Overweight Schoolchildren in New York State: Prevalence and Characteristics

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ABSTRACT

Objectives. Childhood overweight is an increasing public health concern. This study was undertaken to determine the prevalence of overweight in elementary school children in New York State and to identify characteristics associated with child fatness.

Methods. Weight, height, triceps skinfold, midarm circumference, and a 24-hour dietary recall were taken on 1797 second- and fifth-grade students from 51 randomly selected schools in New York State outside of New York City. Parents completed a brief questionnaire.

Results. In comparison with 1974 and 1980 national reference data, up to twice the expected percentages of children had values above the 85th, 90th, and 95th percentiles for body mass index, triceps skinfold, and arm fat area. Regression analyses suggested that children who tended to be fatter were members of low socioeconomic status, two-parent (but not single-parent) households; those with few or no siblings; those who ate school lunch; and those who skipped breakfast.

Conclusions. The findings suggest that overweight is a problem among many elementary school children in New York State and that sociodemographic characteristics may be useful for targeting preventive efforts. (*Am J Public Health.* 1994;84:807–813)

Introduction

Childhood overweight is an increasing public health concern, affecting as many as 20% to 25% of children in the United States.[1–3] According to one analysis, the prevalence of overweight in 6- to 11-year-old children increased by 54% from the early 1960s to the late 1970s.[2]

Overweight children have an increased risk of adult obesity that increases with the age of the child and the severity of the overweight.[4] In longitudinal studies, 27% of overweight 1- to 5-year-olds, 41% to 43% of overweight 3- to 9-year-olds, and 80% to 86% of overweight 10- to 13-year-olds have remained overweight as adults.[5–7] Overweight children also have increased risk factors for heart disease and diabetes and increased emotional stress, orthopedic disorders, and respiratory disease.[8]

The present study was undertaken to determine the prevalence of overweight and underweight in elementary school children in New York State outside of New York City and to identify characteristics associated with child fatness.

Methods

Sample Selection and Representativeness

A two-stage sampling technique was used. First, schools were randomly selected within 21 strata: 7 geographical regions in New York State outside of New York City and 3 socioeconomic status (SES) levels within each of these regions (based on 1980 census data). Of the 110 schools contacted by letter, 51 (46%) volunteered to participate. Parent consent forms with brief questionnaires were given to second and fifth graders; 1797 (51%) agreed to participate and were surveyed. Ages ranged from 6 to 12 years; the mean age of second graders was 7.9 (SD = 0.5), and the mean age of fifth graders was 10.9 (SD = 0.5).

Comparison of the students surveyed with data on all children in New York State outside of New York City suggested that the sample was representative.[9] As in the population, the sample was predominantly White, 18% lived with a single parent, and just over half had mothers who were employed.

Nonparticipation of schools did not appear to relate to the prevalence of overweight. Reasons included small school size, factors related to the dental component of the study,[10] and a misperception that the survey was intended only for low-income children.

Within the 51 schools, only two samples differed significantly from their school population in the proportion of non-White students, and two others differed in the proportion of students eligible for free or reduced-price school lunches. Because this number of differences would be expected as a result of sampling error, no schools were omitted from the analysis.[11]

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Editor's Note. See related editorial by Nestle (p 713) in this issue.

TABLE 1—Prevalence Estimates (%) of Overweight in the Study Sample and in the Northeast NHANES II Subsample

	New York State Outside New York City, 1987/88					Northeast United States 1976–1980 (NHANES II)	
	NHANES I			NHANES II			
Percentile	BMI	TSF	AFA	BMI	TSF	BMI	TSF
>85th	28	23	NA	23	19	25	24
>90th	NA	NA	19	17	14	20	15
>95th	13	13	12	10	8	8	8

Note. Variation depended on the reference data used for comparison (National Health and Nutrition Examination Survey [NHANES] I [1971–1974][20] or NHANES II [1976–1980][15]), the cutoff level (percentile) used to define overweight, and the indicator used to measure child fatness (body mass index [BMI], triceps skinfold [TSF], or arm fat area [AFA]).

