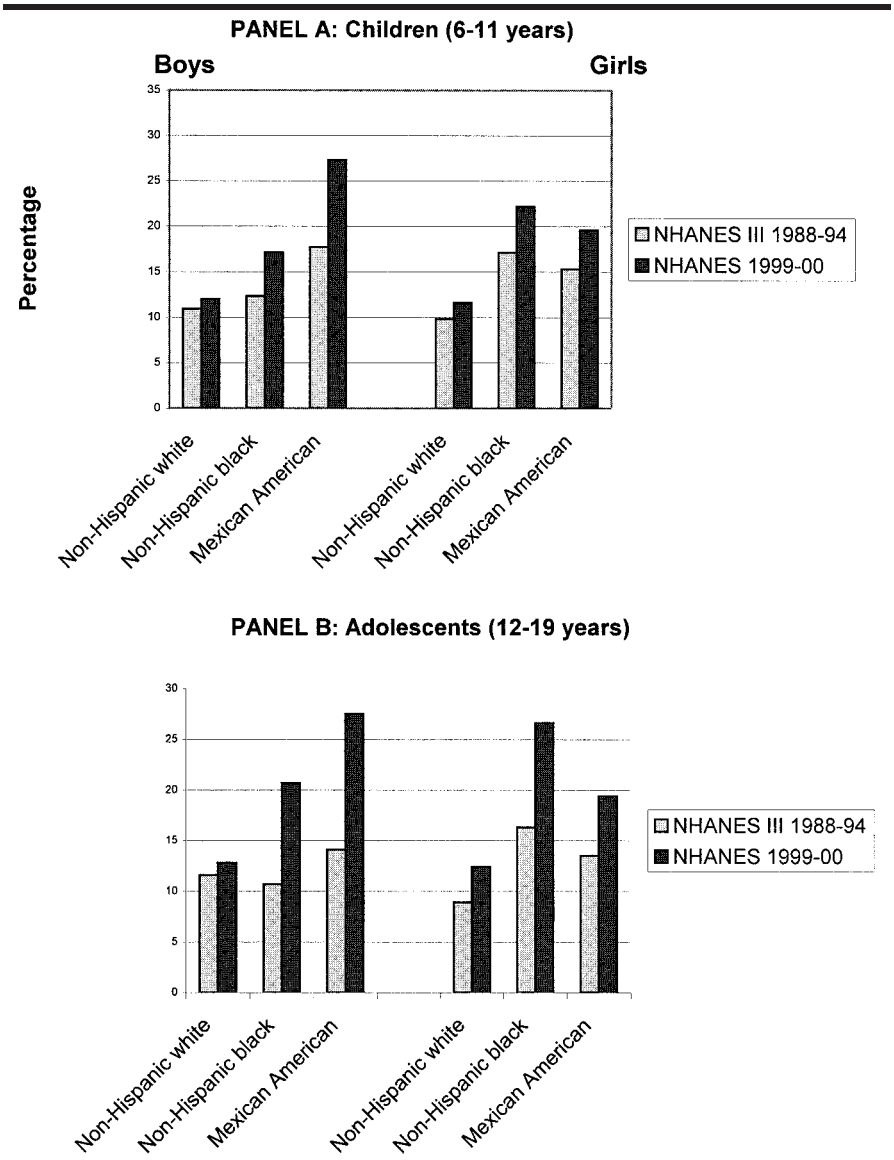

Fig 2. Overweight prevalence by race/ethnicity for children (6–11 years) and adolescents (12–19 years)

Source: Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and Trends in Overweight Among US Children and Adolescents, 1999–2000. *JAMA.* Oct 9 2002; 288(14): 1728–32

leptin resistance may provide a partial explanation for individual predisposition to obesity. In adults, some evidence suggests that leptin levels in non-Hispanic Blacks and Mexican Americans are higher than in Whites; however, after adjusting for body weight, these differences are minimized in children.[20,21]

Constitutional and Non-Modifiable Factors

Because families usually share environmental and genetic backgrounds, the most compelling evidence for a genetic predisposition to obesity is derived from studies of twins,[22–25] and subjects adopted at birth.[26,27] Although such evidence is scarce in minorities, many studies in diverse populations have shown a familial clustering of obesity[28–31]; however, genetic and environmental factors cannot be separated in these studies. Gender differences in the prevalence of overweight status vary among US ethnic groups (Figure 2),[32] suggesting a cultural, or perhaps ethnic, variation in gene expression. Studies of both Black and White children confirm an increased risk of obesity and overweight in children from small families,[30,31,33–36] and in first-born children.[30,33] An increased maternal age has been associated with an increased risk for obesity in Black and White girls.[36] The prevalence rates of overweight vary among racial groups of US children (Figure 2); however, whether these differences are racial, genetic, and biological, or ethnic, environmental, and cultural, remains controversial.[14,37–39]

