SCHOOL ENVIRONMENT AND OBESITY AMONG URBAN ADOLESCENTS

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ABSTRACT

Adolescent obesity is a pressing public health concern. We used data from approximately 142,000 high school students in New York City Public Schools to investigate individual and school-level factors that might contribute to prevalence and disparities in obesity and overweight. Existing research examines the role of social and physical context on obesity in general, and adolescent obesity in particular; however, these studies tend to study an adolescent's residential neighborhood. We extend this research by investigating school composition effects and the environment surrounding schools that could contribute to overall prevalence and disparities in overweight and obesity among urban high school students. We examine school compositional effects of race, percent of students qualifying for a free or reduced price lunch, and foreign born status, as well as characteristics of the built environment surrounding schools, such as the availability of bodegas or corner stores, fast food establishments, and the "walkability" of the neighborhood.

SCHOOL ENVIRONMENT AND OBESITY AMONG URBAN ADOLESCENTS (EXTENDED ABSTRACT)

Rates of childhood overweight and obesity increased over the past three decades to alarming levels; however the rise in overweight children is particularly pronounced among African American and Latino children.[1,2] Stemming and reversing the rate of obesity among American youth and reducing disparities is a policy priority among local, state, and federal policymakers. Researchers and policymakers have given increasing attention to the neighborhood environments in which children and adolescents live as a possible explanation for the higher rates of overweight and obesity.

However, the context of neighborhoods in and around the schools that adolescents attend might be as or more important than the neighborhoods in which they live. Students' access to energy-dense food and beverages increases if their school is surrounded by establishments those products.[3] Adolescents might be especially vulnerable to the school environment because they have sufficient autonomy and financial independence to make their own purchasing decisions on their way to school, from school, or during lunch. Minority and low-income students might also be particularly vulnerable since the schools that they attend tend to be surrounded by more establishments that sell energy-dense foods, including fast food stores and bodegas.[4]

Recent studies find that the food environment surrounding a school influences consumption and obesity-related outcomes of students. One finds that the presence of a fast-food restaurant within a one-half mile radius of a school predicts a higher probability of obesity and overweight among children; however, the results vary by the geographic distance considered and the *number* of fast food restaurants had little impact on body mass index.[5] Another study of high school freshman finds that the presence of a fast food restaurant within a tenth of a mile increases obesity rates by approximately five percent.[6] Both of these studies are conducted based on statewide data from California, and the latter study is based on obesity

rates of schools. Since urban environments differ substantially in the built environment context from suburban and rural areas where, due to racial residential segregation,[7,8] many minorities live, we examine the importance of residential context in an urban sample. Furthermore, we are interested in controlling for individual-level factors, including student socioeconomic status, of students that is not possible based on measuring rates of obesity within schools.

Therefore, in this paper, we use a sample of approximately 142,000 high school students enrolled in New York City Public Schools to examine the effects of school composition and neighborhood food environment on individual-level overweight and obesity. The size of this dataset allows even small influences of the built environment to be detected, and the best estimates from existing data suggest that effect sizes tend to be relatively small,[6] though multiplied over a large population even small effect sizes can have large consequences for the number of students and potential costs of obesity and overweight. Specifically, we plan to investigate the role of individual-level factors, school student composition factors, and school built environment factors on the odds of obesity and overweight among New York City Public Schools. Initial findings suggest that school composition influences obesity rates beyond individual-level factors.

DATA

The data for this analysis come from the New York City Public Schools Fitnessgram program. The Fitnessgram program, which was instituted in NYCPS in 2005-2006, was developed by the Cooper Institute of Aerobic Research to assess physical fitness of students. The assessment consists of a number of tests implemented by physical education teachers. This city-wide fitness assessment provides feedback to students to help them reach healthy fitness goals. Our data come from the 2007-2008 school year and use only the measured height and measured weight of students. We calculate obesity as equal to or greater than the 95th percentile by gender and age, as calculated by the CDC. Overweight is equal to students greater than or equal to the 85th percentile, but less than the 95th percentile.

Also available from the student-level dataset are the students' *age* and *gender* (ref.=female). Self-identified *race or ethnicity* is included in models and can be one of white (reference), Asian, Black, Hispanic, or other. We also include a measure of *free or reduced lunch*. A student can be enrolled automatically by his/her parents' enrollment in an assistance program (reference), receive free meals based on eligibility after submitting the appropriate form, receive reduced priced meals, or pay full price for meals. Finally, we measure whether the student is *born in the U.S.*

From these variables, we also create four school context variables. To measure the effects of a racially or ethnically segregated student body, we include indicators for black clustering (defined as ≥70 percent of students are black) and Hispanic clustering (defined as ≥70 percent of students are Hispanic). We also include the percent of students who are foreign-born and the percent of students who receive free or reduced price lunch.

