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Original Contribution

Individual- and School-Level Sociodemographic Predictors of Obesity Among New York City Public School Children

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To identify student- and school-level sociodemographic characteristics associated with overweight and obesity, the authors conducted cross-sectional analyses of data from 624,204 public school children (kindergarten through 12th grade) who took part in the 2007–2008 New York City Fitnessgram Program. The overall prevalence of obesity was 20.3%, and the prevalence of overweight was 17.6%. In multivariate models, the odds of being obese as compared with normal weight were higher for boys versus girls (odds ratio (OR) = 1.39, 95% confidence interval (CI): 1.36, 1.42), for black (OR = 1.11, 95% CI: 1.07, 1.15) and Hispanic (OR = 1.48, 95% CI: 1.43, 1.53) children as compared with white children, for children receiving reduced-price (OR = 1.17, 95% CI: 1.13, 1.21) or free (OR = 1.12, 95% CI: 1.09, 1.15) school lunches as compared with those paying full price, and for US-born students (OR = 1.54, 95% CI: 1.50, 1.58) as compared with foreign-born students. After adjustment for individual-level factors, obesity was associated with the percentage of students who were US-born (across interquartile range (75th percentile vs. 25th), OR = 1.10, 95% CI: 1.07, 1.14) and the percentage of students who received free or reduced-price lunches (across interquartile range, OR = 1.13, 95% CI: 1.10, 1.18). The authors conclude that individual sociodemographic characteristics and school-level sociodemographic composition are associated with obesity among New York City public school students.

child; obesity; overweight; physical fitness; schools

Abbreviations: BMI, body mass index; DOE, Department of Education; NYC, New York City; SES, socioeconomic status.

Recent data from the National Health and Nutrition Examination Survey (2007–2008) indicate that 17% of children between the ages of 2 and 19 years in the United States are obese (1). New York City (NYC), like other large cities with a disproportionately low-income and minority population, has been particularly affected. A 2001 study of NYC children in the Women, Infants, and Children program (ages 2–4 years) found that 22% of the children were obese (2); a 2004 study of NYC children in the Head Start program (ages 2–4 years) found that 27% of the children were obese (3); and a 2003 study of NYC elementary school children found that 24% were obese (4). All 3 studies found a substantially higher prevalence of obesity among Hispanic children as compared with non-Hispanic children, and among elementary school children, Hispanic boys were found to have the highest prevalence of obesity.

As one of the primary environments that children experience, schools have attracted attention for their potential role in diet and physical activity behaviors that contribute to childhood obesity. They have been critiqued for providing meals of poor nutritional value and inadequate physical education (5–9). Applied researchers have focused on schools as one of the primary settings for delivering physical activity and nutritional interventions (10–12). While much of the literature on schools focuses on nutrition and physical activity-related aspects of schools, little attention has been paid to whether the sociodemographic composition of a school's student body can also affect an individual student's risk of obesity (13–15). The racial, ethnic, immigrant, and socioeconomic composition of a school's student population may influence social norms regarding appropriate, attractive, or healthy body size (16–18) and/or may influence the formation of social networks within which health behaviors develop and are transmitted (19–21). For instance, recent research found that children's physical activity levels are associated with the activity levels of their school-based friendship groups (22). The sociodemographic composition of schools may also be associated with factors in the neighborhood around the school that could affect diet and physical activity, such as the availability and quality of parks and playgrounds, crime and social disorder, and the mix of retail food outlets (23).

Our objective in this study was to examine the association of both individual- and school-level sociodemographic characteristics with obesity and overweight among public school students in NYC. Data were drawn from the NYC Fitnessgram Program, which collected valid and objectively measured height and weight data from 625,962 students in kindergarten through grade 12. We examined the association between childhood body size and race/ethnicity, nativity, and socioeconomic status (SES) measured at both the individual and school levels, comparing these associations by sex and school level.