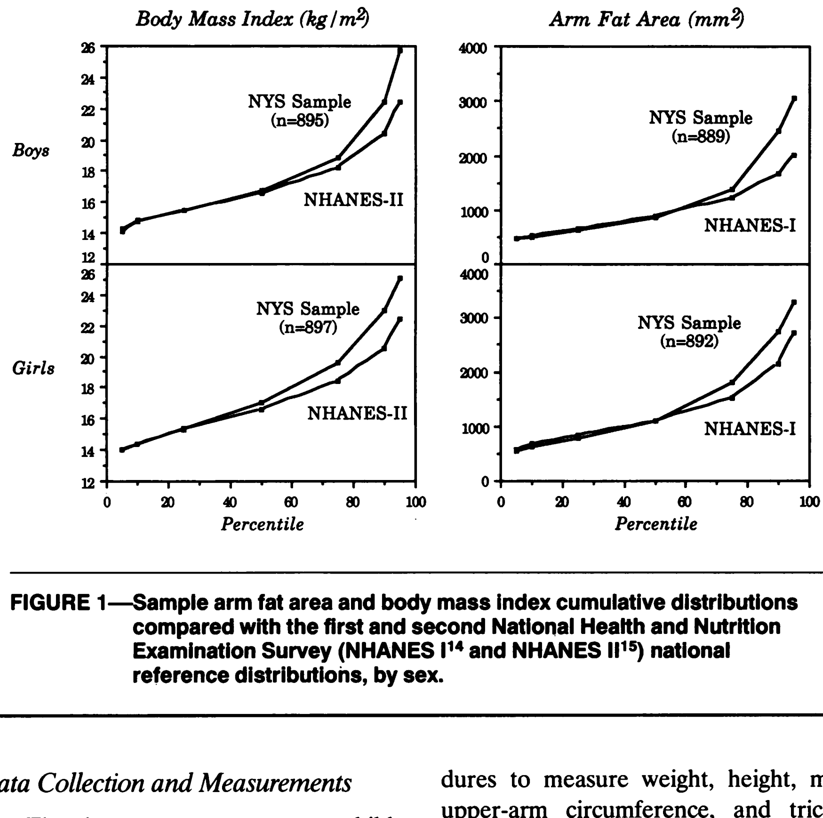

FIGURE 1—Sample arm fat area and body mass index cumulative distributions compared with the first and second National Health and Nutrition Examination Survey (NHANES I[14] and NHANES II[15]) national reference distributions, by sex.

Data Collection and Measurements

The best way to measure child fatness in the field is unclear. Various authors have recommended body mass index (weight/height^2),[12,13] triceps skinfold,[13] or arm fat area[14] (calculated from triceps skinfold and mid-upper-arm circumference: arm fat area [mm^2] = arm area [A] − arm muscle area [M], where $A = \pi/4 \times [C/\pi]^2$ and $M = [C - \pi T]^2/4\pi$ [C = arm circumference, T = triceps skinfold]) as the best indicator of body fat in school-aged children.

In this study, body mass index, triceps skinfold, and arm fat area were all used to measure child fatness. One of two trained examiners used standard procedures to measure weight, height, mid-upper-arm circumference, and triceps skinfold on each child. The principal examiner (first author) measured 1615 children between November 1987 and March 1988 and also administered a nonquantitative 24-hour dietary recall. The other examiner measured 182 children in the spring of 1987.

Measurement errors[16] for the four anthropometric indices were acceptable. Intraobserver (test–retest) reliabilities for each examiner ranged from 97% to 100%. Interobserver reliabilities, based on independent samples, were 93% to 100% between the principal examiner and an anthropometric expert and 96% to 100% between the principal and secondary examiners.

The best way to define overweight or underweight in children is also unclear. Therefore, various percentile cutoffs, as well as reference data from both the first and second National Health and Nutrition Examination Surveys (NHANES I and NHANES II), were used for comparison purposes in deriving prevalence estimates. In addition, because obesity rates are known to be higher in the Northeast than in other regions of the United States,[2,17] prevalence estimates for 6- to 12-year-olds in the Northeast subsample of NHANES II, with the total NHANES II distribution as the reference, also were calculated. Logistic regression was used to adjust the seasonality of this subsample to match that of the New York sample (November through March), since prevalence rates also vary with season.[2,17]

Five diet quality indices were derived from the recall: food diversity (number of different food items eaten), skipping of breakfast, consumption of no vegetable other than potatoes or tomato sauce, number of snack foods eaten, and a food group pattern score ("poor" defined as missing one or more of the four food groups or consuming two or more groups only one time each). Children who skipped breakfast were asked whether this was typical; most said it was.