In order to account for clustering within schools, we use generalized estimation equations clustering students by school. Analysis was conducted in SAS. Future models will test the robustness of these models with hierarchical linear models.

PRELIMINARY RESULTS

The descriptive statistics of our sample are presented in Table 1. We present the percentage of students who are included in the Fitnessgram program and compare them to students who were not included. The Fitnessgram students are less likely to have free or reduced lunch, more likely to be white and Asian and less likely to be black or Hispanic. Thus, our sample tends to have students who are less likely to be overweight or obese.

The odds ratios and confidence intervals from generalized estimation equations predicting obesity compared to normal weight are presented in Table 2. Model 1 includes only individual-level factors that might predict obesity. We find that older students are less likely to be obese, with a reduction in the odds

of obesity of approximately 10 percent for every year older the student is. Boys are 50 percent more likely to be overweight than girls. Asian students are far less likely to be obese than whites, but black and Hispanic students are more likely. Those born in the U.S. are approximately 80 percent more likely to be obese than immigrants.

Model 2 of Table 2 adds school composition variables to the model. Doing so has little effect on the individual-level characteristics in the model. Though the magnitudes of the effects are slightly diminished, the same patterns hold compared to Model 1. Among the school composition variables, we find that only the percent free or reduced lunch is a significant predictor of obesity. A ten percentage point increase in students who receive free or reduced price lunch who attend a student's school will increase the odds of that student being obese by about 3 percent. This effect is *in addition* to the approximately 8 percent increase in the odds of obesity of a student being on financial assistance compared on one who is not (i.e., 1/0.924).

Results of the generalized estimation equation predicting overweight compared to normal weight are presented in Table 3. We find similar patterns to those found in Table 2. Older and Asian students are less likely to be overweight than younger and white students. Black and Hispanic students are more likely to be overweight than whites; however, while blacks are only about 10 percent more likely to be overweight, Hispanics are almost 30 percent more likely than whites to be obese. U.S.-born students are a quarter more likely to be overweight than their foreign-born counterparts. Interestingly, socioeconomic status, as estimated by receipt of free or reduced meals, is not associated with being overweight.

Model 2 adds the school-level composition predictors. The effects of age, gender, and foreign-born status of students are nearly identical to the results found in Model 1. We find some reduction in the magnitude of the racial and ethnic effects, though the general pattern from Model 1 holds true. We find, just as we did examining obesity, that the percent of students receiving free or reduced lunch increases the likelihood of a student being obese by about the same magnitude. In addition, we find that being in an

isolated black school has a marginally significant positive effect on a student being more obese, suggesting that racial composition as much as individual race might play a role in a student being overweight.

FUTURE STEPS

We find that school composition, particularly the socioeconomic composition of students, increase the chances of students being obese above and beyond the individual-level effect of socioeconomic status. We also find a borderline significant result for black segregated schools. We will investigate characteristics of the built environment surrounding schools to investigate whether these significant predictions can be explained by characteristics of the built environments surrounding poor compared to wealthier schools. For example, previous research finds that poorer schools in New York City are more likely to be surrounded by bodegas,[4] which sell a great deal of energy-dense, non-nutritious food that could contribute to socioeconomic disparities in obesity. We have appended food environment characteristics of schools for all schools in New York City. Table 4 presents the descriptive statistics of the count of bodegas as well as fast food and pizza establishments surrounding 175 and 400 meters of schools (approximately 0.10 and 0.25 miles, respectively) as well as the distance to the nearest bodega and fast food or pizza establishment. We will examine whether these factors, in addition to other factors of the surrounding built environment, can mediate the relationship between obesity, overweight and socioeconomic status.