MATERIALS AND METHODS

Height, weight, sex, age, and school identification data were obtained from the NYC Department of Education (DOE) for students taking part in the 2007–2008 NYC Fitnessgram Program. The NYC Fitnessgram Program is part of the NYC DOE's physical education curriculum and collects data annually on height, weight, and fitness for NYC public school students. Originally developed by the Cooper Institute (Dallas, Texas), Fitnessgram supports students in learning about and measuring components of health-related fitness and body size. After a 2-year pilot testing and training phase, the NYC Fitnessgram Program was first fully implemented in the 2007–2008 school year. Using a standardized protocol, height and weight measurements were made by physical education teachers, who all received training through an NYC DOE-sponsored workshop, with additional reference material posted online (http://schools.nyc.gov/teachers/resources/classroom/fitnesshealth/videos/fitnessassessmentvideo.htm).

Sociodemographic data for all students were obtained from a separate school enrollment data set. Each data set included a student pseudo-identification number generated by the NYC DOE allowing the data sets to be linked without revealing the identities of the students. For the analyses presented here, children enrolled in special education programs as indicated in the school enrollment data set were excluded, because they are not consistently required to complete Fitnessgram testing, are often taught in separate classroom facilities, and may have medical conditions likely to affect weight. Analyses of these data were approved by the NYC DOE institutional review board and the Columbia University institutional review board.

Measures

Data on height, weight, age, and sex were used to calculate body mass index (BMI) Z score and BMI percentile using a Centers for Disease Control and Prevention SAS macro (SAS Institute Inc., Cary, North Carolina) (24). Overweight was defined as a BMI ≥85th percentile and <95th percentile, and obesity was defined as a BMI ≥95th percentile. The school enrollment file included data on race/ethnicity, place of birth, grade, and whether the child received full-price, reduced-price, or free school lunch. Information on the child's race/ethnicity (Asian, black, Hispanic, white, or other) and nativity (US-born or foreign-born) was provided by the parents during the process of enrolling their children in school. Children whose race/ethnicity was reported as "other" constituted a very small proportion of the sample (0.5%) and were dropped from analyses. Four categories of school lunch pricing were used as a measure of student SES: 1) NYC Human Resources Administration free lunch, provided to children whose families participate in Temporary Assistance for Needy Families or the Supplemental Nutrition Assistance Program (previously known as food stamps) or who attend school in an impoverished area; 2) form-based free lunch, obtained by parents applying to the school and qualifying based on income; 3) form-based reduced-price lunch, obtained through the same application process as for form-based free lunch; and 4) full-price lunch (13, 25, 26).

Several school-level descriptors were created from the enrollment data: percentage of children receiving a free or reduced-price lunch, percentage of the students who were foreign-born, and indicators of whether the school served predominantly black (>70%) or predominantly Hispanic (>70%) children.

Data analyses

The sociodemographic characteristics of the children for whom Fitnessgram data were available were compared with the sociodemographic characteristics of children for whom Fitnessgram data were not available. Fitnessgram data were not available from some schools because they did not have physical education programs or because they lacked the administrative resources or physical space to fully implement the program. Data were not available for some individual children because they were absent from school when the program was administered. Because the total data set included approximately 1 million children, even very small differences met the criteria for statistical significance; therefore, descriptive comparisons were made without formal statistical testing. Initial descriptive analyses of the Fitnessgram data documented the prevalence of overweight and obesity by sex and race/ethnicity for elementary, middle school, and high school children. Data were stratified by sex because prior analyses of elementary school children in NYC suggested that racial/ethnic differences in obesity prevalence differed by sex (4).

Multivariable generalized estimating equations with a logit link were used to calculate odds ratios and 95% confidence intervals for the associations between body size category (normal-weight vs. obese and normal-weight vs. overweight) and individual-level sociodemographic characteristics and school-level compositional characteristics (27). Robust standard errors were estimated to account for clustering by school. Elementary school children were defined as being in grades kindergarten through 5, middle school children as being in grades 6–8, and high school children as being in grades 9–12.

RESULTS

The 2007–2008 school enrollment data included 926,692 non-special education students in kindergarten through the 12th grade. The Fitnessgram database included 625,962 students with valid height and weight data from 1,276 schools across the 5 boroughs of NYC. Among these students, data were available on age and sex for all students, on race/ethnicity for 624,648 students (99.8%), on school lunch status for 535,021 students (85.5%), and on place of birth for 625,514 students (99.9%). Students missing school lunch data were included in the analyses and coded with a variable indicating their missing-data status; thus, the analyses included 624,204 students (99.7% of those with valid height and weight data). Participating students were more likely to be white or Asian than black or Hispanic; racial/ethnic disparities in participation were substantially smaller in elementary schools than in high schools. Among elementary and middle school children, the prevalences of receipt of full-price school lunch were similar for those who did and did not participate, however, among high school students, participants were more likely to pay full price for lunches.

