Childhood Obesity and Neighborhood Food-Store Availability in an Inner-City Community

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Objective.—Prior studies have shown an association between fast-food restaurants and adolescent body size. Less is known about the influence of neighborhood food stores on a child's body size. We hypothesized that in the inner-city, minority community of East Harlem, New York, the presence of convenience stores and fast-food restaurants near a child's home is associated with increased risk for childhood obesity as measured by body mass index (BMI).

Design.—Baseline data of 6- to 8-year-old East Harlem boys and girls (N = 323) were used. Anthropometry (height and weight) was conducted with a standardized protocol. Food-store data were collected via a walking survey. Stores located within the same census block as the child's home address were identified by using ArcGIS 8.3. We computed age- and sex-specific BMI percentiles by using national norms of the Centers for Disease Control and Prevention. Using odds ratios, we estimated risk of a child's BMI percentile being in the top tertile based on number and types of food stores on their census blocks.

Results.—Convenience stores were present in 55% of the surveyed blocks in which a study particpant lived and fast-food restaurants were present in 41%. Children (n = 177) living on a block with 1 or more convenience stores (range, 1–6) were more likely to have a BMI percentile in the top tertile (odds ratio 1.90, 95% confidence interval, 1.15–3.15) compared with children having no convenience stores (n = 146).

Conclusions.—The presence of convenience stores near a child's residence was associated with a higher BMI percentile. This has potential implications for both child- and neighborhood-level childhood obesity interventions.

KEY WORDS: childhood obesity; food-store availability; inner city neighborhood

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The childhood obesity epidemic is an increasing cause for national concern. Although a number of studies have demonstrated associations between availability of food stores and risk for obesity in adults,[1,2] fewer studies have assessed impacts on children. Enhanced understanding of disparities in neighborhood food-store availability may help in part explain racial/ethnic and socioeconomic disparities in childhood obesity.

Low-income, minority communities are particularly at risk for obesity, the very same communities that have limited access to grocery stores and supermarkets and increased access to fast-food stores. Studies across the United States, including Chicago,[3] Detroit,[4] and Los Angeles,[5] all demonstrate that lower socioeconomic and minority neighborhoods have fewer supermarkets. Meanwhile, studies from New Orleans, Louisiana to Canada, and Australia have demonstrated more fast-food stores in low-income neighborhoods compared to higher-income neighborhoods.[6–8]

Low socioeconomic status populations have less access to healthy foods to meet dietary guidelines. In a study comparing East Harlem, New York, to the higher-socioeconomic and predominantly white Upper East Side, only 18% of East Harlem stores carried foods recommended for diabetics compared with 58% of the Upper East Side stores.[9] In a separate study comparing 2 neighborhoods of Brooklyn, New York, predominantly black area stores carried canned and frozen fruits and vegetables, whereas white neighborhood stores more typically offered fresh and organic produce.[10] These studies highlight the community level barriers residents may face when trying to meet basic nutritional recommendations.

Why does this all matter? Food-store availability, and supermarket availability in particular, has been shown to affect both dietary quality and body size as measured by body mass index (BMI). Residents without supermarkets close to their homes were 25% to 46% less likely to have a healthy diet than study participants who lived in areas of high supermarket density.[11] Moreover, decreased neighborhood access to large chain supermarkets was associated with higher BMI in adults.[12]

Less is known about the influence of the inner-city food environment on a child's body size. Kipke and colleagues[13] demonstrated that children living in low-income neighborhoods of East Los Angeles had proportionately more fast-food restaurants than grocery stores within walking distance of schools, which suggests that children have easy access to fast food and limited access to healthy food options. The greater the number of fast-food restaurants and convenience stores in proximity to the home, the lower the child's intake

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of fruits and vegetables[14] and the higher the BMI.[15] As seen in adults, decreased availability of supermarkets has demonstrated correlations with higher BMI in children aged 3 to 18 years.[16]

The present study investigated the relationship between the urban food environment of East Harlem, NY and body size of minority children living there. Specifically, we wanted to explore the relationships between convenience stores and fast-food restaurants, both potential sources of high fat, calorie-dense foods, and the risk for childhood obesity. This study contributes to our understanding of how the local food environment factors into the childhood obesity epidemic.

DESIGN/METHODS

Baseline data from a 3-year longitudinal study of 6- to 8-year-old East Harlem boys and girls (N = 323) were used. Children were recruited as per an institutional review board–approved protocol from the Mount Sinai Pediatrics Practice, East Harlem community health centers, community-based organizations, and East Harlem schools. Boys and girls were eligible to participate if they were English or Spanish speaking and were residents of East Harlem, NY. Children with medical conditions involving endocrine disorders or other medical conditions that may be related to obesity were ineligible as these conditions can affect growth.