Table 1. Descriptive Statistics of Students with Fitnessgram versus Students without Fitnessgram, New York City Public Schools

	Students with FG		***Students without FG***	
	N	*%*	*N*	*%*
Free or Reduced Lunch	78,609	59%	82,356	71%
White	22,256	16%	11,570	9%
Black	44,907	32%	47,144	38%
Asian	26,593	19%	12,011	10%
Hispanic	47,734	34%	53,776	43%
US Born	100,934	71%	96,229	76%

Table 2. GEE model predicting odds of obesity versus normal weight by individual and school-level characteristics

	Model 1				Model 2			
	OR	Lower C.I.	Upper C.I.	P VALUE	OR	Lower C.I.	Upper C.I.	P VALUE
Individual Characteristics								
Age	0.901	0.885	0.917	<.0001	0.900	0.884	0.916	<.0001
Male	1.525	1.411	1.649	<.0001	1.532	1.413	1.661	<.0001
Race/Ethnicity								
Asian	0.670	0.617	0.728	<.0001	0.666	0.610	0.727	<.0001
Black	1.154	1.042	1.278	0.006	1.138	1.030	1.258	0.011
Hispanic	1.354	1.233	1.486	<.0001	1.336	1.226	1.457	<.0001
Other	1.059	0.790	1.420	0.700	1.047	0.779	1.406	0.762
U.S. born	1.797	1.704	1.895	<.0001	1.811	1.719	1.908	<.0001
Free/Reduced Meals								
Free meals (via form)	0.973	0.926	1.021	0.266	0.975	0.928	1.024	0.306
Reduced-price meals	0.982	0.921	1.046	0.572	0.986	0.924	1.051	0.658
Full-price meals	0.924	0.875	0.976	0.005	0.941	0.889	0.995	0.033
School Composition								
% Foreign Born					1.000	0.996	1.005	0.909
% Free or Red Lunch					1.003	1.001	1.005	0.002
≥ 70% Black					1.027	0.876	1.203	0.746
≥ 70% Hispanic					0.983	0.747	1.294	0.904
Intercept	0.557	0.404	0.769	0.000	0.447	0.269	0.742	0.002

*reference categories were HRA free lunch, white, female, foreign born

Table 3. GEE model predicting odds of overweight versus normal weight by individual and school-level characteristics

	Model 1				Model 2			
	OR	Lower C.I.	Upper C.I.	P VALUE	OR	Lower C.I.	Upper C.I.	P VALUE
Individual Characteristics								
Age	0.917	0.901	0.933	<.0001	0.916	0.900	0.932	<.0001
Male	1.104	1.028	1.185	0.007	1.104	1.028	1.186	0.007
Race/Ethnicity								
Asian	0.737	0.681	0.798	<.0001	0.734	0.677	0.796	<.0001
Black	1.103	1.020	1.193	0.014	1.080	1.001	1.164	0.046
Hispanic	1.301	1.203	1.407	<.0001	1.280	1.187	1.381	<.0001
Other	1.304	1.002	1.696	0.048	1.282	0.988	1.664	0.062
U.S. born	1.262	1.208	1.318	<.0001	1.268	1.215	1.322	<.0001
Free/Reduced Meals								
Free meals (via form)	0.993	0.940	1.049	0.804	0.995	0.942	1.052	0.869
Reduced-price meals	0.998	0.935	1.066	0.961	1.003	0.939	1.072	0.923
Full-price meals	0.989	0.936	1.045	0.698	1.008	0.955	1.064	0.770
School Composition								
% Foreign Born					1.000	0.996	1.003	0.819
% Free or Red Lunch					1.002	1.001	1.003	0.001
≥ 70% Black					1.072	0.994	1.155	0.071
≥ 70% Hispanic					1.056	0.897	1.243	0.511
Intercept	0.760	0.566	1.020	0.068	0.688	0.456	1.039	0.075

*reference categories were HRA free lunch, white, female, foreign born

Table 4. Descriptive statistics of food environment variables by student BMI category

	Normal Weight			Overweight			Obese		
	Median	**25th %ile**	**75%ile**	**Median**	**25th %ile**	**75%ile**	**Median**	**25th %ile**	**75%ile**
COUNT (175 M)									
bodega	*1*	*0*	*3*	*1*	*0*	*3*	*1*	*0*	*3*
All Fast or Pizza	*0*	*0*	*1*	*0*	*0*	*1*	*0*	*0*	*1*
COUNT (400 M)									
bodega	7	2	13	7	3	13	8	3	14
All Fast or Pizza	2	1	4	2	1	4	2	1	4
DISTANCE (M)									
bodega	193.88	112.27	306.46	187.75	108.89	299.08	177.91	105.82	283.76
All Fast or Pizza	299.43	195.87	450.57	295.59	195.66	441.90	291.49	195.02	426.23

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