Socioeconomic and Environmental Factors

In high-income countries, children from lower-income families are at increased risk for obesity and overweight, while in low-income countries, the opposite is true.[40] In the United States, this association varies by sex, age, and ethnic group. The prevalence of obesity is higher in US non-Hispanic White children from low-income families,[31,32,41] but higher in middle- or upper-class families of Mexican-American, or non-Hispanic Black, children,[32] as is the case in low-income countries.[40] Lower parental education has been associated with obesity in non-Hispanic White and Black boys,[32] and in non-Hispanic White, but not Black, girls.[41] In young children, maternal feeding method and control have been associated with obesity in Black and White children.[42,43]

Environmental influences on obesity and overweight may be present early in life. Maternal diabetes during pregnancy has been associated with the development of obesity in Pima Indian children.[44] Observational studies suggest

that breastfeeding may decrease the risk for obesity.[45–47] An association of total caloric and fat intake with obesity has been documented in later childhood, at ages 9 to 10 years[41,48]; however, many studies failed to show an association in children aged 4 to 7 years, possibly due to the difficulties in assessing dietary intake in younger children. The consumption of sugar-containing beverages,[49,50] large portion sizes,[49,51] and meal structure and patterns have also been associated with overweight in US children.[34,35,52]

Several studies demonstrate the association between television viewing and excessive weight gain in childhood,[31,53,54,55] including randomized controlled treatment and prevention trials.[52,53] These studies were conducted in mostly European-American children, however, and may not generalize to minority children. An inverse association of physical activity with body mass index was demonstrated in studies of Native American and African-American children,[56,57] but successful randomized trials are limited.[58] Goran[14] has shown in longitudinal studies that a low level of fitness (as measured by VO_2 max), but not energy expenditure, predicts greater likelihood of developing obesity, in both African-American and White children. In recent decades, opportunities for physical activity have decreased, in conjunction with an increase in automobile use,[59] and a decrease in school physical education.[49] For unknown reasons, fitness levels, as measured by VO_2 max, are lower among African Americans, compared to Whites.[14] Unpublished data in Hispanics show results similar to those for African Americans (personal communication, Goran). Additionally, children's eating and drinking opportunities have increased, with greater numbers of vending machines being located in schools. Many schools exclusively contract with soft-drink companies, and an increasing number of fast food restaurants,[49] leading to what some have called a "toxic environment."[60]

Growth Patterns and Critical Periods

Using a life-course approach to chronic disease,[61] sensitive or critical periods in obesity development have been investigated as important periods for prevention.[62] Fetal life is recognized as one of these critical periods.[63–65] Rapid infancy weight gain has also been associated with childhood obesity, particularly in African Americans,[66–69] while early malnutrition and stunting are associated with an increased risk for obesity in low-income countries.[70,71] The period of adiposity rebound, between ages 3 and 6 years, also appears to be a critical for obesity development,[72–73] as is adolescence.[72] Most studies, however, did not include a large number of minority children.

Among overweight children, those who have additional cardiovascular risk factors are at greatest risk for developing cardiovascular disease. It is critical to understand the relationship of overweight in children to known cardiovascular risk factors.

FOCUS AREA 3: OBESITY-RELATED HYPERTENSION IN CHILDREN

Epidemiology

Numerous studies in a variety of ethnic and racial groups have reported an association between obesity and hypertension in children, and virtually all studies find higher blood pressure levels, or higher prevalence of hypertension, in obese, compared to lean, children.[74–84] Rosner et al pooled data from 8 large US epidemiological studies, involving more than 47,000 children, to describe blood pressure differences between Black and White children in relation to body size.[85] Regardless of ethnicity, gender, or age range, children in the upper decile of BMI had an odds ratio of systolic hypertension ranging from 2.5 to 3.7. Similarly, Sorof et al found that obese adolescents exhibited an approximately 3 times greater prevalence of hypertension, compared to non-obese adolescents, in a school-based screening study of predominantly ethnic minorities.[84] Further analysis by Rosner et al revealed that among lean children, the risk of hypertension was greater in Blacks, whereas among obese children, hypertension risk was greater in Whites.[85] These data suggest that hypertension in Black children, although exacerbated by obesity, is likely mediated by mechanisms that are, to some extent, obesity-independent.

The risk of hypertension in children increases across the entire range of BMI values, and is not defined by a simple threshold effect. Rosner et al reported a progressive increase in the prevalence of diastolic hypertension in children of all race, gender, and age combinations, as BMI increased across the normal range.[85] Sorof et al found an increased prevalence of systolic hypertension as relative BMI increased from the 5th to the 95th percentile (Figure 3).[84] Although this latter study showed a higher prevalence of hypertension in Black, compared to White, adolescents, the difference in prevalence was not significant, after controlling for the higher BMI in the Black adolescents.

