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Assessment of a government-subsidized supermarket in a high-need area on household food availability and children's dietary intakes

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Abstract

Objective: To assess the impact of a new government-subsidized supermarket in a high-need area on household food availability and dietary habits in children.

Design: A difference-in-difference study design was utilized.

Setting: Two neighbourhoods in the Bronx, New York City. Outcomes were collected in Morrisania, the target community where the new supermarket was opened, and Highbridge, the comparison community.

Subjects: Parents/caregivers of a child aged 3–10 years residing in Morrisania or Highbridge. Participants were recruited via street intercept at baseline (pre-supermarket opening) and at two follow-up periods (five weeks and one year post-supermarket opening).

Results: Analysis is based on 2172 street-intercept surveys and 363 dietary recalls from a sample of predominantly low-income minorities. While there were small, inconsistent changes over the time periods, there were no appreciable differences in availability of healthful or unhealthful foods at home, or in children's dietary intake as a result of the supermarket.

Conclusions: The introduction of a government-subsidized supermarket into an underserved neighbourhood in the Bronx did not result in significant changes in household food availability or children's dietary intake. Given the lack of healthful food options in underserved neighbourhoods and need for programmes that promote access, further research is needed to determine whether healthy food retail expansion, alone or with other strategies, can improve food choices of children and their families.

Keywords
Children
Dietary intake
Food access
Supermarket
Policy

Low-income and minority children are disproportionately affected by obesity[1] and children residing in low-income and minority neighbourhoods are less likely to have access to healthful food options than children living in wealthier White neighbourhoods[2,3]. Chain supermarkets, which tend to offer more varieties of fresh, affordable produce, are significantly less available in low-income communities[4–6]. By contrast, fast-food restaurants and small grocers selling energy-dense, nutrient-poor foods and beverages are more prevalent in poorer neighbourhoods than in wealthier neighbourhoods[3–6].

It has been suggested that a more equitable distribution of healthful food retail outlets could narrow the gap in childhood obesity by providing low-income neighbourhood residents with better access to healthful food options. Early research examining the correlation between food availability and childhood obesity is promising in this regard, with one study showing a link between proximity to full-service supermarkets and lower BMI in adolescents[7]. There is also evidence that neighbourhoods with supermarket access have residents with lower obesity rates[8] and healthier eating habits[9] than neighbourhoods without. Although research on weight status, dietary habits and availability of neighbourhood food retail outlets is generally only correlational, the aforementioned studies have formed the basis for current policy recommendations. From 2009 to 2012, the Centers for Disease Control and Prevention, Institute of Medicine and White House Task Force on Childhood Obesity issued recommendations encouraging local governments to finance healthful food

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retailers in underserved areas[10–12]. Since 2011 the federal government's Healthy Food Financing Initiative has provided over $US 500 million to finance food access programmes in dozens of cities and states across the country[13].

To date, these efforts have not been rigorously evaluated for their impact on household food availability or for changes in dietary patterns among children residing in the target communities. Moreover, the correlation between neighbourhood food availability and obesity does not suggest causation. Even if the relationship does appear causal, it is unclear whether opening a new supermarket would overcome the many other factors that determine food choice. While a similar paper has focused on adults[14], the present study is the first within the USA to consider these questions by examining the influence of a new, government-subsidized supermarket opening in a high-need area on children's food consumption using a comparison group.

The supermarket in the present study was built as part of New York City's Food Retail Expansion to Support Health (FRESH) Program, part of a collection of obesity prevention efforts initiated in New York City to improve the food environment in underserved neighbourhoods[15]. Under this programme, the City designates zones lacking in full-service supermarkets and retailers can apply for financial and zoning incentives to defray costs of operating in these high-need zones. To qualify, a store must meet basic nutrition criteria, including dedicating at least 30 % of floor space to perishable food items and designating 500 ft^2 (46·45 m^2) to fresh produce. To date, six applications have been approved for supermarket locations in the Bronx and ten throughout other boroughs in New York City. Together, these sixteen stores add over 520 000 ft^2 (48 308 m^2) of food retail in New York City's neediest neighbourhoods[16]. The present study evaluated the first new store built, a 17 000 ft^2 (1579·3 m^2) store in the Morrisania section of the South Bronx. The objective of the study was to determine the impact of the new supermarket on dietary intake in children aged 3–10 years and on shopping behaviours of their parents/caregivers.