Overall, the prevalence of obesity among students participating in the Fitnessgram Program was 20.3%, and the prevalence of overweight was 17.6%. The prevalence of obesity was lower among high school (13.7%) Fitnessgram participants than among elementary (22.7%) and middle school (20.6%) participants. Among whites, Hispanics, and Asians, boys had a higher prevalence of obesity than girls, but among blacks the prevalences of obesity were similar for boys and girls. Overall, Hispanic boys had the highest prevalence of obesity (see Table 1).

Table 2 shows the odds ratios and 95% confidence intervals for associations between individual-level sociodemographic characteristics and school-level compositional characteristics and overweight and obesity. The odds of being overweight or obese as compared with normal weight increased with increasing age and were higher for boys versus girls, black and Hispanic children as compared with white children, children receiving reduced-price or free school lunches as compared with those paying full price, and US-born students as compared with foreign-born students. The odds of being overweight were lower in Asian children than in white children. After adjustment for individual-level sociodemographic characteristics, overweight and obese status were predicted by the percentage of students in the school receiving free or reduced-price lunches and the percentage of students in the school who were US-born. Obese status was also predicted by attendance at a predominantly Hispanic school. Further adjustment for the borough in which the school was located did not alter the results.

Table 3 shows the odds ratios and 95% confidence intervals for associations between individual-level sociodemographic characteristics and school-level compositional characteristics and overweight and obesity for boys, by school level. Compared with white boys, Hispanic boys consistently had higher odds of overweight and obesity. Black boys, as compared with white boys, had lower odds of overweight in middle school and lower odds of overweight and obesity in high school. Associations between receipt of reduced-price or free lunch and overweight and obesity were

Table 1. Prevalences of Overweight and Obesity Among Participants in the New York City Fitnessgram Program, 2007–2008[a]

Sex and Race/Ethnicity	Elementary School Students		Middle School Students		High School Students	
	% Overweight	% Obese	% Overweight	% Obese	% Overweight	% Obese
Girls	*n* = 164,915		*n* = 75,405		*n* = 65,379	
White	16.5	15.3	17.2	13.9	14.8	8.8
Black	17.0	21.4	20.1	23.1	18.8	15.6
Hispanic	18.8	24.3	21.4	20.9	19.4	12.6
Asian	14.5	10.7	14.0	7.5	9.8	4.2
Boys	*n* = 171,856		*n* = 78,141		*n* = 66,350	
White	16.6	20.7	18.6	20.5	17.2	16.0
Black	17.1	22.4	17.0	22.3	16.4	15.5
Hispanic	18.1	31.2	20.1	27.7	18.9	20.5
Asian	16.5	19.8	19.1	15.2	14.4	10.4

Abbreviation: BMI, body mass index.

[a] Data on height, weight, age, and sex were used to calculate BMI (weight (kg)/height (m)^2) *Z* score and BMI percentile using a Centers for Disease Control and Prevention macro (24). Overweight was defined as a BMI ≥85th percentile and <95th percentile, and obesity was defined as a BMI ≥95th percentile.

Table 2. Associations Between Individual- and School-Level Sociodemographic Characteristics and Overweight and Obesity Among Participants in the New York City Fitnessgram Program, 2007–2008[a]

Predictor	Overweight vs. Normal Weight		Obese vs. Normal Weight	
	OR[b]	95% CI	OR[b]	95% CI
Individual-level predictors				
Age, years	1.02	1.01, 1.02	1.02	1.01, 1.02
Sex				
Female	1.00		1.00	
Male	1.09	1.07, 1.11	1.39	1.36, 1.42
Race/ethnicity				
White	1.00		1.00	
Asian	0.82	0.80, 0.85	0.73	0.70, 0.76
Black	1.05	1.02, 1.08	1.11	1.07, 1.15
Hispanic	1.26	1.23, 1.30	1.48	1.43, 1.53
School lunch status				
Full price	1.00		1.00	
HRA free meal	1.03	1.00, 1.05	1.13	1.10, 1.17
Form-based free meal	1.06	1.03, 1.08	1.12	1.09, 1.15
Reduced-price meal	1.06	1.04, 1.09	1.17	1.13, 1.21
Missing meal data	1.04	1.00, 1.08	1.10	1.05, 1.14
Nativity				
Foreign-born	1.00		1.00	
US-born	1.18	1.16, 1.20	1.54	1.50, 1.58
School-level predictors				
% US-born[c]	1.02	1.01, 1.03	1.10	1.07, 1.14
% receiving free or reduced-price lunch[c]	1.10	1.05, 1.18	1.13	1.10, 1.18
% of black students				
<70	1.00		1.00	
≥70	1.01	0.97, 1.06	0.96	0.91, 1.02
% of Hispanic students				
<70	1.00		1.00	
≥70	1.04	0.99, 1.09	1.07	1.03, 1.14