Pathophysiology

Most studies in children have focused on the investigation of 3 main pathophysiological mechanisms for obesity-related hypertension: over-activity of the sympathetic nervous system (SNS), insulin resistance, and abnormalities in vascular structure and function. Evidence for SNS over-activity derives from studies demonstrating correlations between heart rate and subscapular skinfold thickness,[86] and between hyperdynamic cardiovascular states and several measures of obesity.[87] Obese hypertensive children also have higher heart rates,[84] increased heart-rate variability,[88] and increased 24-hour blood pressure variability,[84] compared to lean

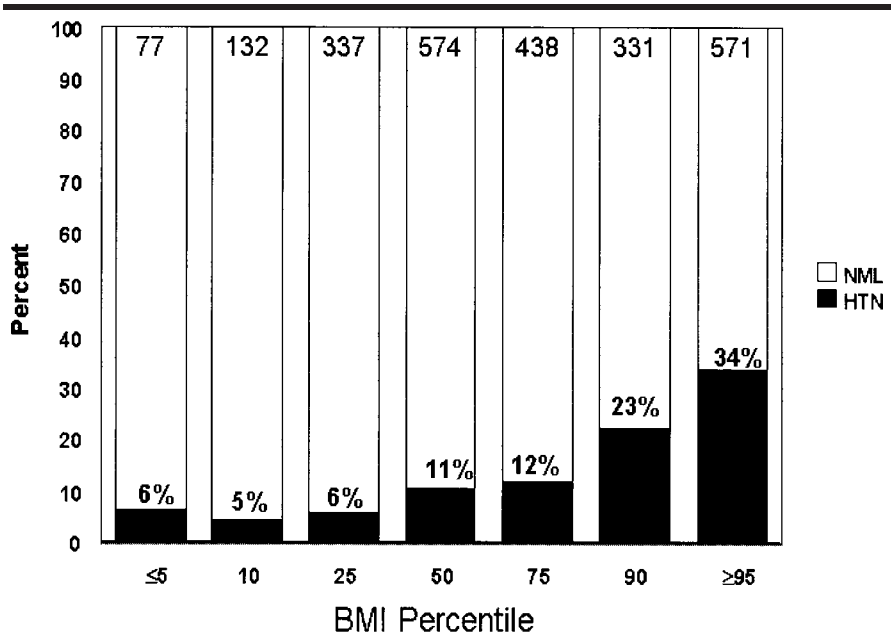

Fig 3. Distribution of BMI percentiles and the prevalence of hypertension within each BMI percentile category. Values above bars indicate number of children within each BMI category.
NML=normotensive;
HTN=hypertensive

Sorof JM, Poffenbarger T, Franco K, Bernard L, Portman RJ: Isolated systolic hypertension, obesity, and hyperkinetic hemodynamic states in children. *J Pediatr* 2002;140:660–666

hypertensive children. Evidence for insulin resistance comes from reported positive associations between fasting insulin levels and resting blood pressure in obese children and young adults.[89–94] In addition, a direct relationship between insulin and the sodium sensitivity of blood pressure has been demonstrated in obese adolescents.[95] Evidence of altered vascular structure and function comes from reports of lower arterial compliance, lower distensibility function, and lower endothelium-dependent and -independent function in severely obese, compared to control, children.[96] Further, obese adolescents are reported to have decreased maximal forearm blood flow, and increased minimal forearm vascular resistance, compared to healthy controls.[97] Other factors implicated in the pathogenesis of obesity-related hypertension include structural changes in the kidney due to encapsulation by fatty tissue,[98] alteration of the renin-angiotensin-aldosterone system,[99] and alterations of the hypothalamic-pituitary-adrenal axis.[100] Although racial predispositions to risk factors for hypertension, such as salt sensitivity, are likely to be important, no studies to date have systematically investigated the influence of ethnicity on the putative mechanisms of obesity-related hypertension in children. Further studies in children are needed to determine whether racial factors moderate the pathophysiology of obesity-related hypertension.

Treatment

The relationship between weight loss and blood-pressure reduction in children is demonstrated in several interventional studies.[101–104] The only controlled trial was performed by Rocchini et al, who randomized overweight adolescents to 3 interventions over a 20-week period: diet alone, diet plus exercise, and control (no intervention).[105] Changes in systolic blood pressure from baseline in the diet plus exercise group, diet alone group, and control group, were −16 mm Hg, −10 mm Hg, and +4 mm Hg, respectively. This latter study provides the most definitive evidence that weight loss, particularly in conjunction with exercise, is beneficial in treating obesity-related hypertension in children. The mechanisms by which weight loss results in blood-pressure reduction have been investigated. Both heart rate[106] and fasting insulin levels[103,106] are lower after weight loss occurs in obese adolescents. Weight loss in obese adolescents also renders previously salt-sensitive individuals insensitive to the hypertensive effects of salt-loading,[95] and reverses impaired post-ischemic maximal forearm blood flow.[105] Therefore, the beneficial effects of weight loss on blood pressure in obese adolescents appear to be mediated through a combination of neurohumoral, metabolic, and vascular changes. It is important to note that each of these studies was conducted either exclusively in White children, or provided no description of the ethnic distribution of study subjects. To date, no studies have focused specifically on racial or ethnic differences in the effect of weight loss on blood-pressure reduction in children.