Experimental methods

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the New York University School of Medicine Institutional Review Board. Oral informed consent was obtained from all participants. Written consent was witnessed and formally documented from the participants who gave 24 h dietary recalls.

Study design

The study utilized a difference-in-difference study design which employed a geographically close and demographically similar community as a comparison group. This study design was chosen to ensure any changes in outcomes over time could be attributed to the introduction of the supermarket and not to changes in larger trends, such as food prices, seasonality, the overall economy or other health initiatives.

Shopping and consumption data were collected in two low-income neighbourhoods in the South Bronx, New York City, the county with the lowest health profile in New York State[17]. Data were collected in Morrisania, the community in which the New York City FRESH Program supermarket was opened, and in Highbridge, the comparison community that did not receive the new supermarket. Highbridge was chosen as the comparison community based on a matching algorithm that selected the demographically 'closest' community in the Bronx, based on Euclidean distance calculated from census-tract-level data including poverty rate, population size and age, and race/ethnicity. Morrisania is part of Bronx Community District 3, where residents are largely African-American (39 %) or Hispanic/Latino (57 %)[18]. This community district has the highest poverty rate in New York City, at 43 %[19]. Highbridge is also predominantly African-American (32 %) and Hispanic/Latino (63 %)[20] and is located in Bronx Community District 4, where 41 % of residents live below the poverty line[21]. Despite rapidly increasing population densities, the two neighbourhoods have comparatively low grocery store area availability, each at 0·5 ft^2 (0·046 m^2) per person compared with New York City's average of 1·5 ft^2 (0·139 m^2) per person[22]. Both neighbourhoods are classified as 'Supermarket High-Need Areas'[23] and are eligible to receive FRESH Program incentives[16]. Morrisania is 1·6 sq miles (414·4 ha)[19] and Highbridge is 2·0 sq miles (518·0 ha)[20].

Data collection

Data on children were collected through parents/caregivers via a street-intercept survey and follow-up 24 h dietary recall over the telephone with the same proxy. Baseline survey data were collected beginning in early March 2011 and ending in mid-June 2011, two months before the FRESH Program supermarket opened in Morrisania. Baseline telephone dietary recalls also began in early March 2011 and continued through mid-August 2011, concluding before the supermarket's opening. The second round of surveys was administered mid-September 2011 through November 2011, and dietary recalls were administered from mid-September 2011 through late December 2011. The third wave of surveys was collected beginning in mid-August 2012, approximately one year after the supermarket opened in Morrisania. Dietary recalls were collected during the baseline and first follow-up waves only.

The street-intercept survey methodology has been shown to produce a more representative sample than traditional sampling methods when trying to reach a low-income,

difficult-to-contact population[24,25]. Street-intercept surveys have also been successfully implemented in several other studies looking at food environments in low-income neighbourhoods[26–29] and thus were chosen as a reliable means of recruitment for the present study.

During all three waves of data collection, pairs of trained research assistants were stationed throughout busy intersections and block segments of Morrisania and Highbridge during daylight hours, every day, weather permitting. We focused on the neighbourhood as a whole, given that there is no prior work to inform us about which areas of the community might be impacted. All adults (18 years and older) who resided in the neighbourhood in which they were intercepted and were parents/caregivers to a child aged 3–10 years were eligible to participate in the study. The survey focused on only one child under the adult's care; participants who had multiple children between 3 and 10 years were asked to focus on the child who next had a birthday. During the same time periods, a separate group of data collectors gathered data on a completely separate sample of adults who were not required to be parents for a companion study on their purchasing and eating behaviours. However, for the third round of data collection, the non-parent adult sample was the primary sampling unit – adults who were sampled were asked if they had a child aged 3–10 years and if so, they were asked to complete an additional survey. Upon the successful completion of the street-intercept survey, each participant was given an incentive of $US 2 and asked to participate in a telephone interview to complete a 24 h dietary recall for the same child (in exchange for an additional $US 10). Both the survey and dietary recall were conducted in English and Spanish.

Survey

The street-intercept survey utilized validated questions wherever possible and was pre-tested extensively. The survey, which took about 5–6 min to answer, contained four components: (i) demographics and health; (ii) supermarket choice; (iii) food shopping and availability at home; and (iv) food consumption.

