TRENDS IN ABDOMINAL OBESITY IN YOUNG PEOPLE: UNITED STATES 1988–2002

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Objective: To determine the prevalence and trends of abdominal obesity from 1988–1994 to 1999–2002 in American White, Black, and Hispanic youths.

Methods: Data ($N=5020$) from the 1988–1994 and 1999–2002 US National Health and Nutrition Examination Surveys were used for this analysis. Abdominal obesity was defined as sex-specific values ≥95th percentile for waist circumference. Prevalence of abdominal obesity was compared across study periods, race/ethnicity, socioeconomic status (SES), and age groups 6–11 years.

Results: Between 1988–1994 and 1999–2002, increases in waist circumference exceeded those of body mass index in White, Black, and Hispanic young people. The prevalence of abdominal obesity was higher in the 1999–2002 than the 1988–1994 study periods. In 1988–1994, prevalences of abdominal obesity in White, Black, and Hispanic boys were 3.0%, 3.2%, and 6.2% compared with 5.6%, 5.0%, and 9.1% in 1999–2002. The values in girls were 3.9%, 2.9%, and 4.9% in 1988–1994 and 6.0%, 8.1%, and 8.5% in 1999–2002, respectively. Prevalences of abdominal obesity increased with decreasing level of SES in 1988–1994 and 1999–2002 for Whites, Blacks, and Hispanics. At same levels of SES, prevalences of abdominal obesity were higher in Blacks and Hispanic children compared to White children.

Conclusion: The trend toward increasing obesity among White, Black, and Hispanic American youths is compounded by an unequal increase in abdominal fat accumulation. Further studies are needed to determine the long-term significance of these trends, particularly in Hispanic youths who have greater tendencies for abdominal obesity compared with White and Black youths. The higher increase in the anthropometric markers (waist circumference) of abdominal obesity compared to body mass index suggests that body mass index may be inadequate in estimating changes in generalized adiposity in young people. Health promotion programs in the United States including education, nutrition, and appropriate physical activity targeted at children may help to ameliorate obesity epidemics. Emphasis should be placed on reducing abdominal obesity through physical activity and nutrition, both in school and at home for all children. (*Ethn Dis*. 2006;16:338–344)

Key Words: Abdominal Obesity, Adiposity, Central Fat, Waist Circumference

INTRODUCTION

The prevalence of childhood obesity is increasing in the United States.[1–4] Studies have indicated that childhood obesity in the United States increased by two- to three-fold in the past three decades.[3,4] Previous studies from nationally representative samples show that ≈14% of US children are obese.[3,4] Minority children in the United States, particularly those of African and Hispanic origins, have disproportionately higher prevalences of obesity compared to children of European origin.[1–4] Like many other studies describing obesity trends in US children, the above studies used body mass index (BMI) as a surrogate measure of generalized obesity. An equally important but seldom described form of adiposity in children is abdominal obesity.

Described originally as gynoid and android obesity,[5] abdominal obesity is associated with increased risk of diabetes mellitus, stroke, and ischemic heart disease.[6–14] Abdominal obesity is also associated with increased risk of hypertension and cardiovascular diseases.[7–11] Because of the high correlation of abdominal adiposity with visceral adiposity, abdominal fat cells may be more metabolically potent in the development of cardiovascular diseases compared with fat cells in generalized body habitus.[15,16] Abdominal obesity is a good indicator for predicting risk for overall mortality.[17–19]

The anthropometric marker of abdominal obesity is a measured waist circumference at the end of a normal expiration, midpoint between the lowest aspect of the rib cage and highest point of the iliac crest. Waist circumference measures visceral and subcutaneous fat, and hence total fatness.[20] In contrast, BMI measures body weight, which includes total fat mass and fat-free mass, and determining the relative contributions of each is impossible.[21] Indeed, trend analyses of BMI alone often fail to identify shift from muscle to fat. Body mass index (BMI) gives no clue of the distribution of body fat, and in children, as in adults, abdominal and upper body fat carries an increased risk for metabolic abnormalities.[20] In obese youths, fat accumulation often occurs in the upper body rather than in the peripheral region.[22–23]

In adults, waist circumference ≥102 cm in men and ≥88 cm in women defines abdominal obesity while waist circumference ≥94 cm in men and ≥80 cm in women defines abdominal overweight.[24,25] At present, no consensus exists on waist circumference cutoff points for abdominal obesity in young people.

