Measuring the Prevalence of Overweight in Texas Schoolchildren

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Objectives. We describe results from year 1 of a surveillance system to monitor body mass index in children at the state level.

Methods. A sample of 6630 children attending Texas public schools, weighted to represent 4th, 8th, and 11th grades within race/ethnic subpopulations, was assessed. Body mass index was calculated from measured height and weight; demographic information was obtained from a questionnaire.

Results. Prevalence of overweight was 22.4%, 19.2%, and 15.5% for 4th-, 8th-, and 11th-grade students, respectively. Overweight prevalence was highest among Hispanic boys (29.5%–32.6%), fourth-grade Hispanic girls (26.7%), and fourth- and eighth-grade African American girls (30.8% and 23.1%, respectively). Eleventh-grade White/other girls had the lowest prevalence of overweight (5.5%).

Conclusions. These data confirm the increasing prevalence of overweight among US children, especially among Hispanic and African American students compared to White/other students and fourth-grade students relative to 8th- and 11th-grade students. (*Am J Public Health.* 2004;94:1002–1008)

The prevalence of overweight among children has more than doubled in the past 20 years, and rates are highest among minority populations.[1–6] This trend is alarming, especially in view of the fact that obesity is considered a risk factor for many chronic diseases[7–11] as well as increased mortality.[12] Because overweight in childhood often persists into adolescence and adulthood,[13–18] increased prevalence of overweight in children will undoubtedly lead to an exacerbation of obesity-related chronic disease among adults in the future.

Although national estimates of childhood overweight exist, few surveillance systems are in place to monitor this problem by use of objectively measured height and weight data gathered at the state level, and no such systems exist for children in elementary school. For example, whereas the Youth Risk Behavior Surveillance System does obtain state-level data for body mass index (BMI), this information is self-reported and includes only high-school and some middle-school students.[6] Because funding decisions for intervention programs often occur at the local level rather than the national level, it is critical to provide data at the level at which change can be effected.

This article describes the design and implementation of a surveillance system to monitor trends in BMI in school-aged children at the state level, and it presents prevalence data from the first year of implementation of the School Physical Activity and Nutrition (SPAN) monitoring system in Texas.

METHODS

Study Design

SPAN uses a repeated cross-sectional sample to monitor annual BMI changes in a sample of schoolchildren representative of the Texas population, breaking it down by gender, race/ethnicity (African American, Hispanic, and White/other), and grade (4th, 8th, and 11th) and to monitor biennial changes in samples representative of each Texas public health region, by gender. This article provides data from year 1 of the survey (school year 2000–2001).

Participants

The surveillance system was designed to estimate the BMI of school-aged children in elementary, middle, and high schools. A single grade within each of these categories was selected to represent each age group of schoolchildren: fourth grade for elementary, eighth grade for middle school, and 11th grade for high school. Enrollment data from the Texas Education Agency for grades 4, 8, and 11 during the 1999–2000 school year were used as the reference base for the sampling plan.[19]

For Texas Department of Health administrative purposes, the state of Texas is divided into 11 public health regions[20]; these regions vary by geographic location and racial/ethnic population. The sampling scheme included surveying 5 public health regions in the first school year (2000–2001) and 6 regions in the second school year (2001–2002); this sampling yielded a state-representative sample each year and regionally representative data on a biennial basis. In this article we present year 1 (2000–2001) state-level data results, which include those for schools from Texas Department of Health Public Health regions 1, 3, 5, 7, and 11.

Sample

Within each public health region, school districts were grouped into 3 categories—urban center, urban/suburban, and rural—based on population size designations.[21] Urban-center school districts were the largest school districts in each public health region. Urban/suburban school districts included districts in counties of between 25 000 and 650 000 residents; in general, these school districts were located in and around major urban areas. Rural school districts included school districts in communities of less than 25 000 people. Private schools were not included in the sampling frame; data from 1997 indicate that 5.4% of students in Texas are enrolled in private schools.[22,23] School districts with fewer than 75 students per targeted grade level were excluded, as were

charter schools and special education or alternative schools. The total sampling frame consisted of 439 school districts, which included 91.5% of the total public school enrollment for grades 4, 8, and 11 in the state of Texas. Because year 1 of the sampling design included 5 public health regions, the sampling frame consisted of 228 school districts and 2619 schools.