Abbreviations: BMI, body mass index; CI, confidence interval; HRA, Human Resources Administration; OR, odds ratio.

[a] Data on height, weight, age, and sex were used to calculate BMI (weight (kg)/height (m)^2) *Z* score and BMI percentile using a Centers for Disease Control and Prevention macro (24). Overweight was defined as a BMI ≥85th percentile and <95th percentile, and obesity was defined as a BMI ≥95th percentile.

[b] ORs were estimated from a multivariable model, and all ORs were mutually adjusted for the other variables in the table.

[c] ORs were estimated comparing the 75th percentile with the 25th percentile for the school-level composition variable.

present in elementary school children, were less pronounced in middle school children, and were not apparent in high school children. The association between being US-born and overweight and obesity was present for each school level and increased in magnitude from elementary school to middle school to high school. After adjustment for associations with individual-level sociodemographic characteristics at each school level, the odds of obesity increased with increasing percentage of students in the school who received free or reduced-price school lunches. Further adjustment for the borough in which the school was located did not alter the results.

Table 4 shows the odds ratios and 95% confidence intervals for associations between individual-level sociodemographic characteristics and school-level compositional characteristics and overweight and obesity for girls, by school level. Compared with white girls, black and Hispanic girls consistently had higher odds of overweight and obesity, while Asian girls consistently had lower odds of overweight and obesity. Receipt of free lunches was

Table 3. Associations Between Individual- and School-Level Sociodemographic Characteristics and Overweight and Obesity for Boys Among Participants in the New York City Fitnessgram Program, 2007–2008[a]

Predictor	Elementary School Students[b]				Middle School Students[c]				High School Students[d]			
	Overweight vs. Normal Weight		Obese vs. Normal Weight		Overweight vs. Normal Weight		Obese vs. Normal Weight		Overweight vs. Normal Weight		Obese vs. Normal Weight	
	OR[e]	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual-level predictors												
Age, years	1.07*	1.06, 1.08	1.07*	1.06, 1.08	0.89*	0.87, 0.90	0.87*	0.85, 0.89	0.90*	0.88, 0.93	0.90*	0.89, 0.92
Race/ethnicity												
White	1.00		1.00		1.00		1.00		1.00		1.00	
Asian	0.92*	0.87, 0.97	0.90*	0.85, 0.95	0.96	0.90, 1.03	0.78*	0.72, 0.85	0.81*	0.74, 0.88	0.71*	0.64, 0.79
Black	1.01	0.96, 1.07	0.99	0.93, 1.05	0.89*	0.83, 0.95	0.93	0.86, 1.01	0.90*	0.82, 0.98	0.85*	0.76, 0.95
Hispanic	1.25*	1.19, 1.32	1.60*	1.53, 1.69	1.26*	1.18, 1.34	1.50*	1.40, 1.61	1.22*	1.13, 1.31	1.33*	1.21, 1.47
School lunch status												
Full price	1.00		1.00		1.00		1.00		1.00		1.00	
HRA free meal	1.07*	1.01, 1.13	1.17*	1.11, 1.24	0.97	0.91, 1.05	1.09*	1.02, 1.17	0.96	0.90, 1.02	0.99	0.92, 1.07
Form-based free meal	1.14*	1.08, 1.19	1.20*	1.14, 1.26	1.04	0.98, 1.11	1.08*	1.02, 1.15	0.97	0.91, 1.04	0.98	0.93, 1.03
Reduced-price meal	1.15*	1.08, 1.23	1.23*	1.16, 1.31	1.02	0.95, 1.11	1.20*	1.11, 1.29	0.97	0.90, 1.05	1.01	0.93, 1.09
Missing meal data	1.07	1.00, 1.16	1.13*	1.06, 1.21	1.06	0.96, 1.16	1.10	0.99, 1.23	0.96	0.84, 1.11	1.05	0.92, 1.19
Nativity												
Foreign-born	1.00		1.00		1.00		1.00		1.00		1.00	
US-born	1.11*	1.07, 1.16	1.37*	1.31, 1.44	1.14*	1.09, 1.20	1.44*	1.37, 1.52	1.18*	1.12, 1.24	1.76*	1.66, 1.87
School-level predictors												
% US-born	0.94*	0.90, 0.99	0.96	0.91, 1.02	1.00	1.00, 1.00	1.05	1.00, 1.10	1.01	0.98, 1.05	0.98	0.94, 1.01
% receiving free or reduced-price lunch	1.02	1.00, 1.05	1.08*	1.02, 1.13	1.05	1.00, 1,08	1.18*	1.10, 1.24	1.02	1.00, 1.08	1.08*	1.00, 1.13
% of black students												
<70	1.00		1.00		1.00		1.00		1.00		1.00	
≥70	0.99	0.92, 1.05	1.00	0.94, 1.07	1.10	1.01, 1.19	1.07	0.97, 1.18	1.07	0.96, 1.19	1.11	0.98, 1.25
% of Hispanic students												
<70	1.00		1.00		1.00*		1.00		1.00		1.00	
≥70	1.03	0.96, 1.10	1.05	0.97, 1.13	1.03	0.94, 1.13	0.97	0.86, 1.09	1.11	0.93, 1.33	0.94	0.75, 1.19

