Published in final edited form as:

Prev Med. 2013 March ; 56(0): . doi:10.1016/j.ypmed.2012.11.023.

Proximity to Supermarkets Associated with Higher Body Mass Index among Overweight and Obese Preschool-Age Children

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Abstract

Objective—The objective of this study is to examine associations of proximity to food establishments with body mass index (BMI) among preschool-age children.

Methods—We used baseline data from 438 children ages 2–6.9 years with a BMI 85th percentile participating in a RCT in Massachusetts from 2006 to 2009. We used a geographic information system to determine proximity to six types of food establishments: 1) convenience stores, 2) bakeries, coffee shops, candy stores, 3) full service restaurants, 4) large supermarkets, 5) small supermarkets, and 6) fast-food restaurants. The main outcome was child's BMI.

Results—Children's mean (SD) BMI was 19.2 (2.4) kg/m²; 35% lived <1 mile from a large supermarket, 42% lived >1 to 2 miles, and 22% lived >2 miles. Compared to children living >2 miles from a large supermarket, those who lived within 1 mile had a BMI 1.06 kg/m² higher. Adjustment for socioeconomic characteristics and distance to fast-food restaurants attenuated this estimate to 0.77 kg/m². Living in any other distance category from a large supermarket and proximity to other food establishments were not associated with child BMI.

Conclusions—Living closer to a large supermarket was associated with higher BMI among preschool-age children who were overweight or obese.

Keywords

supermarkets; food establishments; children; body mass index; obesity

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None of the authors have any conflicts of interest to declare.

INTRODUCTION

Childhood obesity is prevalent and places a substantial burden on morbidity, quality of life, and health care utilization and costs (Trasande and Chatterjee, 2009). Effective interventions for addressing obesity will require multi-component strategies that are mindful of factors that influence eating and physical activity at individual, family, and socio-environmental levels. Recent evidence suggests that neighborhood socioeconomic characteristics and built environment factors may be associated with health behaviors and dietary intake.(Galvez et. al., 2010; Navalpotro et al., 2012; Papas et al., 2007, Timperio et al., 2008),

Several studies have examined associations of proximity to food establishments with adult diet quality and weight status (Block et al., 2011; Laraia et al., 2004; Murakami et al., 2011). Additionally, increasing access to supermarkets has been proposed by The White House Task Force on Childhood Obesity as a strategy to eliminate “food deserts” and to provide more healthful food options to children.(White House Task Force, 2010). However, there are few studies assessing the associations of proximity to food establishments and child body mass index (BMI), few which have examined the associations among children under age 5 years, and none that have examined associations among children who are already overweight or obese. Thus, the purpose of this brief report was to examine the associations of proximity to 6 types of food establishments with BMI among overweight and obese preschoolers.

METHODS

Study Design and Participants

Study subjects were children participating in the baseline assessment of the High Five for Kids study, a cluster-randomized controlled trial to prevent obesity among children 2–6.9 years of age which was conducted from 2006–2009. The study took place in 10 primary care offices of Harvard Vanguard Medical Associates in Eastern Massachusetts. Children were eligible for the study if the child had a BMI ≥ 95th percentile or a BMI between the 85th and 94th percentile if they had at least one overweight parent. Of the 445 children recruited, we excluded 7 participants who lived outside of Massachusetts, leaving a study sample of 438. The Human Subjects Committee of Harvard Pilgrim Health Care approved all study procedures.

Main Exposures

We geocoded each participants’ residential address provided at enrollment. We collected food establishment information from the 2007 InfoUSA database. We categorized food establishments based on definitions of the North American Industry Classification System which is used by US federal agencies. Our categories were 1) convenience stores, 2) bakeries, coffee shops, candy stores, 3) full service restaurants, 4) large supermarkets (supermarkets with ≥ 50 employees), 5) small supermarkets (food stores with < 50 employees) and 6) fast-food restaurants. Distances along the street network were calculated using the ArcGIS v. 10 software Network Analyst Extension Closest Facility tool and StreetMap USA detailed streets (ESRI, Redlands CA). Distances along the network were calculated from the nearest point on the street network to the home address to the nearest point on the street network to each category of food establishment. We categorized proximity to each of the food establishments as: ≤ 1 mile, >1 to 2 miles and >2 miles.

Outcomes

The main outcome for this study was child BMI (kg/m²) which we obtained from the child’s electronic medical record measured by a clinical assistant at the annual well-child visit.

Covariates

We obtained the child's gender and age from the electronic medical record. Mothers reported their heights and weights, educational attainment, marital status, annual household income and their child's race/ethnicity. We obtained neighborhood median income from the 2000 Census information.

Statistical Analysis

We examined the bivariate associations of proximity to each of the food establishments and child BMI. We then used separate multivariable linear regression models to assess the associations of proximity to each of the food establishments with child BMI. In adjusted models, we controlled for child age, sex, race/ethnicity, mother's education, mother's weight category, household income and census tract median household income. We also further adjusted for closest distance to a fast-food restaurant. Analyses accounted for clustering by primary care practice site using generalized linear mixed models and p-values were Bonferroni adjusted.