Within each public health region, we identified and targeted for recruitment the largest urban-center school district, within which 5 elementary schools, 5 middle schools, and 5 high schools were randomly selected. From the urban/suburban and rural categories, 5 districts in the region were randomly chosen, with selection probabilities proportional to the number of schools in the district predicated on "with-replacement" sampling (duplicate selection is allowed), but no district was selected more than once. From each selected urban/suburban or rural district, 1 school at each grade level (4th, 8th, and 11th, respectively) was randomly selected and targeted for recruitment. At least 2 representative classes per school were selected to provide samples of 50 students. Overall participation rates for 4th-, 8th-, and 11th-grade students were 80.1%, 57.7%, and 39.0%, respectively.

Districts and schools were targeted for recruitment by identifying key personnel for approval of health-related research projects and contacting these individuals by phone, followed by written correspondence and copies of the questionnaires and protocols. As an incentive, participating school districts received a digital scale and stadiometer and other health-related materials (i.e., grade appropriate nutrition education lessons (4th, 8th, 11th), a copy of the CDC School Health Index, a list of appropriate nutrition and physical education materials available for teachers, an application form for the Dole 5-a-day CD-ROM). In addition, districts were provided with a written report of selected state- and district-level results.

Instruments

Questionnaires and protocols for SPAN were developed as part of the School-Based Nutrition Monitoring project.[24] The questionnaires were developed to assess demographic information; nutrition behaviors, attitudes, and knowledge; and physical activity behaviors and to record student weight and height. Two questionnaires were developed on computer-scanned forms: 1 to assess elementary-school students (fourth grade) and 1 to assess secondary-school students (8th and 11th grades). A protocol was developed for administration of the questionnaires in school classrooms with standard procedures adapted from similar instruments.[25,26] Administration of the survey and measurement of height and weight for a class of 50 students lasted approximately 60 to 90 minutes.

Measurement of Height and Weight

Height and weight of students were measured with a standard protocol by trained and certified project staff (n=7) and Texas Department of Health employees (n=63). Height was measured to the nearest 0.1 centimeter with a portable stadiometer (Perspective Enterprises Portable Adult Measuring Unit PE-AIM-101, Portage, Mich). Weight was measured to the nearest 0.1 kg with a portable digital scale with remote display (SECA 770 or Tanita BWB-800S, Arlington Heights, Ill) calibrated to 200 lb before each series of measurements. Both measurements were written directly on the student questionnaire. As a quality control measure, a 5% sample of students was remeasured in the field. Intraobserver Pearson correlations between original and quality-control heights and weights were 0.998 and 0.997, respectively.

BMI was calculated from the measured heights and weights of students with a standard equation.[27] In the context of current US norms, a BMI of greater than or equal to the 95th percentile for age and gender[28] was considered overweight, and a BMI greater than or equal to the 85th percentile but less than the 95th percentile for age and gender was considered at risk of overweight.[28] Children reported age but not birth date on the SPAN questionnaire. Because exact age and gender are used to classify children into normal, at risk of overweight, and overweight categories with the CDC growth charts, child age was assigned as the midpoint for the reported age (e.g., 10 years was assigned as 10 years and 6 months) for classification purposes. This method has been found to have little effect on prevalence estimates.[29]

Data Quality Control

Before being scanned, questionnaires were visually inspected for stray marks, tears, or other imperfections that could affect the data entry process. The rate of missing or ambiguous responses for the elementary and secondary level surveys was less than 1%.