Dependent Variable

Anthropometry (height, weight) was conducted with a standardized protocol by trained interviewers.[17,18] We computed age- and sex-specific BMI percentiles based on the 2000 Centers for Disease Control and Prevention growth charts for the United States, which are used to define children as overweight (≥85th to 95th percentile for age and gender) and obese (≥95th percentile for age and gender). BMI percentiles were categorized into tertiles, ensuring sufficient sample size in each group to maintain sufficient power.[19,20]

Independent Variable

The unit for analysis for this study was the census block, the smallest defined geographic area available. New York City census blocks in general correspond to individual city blocks bounded by streets. Food-store data on convenience stores, specialty stores, grocery stores, supermarkets, fast-food restaurants, and restaurants were collected via comprehensive walking survey of East Harlem zip codes 10029 and 10035 in 2004. Food stores were classified as per the North American Industry Classification System as previously reported.[21] Stores located within the same census block as the child's home address were identified using ArcGIS software version 8.3 (Environmental Systems Research Institute, Inc, Redlands, Calif), which allowed for geocoding of both home and store address. Food stores and restaurants were measured as individual counts (0,1,2, . . . , x). Models were run separately for each type of food store/restaurant.

Statistical Analysis

Using odds ratios, we estimated risk of a child's BMI percentile being in the top tertile for BMI based on the presence of certain types of food stores on their census blocks. Odds ratios adjusted for gender, race/ethnicity, and family income were calculated using the statistical software package SAS 9.1 (SAS Institute Inc, Cary, NC).

RESULTS

Three hundred twenty-three children aged 6 to 8 years enrolled in the study (Table 1), with an even distribution among 6-year-old (37%), 7-year-old (31%), and 8-year-old (32%) children. Seventy-one percent were female. Sixty-seven percent of the study participants were Hispanic, 18% were black, and 15% were black Hispanic. The majority of household incomes (91%) were less than $49,999, and of those 60% had incomes less than $24,999, well below the 2008 U.S. Census Bureau poverty line of $35,600 for a family of 8. Of the participants included in the study, 40% of the girls and 50% of the boys had BMIs above the 85th percentile for age and gender as per norms of the Centers for Disease Control and Prevention.

Convenience stores were present in 55% of the census blocks on which a study participant lived (Figure). Fast-food restaurants were present in 41% of census blocks. Sixty-six percent of the 323 children lived in census blocks with no specialty stores, grocery stores, or restaurants. Mean BMI percentiles for each tertile were 33rd percentile, 76th percentile, and 97th percentile. Statistically significant associations between BMI percentile and number of specialty stores, grocery stores, supermarkets, fast-food restaurants, or restaurants on a child's census block were not observed likely due to the small sample size (Table 2).

Table 1. Baseline Characteristics (N = 323)

Characteristic	Percentage
Age, y	
6	37
7	31
8	32
Race	
Black	18
Hispanic	67
Black Hispanic	15
Gender	
Female	71
Income, $	
< 12 000	20
12 000–24 999	40
25 000–49 999	31
50 000–74 999	5
75 000–99 999	3
> 100 000	1
Overweight (BMI ≥ 85th percentile)*	
Girls	40
Boys	50
Mean BMI percentile by tertiles	
1	33rd percentile
2	76th percentile
3	97th percentile

*BMI = body mass index.

Figure. *Map of East Harlem food stores and blocks by body mass index. In 2004, there were 168 convenience stores, 34 specialty stores, 8 grocery stores, 9 supermarkets, 139 fast-food restaurants, and 57 restaurants in East Harlem. 55% of children in the study had a convenience store and 41% had a fast food restaurant on the block in which they reside.*

However, children (n = 177) living on a block with 1 or more convenience stores (range, 1–6) were more likely to have a BMI percentile in the top tertile (odds ratio 1.90, 95% confidence interval, 1.15–3.15, $P = .01$), than children living on a block with no convenience stores on their block of residence (n = 146).

DISCUSSION

This study examined the relationship between neighborhood food stores and a child's body size. We found that in the inner-city, minority community of East Harlem, New York, presence of convenience stores on the block in which a child resides is associated with increased risk for childhood obesity as measured by BMI. These findings are supported by Powell and colleagues,[15] who found that greater availability of convenience stores in school zip codes was significantly associated with higher BMI among 8th- and 10th-grade students, and Morland and colleagues,[22] who demonstrated similar findings in adults.