To our knowledge, trends in prevalence of abdominal obesity in American young people are unknown. Because of racial/ethnic differences in trends of generalized adiposity in American youths,[26,27] we hypothesize increasing trends of abdominal obesity. Because of the high metabolic potency of abdominal obesity, understanding the trends in abdominal obesity across race/ethnicity is critical for thoughtful design and

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assessment of prevention programs. The objective of this investigation was to determine the prevalence and trends of abdominal obesity in a population of American White, Black, and Hispanic youths, ages 6–11 years.

METHODS

Data Source

Datasets from the US National Health and Nutrition Examination Surveys (NHANES) provided by the US National Center for Health Statistics (NCHS), a component of the Centers for Diseases Control and Prevention were analyzed. These datasets represent two time periods (1988–1994 and 1999–2002) and are cross-sectional surveys that were carried out among noninstitutionalized US civilian populations. The plan and operation of these surveys have been previously described by other investigators.[28,29] These surveys have the same structure and design and are national in scope.

The 1988–1994 NHANES was the seventh national survey and was based on a complex, multistage sampling plan. In the 1988–1994 NHANES, a home examination option was employed for the first time to obtain examination data for very young children who were unable to visit the mobile examination centers. The 1999–2002 NHANES is the most recent of the health examination surveys carried out by NCHS. The 1999–2002 NHANES was a stratified multistage probability sample based on selection of counties, blocks, households, and persons within households. Both the 1988–1994 and the 1999–2002 NHANES were designed to oversample Mexican Americans and non-Hispanic Blacks to improve estimates for these groups. Approximately 30,000 and 20,000 persons were examined in the 1988–1994 and 1999–2002 NHANES, respectively.

Only subjects measured for waist circumferences, aged 6–11 years, were eligible for this study. In the two surveys, weight and height were measured by using standardized techniques. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. In the two NHANES, waist circumferences were measured at the junction of the iliac crest and the midaxillary line, at minimal respiration to the nearest 0.1 cm.

DEFINITION OF TERMS

For this study, abdominal obesity was defined as sex-specific values ≥95th percentile of waist circumference. In boys, the waist circumference cutpoint that corresponded to 95th percentile was 85.4 cm. The corresponding value in girls was 82.7 cm. The use of 95th percentile of waist circumference to define abdominal obesity is consistent with studies by Thorpe et al[30] and Troiano et al[31] that used 95th percentile values of BMI-for-age and BMI, respectively to define childhood obesity. Parent's education was used as the proxy measure of subject's socioeconomic status (SES).

Statistical Analysis

Statistical programs available in SAS for Windows[32] and SUDAAN[33] were used for this analysis. To account for unequal probabilities of selection, oversampling, and nonresponse, appropriate sample weights were used for the analyses. Because of sampling differences between surveys, different methods were used to assess standard errors.[34] Standard error estimates were calculated by using the SUDAAN statistical program. For the 1988–1994 NHANES, the Taylor series linearization method was used to estimate standard errors.[32] For 1999–2002 NHANES, standard errors were estimated by the delete one jackknife method,[35] partitioning the sample into 52 replicates by deleting one unit at a time.

Differences in waist circumference between surveys were assessed by using Student *t* tests. Sex- and race/ethnicity-specific distribution of waist circumference in the population were evaluated by using nonparametric, smoothed, age-adjusted curves, based on sequential calculations of running medians for groups with adjacent points.[35–36] Overall and race/ethnicity-specific prevalences of abdominal obesity were computed for boys and girls across study periods. Prevalences of abdominal obesity stratified by SES were also computed. Prevalences of abdominal obesity were age-adjusted by direct methods according to the 2000 US Census population data. The customary 95% confidence intervals and P values $<.05$ were used to indicate statistical significance.