FOCUS AREA 4: DYSLIPIDEMIA AND CARDIOVASCULAR DISEASE IN OVERWEIGHT AND OBESE CHILDREN

Epidemiology

Dyslipidemias have been described in obese adults, and there is a linear relationship between increasing BMI and increases in levels of total cholesterol, triglycerides, and low-density lipoproteins (LDL), and decreases in levels of high-density lipoproteins (HDL), in both women and men.[107] Abnormal lip-

id levels, and the frequently associated insulin resistance syndrome, are related to adverse atherosclerotic disease in the obese adult population. In children, however, lipids are required for growth and maturation. Lipid levels change with age and puberty, and differ by gender.[108]

In cross-sectional data, dyslipidemia is prevalent in obese children, but is most striking in the ethnic minorities, including Blacks and Latinos. Data from 11,389 school-aged children showed that among Whites and Latinos, mean cholesterol and odds of hypercholesterolemia increase as BMI increases, especially in children with BMI greater than the 95%.[109] Although young Mexican Americans have levels of total cholesterol and LDL similar to those of the general population, consistently higher levels of triglycerides are found in males, while lower levels of HDL are found in females.[110] All obese children have higher odds of developing dyslipidemia.[111] The association of dyslipidemia and obesity is most striking in Black boys and girls, where obese children and adolescents had higher levels of total cholesterol, triglycerides, and LDL, and lower levels of HDL, compared to leaner children. Obese Black boys were 9 times more likely than non-obese Black boys to have hypertriglyceridemia >200 mg/dL, and 4 times more likely to have HDL <35 mg/dL.[112]

In the longitudinal Princeton School Study, BMI increased in both Black and White children, but was most prominent in Black females aged 7–12 years.[113] There was a parallel rise in total cholesterol, particularly among Blacks.[113] In the Child and Adolescent Trial for Cardiovascular Health (CATCH) study, overweight multi-ethnic children, as young as 8 years old, were monitored for 2.5 years.[114] Twenty-five percent of these children remained obese, while another 7% gained weight despite weight-loss interventions. These overweight children also had an increase in levels of total cholesterol and apoprotein B, and a large decrease in HDL levels.[114]

Distribution of abdominal fat appears to be closely associated with dyslipidemias in adults, as defined by a waist-to-hip ratio (WHR). Central adiposity is associated with an increase in levels of LDL and triglycerides, in both Black and White girls aged 9–10 in the National Heart, Lung, and Blood Institute's (NHLBI) Growth and Health Study.[115] Black girls, however, are more likely than White girls to exhibit central adiposity.[115] Body fat distribution and age at obesity onset are strong determinants of obesity tracking into adulthood.[116] A cross-sectional analysis of NHANES data shows an association with WHR in pre-pubertal White and Mexican-American children. After adjustment for BMI and age, WHR is not important in determining apo A or apo B, and lipoprotein (a) >30 mg/d L in all children; however, WHR is important for determining levels of triglycerides for both White and Mexican-American children.[117]

Cardiovascular Disease

Recent data from the Pathobiological Determinants of Atherosclerosis in Youth (PDAY) study provide compelling evidence in the general pediatric population that initial fatty streaks in adolescents may become atheromatous plaques in young adults.[118] Obesity in young Black and White men is associated with a 2-times greater prevalence of an initial atheromatous lesion in the coronary artery, and a 5-times greater prevalence of advanced coronary plaque, as compared to non-obese men. Left anterior descending artery stenosis also occurred in 2 times as many obese men, compared to non-obese males.[119,120] In addition, the long-term risk for the development of atherosclerotic disease in obese men is 2.3–13.2 times higher, than in those without obesity, and 0.4–0.8 times higher, in obese, compared to non-obese, women.[121] This appears to be independent of weight at later stages, and may represent the weight gain of central body fat.

Pathophysiology and Treatment

Adipose tissue is an active endocrine organ primarily used for storage of fatty acids. The release of free fatty acids is thought to be involved in the development of dyslipidemia and insulin resistance in children. Given the fatty acid requirements of children, the development of dyslipidemia in atherosclerosis in children must be clarified to properly prescribe treatment. In adults, exercise has been show to be beneficial in modifying lipid levels. In children, one 7-year study of Black and White children showed a beneficial effect of dietary intervention with a low-fat diet to reduce lipid levels, but the impact of these changes on coronary disease has not been investigated.[122] Although exercise and diet may affect HDL, it is not clear that these treatments affect levels of total cholesterol and triglycerides in adolescents.[123] Drug therapy is currently reserved for children with severe dyslipidemias, and those at high risk for early CVD.