Abbreviations: BMI, body mass index; CI, confidence interval; HRA, Human Resources Administration; OR, odds ratio.

* $P < 0.05$ (2-sided P value).

[a] Data on height, weight, age, and sex were used to calculate BMI (weight (kg)/height $(m)^2$) Z score and BMI percentile using a Centers for Disease Control and Prevention macro (24). Overweight was defined as a BMI ≥85th percentile and <95th percentile, and obesity was defined as a BMI ≥95th percentile.

[b] Kindergarten through grade 5.

[c] Grades 6–8.

[d] Grades 9–12.

[e] ORs were estimated from a multivariable model, and all ORs were mutually adjusted for the other variables in the table.

Table 4. Associations Between Individual- and School-Level Sociodemographic Characteristics and Overweight and Obesity for Girls Among Participants in the New York City Fitnessgram Program, 2007–2008[a]

Predictor	Elementary School Students[b]				Middle School Students[c]				High School Students[d]			
	Overweight vs. Normal Weight		Obese vs. Normal Weight		Overweight vs. Normal Weight		Overweight vs. Normal Weight		Obese vs. Normal Weight		Overweight vs. Normal Weight	
	OR[e]	95% CI	OR	OR[e]	95% CI	OR	OR[e]	95% CI	OR	OR[e]	95% CI	OR
Individual-level predictors												
Age, years	1.05*	1.04, 1.06	1.05*	1.04, 1.06	0.96*	0.94, 0.98	0.95*	0.93, 0.97	0.92*	0.91, 0.94	0.90*	0.88, 0.92
Race/ethnicity												
White	1.00		1.00		1.00		1.00		1.00		1.00	
Asian	0.79*	0.74, 0.84	0.62*	0.58, 0.67	0.70*	0.64, 0.76	0.50*	0.45, 0.57	0.65*	0.57, 0.74	0.58*	0.52, 0.65
Black	1.09*	1.03, 1.15	1.24*	1.16, 1.32	1.20*	1.11, 1.29	1.47*	1.34, 1.61	1.27*	1.16, 1.41	1.52*	1.35, 1.71
Hispanic	1.29*	1.22, 1.36	1.55*	1.46, 1.64	1.28*	1.19, 1.37	1.37*	1.26, 1.51	1.31*	1.19, 1.44	1.31*	1.18, 1.45
School lunch status												
Full price	1.00		1.00		1.00		1.00		1.00		1.00	
HRA free meal	1.04	0.98, 1.10	1.17*	1.11, 1.24	1.06	0.99, 1.14	1.14*	1.06, 1.23	1.02	0.96, 1.09	1.19*	1.09, 1.29
Form-based free meal	1.05	0.99, 1.11	1.15*	1.09, 1.21	1.07*	1.01, 1.14	1.09*	1.02, 1.17	1.01	0.96, 1.07	1.14*	1.07, 1.21
Reduced-price meal	1.04	0.97, 1.11	1.19*	1.11, 1.28	1.09*	1.01, 1.18	1.18*	1.09, 1.29	1.01	0.92, 1.11	1.10*	1.00, 1.21
Missing meal data	1.02	0.95, 1.09	1.09*	1.01, 1.17	1.06	0.95, 1.18	1.02	0.91, 1.13	1.04	0.91, 1.20	1.08	0.91, 1.28
Nativity												
Foreign-born	1.00		1.00		1.00		1.00		1.00		1.00	
US-born	1.16*	1.11, 1.21	1.52*	1.45, 1.59	1.18*	1.12, 1.25	1.63*	1.54, 1.72	1.32*	1.25, 1.39	1.91*	1.77, 2.06
School-level predictors												