Convenience stores provide ample opportunities for children to purchase and consume energy-dense foods. Several studies have reported that convenience stores lower healthy food consumption among children. Timperio and colleagues[14] found that among 5- to 6- and 10- to 12-year-old Australian children, the more convenience stores located close to a child's home, the lower the likelihood of consuming fruit 2 or more times per day. Similar findings have been reported for boys aged 10 to 14 years.[23]

There are several limitations to our study in addition to a small sample size, which we noted earlier. First, we were interested in the food environment of the census block in which a child resides. When studying the impact of the food environment on BMI, it remains unclear what geographic boundaries are most precise for examining a child's food habits. Geographic areas thus far used in research include the census block, census tract, zip code, or defined "buffer" zones that are within walking distance from the primary residence. Each of these geographic boundaries has intrinsic limitations. By restricting analyses

Table 2. Adjusted Odds Ratios of Child's Body Mass Index in Top Tertile by Food-Store Availability*

Store Type**	No.	Percentage Of Census Blocks With Store Availability	OR† (95% CI‡)	*P* Value
Convenience Stores				
0	146	45	1	
1+	177	55	1. 90 (1.15–3.15)	.01
Specialty Stores				
0	282	87	1	
1+	41	13	0.75 (0.39–1.46)	.40
Grocery Stores				
0	311	96	1	
1	12	4	0.88 (0.30–2.56)	.81
Supermarkets				
0	301	93	1	
1	22	7	1.09(0.47– 2.52)	.84
Fast-food Restaurants				
0	192	59	1	
1+	131	41	1.11 (0.71–1.73)	.65
Restaurants				
0	242	75	1	
1+	81	25	1.26 (0.74–2.14)	.40

*Odds ratios adjusted for gender, race/ethnicity, and family income.
**Food Store Counts by Block (0, 1 or 1+).
†OR = odds ratio.
‡CI = confidence interval.

to the census block, we did not consider adjacency, that is, food stores that were available on a neighboring block to where a child resides. Still, it remains significant that 55% of the children in our study had a convenience store and 41% had a fast-food restaurant on the block in which they reside.

Analysis restricted to the census block level provides a limited assessment of the entire scope of food environment exposures in a child's day-to-day life. We did not account for (1) exposures to food stores at different points in the course of a child's day, that is, en route to and from school and after-school activities, (2) individual behaviors, including frequency with which children are purchasing from stores on their block of residence, or (3) quantity and/or quality of purchases children are making at various food stores.

To deepen our understanding of how food-store availability shapes a child's dietary behavior, further studies are needed across all racial/ethnic groups, socioeconomic demographics, and geographic areas, including urban, suburban, and rural settings to explain children's daily travel, purchasing, and consumption patterns in relationship to the local food environment. Factors to explore in future research include what types of foods are available in stores and how they are displayed, advertised, and priced. These data would further enhance support for our findings that suggest that children who live near convenience stores may be at increased risk for obesity due to increased exposure to unhealthy foods.

Interestingly, we observed no statistically significant associations between a child's BMI and the number of fast-food restaurants on a child's census block. Existing studies that examined fast-food restaurant availability report similar results.[24,25] One issue is the classification of food stores, and it remains unclear which elements are essential to defining food-store types.

In summary, we found that convenience stores located on the census block in which a child resides may influence a child's risk for obesity. This suggests that in addition to interventions targeting individuals, there is a role for community-level changes to address the obesity epidemic. Every public health success of the past several decades has employed a multifaceted approach. Novel approaches to tackling obesity have targeted access to unhealthy snacks. Some examples include eliminating vending machines from schools, requiring fast-food restaurants to post calorie counts, partnering with convenience stores to encourage stocking low-fat milk, reducing prices on healthy food items, and offering coupons to encourage shopping at green markets. Longitudinal studies examining the influence of neighborhood food stores can inform multifaceted obesity interventions that combine counseling families on children's neighborhood food purchasing behaviors with innovative food policy initiatives and urban planning that promotes healthy communities.

Conclusions

The presence of convenience stores within the same census block as a child's residence was associated with a higher BMI percentile. Children living on a block with 1 or more convenience stores (range, 1–6) were more likely to have a BMI percentile in the top tertile (odds ratio 1.90, 95% confidence interval, 1.15–3.15, $P = .01$) compared with children having no convenience stores on their block. This has potential implications for both child- and neighborhood-level interventions with respect to childhood obesity.