FOCUS AREA 5: OVERWEIGHT AND OBESITY AND DIABETES IN CHILDREN

Type 2 diabetes has emerged as a critical health issue in overweight children, especially overweight African-American, Hispanic, and Native American adolescents.[124,125] More recently, pre-diabetes (previously termed impaired glucose tolerance) has emerged as a major concern in obese children and adolescents, with several studies demonstrating that 20%–30% of obese children have pre-diabetes.[4,126] These studies included children from various ethnic groups, and reported no differences across groups (although, in some cases, the sample sizes of ethnic groups were small).

Extensive work has elucidated the natural history of type 2 diabetes in adults. During the long period preceding the development of the disease, there is a progressive increase in fasting insulin and, subsequently, glucose.[127] At a critical moment, insulin fails to increase in proportion to glucose, and hyperglycemia ensues. While impaired glucose tolerance is regarded as a state of early risk for type 2 diabetes, recent studies have shown that the ability of the beta cell to compensate for insulin resistance may be just as important.[128,129] In youth, risk factors may be similar (increased body fat, decreased physical activity), but the time course is different, and type 2 diabetes in adolescence is further confounded by transient insulin resistance associated with puberty.

The most significant factor contributing to increased risk of type 2 diabetes in children is increased body fat, and possibly specific body fat deposits, such as visceral fat.[130–135] The strong relationship between body fat and insulin resistance has been shown to occur across different ethnic groups of children, including Caucasian, African-American, and Hispanic. Several studies show that African-American children are more insulin-resistant than are Caucasian children, independent of body composition and obesity status.[14,130,134,136,137] Lower insulin sensitivity in African-American children is associated with a higher-than-expected acute insulin response to glucose.[134] These higher insulin levels are partly attributable to increased secretion and a lower hepatic extraction.[138] Studies of obesity, insulin resistance, insulin secretion, and the beta-cell response in other ethnic groups of children are extremely limited. In one study comparing Caucasian, African-American, and Hispanic children in Los Angeles, Hispanic and African-American children were both, and to an equal degree, more insulin-resistant than were Caucasian children.[139] This difference in insulin resistance is independent of adiposity. The compensatory response to the same degree of insulin resistance was different in Hispanic, compared to African-American children. African-American children compensated with a higher acute insulin response to glucose, an effect that may be partly due to a reduction in hepatic insulin extraction, which spares the need to increase insulin secretion. Hispanic children compensated with greater insulin secretion.

Puberty is another important factor affecting insulin resistance in children.[140,141] Pubertal development is associated with a 25%–30% reduction in insulin sensitivity, with the peak reduction occurring at Tanner stage III, followed by recovery by Tanner stage V.[142] Given the increased risk of developing type 2 diabetes among ethnic groups, and the role of puberty in this pathogenesis, it is important to know whether the influence of puberty on insulin resistance varies across ethnic groups; however, this has not yet been studied.

Several recent studies have suggested that low birth weight may contribute to greater insulin resistance among children in different age groups among Caucasians, Asians, Mexican-Americans, Pima Indians, and Black South Africans.[143] Only one study, however, has studied possible associations between low birth weight and greater insulin resistance across multiethnic groups,[144] finding that ethnicity and birth weight had a significant influence on fasting insulin among African Americans.

Previous studies in adults suggest a strong hereditary component in risk for type 2 diabetes.[145–153] Very few studies have looked at the relationship between family history and insulin resistance in children.[126,154,155] Collectively, the studies in children indicate that fasting glucose and insulin may not be affected by a positive family history of type 2 diabetes. Family history may affect the glucose and insulin response to an oral glucose load and insulin sensitivity, as assessed by the clamp technique; however, this was not found to be true for insulin sensitivity when measured by the intravenous glucose tolerance test.

Several studies in children have examined treatment and prevention issues relating to obesity, insulin resistance, and type 2 diabetes, showing moderate, but inconsistent, improvements in insulin resistance.[156–159] Treatment studies have been limited to a study of metformin, with no specific studies comparing effects across ethnic groups. Three published studies of adults provide convincing evidence that type 2 diabetes can be prevented[160–162] with lifestyle intervention or drug treatment; however, there are no studies of children to support this notion. In addition, it is well known that exercise training can improve insulin resistance and reduce risk of type 2 diabetes in adults,[163] but remarkably few studies exist for children and ethnic minorities.

FOCUS AREA 6: EFFECTIVENESS OF WEIGHT LOSS METHODOLOGY IN CHILDHOOD OVERWEIGHT AND OBESITY

Clinical trial data on weight loss in children have been published primarily based on small single-site trials. The focus of these trials has been on dietary, behavioral, physical activity, and multidisciplinary modalities, and on limited drug interventions. Few trials have included ethnic minorities, and even fewer have been designed to focus on the special needs of these groups.