On the basis of the parent questionnaire, children were classified as being of low SES if they met at least one of the following criteria: no parent working, eligibility for free or reduced-price school lunches, or receipt of social or food assistance. Children were classified as medium/high SES only if they met none of these criteria and had values for all three variables. Twenty-six percent of the children were considered low SES. In schools involved in the National School Lunch Program, children were classified as participants if their parent responded positively to the question "Does your child eat school lunch?"

Statistical Analysis

Regression models were developed to identify factors characterizing fatter from leaner children after adjustment for possible confounding and interactive effects. Factors examined were height, grade, age within grade, sex, race (White or African American), SES, family structure, school lunch participation, number of siblings, maternal employment, and the five dietary indices. ("Whites" included the small number of Hispanics and "others";

the body fatness of these groups did not differ significantly from that of Whites.) Because all variables were examined simultaneously for their effects after adjustment for the others, children with missing values for any of the variables, including those in nine schools that did not participate in the National School Lunch Program and those in six schools for which dietary data were not available, were omitted from the regression analyses.

Regression models were developed for each of six different anthropometric dependent variables. Two ordinary least squares models were developed for body mass index and arm fat area treated as continuous variables. Because their distributions were positively skewed and their variances increased with age and height, both were transformed into natural logarithms to make the regression residuals more symmetrically distributed.

To test for the risk of overweight or underweight, four additional models were examined with multiple logistic regression; body mass index and arm fat area were dichotomized into (a) overweight (>90th percentile) vs normal weight (≤90th and >10th percentile) and (b) underweight (≤10th percentile) vs normal weight. Body mass index values were compared with age- and sex-specific reference percentiles from the NHANES II national probability sample survey,[15] while arm fat area values were compared with reference percentiles developed by Frisancho from NHANES I.[14] Although derived from different surveys, these were the only published national reference percentiles available for body mass index and arm fat area when the regression analyses were done. For consistency in the analyses, the 90th percentile was selected as the cutoff for both indices (the 85th percentile was not available for arm fat area).

For the least squares analyses, a stepwise multiple regression procedure was run in which all main effects were retained and each conceptually plausible two-way interaction effect was tested; the least significant interaction was removed at each step, and those with a P value of .10 or less were retained.[18,19] This procedure was repeated retaining all significant two-way interactions and their inclusive main effects and testing the remaining main effects (retaining those with a P value of less than .05). The resulting models were then tested with logistic regression; variables were removed by means of a similar stepwise procedure.

TABLE 2—Sample Distributions of Physical Indices, Compared with Age- and Sex-Specific National Reference Percentiles

Indices and Percentiles	Boys (n = 900), %	Girls (n = 897), %	Second Graders (n = 960), %	Fifth Graders (n = 837), %	Total (n = 1797), %
Body mass index[a]					
≤5th	2.3	5.0	4.0	3.2	3.7
≤10th	7.0	8.2	6.9	8.3	7.7
>85th	20.9	24.5	23.0	22.4	22.6
>90th	15.6	18.3	18.3	15.5	16.9
>95th	8.7	10.9	8.8	8.3	9.8
Triceps skinfold[a]					
≤5th	4.5	5.5	4.9	5.2	5.0
≤10th	10.7	12.5	11.3	12.0	11.6
>85th	15.9	21.8	19.0	18.8	18.9
>90th	12.0	16.3	13.4	15.1	14.2
>95th	7.4	9.6	10.7	8.5	8.5
Arm fat area[b]					
≤5th	4.3	4.8	3.3	5.9	4.5
≤10th	8.4	11.4	9.7	10.1	9.9
>90th	18.3	20.1	17.9	20.8	19.3
>95th	13.2	11.7	13.7	11.1	12.5
Midarm circumference[a]					
≤5th	4.3	4.1	4.1	4.4	4.2
>95th	8.9	10.0	10.5	8.2	9.4
Height for age[c]					
≤5th	4.0	3.5	3.2	4.5	3.8
>95th	7.2	6.0	6.0	5.8	6.6

[a]Compared with the second National Health and Nutrition Examination Survey (NHANES II).[15]
[b]Compared with NHANES I.[14]
[c]Compared with National Center for Health Statistics percentiles.[21]

Results

Prevalence Estimates for Overweight and Underweight

The estimated prevalence of overweight in the sample (Table 1) varied with (a) the reference data used for comparison,[15,20] (b) the cutoff level used to define overweight, and (c) the indicator used to measure child fatness. Regardless, the prevalence was higher (by as much as twice) than that expected based on the US reference populations. Prevalence estimates differed little from those for the Northeast subsample of NHANES II, however.