Data were examined for outliers in height, weight, and age, as well as for missing gender information. Acceptable age ranges were 8–12 years of age for fourth grade, 12–15 years of age for eighth grade, and 15–18 years of age for 11th grade. For 36 children, age was imputed as the mode for grade; race/ethnicity was imputed as the school majority for 43 children, and height or weight (never both) as the grade mean for 23 children. Twelve questionnaires were eliminated because of missing gender, 12 because of extreme height or weight, and 21 because of age outside of the range, resulting in a final sample of 3004 fourth-grade students, 2165 eighth-grade students, and 1461 11th-grade students.

Data Analysis

Probability weights were calculated to account for differential inclusion probabilities in cluster sampling at the school level. Weights were the inverse of selection probability for the sampling ratio at each stage of selection. Poststratification weight adjustments were made to ensure that the racial/ethnic composition of the sample was the same as that of the total school enrollment in Texas. Sample design features (stratification of the sample and clustering of students within schools) were accounted for in weighting estimates and performing statistical tests. The survey analysis module of Stata (Version 7.0)[30] was used to analyze the data (Taylor series approximation or linearization model was used).

RESULTS

Students were evenly distributed by gender (Table 1), and the total percentages by race/ethnicity were similar to those for the state population.[31] For this survey, the White/other category included students who reported their racial/ethnic group as Native American, Asian, Pacific Islander, Non-Hispanic White, or "other." Approximately two thirds of fourth-grade students (66%) in the White/

TABLE 1—Demographic Characteristics of Texas Schoolchildren: School Physical Activity and Nutrition (SPAN) Monitoring System, Year 1 (2000–2001)

Characteristic	4th Grade (n = 3004)	8th Grade (n = 2165)	11th Grade (n = 1461)	Total (n = 6630)
Age, y, mean ± SD	9.7 ± 0.6	13.7 ± 0.6	16.8 ± 0.6	12.6 ± 2.9
Gender, %				
Girls	50.8	50.0	50.6	50.5
Boys	49.2	50.0	49.4	49.5
Race/ethnicity, %				
African American	11.0	13.2	9.7	11.4
Hispanic	28.1	32.6	29.0	29.8
White/other[a]	60.9	54.2	61.3	58.8
School district stratum, %				
Rural	45.2	46.1	54.3	47.5
Other urban/suburban	23.1	29.0	30.1	26.6
Large urban	31.7	24.9	15.7	26.0
Consent,[b] %				
Active	13.3	18.9	11.8	14.8
Passive	86.7	81.1	88.2	85.2

[a]White/other category includes non-Hispanic White, Asian, Pacific Islander, Native American, and "other."
[b]*Active* indicates that parents signed and returned consent forms for participation in the study. *Passive* indicates that parents signed and returned consent forms only if they did not want to participate in the study.

TABLE 2—Median Body Mass Index Among Texas Schoolchildren, by Grade, Gender, and Race/Ethnicity: School Physical Activity and Nutrition (SPAN) Monitoring System, Year 1 (2000–2001)

	Median Body Mass Index (Interquartile Range)			
	African American	Hispanic	White/Other	All
Girls				
4th grade	20.9 (5.6)	19.3 (7.5)	18.5 (4.8)	19.2 (5.9)
8th grade	20.9 (7.9)	22.3 (6.1)	21.6 (6.1)	21.9 (6.3)
11th grade	22.9 (5.5)	23.7 (7.0)	22.2 (4.1)	22.5 (4.5)
Boys				
4th grade	19.3 (4.5)	19.5 (7.3)	17.6 (3.7)	18.4 (5.9)
8th grade	19.2 (3.4)	22.8 (8.3)	20.9 (4.9)	21.3 (5.8)
11th grade	23.2 (4.6)	23.0 (7.2)	23.2 (3.1)	23.2 (5.6)

[a]White/other category includes non-Hispanic White, Asian, Pacific Islander, Native American, and "other."

other category characterized themselves as non-Hispanic White, compared with 85% of eighth-grade students and 91% of 11th-grade students. Nearly half of survey participants were from rural schools.