Dietary Trials

There are few dietary trials in children. One of the most frequently studied diets is the protein-sparing modified fast. This diet typically consists of low-calorie, high-protein meals containing lean meats, poultry, fish, and low-carbohydrate vegetables. Several small studies have shown significant weight losses

in overweight children. The dietary phase of these trials has lasted from 10 to 30 weeks. All participants in each study lost weight during the intense phase. In the 1-year maintenance phase, most maintained their weight reduction. However, the dropout rate during the maintenance phases was considerable.[102,164–166] While such diets reduce fat mass, lean body mass and growth velocity were unaffected in both Black and White children.[167–171] The focus of these studies was not on ethnicity, and only a few subjects were African-American. However, researchers observed notable differences in responses according to ethnicity.

The low-glycemic-index diet, which emphasizes food selection rather than calorie restriction, was more effective than a low-fat diet in overweight children after 4 months and maintained at 1 year.[172] Similar results were seen recently in adolescents.[173] Although these findings are encouraging, the data are not from a randomized controlled clinical trial, and should be further investigated.

These diets are not without some small risk of side effects, such as cholelithiasis, hyperuricemia, low serum protein, orthostatic hypotension, halitosis, and diarrhea. The indication for wide-ranging use of these diets in overweight children remains uncertain; therefore, such diets should be reserved for individuals who require rapid weight loss, and those who will be monitored closely under medical supervision.[174,175]

A recent trial of dietary intervention in children revealed that a low-fat diet lowered lipid levels with no adverse effects on growth or pubertal development; however, there were also no significant reductions in body mass index.[122] Another trial, performed in school children to assess the effects of a school-based dietary intervention on fruit and vegetable consumption, demonstrated that the intervention increased fruit and vegetable intake in both children and their parents at 1 year, with a diminishing effect over time. This study showed similar results in the African-American sub-sample of this population.[176]

Behavioral Modification

Clinical studies of behavioral modification programs in children and adolescents have focused on the mode of delivery and the additional effect of exercise.[177] Key findings are that: behavioral therapy is effective in facilitating weight loss, regardless of whether children are treated alone, separate from parents, or simultaneously with parents; physical activity improves the response to behavioral modification in the short term, but not necessarily in the long term; lifestyle exercise is more successful than structured exercise programs; longer-term cognitive behavior therapy is superior to short-term treatment; and, although short-term results of individual and group therapy are apparently better than a school model of treatment, long-term success was similar for all methods.[178–184]

Cultural differences contribute to the eating and lifestyle habits of individuals. Despite the trend of higher rates of overweight among Blacks and Hispanics, few clinical trials have focused on these groups.[185] Low socioeconomic status (SES) and African-American ethnicity overshadow other indicators of obesity. In overweight males, engaging in one high-intensity physical activity 3 to 5 days per week decreases the ethnic and SES-adjusted relative risk of being overweight.[186] In a dietary hospital-based program, although weight losses were similar for Blacks and Whites, the completion rate for low-income Black children was far below that of middle-income Black and White children.[165] This highlights the need for studies to address ethnic groups as a separate priority.

Culturally specific studies of African-American girls and their mothers that include behavioral modification, exercise, and food preparation, demonstrated that: fat intake was reduced after 12 weeks[187]; as shown in other groups, children were more successful than their parents in maintaining weight loss[188,189]; academic performance and family support were determinants of successful weight loss, while early onset of obesity predicted less weight reduction[190]; and parental support was not necessarily important for weight loss in White children, but was clearly important for overweight Black girls and Hispanic children.[101,191–194]

The clinical response to weight loss interventions is affected by attitudes about weight. White adolescent girls from middle- and upper-middle-class families are more likely to aspire to be very thin.[40,195–199] Conversely, Blacks and Hispanics do not idealize ultra-thin body habitus.[200–203] In a recent study of African-American girls (8–10 years old) and their parents, most of the girls were happy with their weight or did not think about it; however, African-American girls living in predominantly White environments were more likely to report weight dissatisfaction, compared to girls living in predominantly Black environments. However 28% of parents were concerned about their daughters' weight, and 71% were concerned about their own weight.[204]

Overall, long-term behavioral studies show that behavioral modification is a vital part of sustained weight loss programs in all children, and family-based therapy may be more successful than individual therapy, particularly for African Americans.

Multidisciplinary School-Based Programs

Although school-based programs have inconsistent success as measured by BMI reduction, they are overwhelmingly successful in changing behavior patterns following these interventions.[205–211] Children emerge with improved health knowledge and awareness, and healthier patterns of eating and exercise. These changes are the beginning of a healthier

lifestyle that is less likely to result in further overweight.