The sample anthropometric distributions are shown in Figure 1 and Table 2.[14,15,21] A higher than expected percentage of children had values in the upper percentiles for body mass index, triceps skinfold, and arm fat area, while the percentage with values in the lower extremes (underweight) was similar to or less than expected. Weight status did not vary by grade or sex; within these categories, body mass index measurements were correlated significantly with both arm fat area (coefficients of .92 to .94) and triceps skinfold (.87 to .90).

Characteristics Associated with Child Fatness

In the least squares models (Table 3), arm fat area and body mass index were examined as unadjusted raw variables; therefore, most of the explained variation was attributable to biological variables (R^2s for the biological models alone were 25.4% and 11.4% for arm fat area and body mass index, respectively, compared with 28.5% and 12.2% for the full models). As expected, fatness increased significantly with grade (age) and height, girls had higher arm fat area indices than boys,[22] and African Americans had lower arm fat area indices than Whites.[23]

In the arm fat area model, all sociodemographic variables entered except maternal employment were related to child fatness after adjustment for the others. In the body mass index model, similar results were found, although some relationships were slightly less significant.

TABLE 3—Multiple Least Squares Regression Models of Child Fatness as a Continuous Variable

	Dependent Variable			
	Arm Fat Area (n = 1135)		Body Mass Index (n = 1138)	
Explanatory Variable	Regression Coefficient	SE	Regression Coefficient	SE
Biological variables				
Grade (5th vs 2nd)	.36*	.030	.10*	.010
Age within grade, m[a]	−.007*	.003	.003*	.001
Height within grade, cm[a]	.046*	.005	. . .[b]	. . .
Sex (female vs male)	.28*	.058	.034	.019
Race (African American vs White)	−.32*	.062	−.040	.021
Sociodemographic variables				
SES score (medium/high vs low)	−.094	.052	−.031	.018
Family structure (single parent vs dual parent)	−.15*	.062	−.046*	.021
School lunch (participants vs nonparticipants)	.12*	.037	.039*	.012
Siblings 1 (single child vs 1 or more siblings)	.10*	.046	.020	.015
Siblings 2 (3 or more siblings vs 2 or less)	−.084*	.042	−.027	.014
Breakfast skipping (no breakfast vs some breakfast)	.11*	.056	.063*	.019
Interactions				
SES × Family Structure	.22*	.084	.072*	.028
SES × Height	−.014*	.005	. . .	. . .
SES × Sex	−.10	.067	−.032	.022
Breakfast × Family Structure	−.26*	.12	−.14*	.038
Intercept	6.76*	.060	2.81*	.020

Note. SES = socioeconomic status.
[a]Centered around the mean for each grade.
[b]Not entered (already adjusted for in dependent variable).
*$P < .05$.

Low-SES children tended to be fatter (by about 5%) than medium/high-SES children, except in single-parent households (an interaction). The inverse relationship of fatness with SES was stronger in girls than in boys; although this interaction was slightly less significant than the $P < .10$ cutoff, it was kept in the model because of the similar findings in adults.

Children in single-parent families tended to be thinner than those in two-parent families. Children who participated in school lunch tended to be slightly but significantly fatter than those who did not; this relationship held even when children eligible for free or reduced-price lunches were omitted from the comparison. Children with no or few siblings tended to be fatter than those with many siblings. Finally, children who skipped breakfast tended to be fatter than those who ate breakfast, except in single-parent households. The other dietary indices examined did not relate to child fatness.