RESULTS

Mean (SD) network distance from participants' residence to a large supermarket was 1.53 (1.10) miles with a range of 0.20–9.25 miles. Spearman correlation coefficients among the different types of food establishments showed that proximity to large supermarkets was moderately correlated ($r = 0.51$ and 0.50 , respectively) with proximity to fast food restaurants and with proximity to full service restaurants. Bivariate analyses are shown in Table 1.

Multivariable results are shown in Table 2. After adjusting for child age, sex, race/ethnicity, mother's education, maternal overweight/obesity category and household income in Model 2, BMI was 1.06 kg/m^2 (95% CI: 0.47, 1.65) higher in the children living 1 mile from a large supermarket than those living > 2 miles away. Further adjustment for network distance to fast-food establishments in Model 3 attenuated these results (0.77 kg/m^2 , 95% CI: 0.03, 1.51). In fully adjusted models, living in any other distance category from large supermarkets was not associated with BMI. We did not observe an association between proximity to any of the other food establishments and child BMI.

DISCUSSION

In this cross-sectional study of overweight or obese preschool age children, we found that those who lived 1 mile from a large supermarket had a mean BMI that was 0.77 kg/m^2 higher than those living >2 miles away. These results were robust to multivariable adjustment. Proximity to other food establishments was not associated with child BMI. In contrast to previous studies, we did not find an association between proximity to fast-food restaurants, convenience stores, smaller supermarkets, or bakeries, coffee shops, and candy stores with child BMI. ((Fraser and Edwards, 2010; Powell et al., 2007).

In contrast to our findings, some previous studies among older children and among non-overweight children found that proximity to large supermarkets was not associated with BMI or was associated with lower BMI and more healthful behaviors. For example in a study of 8th–10th grade students each chain supermarket per 10,000 capita was associated with a 0.11 kg/m^2 lower BMI. (Powell et al., 2007) Our findings that our lowest income participants and our racial/ethnic minority participants lived closer to a large supermarket are also in contrast to recent reports of "food deserts" thought to be more prevalent among racial/ethnic minority or socioeconomically disadvantaged populations.

Several potential mechanisms could explain our observed association between closer proximity to large supermarkets and higher child BMI among already overweight and obese children. It is possible that participants living closer to large supermarkets purchased more food and/or more calories. Heavy marketing of unhealthy foods on television and in stores could lead children to more frequently request the purchase of these foods.(Aktas Arnas, 2006) The higher price of healthful foods may also be contributing to the relationship we observed. Evidence suggests that access to low priced fresh fruit and vegetables is associated with lower BMI in children 2–9 years old.(Powell et al., 2010)

Despite the limitations of our study which include a relatively small sample of already overweight or obese children, our findings raise questions about the commonly held perception that having access to a supermarket is protective against childhood obesity. Policies that propose to decrease food deserts by increasing the availability of large supermarkets may not have its intended effect on child BMI among overweight and obese children.

Acknowledgments

The abstract of this manuscript was published as part of the proceedings of the 2012 Pediatric Academic Societies Meeting. This study was supported by a grant from the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (R01 HD 050966).

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Characteristics of 438 children at baseline in the High Five for Kids Study in Massachusetts, 2006 to 2009, according to category of network distance to large supermarkets

Table 1

	Category of Networked Distance to Supermarkets				
	Overall	1 mile	>1 to 2 miles	>2 miles	Global P-value
Parent & Household Characteristics					
Parent overweight/obesity status					0.52
Normal weight (BMI < 25 kg/m ²)	17 (3.9)	7 (4.5)	6 (3.3)	4 (4.0)	
Overweight (BMI 25 to < 30 kg/m ²)	186 (42.6)	60 (39.0)	77 (41.8)	49 (49.5)	
Obese (BMI ≥ 30 kg/m ²)	234 (53.5)	87 (56.5)	101 (54.9)	46 (46.5)	
Parent educational attainment					0.002*
Some college or below	167 (38.1)	71 (45.8)	72 (39.1)	24 (24.2)	
College graduate	271 (61.9)	84 (54.2)	112 (60.9)	75 (75.8)	
Annual Household Income					0.0002*
\$50,000 or less	122 (28.2)	58 (37.4)	51 (28.5)	13 (13.3)	
\$50,001	310 (71.8)	97 (62.6)	128 (71.5)	85 (86.7)	
Marital Status					0.001*
Not married	106 (24.2)	50 (32.3)	45 (24.5)	11 (11.1)	
Married	332 (75.8)	105 (67.7)	139 (75.5)	88 (88.9)	
Neighborhood Characteristics					
Neighborhood Household Median Income (SD)	59426 (20276)	53407 (20179)	57756 (18542)	71953 (18176)	<.0001*
Child Characteristics					
Age, years (SD)	4.9 (1.2)	5 (1.2)	4.9 (1.2)	4.9 (1.1)	0.42
Gender					0.50
Female	211 (48.2)	69 (44.5)	91 (49.5)	51 (51.5)	
Male	227 (51.8)	86 (55.5)	93 (50.5)	48 (48.5)	
Race/Ethnicity					<.0001*
White	250 (57.1)	73 (47.1)	95 (51.6)	82 (82.8)	
Black	82 (18.7)	43 (27.7)	35 (19.0)	4 (4.0)	