RESULTS

A total of 3034 and 1986 participants age 6–11 year from the 1988–1994 and 1999–2002 NHANES, respectively, were eligible for this investigation. As shown in Table 1, no statistically significant age and height differences were found between eligible subjects from the 1988–1994 and 1999–2002 surveys. Eligible subjects from 1999–2002 survey were heavier as determined from body weight and BMI and had larger waist girth com-

Table 1. Descriptive characteristics of studied populations

Variable	1988–1994	1999–2002	*P* value
n	3034	1986	
Age (years)	8.5 ± 1.7	8.5 ± 1.7	.495
Height (cm)	134.4 ± 12.3	134.6 ± 13.3	.654
Weight (kg)	33.1 ± 11.3	34.0 ± 11.7	<.001
Body mass index	17.9 ± 3.6	18.3 ± 3.8	<.001
Waist (cm)	61.9 ± 10.2	63.8 ± 11.0	<.001
Sex (%)			
Boys	50.5	51.5	.261
Girls	49.5	48.5	
Race/ethnicity (%)			
White	27.8	28.7	.659
Black	35.5	35.8	
Hispanic	36.8	35.6	

pared with eligible subjects from the 1988–1994 survey ($P<.01$). No statistical differences between eligible subjects from the two surveys were seen in terms of sex and racial/ethnic distributions.

Sex- and race/ethnicity-specific distributions of waist circumference in the two surveys are shown in Figure 1. As shown, distributions of waist circumference tended to be normally distributed in 1988–1994 and 1999–2002, except for a slight tendency toward (right shift) higher waist circumferences in 1999–2002. Tendencies toward higher waist circumferences were more evident in Hispanic boys and girls compared with their White and Black counterparts.

We compared mean values of waist circumference with mean BMI between 1988–1994 and 1999–2002 in White, Black, and Hispanic boys and girls (Table 2). Changes in waist circumference during the study periods were greater than those of BMI in Whites, Blacks, and Hispanics. Hispanics boys had larger waist girth compared to White and Black boys in each study period. Hispanic boys were also heavier as determined by BMI compared to White and Black boys in each study period. In boys, the greatest absolute difference between 1988–1994 and 1999–2002 for waist girth was observed among Hispanics with a value of 2.3 cm. In girls, Blacks had larger waist girth in each of the study periods compared to Whites and Hispanics. Black girls also had a greater increase between study period for waist girth and BMI with values of 2.5 cm and 0.6 kg/m^2, respectively.

In both boys and girls, prevalences of abdominal obesity were significantly higher in 1999–2002 than 1988–1994 study periods (Figure 2). In boys, prevalences of abdominal obesity were 4.2% and 6.1% in 1988–1994 and 1999–2002, respectively. In girls, prevalences of abdominal obesity were 3.9% and 7.0% in 1988–1994 and 1999–2002, respectively.

In Table 3, we compared overall prevalence and trends in abdominal obesity across age categories of 6–