On the basis of the body mass index model, these relationships translate into low-SES children being from 0.4 to 1.8 kg (1 to 4 lb) heavier (depending on their other characteristics), single-parent children being up to 0.4 kg (1 lb) lighter, school lunch participants being 0.7 to 0.9 kg (1.5 to 2 lb) heavier, children with no siblings being 0.4 to 0.7 kg (1 to 1.5 lb) heavier, and children with three or more siblings being 0.4 to 0.7 kg (1 to 1.5 lb) lighter than their respective counterparts.

Characteristics Associated with Overweight and Underweight

On the basis of chi-square tests with no adjustment for other variables, there was significantly more overweight (>90th percentile for body mass index or arm fat area) in children with few or no siblings, those with employed mothers, and those who ate school lunch. There was more underweight (≤10th percentile) in children with single parents.

The logistic regression models (Table 4) mostly supported the findings of the least squares models. African-American children were slightly less likely to be overweight, based on body mass index, and much more likely to be "underfat," based on arm fat area, than White children. In two-parent households, medium/high-SES children were about half as likely as low-SES children to be overweight and slightly less likely to be underweight. In single-parent households, on the other hand, SES was not significantly related to overweight or underweight, except for a trend toward medium/high-SES children being heavier than low-SES children.

Compared with children who did not eat school lunch, children who ate school lunch were about half as likely to be underweight and somewhat, but not significantly, more likely to be overweight. Children with no siblings were somewhat more likely, and those with three or more siblings significantly less likely, to be overweight than those with one or two siblings. In two-parent families, children who skipped breakfast were almost twice as likely as breakfast eaters to be overweight; they were less likely to be underweight, as measured by arm fat area, than those who ate breakfast.

Discussion

Because the exact degree of child fatness related to later health problems is unknown, there is no health-based definition of child overweight. Its diagnosis thus remains statistical rather than pathological, and the prevalence in a given population depends on the reference data, the cutoff level, and the indicator used.

The most useful reference data are those representative of the US population. Therefore, the sample measurements were compared with the national NHANES I and NHANES II survey data. Because children in the nation as a whole became fatter during the 1970s,[2] the prevalence of overweight in the sample is higher when compared with NHANES I national percentiles than with NHANES II percentiles, even though both data sets are representative samples of healthy individuals in the United States.

As far as cutoff level, values over the 95th percentile clearly represent a nutritional concern. Many also recommend use of the 85th percentile to define overweight in children, as is used increasingly in adults.[24–26] All three of the fatness indicators resulted in similar prevalences

TABLE 4—Odds Ratios (95% Confidence Intervals) of Being Overweight or Underweight Compared with Normal Weight, Based on Logistic Regression, for Each Explanatory Characteristic

	Dependent Variables			
	Overweight (> 90th Percentile)		Underweight (≤ 10th Percentile)	
Explanatory Characteristic	Body Mass Index	Arm Fat Area	Body Mass Index	Arm Fat Area
African American vs White	0.43[a] (0.19, 0.98)	0.87 (0.44, 1.73)	1.57 (0.72, 3.43)	3.63[a] (1.94, 6.80)
Medium/high vs low SES[b]	0.53[a] (0.35, 0.80)	0.59[a] (0.40, 0.87)	0.57 (0.30, 1.08)	0.79 (0.42, 1.47)
In 2-parent families				
In 1-parent families	2.01 (0.93, 4.36)	1.14 (0.53, 2.43)	0.76 (0.26, 2.25)	0.72 (0.28, 1.83)
Single-parent vs dual-parent family[b]				
In low-SES families	0.54 (0.27, 1.08)	0.62 (0.33, 1.16)	0.90 (0.38, 2.12)	1.28 (0.59, 2.81)
In medium/high-SES families	2.05[a] (1.12, 3.77)	1.20 (0.66, 2.18)	1.21 (0.48, 3.07)	1.17 (0.52, 2.63)
School lunch participants vs nonparticipants	1.48 (0.96, 2.27)	1.40 (0.95, 2.08)	0.66 (0.38, 1.14)	0.51[a] (0.32, 0.82)
Single child vs 1–2 siblings	1.46 (0.91, 2.34)	1.35 (0.88, 2.08)	1.51 (0.79, 2.88)	0.96 (0.50, 1.83)
3 or more siblings vs 1–2	0.60[a] (0.37, 0.98)	0.50[a] (0.31, 0.82)	0.66 (0.32, 1.37)	0.90 (0.50, 1.61)
No breakfast vs some[b]				
In 2-parent families	1.95[a] (1.17, 3.25)	1.51 (0.92, 2.46)	1.36 (0.59, 3.17)	0.23[a] (0.06, 0.97)
In 1-parent families	0.64 (0.20, 2.03)	0.43 (0.12, 1.54)	0.69 (0.15, 3.28)	0.61 (0.17, 2.22)