Medications to Reduce Weight

Although phentermine and dexfenfluramine previously showed some success in small trials,[212–216] only subitramine and orlistat remain under study in children and adolescents.[217,218] A recent study of subitramine with behavioral therapy in adolescents demonstrated more weight loss with subitramine, compared to placebo, over 1 year, with minimal side effects.[219] Orlistat, along with diet and exercise, has shown promising results, including weight reduction and improvement in lipid levels and insulin resistance, with minimal side effects in the adolescent population.[220] The diabetes drug metformin has been studied in insulin-resistant and diabetic adolescents, showing significant weight reduction and improvement in insulin sensitivity, without adverse effects.[156–158]

Surgery as a Treatment Modality

The results of gastric bypass surgery have been positive in small case-series reports. However, there are several possible complications from this surgery, and it remains a last resort for severely obese adolescents.[174,221]

It is clear that there is a role for dietary, exercise, and behavioral modification in successful weight-loss programs for children, and those incorporating these methods have longer-term results. Since rates of overweight among children continue to rise, the question of whether school-based or clinic-based programs are most successful is academic. It is necessary to combine all efforts to address the problem, in order to avert further increases in the prevalence of childhood overweight. It would seem appropriate for future clinical trials to place greater focus on high-risk groups such as African Americans and Hispanics, given the disparity in their prevalence rates compared to Whites of overweight and associated risk factors.

CONCLUSIONS

Evidence-Based Treatment Recommendations for Obese and Overweight Children

Obesity in the young, as in adults, results from an imbalance between energy intake and energy expenditure. This imbalance occurs when more calories are consumed than are expended in physical activity and physiological growth. There is ample evidence that maneuvers undertaken to restore energy balance through an increase in physical activity, and a reduction in excessive dietary intake, can correct this imbalance (thereby reducing excess body fat) over a period of time. However, treatment strategies that can be used to achieve and maintain a correction in body size remain elusive. This conundrum applies to children and adults of all ethnic groups, although there are some aspects to the causal pathway that render minority children uniquely vulnerable to the development of obesity. The preceding sections discussed the available evidence, and provided a rationale for a treatment plan. Health risks associated with obesity indicate that obesity is a medical problem that must be addressed by clinicians for the care of individual patients. Obesity is also a health problem with a rising prevalence among the pediatric population. Obesity is, therefore, a public health concern requiring public health strategies and policies that facilitate the implementation and effectiveness of individual case management and prevention efforts.

Prevention

Obesity prevention interventions should be included in well-child care provided by primary care clinicians. Physicians or trained support staff should provide diet counseling and dietary guidelines to parents for their children as part of well-child visits. These anticipatory guidance measures should include parent education on food quality and quantity, as well as on eating patterns. A clinician should calculate and plot the child's BMI on the BMI growth curves. Our work group recommends that efforts to prevent obesity with diet and activity interventions should begin when BMI exceeds the 75th percentile.

Physicians or trained support staff should provide diet counseling and dietary guidelines to parents for their children as part of well-child visits.

In a recent survey of health practitioners' needs in treating overweight children and adolescents, the majority felt that childhood obesity needs treatment due to its effects on chronic disease and future quality of life. Although the most recent Expert Committee Recommendations on Obesity Evaluation and Treatment in Children and Adolescents recommends the use of BMI as a clinically useful assessment of excess body fat, very few practitioners utilize this measure.[222,223]

Treatment of Overweight/ Obesity

Overweight/obesity in childhood is a risk factor that contributes to chronic diseases, and therefore should be treated. Modest reductions in caloric intake and modest increases in physical activity can have positive effects. Treatment should include measures to reverse diet and activity behaviors that promote obesity. Parents should be educated about heart-healthy diets that engage the entire family. The treatment plan should use behavioral change strategies, along with nutrition education, to lower energy intake. Parents should be strongly encouraged to enable the obese or overweight child to shift from sedentary