Median BMI Values

Median BMI values and interquartile ranges are presented in Table 2 by race/ethnicity, grade, and gender. Medians were similar across racial/ethnic groups, especially in the 11th grade, indicating no appreciable differences in central tendency. As expected, median BMI increased by grade. Interquartile ranges were higher for Hispanic children at most ages compared with African American and White/other children, indicating that BMI values for Hispanic children were more extreme, especially among Hispanic boys.

Prevalence of Overweight

Table 3 presents the prevalence of overweight based on Centers for Disease Control and Prevention criteria.[28] Prevalence of overweight was highest among Hispanic boys at all grade levels and among African American girls in the fourth and eighth grades; for these groups, the prevalence of overweight ranged from 23.1% to 32.6%. Significant differences in prevalence of overweight (confidence intervals do not overlap) can be seen between African American and White/other girls in the fourth grade and between Hispanic and White/other boys in the eighth grade. In addition, significant differences in prevalence of overweight are apparent between Hispanic boys and girls in the eighth grade.

The lowest prevalence of being at risk for overweight[28] among Texas schoolchildren was 8.6% among White/other children in the 11th grade and the highest was 26.7% among African American children in the 11th grade (Figure 1).

DISCUSSION

Rates of overweight in Texas schoolchildren are among the highest reported to date, confirming that the childhood obesity problem is indeed worsening, perhaps at a faster rate than was previously thought. All group estimates for overweight prevalence among Texas children were higher than the *Healthy People 2010* goal of 5%[32]; 11th-grade White/other girls were closest to the recommendation, at 5.5%, and eighth-grade Hispanic boys were farthest, at 32.6%. Estimates of overweight prevalence for Texas girls and boys in the fourth grade were almost 50% higher than prevalences reported in the 1999–2000 National Health and Nutrition Examination Survey (NHANES) for girls and boys aged 6–11 years (22% vs 15.3%),[1] whereas the overweight prevalence for eighth-grade Texas students were 24% higher than those previously reported for boys and girls aged 12–17 years. Prevalence of overweight among 11th-grade boys in Texas were also substantially higher than values previously reported for

TABLE 3—Prevalence of Overweight[a] Among Texas Schoolchildren, by Grade, Gender, and Race/Ethnicity According to Centers for Disease Control and Prevention Standard Tables: School Physical Activity and Nutrition (SPAN) Monitoring System, Year 1 (2000–2001)

	Percentage Overweight (95% Confidence Interval)			
	African American	Hispanic	White/Other[b]	All
Girls				
4th grade	30.8 (20.8, 43.0)	26.4 (17.3, 38.1)	13.7 (10.3, 18.1)	21.3 (17.8, 25.1)
8th grade	23.1 (17.0, 30.7)	16.2 (11.1, 22.9)	15.3 (12.4, 18.6)	16.7 (13.8, 20.1)
11th grade	17.2 (5.1, 44.1)	19.4 (14.7, 25.1)	5.5 (1.8, 15.5)	11.7 (8.5, 16.0)
Boys				
4th grade	21.6 (8.2, 46.1)	31.1 (23.3, 40.2)	17.7 (12.3, 24.8)	23.6 (17.8, 30.6)
8th grade	13.8 (4.4, 35.9)	32.6 (25.1, 41.1)	15.0 (9.5, 23.0)	21.4 (15.0, 29.7)
11th grade	19.0 (4.3, 54.8)	29.5 (21.3, 39.2)	12.7 (5.2, 28.2)	19.2 (11.5, 30.3)

[a]Overweight was defined as having a body mass index greater than or equal to the 95th percentile by age and gender according to Centers for Disease Control and Prevention growth charts.
[b]White/other category includes non-Hispanic White, Asian, Pacific Islander, Native American, and "other."

children aged 12–17 years in the United States, although the overall prevalence of overweight among 11th-grade students in our survey was the same as that in the most recent NHANES data.[1]