Demographics and health

Demographic and health questions included participant's gender, age, race/ethnicity, household income, highest level of educational attainment, marital status, household size, employment status and location (participants were asked if they worked in the Bronx, Manhattan or elsewhere, in order to assess potential exposure to other food sources), and the child's gender, age, height and weight. Additional questions asked whether parents/caregivers considered the child to be overweight, underweight or the right weight, how many calories the child should eat per day, as well as any special dietary needs such as allergies or medical conditions that may impact the child's food choices.

Supermarket choice

Participants were asked where they typically shopped for food and how far they travelled to their usual store. If participants had heard of a new store opening in their neighbourhood, researchers asked what the store was and whether they shopped there. During the third round of data collection, over a year had passed since the new supermarket opened and it may not have been considered to be new by survey participants. Therefore, we did not rely exclusively on these questions during this period. In addition to asking about new grocery stores and coding which responses identified the intervention store, we asked Morrisania residents whether they knew of a supermarket of the name and at the street location of the new store.

Food shopping and availability at home

Household food availability of selected healthful and unhealthful foods was assessed using a slightly modified 5-a-Day Power Plus Program survey[30], which asks respondents how often fruits, vegetables, salty snacks, soft drinks, and cookies, candy, cakes and pastries are available at home.

Food consumption

This part of the survey was adapted from the Eating and Physical Activity Questionnaire (EPAQ), with minor modifications to the measure of food consumption[31]. The EPAQ assesses the frequency of consumption of specific food groups on a typical day and has been validated against a 24 h dietary recall. To standardize responses, examples of serving sizes for solid foods were provided with each question. As a visual aid, research assistants carried a paper cup that indicated a 4-ounce serving size. Participants were asked two questions regarding how often the child ate meals prepared at home. Given that nearly 1·8 million New York State students participate in the National School Lunch Program[32], participants were also asked if breakfast and lunch were prepared at home or at school. Lastly, researchers asked if the parent/caregiver changed what the child ate in the last three months; if so, what changed and why.

24 h Dietary recall

During the baseline and first follow-up data collection, after the successful completion of the survey, each participant was asked to participate in a follow-up telephone interview about what the same child had eaten the day prior to the call (our study was not budgeted for recalls at the third wave of follow-up). Trained dietary interviewers made up to five call attempts to each participant who agreed to the call. One dietary recall was collected from each participant. Each participant was asked to provide details about everything the child had to eat and drink during the previous 24 h. Calls were made throughout the week; therefore dietary recalls included children's

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weekday (school day for those in school) and weekend consumption. Days when atypical consumption could be expected, such as those surrounding Thanksgiving and Christmas, were avoided. All 24 h dietary recall data were analysed using the ESHA Research Food Processor database version 10·9 (ESHA Research, Salem, OR, USA).

Statistical analysis

Data were analysed in a fully controlled, difference-in-difference model, which includes an indicator for the time period (pre- or post-supermarket), the geographic location (Morrisania or Highbridge) and an interaction between time period and geographic location. The interaction is the key outcome of interest, showing whether there is any change in one geographic area over time that did not occur in the other. Ordinary least squares regression was utilized for continuous outcomes and logit models were used for dichotomous outcomes. Given the difficulty of interpreting interactions in non-linear models, ordinary least squares models were also estimated for these outcomes, with no appreciable change in results. The analysis controlled for gender, race/ethnicity, age, education, marital status and self-reported income of the parent/caregiver. *P* value <0·05 was considered statistically significant. The statistical software package Stata version 12 was used to perform all analyses.

Results

A total of 2230 surveys were collected. In Morrisania, where the supermarket opened, 423 surveys were collected at baseline, 431 at first follow-up and 249 at second follow-up. In Highbridge, the comparison community, 427 surveys were collected at baseline, 430 at first follow-up and 270 at second follow-up. Of all participants who took the survey at baseline or first follow-up, 53 % (912) consented to the telephone dietary recall.

The present analysis is based on 2172 street-intercept surveys and 363 dietary recalls. A total of fifty-eight surveys across both neighbourhoods and all time periods were excluded as they were identified as duplicates, incomplete or the participant lived outside the two neighbourhoods. Of 912 parents/caregivers who consented to the dietary recall, 61 % (*n* 557) completed the recall and 40 % (*n* 363) were included in the analysis. Twenty-one recalls were excluded because food intake was reported for a child who was not the focus of the survey, the family moved out of the neighbourhood or the parent/caretaker was not able to report on the majority of foods consumed by the child. An additional 173 dietary recalls were excluded from analysis because parents/caretakers were unable to provide sufficient information on their child's lunch.