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REFERENCES

1. Inagami S, Cohen DA, Finch BK, Asch SM. You are where you shop: grocery store locations, weight, and neighborhoods. *Am J Prev Med.* 2006;31:10–17.
2. Wang MC, Kim S, Gonzalez AA, et al. Socioeconomic and food-related physical characteristics of the neighbourhood environment are associated with body mass index. *J Epidemiol Community Health.* 2007;61:491–498.
3. Alwitt L, Donley TD. Retail stores in poor urban neighborhoods. *J Consum Aff.* 1997;31:139–164.
4. Zenk SN, Schulz AJ, Israel BA, et al. Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit. *Michigan. Ethn Dis.* 2006;16:275–280.
5. Shaffer A. *The Persistence of L.A.'s Grocery Gap: The Need for a New Food Policy and Approach to Market Development.* Los Angeles, CA: Center for Food and Justice, Urban and Environmental Policy Institute, Occidental College; 2002.
6. Block JP, Scribner RA, DeSalvo KB. Fast food, race/ethnicity, and income: a geographic analysis. *Am J Prev Med.* 2004;27:211–217.
7. Smoyer-Tomic KE, Spence JC, Raine KD, et al. The association between neighborhood socioeconomic status and exposure to supermarkets and fast food outlets. *Health Place.* 2008;14:740–754.
8. Reidpath DD, Burns C, Garrard J, et al. An ecological study of the relationship between social and environmental determinants of obesity. *Health Place.* 2002;8:141–145.
9. Horowitz CR, Colson KA, Hebert PL, Lancaster K. Barriers to buying healthy foods for people with diabetes: evidence of environmental disparities. *Am J Public Health.* 2004;94:1549–1554.
10. Morland K, Filomena S. Disparities in the availability of fruits and vegetables between racially segregated urban neighbourhoods. *Public Health Nutr.* 2007;10:1481–1489.
11. Moore LV, Diez Roux AV, Nettleton JA, Jacobs DR Jr. Associations of the local food environment with diet quality–a comparison of assessments based on surveys and geographic information systems: the multi-ethnic study of atherosclerosis. *Am J Epidemiol.* 2008; 167:917–924.
12. Brown AF, Vargas RB, Ang A, Pebley AR. The neighborhood food resource environment and the health of residents with chronic conditions: the food resource environment and the health of residents. *J Gen Intern Med.* 2008;23:1137–1144.
13. Kipke MD, Iverson E, Moore D, et al. Food and park environments: neighborhood-level risks for childhood obesity in east Los Angeles. *J Adolesc Health.* 2007;40:325–333.
14. Timperio A, Ball K, Roberts R, et al. Children's fruit and vegetable intake: associations with the neighbourhood food environment. *Prev Med.* 2008;46:331–335.
15. Powell LM, Auld MC, Chaloupka FJ, et al. Associations between access to food stores and adolescent body mass index. *Am J Prev Med.* 2007;33(4 suppl):S301–S307.
16. Liu GC, Wilson JS, Qi R, Ying J. Green neighborhoods, food retail and childhood overweight: differences by population density. *Am J Health Promot.* 2007;21(4 suppl):317–325.
17. Lohman TG, Roche AF, Martorell R, eds. Anthropometric Standardization Reference Manual. Champaign, Ill: Human Kinetics Books; 1991.
18. Wang J, Thornton JC, Kolesnik S, Pierson RN Jr. Anthropometry in body composition. An overview. *Ann N Y Acad Sci.* 2000;904: 317–326.
19. Taylor GW, Becker MP. Increased efficiency of analyses: cumulative logistic regression vs ordinary logistic regression. *Community Dent Oral Epidemiol.* 1998;26:1–6.
20. Fuentes RM, Notkola IL, Shemeikka S, et al. Tracking of body mass index during childhood: a 15-year prospective population-based family study in eastern Finland. *Int J Obes Relat Metab Disord.* 2003;27:716–721.
21. Galvez MP, Morland K, Raines C, et al. Race and food store availability in an inner-city neighbourhood. *Public Health Nutr.* 2008; 11:624–631.
22. Morland K, Diez Roux AV, Wing S. Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. *Am J Prev Med.* 2006;30:333–339.
23. Jago R, Baranowski T, Baranowski JC, et al. Distance to food stores & adolescent male fruit and vegetable consumption: mediation effects. *Int J Behav Nutr Phys Act.* 2007;4:35.
24. Sturm R, Datar A. Body mass index in elementary school children, metropolitan area food prices and food outlet density. *Public Health.* 2005;119:1059–1068.
25. Burdette HL, Whitaker RC. Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Prev Med.* 2004;38:57–63.

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