% US-born	0.99	0.94, 1.04	1.05	0.99, 1.11	1.01	0.98, 1.06	1.09*	1.04, 1.15	0.99	0.94, 1.04	1.04	0.98, 1.11
% receiving free or reduced-price lunch	1.05*	1.00, 1.08	1.13*	1.08, 1.18	1.13*	1.05, 1.18	1.30*	1.21, 1.42	1.05*	1.02, 1.12	1.13*	1.05, 1.21
% of black students												
<70	1.00		1.00		1.00		1.00		1.00		1.00	
≥70	1.01	0.96, 1.07	1.06	0.99, 1.14	1.08	1.00, 1.17	1.03	0.93, 1.14	1.08	0.96, 1.25	1.21*	1.04, 1.42
% of Hispanic students												
<70	1.00		1.00		1.00		1.00		1.00		1.00	
≥70	1.02	0.96, 1.09	1.04	0.97, 1.12	1.02	0.93, 1.12	1.01	0.90, 1.13	0.97	0.78, 1.22	1.16	0.91, 1.49

Abbreviations: BMI, body mass index; CI, confidence interval; HRA, Human Resources Administration; OR, odds ratio.

* $P < 0.05$ (2-sided P value).

[a] Data on height, weight, age, and sex were used to calculate BMI (weight (kg)/height (m)^2) Z score and BMI percentile using a Centers for Disease Control and Prevention macro (24). Overweight was defined as a BMI ≥85th percentile and <95th percentile, and obesity was defined as a BMI ≥95th percentile.

[b] Kindergarten through grade 5.

[c] Grades 6–8.

[d] Grades 9–12.

[e] ORs were estimated from a multivariable model, and all ORs were mutually adjusted for the other variables in the table.

consistently associated with higher odds of obesity, and being US-born was consistently associated with higher odds of overweight and obesity. The association increased in magnitude from elementary school to middle school to high school. After adjustment for associations with individual-level sociodemographic characteristics, obesity among girls was consistently associated with increasing percentage of students in the school who received free or reduced-price lunch. Further adjustment for the borough in which the school was located did not alter the results.

DISCUSSION

The Fitnessgram data showed a high prevalence of overweight (17.6%) and obesity (20.3%) among NYC public school children. Because the Fitnessgram data set overrepresents students at relatively lower risk of obesity, including white or Asian students and those who pay full price for school lunch, these figures are likely to understate the prevalence of obesity among NYC public school children. Analyses of the NYC Fitnessgram data showed that obesity is associated with black and Hispanic race/ethnicity, receipt of reduced-price or free lunch, being born in the United States, and attending schools with a higher proportion of US-born students and a higher proportion of students receiving free or reduced-price lunch.