Why are children in Texas more overweight than the national average? The primary reason may be that Texas is more ethnically diverse than the United States. Hispanic and African American children have a greater prevalence of overweight compared with White/other children; this trend has been reported in previous studies.[1,4,6,33–37] Whereas the percentage of African Americans in the Texas population mirrors the national percentage (11.5% of Texas population vs 12.3% of national population), the population percentage of Hispanics in Texas is considerably higher than that in the United States as a whole (32% vs 12.5%).[38] Hispanic children account for 40% of the population in Texas public schools, whereas African American and White children account for 14% and 43%, respectively.[31]

Our data are similar to overweight prevalence rates reported in a sample of schoolchildren in San Antonio, Texas, measured from 1991 to 1998.[36] In the San Antonio study, prevalence of overweight among Mexican American children was 26.0% for boys aged 6–11 years, 28.3% for boys age 12–17 years, and 20.4% for girls aged 6–11 years; among African American girls aged 6–11 years, the prevalence was 23.3%. A study conducted in the Houston, Texas, area reported that 21.3% of children from 5 elementary schools and 1 middle school were obese (≥95th percentile of Centers for Disease Control and Prevention BMI criteria).[39] The prevalence estimates in our study are the most recent to date (from 2001), and if these data are found to be similar to trends for adults reported for the Behavioral Risk Factor Surveillance System,[40–42] rates of child and adolescent overweight are increasing substantially each year.

Ours is one of the first studies to present statistically representative statewide childhood overweight prevalence data based on BMIs calculated from measured height and weight rather than from self-reported height and weight. In addition, these data are among the first on elementary-school children that are representative of a state. The Youth Risk Behavior Surveillance System currently tracks adolescent overweight and obesity at the state level, but the data are self-reported and limited to high schools and some middle schools.[6] The Longitudinal Study for Adolescent Health[34,43] collects data at the school level for grades 7 through 12 but does not collect state-representative data. The high rates found in this baseline SPAN survey indicate that the prevalence of overweight in children and adolescents may be increasing as rapidly as that in adults and that the rates among children and adolescents may be higher than expected.

In particular, Hispanic boys seemed to have the greatest prevalence of overweight across all age groups. Little research has been done to investigate the determinants of weight gain in this population; future research in this area is warranted.

Data from the Child and Adolescent Trial for Cardiovascular Health have shown that BMI tends to remain stable over time (i.e., children who are heavier tend to remain heavier) from the third through the eighth grade.[16] In addition, previous studies[17,18] have found that individuals who are overweight as children and adolescents are at higher risk of being overweight as adults; it is likely that a significant proportion of the Texas fourth-grade cohort will remain overweight over time. However, fewer of the 11th-grade girls were classified as overweight compared with girls at other grade levels and compared with 11th-grade boys. Because data from the SPAN survey are cross-sectional, there are no relationships between the cohorts; consequently, it is unknown whether these results are a cohort effect or whether the overweight prevalence actually does change as children get older, as a result of secular or other trends.

Recent studies have linked obesity to development of type 2 diabetes in children,[44,45] and with the widespread prevalence of overweight found in our study, increases in type 2 diabetes and increased cardiovascular risk factors among children in Texas should be expected. In fact, rates of overweight among certain subgroups of Texas schoolchildren approach the rates among populations with increased risk for type 2 diabetes, such as Native Americans, for whom reported rates of overweight range from 22.0% among American Indian children and adolescents in Aberdeen, South Dakota,[46] to 33.7% among girls aged 2–19 years in a Native Canadian community.[47] Hispanic children in our survey also had more extremes in body size than did African American and White/other children and exhibited the large BMI values strongly associated with development of type 2 diabetes.[45]

Because data were collected through schools, rates of overweight, especially at the