The demographics of the samples are reported in Table 1. Children between the ages of 3 and 5 years made up the largest age group, with ages evenly distributed between both neighbourhoods. Half of this sample was male. The majority of parents/caretakers who took the survey identified themselves as Hispanic/Latino (59 %) and 35 % identified as Black/African-American. Half of the full sample was unemployed, 59 % had a total annual household income of under $US 25 000 and 63 % reported a high-school diploma or less as the highest grade or level of school completed. The neighbourhood samples were generally similar in most characteristics, with a few exceptions. Highbridge had a larger Hispanic/Latino population during all data collection periods and fewer participants there took the survey in English, reflecting the 2010 census data. Morrisania had a larger African-American population during both data collection periods. In addition, more participants in Morrisania were never married, whereas more Highbridge residents were married/living as married.

Table 2 shows a significant increase in the number of parents/caregivers who reported hearing about a new grocery store in their community. In Morrisania, the percentage rose from 20 % to 37 % ($P<0·001$) at first follow-up, and remained at 35 % ($P<0·001$) at second follow-up. There was a small increase in Highbridge (15 % to 21 %, $P<0·05$) at first follow-up for a total impact of 10·7 percentage points ($P<0·05$) and a small, statistically insignificant decrease in Highbridge at second follow-up (11 %) for a total impact of 17·7 percentage points ($P<0·001$). Among Morrisania residents who heard about a new store in the community at the first follow-up, there was a significant increase in participants reporting the name or location of the new FRESH supermarket, with 52 % of those who reported a new supermarket indicating the new store that opened in the first follow-up period ($P<0·001$). Of those who noticed the new store in Morrisania in the first follow-up period, 69 % reported shopping there at least 'sometimes', comprising 13 % of the Morrisania sample in that period (3 % always, 2 % usually and 8 % sometimes).

Reliance on local supermarkets or discounters for food prepared at home was very high in both the intervention community (94 %) and the comparison community (92 %) at baseline. Relative to baseline, there was a significant increase seen in both communities at the first post period, but this difference was no longer significant at the second post period and there was no significant difference between communities as a result of the new supermarket. The usual stores for food purchases were relatively close to the respondents' location of residence. At baseline, most respondents (77 %) in Morrisania reported walking less than 15 min to get to their usual store, and 11 % reported driving or taking public transportation to their usual store, with no statistically significant changes in these outcomes at either post-period time point. Lastly, about half (51 %) of parents/caregivers in Morrisania reported before the store opened that their child always eats food prepared at home, and this figure was not

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Table 1 Characteristics of the study sample determined from the street-intercept survey; parents/caregivers of a child aged 3–10 years residing in two neighbourhoods in the Bronx, New York City, March 2011– August 2012

		Morrisania			Highbridge		
	Total sample (*n* 2172)	Pre (*n* 412)	Post 1 (*n* 421)	Post 2 (*n* 239)	Pre (*n* 423)	Post 1 (*n* 407)	Post 2 (*n* 270)
Race/ethnicity (%)							
Black/African American	35·2	46·0	43·2	36·8	27·9	31·5	21·9
Hispanic/Latino	59·4	47·5	54·2	59·8	64·1	64·1	70·7
Other	5·4	6·6	2·6	3·3	8·0	4·4	7·4
Marital status (%)							
Married/living as married	42·2	36·5	39·3	35·9	45·7	47·4	47·1
Never married	40·0	45·8	46·4	45·1	34·8	35·3	31·9
Divorced or separated	15·2	14·7	12·9	14·8	16·7	15·8	17·1
Widowed	2·6	3·1	1·5	4·2	2·9	1·5	3·8
Highest level of education (%)							
Less than high school	28·0	28·0	25·3	34·2	26·1	22·2	38·5
High school	35·1	36·3	38·1	33·8	32·8	38·3	28·5
Some college	25·2	24·3	24·3	23·2	26·1	28·6	23·3
College or higher	11·7	11·4	12·3	8·9	15·1	10·9	9·6
Employment (%)							
Full time	29·7	31·5	32·9	24·5	31·2	29·8	24·2
Part time	17·2	14·5	17·2	14·8	15·1	21·1	20·5
Not employed	50·8	52·2	47·7	57·4	51·6	46·7	53·0
Retired	2·3	1·8	2·2	3·4	2·2	2·5	2·3
Annual household income (%)							
<$US 25 000	58·7	53·1	55·0	67·0	56·6	58·6	67·2
$US 25 000–49 999	31·0	35·2	33·7	25·7	31·9	29·4	27·0
$US 50 000–74 999	7·7	9·5	9·2	5·2	7·5	9·3	3·1
≥$US 75 000	2·7	2·2	2·0	2·2	4·0	2·7	2·7
Child's gender (%)							
Male	50·4	51·5	48·8	48·9	47·8	55·9	47·7
Female	49·7	48·5	51·2	51·1	52·2	44·1	52·3
Child's age (%)							
3–5 years	43·0	44·7	41·8	42·9	41·8	45·9	39·4
6–8 years	37·0	35·4	38·0	33·9	39·5	34·6	40·2
9–10 years	20·0	19·9	20·2	23·2	18·7	19·4	20·5
Survey language (%)							
English	70·7	83·3	79·3	58·8	70·3	70·0	49·3
Spanish	29·7	16·9	20·7	41·2	29·3	30·0	50·7