Findings on racial/ethnic disparities in the prevalence of overweight and obesity paralleled those in other studies; Hispanic children were particularly affected by obesity, while Asian children had the lowest prevalence (2–4). As in past studies, in unadjusted analyses black and white boys had similar prevalences of overweight and obesity; however, in our covariate-adjusted analyses, black boys had significantly lower odds of overweight in middle school and significantly lower odds of overweight and obesity in high school. Prior studies of younger children in NYC suggested that black boys have either a similar prevalence or a higher prevalence of overweight and obesity than white boys (2–4). Likewise, studies in other locales and analyses of National Health and Nutrition Examination Survey data find black boys to have a higher or similar BMI or risk of obesity in comparison with white boys (1, 28–30). The multivariate statistical analyses presented here included school-level characteristics as covariates, measures that prior studies did not include in the analyses, and individual-level covariates that were not included in past studies. It is possible that this adjustment for a larger set of covariates explains why the multivariate results presented here for comparisons of black and white boys differ from those observed in prior studies.

Receipt of reduced-price or free school lunch, a widely used proxy for low SES, was associated with higher odds of obesity (26). Additionally, after adjustment for individual characteristics, including receipt of free or reduced-price lunch, children attending schools with higher proportions of students receiving reduced-price or free school lunches had higher odds of overweight and obesity. These results are consistent with prior studies (13, 25). For instance, a study of Fitnessgram data from Los Angeles, California, found that after control for individual sex, grade, and race/ethnicity, the odds of obesity were associated with the percentage of students in the school who were enrolled in free or reduced-price lunch programs (13). These results are also consistent with findings in adults showing that lower SES or living in a lower-SES neighborhood is associated with higher BMI and with obesity (31, 32). The effects of SES on body size may result, in part, from the lower relative price of energy-dense foods as compared with fruits, vegetables, and other healthy food options (33–36). Additionally, lower-income neighborhoods have more social and physical barriers to physical activity, such as crime and disorder, which may reduce active transport (walking, bicycling, etc.), recreation in parks and playgrounds, and other forms of physical activity (37, 38).

As observed in previous studies of adults and in a smaller number of studies of children and adolescents, US-born children had significantly higher odds of overweight and obesity than their foreign-born peers (39–44). The literature on immigrant acculturation and obesity theorizes that home-country dietary practices protect immigrants from the obesogenic food environment in the United States, where energy-dense high-calorie foods are plentiful and inexpensive (39, 40, 44). Among immigrants to the United States, obesity rates increase with duration of residence and generation since immigration, suggesting that over time immigrant groups adopt US dietary practices (41, 44, 45). In the Fitnessgram data, the association between nativity and obesity risk appeared to be larger among older students than among younger students. However, because these were cross-sectional analyses and data on age at arrival in the United States were not available, it was not possible to determine whether the trend of increasing odds ratios reflected increasing duration of residence in the United States.

The strengths of this study include its large sample size, the use of objective measures of height and weight, and the availability of data on individual- and school-level covariates. Limitations include exclusion of the private school population, which is likely to differ considerably in sociodemographic characteristics from the public school population. In addition, BMI measures were available only for schools with physical education programs, and participation was not uniform across sociodemographic groups, particularly in middle and high schools. Underrepresentation of lower-SES students is typical in studies using Fitnessgram data (46). Since students at relatively lower risk of obesity are overrepresented in the Fitnessgram data set, the data are likely to have underestimated the prevalence of obesity among NYC public school children.

The finding that school-level SES and immigrant composition are associated with child obesity suggests the value of further exploration of school-level factors that contribute to obesity. Previous research on school environment and childhood obesity has pointed to the nutritional value of school lunches, the presence of soda and snack-food vending machines, and minimal physical education as potential culprits in the epidemic (5–9). School sociodemographic composition may also be associated with social norms regarding body size (16–18) and/or may influence the formation of social ties across which health behaviors are transmitted (19–22). The sociodemographic composition of schools may also be correlated with differences in neighborhood environment around the schools that affect students' diets and physical activity patterns (16, 23). The observed associations between obesity and school composition suggest that further work on conceptualizing, measuring, and understanding the role of school-level factors is warranted.

In conclusion, we have shown here that childhood obesity in NYC is highly prevalent and that there are disparities by sex, race, SES, and nativity. We have also demonstrated associations between the sociodemographic composition of the school's student body and obesity, suggesting that the sociodemographic characteristics of individual children and of their peers influence obesity risk. While much of the obesity literature related to schools has focused on nutrition and physical activity, social aspects of school environments may also be important. Future studies should examine in more detail the role of school contextual factors, including diet and recreation norms, social networks, neighborhood environments, and the process of school selection, as potential mediators or moderators of individual-level outcomes and school-level composition.

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