Note. The ratios for each explanatory characteristic have been adjusted for the other characteristics. SES = socioeconomic status.
[a]Significant based on 95% confidence interval not including odds ratio of 1.0.
[b]Significant interaction with following variable.

of overweight, although body mass index tended to give higher prevalences than triceps skinfold or arm fat area.

Regardless of the definition, the prevalence of overweight in the sample is substantially higher than that in the nation in 1974 or 1980. This is a concern because it may result in increased rates of adult obesity and rising health care costs, supporting the need for obesity prevention efforts starting in childhood. While the results probably reflect a greater current prevalence of child overweight in New York State than in the nation overall, similar to that found in the Northeast subsample of NHANES II, children nationally may well have increased in fatness between the most recent national survey and the present New York survey.

The prevalence of underweight in the study sample was similar to that in the nation in 1980, suggesting less of a problem than for overweight. However, this finding does not imply adequate dietary quality or the absence of at least episodic hunger (food insecurity) or that some children are not experiencing health problems due to being underweight.

The multivariate analyses identified several factors related to the degree of fatness in children. The lower arm fat area but not body mass index values of African Americans relative to Whites, similar to skinfold vs body weight findings from other studies,[22,26] may relate to racial differences in fat patterning rather than to differences in overall fatness.

The relationship between SES and child overweight is unclear in the literature. An inverse relationship like that revealed in this study was found in three other large US studies, including the National Health Examination Survey.[27–29] However, a positive relationship was found in the Ten State Nutrition Survey (except for an inverse relationship in late teen girls)[30] and the Tecumseh community study.[31] No relationship was found in three other large US studies.[32–34] In an extensive review of studies of all sizes in the United States and other developed countries, no clear trend emerged.[35] However, most of the relationships in girls were in the inverse direction, similar to the trend found in the present study and corresponding to differences found in adults.[35] This suggests that the trend toward females of lower SES being fatter may begin in childhood.

The interaction between SES and family structure, such that low-SES children tended to be fatter than higher SES children except in single-parent households, may be due to single-parent low-SES families being even poorer (in all necessary resources) than two-parent low-SES families. Although further study and better measures of SES are needed, this suggests a nonlinear relationship between SES and overweight, such that overweight is lowest in the very poor and in the wealthy and highest in the somewhat poor. Of four other studies that examined the relationship between child overweight and single parenthood, two showed a positive association[36,37] and two showed no association[38,39]; however, none controlled for SES.

A positive relationship between child fatness and participation in school lunch also was found in the national evaluation of the School Lunch Program.[40] The causal nature of this relationship is unclear, however. For example, children who choose not to eat school lunch could be leaner because they are pickier eaters or have more health-conscious parents. On the other hand, school lunches have been suggested to be high in fat,[41–43] which could lead to greater fatness in children.

The inverse relationship between the number of children in the family and child fatness has been found in a number of other studies,[36,44,45] but the mechanism remains unclear. Children with more siblings may be more physically active.

The positive association between breakfast skipping and overweight also was found in a study of adolescents,[46] but the pathway is unclear. Those who skip breakfast may eat more later in the day or be less active, or already-overweight children may tend to skip breakfast in an attempt to lose weight.

Maternal employment was not related to child overweight, as found elsewhere.[38,44] Other factors reported to relate to child overweight but not examined here include activity level and television viewing.[47]

In conclusion, the prevalence of overweight among school-aged children in New York State outside of New York City (14% to 28%, depending on the definition) is high in comparison with national reference data. Children who tended to be fatter were members of low-SES, two-parent households, those with few or no siblings, those who ate school lunch, and those who skipped breakfast. These variables may be useful for targeting interventions to prevent child overweight, although further research is needed to better understand the relationships and their mechanisms and to identify other related factors. □

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