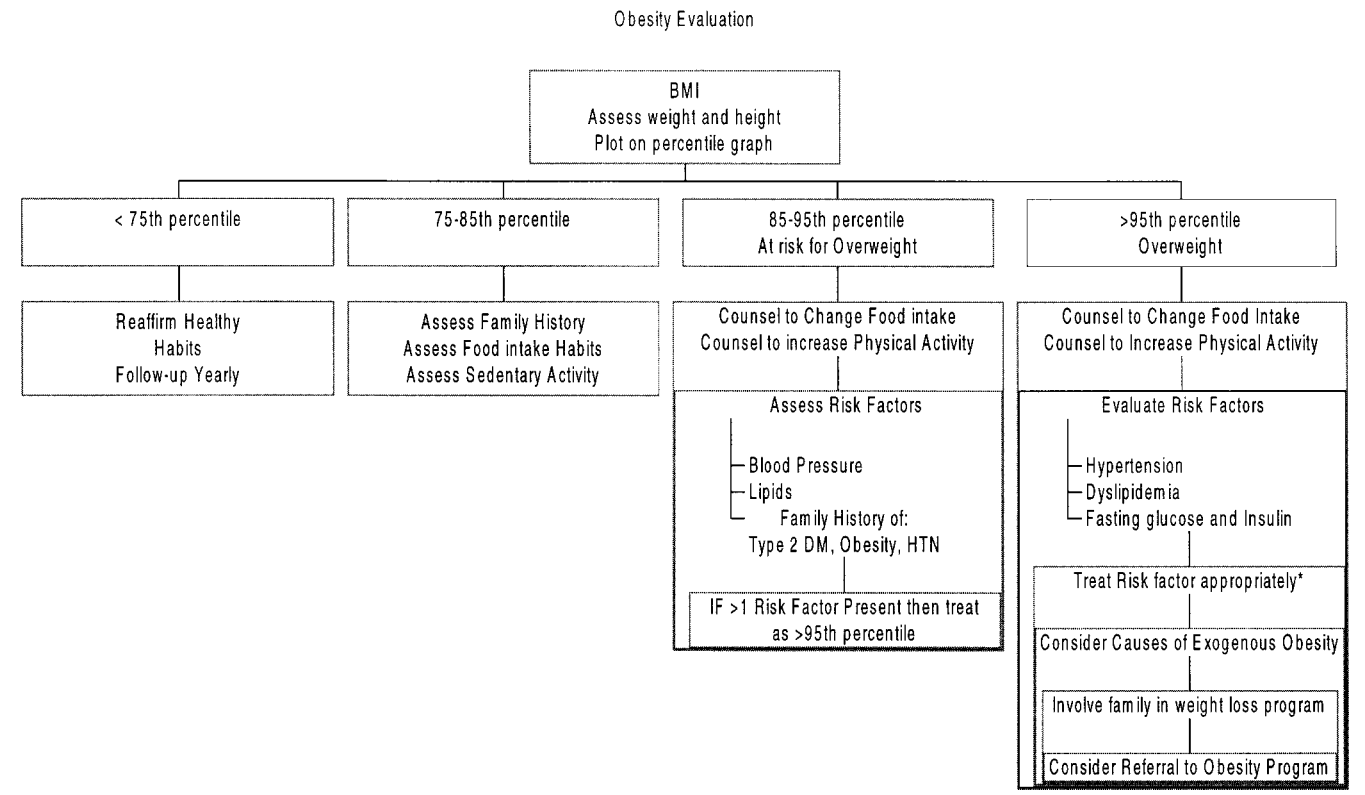

Fig 4. Overweight/obesity evaluation for cardiovascular risk

* Risk factors such as hypertension, dyslipidemia and diabetes should be treated with medication and diet as prescribed by physician. Algorithm useful for evaluating overweight children and adolescents, with greater focus on evaluating concurrent cardiovascular risk factors in overweight children

behaviors, like television viewing, to more physically demanding activities. Counseling on behavioral or "lifestyle" changes must be delivered in consideration of ethnicity, particularly among minority children and their families. Recommendations on diet and physical activity will be more effective when appropriately tailored to the family's culture/ethnicity and available resources.

Risk-Factor Screening

Overweight/obese children should be screened for the presence of other factors that heighten risk for premature onset of obesity-related chronic disease, such as hypertension, dyslipidemia, diabetes, and subsequent atherosclerosis. While most practitioners report routinely evaluating levels of blood pressure and lipids in overweight children, few examine for the presence of insulin resistance and early onset of type 2 diabetes.[224] Some ethnic groups appear to be at higher risk than others for obesity-related diseases. African Americans are at greater risk for hypertension, while Native Americans, African Americans, and Hispanics are all at greater risk for diabetes. Initial screening includes evaluating family history for hypertension, type 2 diabetes (including maternal gestational diabetes), stroke, myocardial infarction, or other premature cardiovascular events. The child's blood pressure should be measured to determine if the blood pressure is elevated for age and height, according to hypertension guidelines for children. An obese or overweight child with another risk factor, elevated blood pressure, or positive family history, should have a medical evaluation. The medical evaluation should examine blood pressure, glucose metabolism, plasma lipid levels, and the presence of multiple risk factors. Figure 4 presents a useful algorithm for evaluating overweight children and adolescents.

Public Health Issues

Despite the basic concept of changing diet patterns and increasing physical activity, the medical management of an overweight/obese child is extremely difficult. The best efforts of clinicians and parents to effect change in diet and exercise patterns can be disrupted by powerful environmental forces and conditions, such as:

• Inadequate safe and accessible recreation facilities.

• Lack of available supervised afterschool programs that promote physical activity.

• Increasing public reliance on processed and fast foods that are less expensive and easily accessible.

• Food-label nutrition information that is difficult to understand.

Health agencies and communities need to confront the adverse effects of these environmental conditions on the health status and health future of the young. Public health approaches must be developed to address the problem of obesity/overweight in the young, particularly among minority youth. These approaches include developing and articulating policies; acquiring resources necessary to enact the policies; and educating the public on the health benefits of the policies vs the health risks of obesity.

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