Pre, baseline survey data collected before the FRESH (Food Retail Expansion to Support Health) Program supermarket opened in Morrisania; Post 1, second round of surveys administered five weeks post-supermarket opening; Post 2, third wave of surveys administered one year post-supermarket opening.

statistically different after the introduction of the new supermarket at both follow-up periods.

Table 2 also presents statistics on reported household food availability. The self-reported availability of fruits and vegetables was not affected by the new supermarket (77 % at baseline in Morrisania), but both neighbourhoods reported a statistically significant decline in the second follow-up period, to 68 % ($P<0·05$) in Morrisania and from 78 % to 65 % in Highbridge ($P<0·001$). Availability of salty snacks decreased significantly in Morrisania at first follow-up, from 32 % to 23 % ($P<0·01$), and the difference-in-difference of 10·1 percentage points was significant between communities ($P<0·05$). Morrisania also experienced a reduction in household availability of other unhealthy foods, such as cookies, cakes and pastries, after the supermarket was introduced; however, a similar decrease was observed in Highbridge during this period and thus was not attributable to the supermarket. No statistically significant differences between the communities were observed in their trends from baseline to the second post period.

Table 3 shows the mean daily servings of healthy and unhealthy foods and beverages, as gathered from the street-intercept survey. The last two columns show the difference-in-difference results, which indicate whether there was any change over time in the community with the new supermarket over and above the change in the comparison community, at each time period. At first follow-up, there were no statistically significant changes in consumption relative to the comparison community. At the second follow-up, there was a net decrease in milk consumption in the community with the new store of 0·37 servings/d ($P<0·05$), driven by an increase in the comparison community while the intervention community stayed flat, and a decrease of 0·26 servings/d in pastries ($P<0·05$), again relative to the change in the comparison community. There were also statistically significant decreases in fruit ($P<0·01$) and packaged snacks ($P<0·01$) in both communities by the second period.

The 24 h dietary recall results (collected only at the first follow-up period) are presented in Table 4. Data are reported on daily intakes of energy and selected nutrients,

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Table 2 Shopping behaviours and household food availability before and after introduction of a new supermarket: results from the street-intercept survey among parents/caregivers of a child aged 3–10 years residing in two neighbourhoods in the Bronx, New York City, March 2011– August 2012