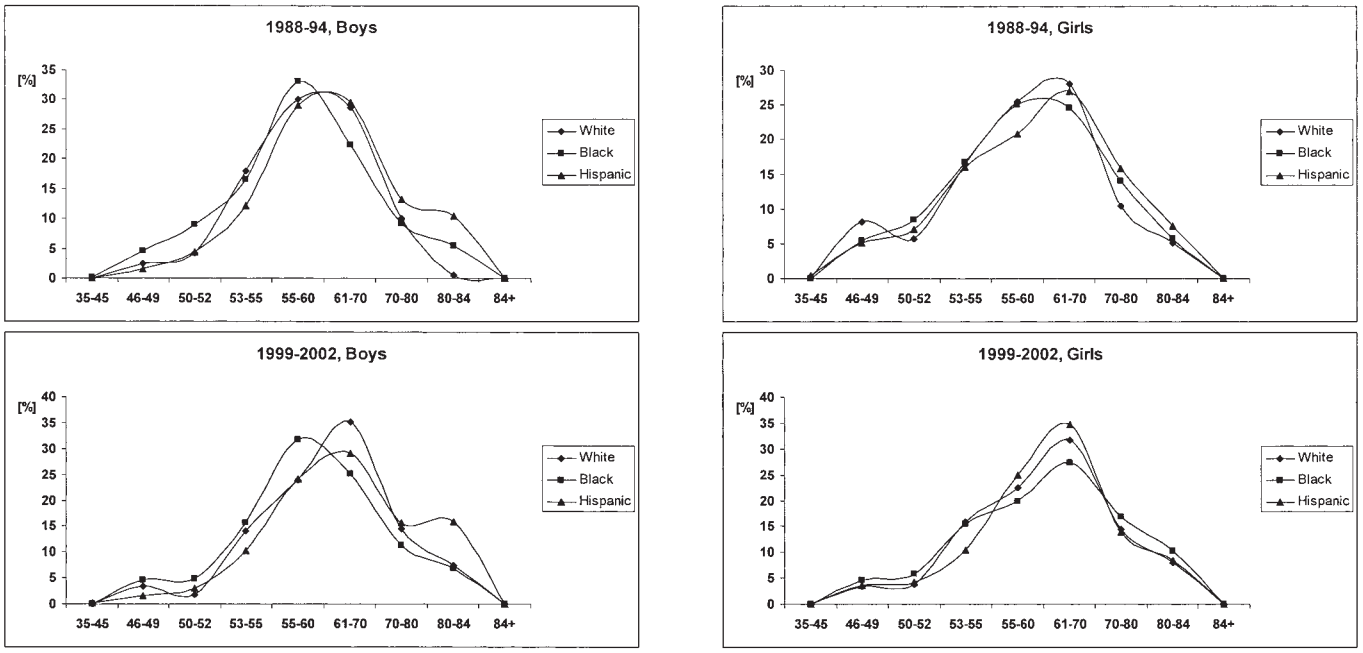

Fig 1. Distribution of waist circumference (cm) in American youths, 1988–1994 and 1999–2002

Table 2. Race/ethnicity and sex changes in markers of abdominal and generalized adiposities, 1988–1994 and 1999–2002

Variable	1988–1994			1999–2002			Mean (%) Difference		
	White	Black	Hispanic	White	Black	Hispanic	White	Black	Hispanic
BOYS									
Waist girth (cm)	61.7 ± 9.3	60.5 ± 9.9	63.9 ± 10.9	63.8 ± 10.9	61.8 ± 10.5	66.2 ± 12.1	2.1 (3.4)	1.3 (2.1)	2.3 (3.3)
Body mass index	17.5 ± 3.1	17.7 ± 3.5	18.3 ± 3.8	17.7 ± 3.5	18.2 ± 3.9	18.8 ± 4.0	.2 (1.1)	.5 (2.8)	.5 (2.7)
GIRLS									
Waist girth (cm)	60.7 ± 9.5	61.3 ± 9.9	60.1 ± 12.6	62.7 ± 10.3	63.8 ± 11.0	63.7 ± 10.6	2.5 (4.1)	2.5 (4.1)	1.0 (1.6)
Body mass index	17.4 ± 3.4	18.0 ± 3.7	18.2 ± 3.8	18.3 ± 3.6	18.6 ± 4.1	18.1 ± 3.8	.5 (2.9)	.6 (3.3)	.2 (1.1)

9 years and 10–11 years. Hispanic boys had higher overall and age-specific prevalences of abdominal obesity in 1988–1994 and 1999–2002 compared with their White and Black counterparts. We also compared changes in abdominal obesity stratified by study periods and sex in Table 3. In boys, the greatest relative change in abdominal obesity between the two study periods was observed in 6- to 9-year-old Hispanics with a value of 3.8%. The analogous value in girls was observed in 10- to 11-year-old Blacks with a value of 9.3%.

To determine the proportion of 10- to 11-year-old subjects in need of lifestyle modification in order to reduce weight, we used the World Health Organization's (WHO) established adult waist circumference and BMI cutpoints for abdominal and generalized overweight, respectively.[24,25] The 1988–1994 prevalences of abdominal overweight in White, Black, and Hispanic in 10- to 11-year-old boys were 1.6%, 2.9%, and 4.6%, respectively, compared with 5.6%, 3.8%, and 5.4% in 1999–2002. The analogous values for girls were 5.3%, 6.2%, and 7.5% in 1988–1994, and 8.5%, 10.2%, and 8.3% in 1999–2002. Prevalences of generalized obesity in 1988–1994 White, Black, and Hispanic boys were 2.8%, 5.9%, and 6.8%, respectively, compared with 4.9%, 7.1%, and 7.8% in 1999–2002. The analogous values for girls were 3.9%, 6.6%, and 5.7% in 1988–1994, and 4.6%, 10.8%, and 6.0% in 1999–2002.

Finally, racial/ethnic differences in abdominal obesity according to SES were determined by computing prevalences of abdominal obesity stratified by SES defined by parent's education level (less than high school, high school, and more than high school). As shown in Table 4, prevalences of abdominal obesity increased with decreasing level of SES in 1988–1994 and 1999–2002 for Whites, Blacks, and Hispanics. At same levels of SES, prevalences of abdominal obesity were higher in Black and Hispanic children compared to White children.