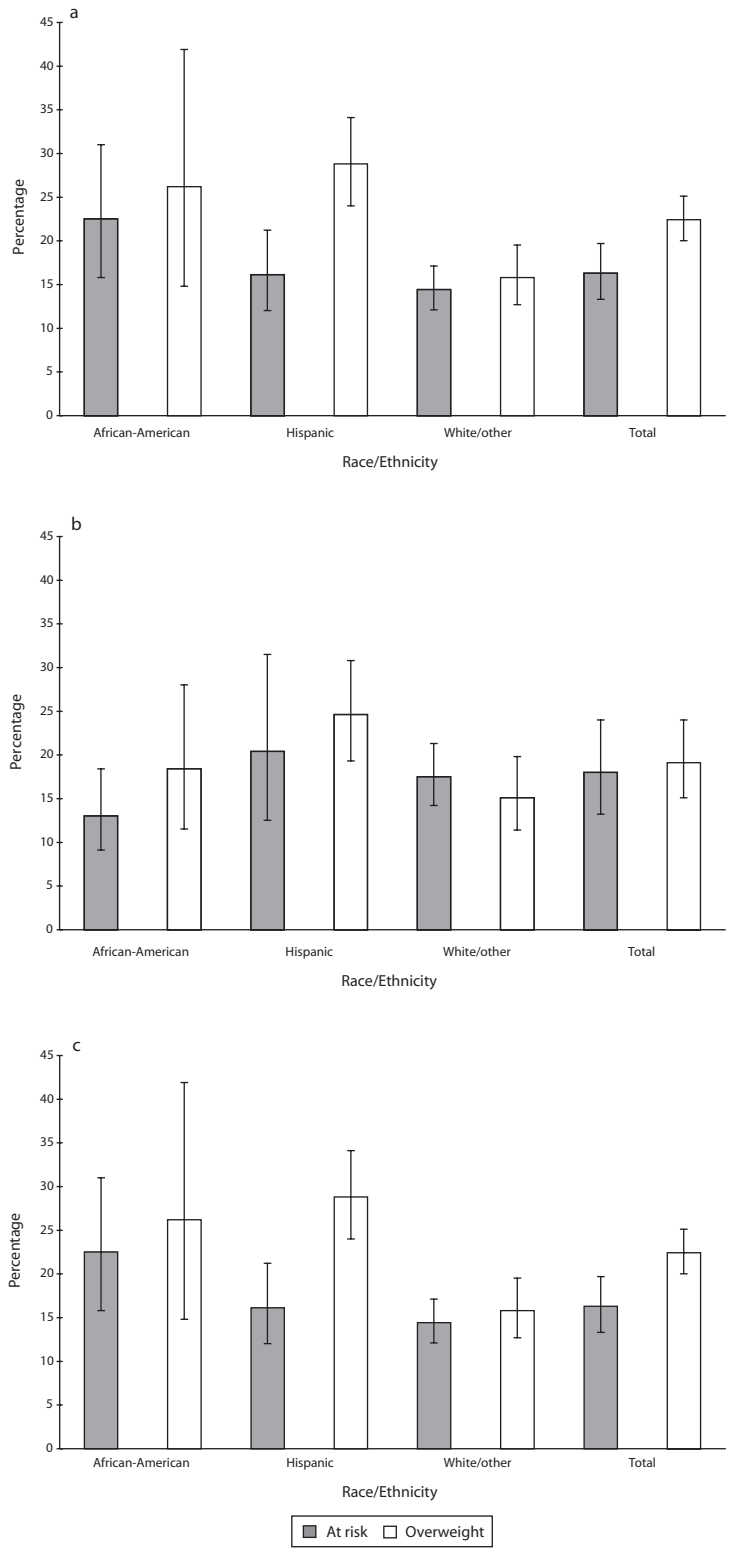

FIGURE 1—Prevalence of at-risk and overweight among (a) 4th-, (b) 8th-, and (c) 11th-grade students in Texas, by ethnicity/race.