	Morrisania					Highbridge					Difference-in-difference	
	Pre (%)	Post 1 (%)	Diff (%)	Post 2 (%)	Diff (%)	Pre (%)	Post 1 (%)	Diff (%)	Post 2 (%)	Diff (%)	Pre *v.* Post 1 (%)	Pre *v.* Post 2 (%)
New supermarket												
Noticed	20·2	37·1	16·9***	34·6	14·4***	14·5	20·7	6·2*	11·1	– 3·4	10·7*	17·7***
Of those who noticed, specifically the FRESH supermarket†	22·2	52·3	30·1***	–	–	1·6	7·4	5·8	–	–	24·3**	–
Food prepared at home												
Child always eats food prepared at home	50·7	46·1	–4·5	54·8	4·1	54·9	51·0	–3·9	56·9	2·0	–0·6	2·0
Usually bought at supermarket or discounter like Costco	93·5	98·8	5·3**	96·8	3·3	91·9	98·6	6·8***	97·5	5·7	–1·5	–2·4
Usually bought at a convenience store or bodega	0·8	0·4	–0·3	3·9	3·1	0·7	0·3	–0·3	2·4	1·7	0·0	1·4
Distance walking to usual store												
1–5 min	77·3	74·8	–2·5	82·6	5·3	74·5	79·3	4·8	83·5	8·9**	–7·3	–3·6
Does not walk to store (takes subway, bus or car)	10·9	11·3	0·4	12·8	1·9	15·7	8·4	–7·3**	9·7	–6·0*	7·7*	7·9*
Food always available at home												
Fruits and vegetables	76·5	73·9	–2·7	67·5	–9·0*	78·3	74·1	–4·1	64·6	–13·7***	1·4	4·7
Soft drinks	37·1	30·2	–7·0*	27·2	–10·0*	31·4	23·-6	–7·8*	23·2	–8·2*	0·8	–1·8
Salty snacks	32·3	22·7	–9·6**	20·9	–11·4**	23·4	23·9	0·5	15·9	–7·5*	–10·1*	–3·8
Candy, cakes, cookies, pies and candy	26·4	16·7	–9·7**	17·5	–8·8*	20·4	14·9	–5·5	15·0	–5·4	–4·2	–3·4

Pre, baseline survey data collected before the FRESH (Food Retail Expansion to Support Health) Program supermarket opened in Morrisania; Post 1, second round of surveys administered five weeks post-supermarket opening; Post 2, third wave of surveys administered one year post-supermarket opening; Diff, difference.
The above are predicted probabilities in percentage form derived from logistic regression models of each outcome controlled for age, education, marital status, income, gender and race/ethnicity.
*$P<0·05$, **$P<0·01$, ***$P<0·001$.
†Results for this model are displayed only for the first post period because the overall model including both periods did not obtain convergence.

Table 3 Mean daily intakes† of foods and beverages before and after introduction of a new supermarket: results from the street-intercept survey among parents/caregivers of a child aged 3–10 years residing in two neighbourhoods in the Bronx, New York City, March 2011–August 2012

	Morrisania					Highbridge					Difference-in-difference	
	Pre	Post 1	Diff	Post 2	Diff	Pre	Post 1	Diff	Post 2	Diff	Pre *v.* Post 1	Pre *v.* Post 2
Fruit juice	3·15	3·38	0·23	3·00	−0·16	3·10	3·09	−0·01	2·99	−0·11	0·24	−0·05
Water	3·82	4·12	0·30*	4·07	0·25	3·78	4·07	0·28*	4·17	0·39**	0·02	−0·13
Milk	2·71	2·78	0·07	2·72	0·00	2·43	2·75	0·32**	2·80	0·37**	−0·25	−0·37*
Fruit	2·29	2·32	0·02	1·91	−0·39**	2·28	2·08	−0·20*	1·85	−0·43***	0·22	0··04
Vegetables	1·74	1·84	0·10	1·49	−0·25*	1·52	1·77	0·25**	1·52	−0·01	−0·15	−0·25
Soda	0·91	0·84	−0·07	0·55	−0·36**	0·81	0·77	−0·04	0·65	−0·15	−0·03	−0·20
Packaged snacks	1·58	1·44	−0·13	1·12	−0·45***	1·33	1·31	−0·02	1·02	−0·30**	−0·12	−0·15
Candy	1·08	0·95	−0·13	0·76	−0·32**	0·90	0·79	−0·11	0·74	−0·15	−0·02	−0·17
Pastries	1·41	1·11	−0·30**	0·94	−0·47***	1·13	0·97	−0·16	0·92	−0·21*	−0·13	−0·26*

Pre, baseline survey data collected before the FRESH (Food Retail Expansion to Support Health) Program supermarket opened in Morrisania; Post 1, second round of surveys administered five weeks post-supermarket opening; Post 2, third wave of surveys administered one year post-supermarket opening; Diff, difference.
Logistic regression models controlled for age, education, marital status, income, gender and race/ethnicity.
*$P<0·05$, **$P<0·01$, ***$P<0·001$.
†All units in serving sizes.