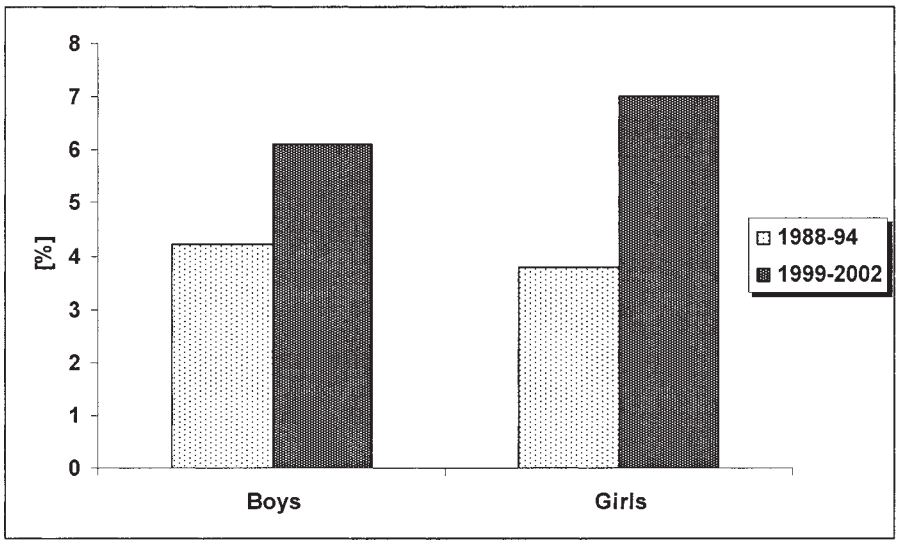

Fig 2. Prevalence (%) of abdominal obesity in American youths

DISCUSSION

Obesity and the associated consequences constitute one of the major problems and challenges for public health in the United States and are increasingly around the world. Despite preventive and therapeutic measures, most published data indicates a progressive increase in obesity prevalence that assumes an even higher importance in young people residing in the United States.[37,38] Aiming to evaluate the evolution of markers of abdominal fat accumulations in American youths in the last 15 years, we analyzed the 1988–1994 and 1999–2002 US National

Table 3. Overall and age-specific prevalence (%) of abdominal obesity in American youths, 1988–2002

	1988–1994			1999–2002			Change in Prevalence, 1988–2002		
Age (years)	White	Black	Hispanic	White	Black	Hispanic	White	Black	Hispanic
				BOYS					
Overall	3.0	3.2	6.2	5.6	5.0	9.1	2.6	1.8	2.9
6–9	2.1	.6	2.3	3.2	2.5	6.1	1.6	1.9	3.8
10–11	5.0	8.2	14.1	10.1	9.9	16.9	5.1	1.7	2.8
				GIRLS					
Overall	3.9	2.9	4.9	6.0	8.1	8.5	2.1	5.2	3.6
6–9	2.5	.9	2.4	3.7	4.0	2.6	1.2	3.1	0.2
10–11	6.7	6.9	9.8	10.8	16.2	15.5	4.1	9.3	5.7

Abdominal obesity was defined as sex-specific values ≥95th percentile of waist circumference; in boys, the waist circumference cut point was 85.4 cm. and the corresponding value in girls was 82.7 cm.

Health and Nutrition Examination Surveys. These surveys provide excellent data to assess trends in regional fat distribution. The surveys are highly respected because the sampling schemes are representative and national in scope. The training program and quality control measures that were instituted in the surveys provide an added level of credibility to the data.

The result of this study indicates an increasing trend in waist circumference in American youths. In the period between 1988 and 2002, increases in waist circumference exceeded those of BMI in Whites, Blacks, and Hispanics. Waist girths for White, Black, and Hispanic American boys increased by approximately 3.4%, 2.1%, and 3.3%, respectively, and 4.1%, 4.1%, and 1.6%, for girls, respectively. Using values ≥95th percentile of waist circumference to define abdominal obesity, the result of our analysis shows increased prevalences of abdominal obesity between 1988 and 2002. Overall, Hispanic boys and girls were more obese as defined by abdominal obesity than White and Black boys and girls. In White, Black, and Hispanic boys, we saw 2.6%, 1.2%, and 2.2% increased prevalences of abdominal obesity in the period between 1988 and 2002. In White, Black, and Hispanic girls we saw 2.1%, 5.2%, and 3.6% increased prevalences of abdominal obesity, respectively.