11th-grade level, may not be representative of the entire state population of 16- to 17-year-olds. In Texas, the annual dropout rate for grades 7–12 for 1998–1999 was 1.6% for the entire population.[48] This rate was higher for Hispanics and African American students (2.3% for each) than for White students (0.8%). Although the differences in BMI between students and dropouts are not well elucidated, our data probably underestimate the prevalence of overweight in the 13- to 14-year-old and 16- to 17-year-old statewide populations, especially among Hispanics and African Americans. However, collecting child and adolescent data on overweight at the school level may be advantageous, because schools are a natural avenue for dissemination of multifaceted health education programs that target both child behavior and the environment.[49] School-based obesity prevention policies, in conjunction with effective health education programs, also have great potential to address "obesigenic" environments for our children, and school-based surveillance systems can assess the effects of these programs.

Our data were collected for a probability sample from each grade level (4th, 8th, and 11th); therefore, they are not representative of other grade levels and age groups. For analysis purposes, the White/other group was combined with other racial/ethnic groups (i.e., Native Americans), because the numbers of participants from such groups were relatively small and the trend for the SPAN data was similar to that found in previous studies (e.g., prevalence of overweight was higher in African Americans and Hispanics than in Whites).

The number of children that self-reported their race/ethnicity as "other" was higher in fourth grade compared with 8th and 11th grades. Standardized tests are routinely administered to children in Texas schools throughout the upper elementary and the secondary grades. It may be that as the children get older, they become more adept at answering the race/ethnicity question on assessment tests. Alternatively, children who self-report as "other" may be of mixed racial/ethnic backgrounds and be hesitant to classify themselves as a specific category. As children grow into adolescents, they may become aware of race/ethnicity issues and come to more

closely identify with a single predominant group rather than continuing to classify themselves as "other."

The survey response rates were lower for 11th-grade students compared with fourth- and eighth-grade students. This difference was the result of low participation rates at the school level as well as low participation within schools. At the school level, the racial/ethnic compositions and percentages of economically disadvantaged students were similar for participating and nonparticipating schools. For example, the distribution of economically disadvantaged students in participating schools was 40.0%, compared with 41.3% in nonparticipating schools and 42.6% in all schools within the state. In addition, the racial/ethnic distributions in schools participating in SPAN were 15.1% African American and 37.3% Hispanic, compared with 12.8% African American and 36.2% Hispanic in nonparticipating schools. Finally, data were weighted after stratification to adjust for race/ethnicity and gender. Nonetheless, there may exist additional biases in participating schools relative to nonparticipating that were not assessed.

Low response rates within schools may be the result of logistical difficulties. In elementary schools, children are predominantly grouped according to grade level and remain in the same classroom for much of the day. In secondary schools (middle school and high school), children of different grade levels are often in the same class, making it difficult to separate a single grade level for a survey. In addition, because children in secondary schools often change classes, it becomes a challenge to interact with multiple teachers for 1 class, to locate study participants during the school day, and to track the measurement status of each student. Secondary-level students are also less likely to provide school information (and consent forms) to their parents.

Our data confirm a high prevalence of overweight among children in Texas, especially among minority populations and elementary-school students. In addition, this study indicates that the prevalence of child and adolescent overweight may be increasing at a rate similar to the rate in the adult population. Finally, our experiences indicate that a statewide childhood obesity surveillance system is feasible at several grade levels and can be administered through school-based measurements to monitor trends in BMI. ■

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Contributors

D.M. Hoelscher conceived the study, supervised all aspects of implementation, and led the writing. R.S. Day assisted in developing the sampling plan; supervised data quality control, analysis, and interpretation; and assisted with writing. E.S. Lee developed the sampling plan, supervised data analyses, and interpreted results. R.F. Frankowski assisted with the sampling plan and data analyses and interpretation. S.H. Kelder assisted in study development. J.L. Ward supervised field implementation and provided context for methods and analyses. M. Scheurer assisted in data quality control and in developing and conducting analyses. All authors helped to conceptualize ideas, interpret findings, and review drafts of the article.

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Human Participant Protection

Human subject approval for this research was obtained through the committee for the protection of human subjects at the University of Texas–Houston Health Science Center (IRB HSC-SPH-00-056), as well as through the institutional review board of the Texas Department of Health (IRB 01-002) and research committees for the various school districts involved in the study.

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