Table 4 Mean daily intakes of food groups and nutrients before and after introduction of a new supermarket: results from 24 h dietary recalls† among parents/caregivers of a child aged 3–10 years residing in two neighbourhoods in the Bronx, New York City, March 2011–August 2012

	Morrisania					Highbridge					Difference-in-difference
	Pre (*n* 85)		Post 1 (*n* 114)			Pre (*n* 72)		Post 1 (*n* 92)			
	Mean	SD	Mean	SD	Diff	Mean	SD	Mean	SD	Diff	Pre *v.* Post 1
Total energy (kJ/d)	7025	3339	7004	3548	−21	6485	2682	5778	2000	−707	
Total energy (kcal/d)	1679	798	1674	848	−5	1550	641	1381	478	−170	165
Energy from fat (kJ/d)	2042		2213		171	2038		1690		−348	
Energy from fat (kcal/d)	488		529		41	487		404		−83	124*
Total fat (g/d)	54·3		58·9		4·6	54·1		45·0		−9·2	13·8*
Saturated fat (g/d)	18·9		19·9		1·1	18·3		15·7		−2·6	3·6
Protein (g/d)	62·4		66·6		4·2	67·9		56·2		−11·7**	15·9**
Carbohydrate (g/d)	239·0		221·9		−17·1	200·9		189·6		−11·4	−5·8
Sugars (g/d)	112·0		97·3		−14·7	84·6		85·4		0·8	−15·5
Dietary fibre (g/d)	13·8		12·2		−1·6	12·4		10·5		−1·8	0·2
Na (mg/d)	2443		2332		−110	2353		1852		−502*	391
Fruit (cups/d)	1·51		1·14		−0·37	1·53		1·35		−0·18	−0·19
Vegetables (cups/d)	0·91		0·69		−0·22	0·63		0·61		−0·02	−0·20
Grains (cups/d)	4·46		5·17		0·71	4·01		3·97		−0·04	0·74
Dairy (cups/d)	1·58		1·76		0·18	1·46		1·60		0·14	0·04
Protein-rich foods (oz/d)	4·19		4·18		−0·02	5·04		3·87		−1·18**	1·16*

Pre, baseline survey data collected before the FRESH (Food Retail Expansion to Support Health) Program supermarket opened in Morrisania; Post 1, second round of surveys administered five weeks post-supermarket opening; Diff, difference.
Logistic regression models controlled for age, education, marital status, income, gender and race/ethnicity.
*$P<0·05$, **$P<0·01$, ***$P<0·001$.
†Limited to samples without missing meals.

as well as servings of fruits, vegetables and whole grains consumed by each sample. There was no statistically significant impact of the new supermarket on mean total energy intake, or intake of any of the more healthful food groups (fruits, vegetables or whole grains). There was a small increase in servings of protein-rich foods and grams of protein consumed, largely driven by a decrease in the comparison community. As proxies for unhealthy foods, there was a slight increase in energy from fat and grams of fat, but again this was driven by a decrease in the comparison community.

Discussion

Our analyses suggest the FRESH Program supermarket had minimal effect on household food availability and no appreciable effect on consumption habits of Morrisania children within the first year of opening, at least for the community as a whole. We saw a significant reduction in the availability of salty snacks at first follow-up; however, by second follow-up results were no longer significant. Although consumption of grams of protein and percentage of energy from fat showed a significant difference at first

follow-up, these results were largely due to decreases in the comparison community and likely not attributable to the new supermarket. We found slight decreases in availability of certain unhealthful food categories (e.g. soda, candy, pastries and packaged snacks); however, a similar decrease was observed in the comparison community and effects were not significant. Although the number of Morrisania parents/caregivers who had heard of a new supermarket opening increased significantly in both follow-up periods, only a minority was able to correctly identify the FRESH supermarket, and its existence did not significantly increase healthful foods purchased or decrease distance travelled to the preferred store.

Our results are consistent with evidence from recent correlational studies. Although none of these studies used a comparison group to evaluate the impact of a new supermarket in an underserved neighbourhood, cross-sectional data showed null or inverse associations between supermarket proximity and healthy dietary habits in children[33–35]. A recent study in California analysed dietary data from children and adolescents aged 5–17 years and found no correlation between supermarket availability and improved diet[36]. Results from a smaller study in Minnesota adolescents showed a significant association between proximity to food retail establishments, including supermarkets, and sugar-sweetened beverage intake[37]. Proximity to supermarkets and consumption of healthful items, such as fruits and vegetables, were not correlated. The data we report here on children are similar to our as yet unpublished companion study on adults.