Using the adult recommended waist circumference values for abdominal overweight as proposed by Lean et al,[38] we found that 5.6%, 3.8%, and 5.4% of 10- to 11-year-old White, Black, and Hispanic boys in 1999–2002 were, respectively, in need of lifestyle modifications in order to reduce waist circumference. The corresponding values in White, Black, and Hispanic girls were 8.5%, 10.2%, and 8.3%, respectively. According to Lean et al,[39] men and women who have waist circumferences ≥94 cm and ≥80 cm, respectively, should be recommended for lifestyle modifications.[39]

The results of this study also show that the prevalences of abdominal obesity increased with decreasing level of SES in 1988–1994 and 1999–2002 for Whites, Blacks, and Hispanics. At same levels of SES, prevalences of abdominal obesity were higher in Black and Hispanic children compared to White children. Our result indicating trends of increasing abdominal obesity

Table 4. Prevalence (%) of abdominal obesity by social economic status* in American youths, 1988–2002

	1988–1994			1999–2002		
Education	White	Black	Hispanic	White	Black	Hispanic
			BOYS			
Less than HS	5.3	7.9	7.8	6.1	7.8	13.3
High school	1.7	4.5	5.6	5.9	6.8	9.8
Greater than HS	1.0	2.1	4.4	.1	2.3	8.4
			GIRLS			
Less than HS	3.6	7.0	6.1	8.2	10.7	7.4
High school	3.7	4.9	4.7	6.7	6.9	6.3
Greater than HS	2.9	3.1	3.2	4.0	4.4	5.4

Abdominal obesity was defined as sex-specific values ≥95th percentile of waist circumference; in boys, the waist circumference cut point was 85.4 cm. and the corresponding value in girls was 82.7 cm.

* Social economic status (SES) was defined by using parent's education status.

HS=high school.

is consistent with findings of other populations.[40–41] It is consistent with the overall increasing prevalence of generalized overweight and obesity that has been reported for US adults.[2,3,16,42]

Increases in abdominal obesity that were observed in our study may be explained by the known increases in sedentary lifestyles and increasing trends of television and video viewing and computer/video game use among American youths.[43–45] The increasing prevalence of abdominal obesity in this study may also be driven by food consumption habits in American youths. According to Nielsen et al,[46] consumption of high-calorie foods and fast food diets has increased by between 91.2% and 208% for all age groups in the United States since 1977.

The higher increase in anthropometric markers of regional adiposity compared to BMI in American children in this study indicates a steeper slope of regional adiposity than BMI. It also suggests that BMI may be inadequate in estimating changes in generalized adiposity in young people. The higher increase in waist circumference compared to BMI is similar to findings in Netherlands and Spain that were based on analyses covering 1993–1997 and 1980–1995, respectively.[47,48] The impact of increases in abdominal obesity on morbidity is not clear, but they may lead to increases in hypertension, glucose intolerance, and dyslipidemia in the future. Indeed, a study by Freedman et al,[49] found waist girths >90th percentiles were associated with higher concentrations of low-density lipoprotein cholesterol and lower concentrations of high-density lipoprotein cholesterol in American youths. Therefore, early public health intervention, particularly in at-risk youths is imperative in averting subsequent obesity-associated sequelae.

Race/ethnicity-specific health education is needed to prevent abdominal obesity in at-risk groups.

Some limitations must be taken into account in the interpretation of results from this study. First, we used a statistical definition for abdominal obesity. The use of waist circumference percentile to define abdominal obesity requires validation by imaging techniques. Second, the use of repeated cross-sectional survey data for temporal comparison in this study is problematic because of the inability to determine agreement of the survey methods.

CONCLUSION

A significant trend toward increasing obesity exists among young people in the United States. This trend is compounded by an unequal increase abdominal fat accumulation. Further studies are needed to determine the long-term significance of these trends, particularly in Hispanic youths who have greater tendencies for abdominal obesity compared with White and Black youths. Race/ethnicity-specific health education is needed to prevent abdominal obesity in at-risk groups. Health promotion programs in the United States, including education, nutrition, and appropriate physical activity targeted at children, may help to ameliorate obesity epidemics. Given the increasing prevalence of obesity and the associated risk factors in the United States, childhood is an important period for prevention. Emphasis should be placed on reducing abdominal obesity through physical activity and nutrition, both in school and at home. For subjects in the age range of 6–11 years, school-based intervention programs can be addressed by using ecological models.

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