	Category of Networked Distance to Supermarkets					
	Overall	1 mile	>1 to 2 miles	>2 miles	Global P-value	
Latino	72 (16.4)	27 (17.4)	39 (21.2)	6 (6.1)		
Other	34 (7.8)	12 (7.7)	15 (8.2)	7 (7.1)		
	Mean (SD)					
Body mass index, kg/m ²	19.2 (2.4)	19.6 (2.6)	19.2 (2.4)	18.5 (1.5)	0.002 *	
Body mass index, z-score	1.86 (0.63)	1.94 (0.64)	1.87 (0.65)	1.7 (0.57)	0.01	
Child Health Behaviors						
Sugar-sweetened beverage intake, svgs/day	2.1 (1.7)	2.1 (1.7)	2.2 (1.8)	1.9 (1.4)	0.33	
Fast-food consumption, svgs/week	1.1 (0.9)	1.2 (1)	1.2 (1)	1.1 (0.7)	0.81	
Fruit and vegetable intake, svgs/week	2.4 (1.5)	2.4 (1.6)	2.4 (1.4)	2.4 (1.4)	0.77	
Cost of Food						
Amount of Money Spent per Week on Groceries (Dollars)	133.8 (61.4)	130.3 (64)	131.7 (61.5)	143.3 (56.7)	0.39	
Cost of last Fast-food Bill (Dollars)	13.6 (9.2)	13.5 (9.9)	14.1 (8.9)	13 (8.5)	0.58	

* Significant at the 0.05 level using Bonferroni adjustment to control for overall table-wise error rate.

Table 2
Multivariable Associations of Built Environment Exposures with Child Body Mass Index. Data from 438 Children at Baseline in the High Five for Kids Study in Massachusetts, 2006 to 2009

Exposures	N	Estimates of BMI at baseline, by multivariable model (Effect Estimate 95% Confidence Interval)*		
		Model 1	Model 2	Model 3
Network distance to Large Supermarkets	155	1.06 (0.47, 1.65) *	0.80 (0.16, 1.45)	0.77 (0.03, 1.51)
	184	0.72 (0.15, 1.29)	0.55 (-0.06, 1.16)	0.52 (-0.14, 1.18)
	99	0.0 (ref)	0.0 (ref)	0.0 (ref)
Network Distance to Small Supermarkets	264	0.68 (-0.02, 1.38)	0.37 (-0.37, 1.12)	0.16 (-0.66, 0.98)
	122	0.69 (-0.08, 1.46)	0.54 (-0.23, 1.32)	0.44 (-0.36, 1.23)
	52	0.0 (ref)	0.0 (ref)	0.0 (ref)
Network Distance to Convenience Stores	313	0.44 (-0.40, 1.29)	0.17 (-0.74, 1.08)	-0.10 (-1.17, 0.98)
	92	-0.20 (-1.14, 0.74)	-0.28 (-1.23, 0.68)	-0.42 (-1.43, 0.58)
	33	0.0 (ref)	0.0 (ref)	0.0 (ref)
Network Distance to Bakeries, Coffee Shops, Candy Stores	340	0.58 (-0.37, 1.52)	0.24 (-0.76, 1.25)	-0.18 (-1.42, 1.06)
	72	0.21 (-0.85, 1.28)	0.04 (-1.04, 1.13)	-0.21 (-1.38, 0.96)
	26	0.0 (ref)	0.0 (ref)	0.0 (ref)
Network Distance to Full Service Restaurants	351	0.69 (-0.48, 1.87)	0.42 (-0.80, 1.64)	0.21 (-1.35, 1.76)
	71	-0.13 (-1.40, 1.15)	-0.24 (-1.52, 1.03)	-0.38 (-1.79, 1.03)
	16	0.0 (ref)	0.0 (ref)	0.0 (ref)
Network Distance to Fast-food Restaurants	330	0.70 (-0.25, 1.64)	0.38 (-0.60, 1.35)	
	82	0.20 (-0.84, 1.24)	-0.08 (-1.13, 0.98)	

Exposures	N	Estimates of BMI at baseline, by multivariable model (Effect Estimate 95% Confidence Interval)*		
		Model 1	Model 2	Model 3
>2 miles	26	0.0 (ref)	0.0 (ref)	

Model 1. Unadjusted. Model 2. Adjusted for child age, sex, race/ethnicity, mother's education, maternal overweight/obesity category, neighborhood median income and household income. Model 3. Model 2 + network distance to fast-food

* Significant at the 0.05 level using Bonferroni adjustment to control for column-wise error rate.