There are substantive explanations for these findings. Although the neighbourhood was 'high need', other supermarkets were available in the community. Almost 90 % of consumers during all three time periods shopped at a supermarket for the food they prepared at home, leaving very little room for this value to improve. Despite housing healthful options, such as fresh produce, low-fat dairy and whole grains, the vast majority of supermarket real estate is occupied by highly processed foods high in salt, sugar and fat. In addition, several factors have been identified in the literature as having an equal or larger impact on purchasing and consumption of healthful foods than availability. One qualitative study that examined barriers to healthful food purchasing in low-income urban families found that although shoppers preferred nutritious items, financial and environmental factors greatly influenced purchasing decisions[38]. Fresh food is often more expensive than processed food[39,40] and it spoils more quickly. Energy density per dollar can be an important factor in determining food choice and shoppers on a budget may be more likely to select items that are more 'filling' (i.e. energy dense) over more nutritious items such as fruits and vegetables. Displays and discounts in supermarkets frequently promote less expensive foods sold in bulk (e.g. 10 for $US 10, buy one get one free), making unhealthful options more financially appealing[41].

The present work has limitations. It examined the whole community and did not separate out residents of the areas directly surrounding the new store; it is possible that those who lived in the immediate 'micro-neighbourhood' may have experienced a greater change to their food purchasing and/or consumption than those in the wider area. To that point, an analysis of competing food retail establishments in the neighbourhood may have provided more insight into which blocks of Morrisania were more heavily impacted by the opening of the new store. Additionally, although the street-intercept survey methodology has been an effective means of recruitment to assess the food environment in other low-income communities, generalizability remains a concern. Furthermore, dietary intake is difficult to measure accurately and valid tools, particularly for children, are limited. The 24 h dietary recall is considered the gold standard for dietary intake assessment but like other tools, it relies on self-report and participants tend to respond with socially acceptable information and may under-report items. Under-reporting may be more problematic when a parent is reporting on behalf of a child, especially for eating occasions that occur outside the home (like school meals) or food purchases that children might make for themselves without parental knowledge. The sample size and response rate for collecting complete 24 h dietary recalls were low, most likely because people were enrolled on the street rather than in a more traditional research setting like a medical centre. It is possible that a better response rate and collecting multiple dietary recalls may have measured dietary intakes of the community members more accurately and thus reflected change in relation to a new supermarket. On a related note, the study was powered *a priori* to detect a relatively small effect ($\Delta/\sigma = 0{\cdot}34$) between waves 1 and 2. However, statistical power was attenuated for detecting impacts between waves 1 and 3 since the wave 3 sample was smaller. Although the study assessed participants at one year after the supermarket opened, an even longer exposure time may be needed for persons to change their food behaviours and choices. Lastly, we examined only one potential outcome, although arguably one of the most important: food consumption and nutrition. The new supermarket could influence a number of other outcomes, including economic development, job creation and related larger economic themes that could have an appreciable downstream impact on the public health of the community.

Conclusions

The present study is the first one that included a comparison group to evaluate the impact of a government-subsidized supermarket on children's food consumption. Results are consistent with other cross-sectional and pre/post studies, which suggest proximity to full-service supermarkets does not significantly impact dietary habits

at least in the course of one year. It is worth noting that even though this was an area with considerably less access to supermarkets than others in New York City, almost all consumers were already shopping at supermarkets for most of the food they prepared at home. We need further work to determine what the exact definition of a 'food desert' should be – at what distance or density does poor access to a supermarket diminish diet? Future work to examine the impact of a supermarket on residents within the immediate neighbourhood *v.* the larger community may be helpful in this regard.

Low-income and ethnic minority neighbourhoods are underserved by supermarkets relative to their higher-income counterparts, and it is at face value logical that increasing availability of healthful foods could improve diets. However, the ubiquity of processed foods and pervasiveness of junk food marketing have implications for behaviour change and may thwart efforts to improve eating habits. It is possible that a more 'healthful' supermarket, one that devotes prime supermarket real estate to healthier options, offers discounts for smaller package sizes, and replaces candy and soda with fresh fruits and vegetables at cash registers could have a larger impact on health[42].

Given the spread of policies to address the food environment across the USA, it is crucial to evaluate the effectiveness of these as tools to promote healthy eating and ultimately impact obesity. Although supermarkets may increase access to healthful options, they also include and promote buying unhealthy foods that can contribute to poor diet and health. Further research is needed to determine whether healthy food retail expansion is an effective strategy for improving household food availability and dietary habits in children, and/or whether other strategies need to be considered perhaps simultaneously with a new supermarket.

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