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Does opening a supermarket in a food desert change the food environment?☆

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ABSTRACT

Improving access to healthy foods in low-income neighborhoods is a national priority. Our study evaluated the impact of opening a supermarket in a 'food desert' on healthy food access, availability and prices in the local food environment. We conducted 30 comprehensive in-store audits collecting information on healthy and unhealthy food availability, food prices and store environment, as well as 746 household surveys in two low-income neighborhoods before and after one of the two neighborhoods received a new supermarket. We found positive and negative changes in food availability, and an even greater influence on food prices in neighborhood stores. The supermarket opening in a 'food desert' caused little improvement in net availability of healthy foods, challenging the underpinnings of policies such as the Healthy Food Financing Initiative.

1. Background

1.1. Inequities in food access

Many low-income, minority neighborhoods in the United States (U.S.) lack access to high-quality healthy and affordable food (Walker et al., 2010). Lack of access to supermarkets in such neighborhoods may constrain residents to buy food from small neighborhood or convenience stores with poor selection of healthy foods, wide selection of unhealthy foods, and higher food prices (Alwitt and Donley, 1997; Block and Kouba, 2006; Bodor et al., 2008; Chung and Myers, 1999; Gittelsohn et al., 2008; Laska et al., 2010) relative to grocery stores. Contributing to the selection of unhealthy foods is the greater density of fast food outlets in areas of socioeconomic deprivation (Maguire et al., 2015). The lack of access to healthy foods may require residents to travel to supermarkets outside the neighborhood, despite financial and physical constraints to mobility (LeDoux and Vojnovic, 2013). While spatial access to healthy foods is critical, high prices may also contribute to inequities in food access (Breyer and Voss-Andreae, 2013). Multiple studies have linked living in a neighborhood without supermarkets or sources of healthy foods to worse dietary intakes (Laraia et al., 2004; Moore et al., 2008; Rose and Richards, 2004) and diet-related health outcomes such as obesity and type 2 diabetes (Black and Macinko, 2008; Bodor et al., 2010; Keenan and Rosendorf, 2011; White, 2007). Collectively, these studies indicate a need for policy action and intervention strategies to ensure equitable access to healthy foods across the U.S.

1.2. What can be done about food access inequities?

Efforts are underway to improve healthy food access by transforming small stores already located in low-income minority neighborhoods (Gittelsohn et al., 2012) or by bringing in large grocery stores. Efforts that involve bringing supermarkets to 'food deserts' have gained more attention, with multiple policy initiatives (e.g. the Healthy Food Financing initiative or HFFI) underway (Flournoy et al., 2010;

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Treuhaft and Karpyn, 2010). The HFFI policy has invested more than $500 million through one-time financing assistance to bring grocery stores and other healthy food retailers to underserved urban and rural communities across America. The goal of HFFI is to provide areas without lack of access to a supermarket with access to a supermarket to bring major improvements in geographic access. One evaluation of such an effort found that a supermarket opening in a food desert increased perceptions of healthy food access, based on a pre-post survey of residents (Cummins et al., 2014). Another large quasi-experimental study, the Pittsburgh Hill/Homewood Research on Eating, Shopping, and Health (PHRESH) study also included surveys of residents and also found significant improvement in perceptions of healthy food access (Dubowitz et al.,2015). Although the primary goal of these policy initiatives is to expand healthy food access, studies have not gone beyond residents' perceptions to determine the impact of opening a supermarket on the neighborhood food environment.

Supermarkets are meant to increase the variety and quality of fresh produce and the number of healthy food options (e.g.broccoli), as well as to reduce the price of healthy foods and the distance residents have to travel to access these foods directly, through their products, prices and location of the store in the neighborhood. However, supermarkets may also modify the availability of unhealthy foods by offering such foods. The introduction of a supermarket into the local food system may also influence healthy and unhealthy food access by acting as a driver for wider food system change (Diez Roux, 2011). For example, the increased competition may cause some local food stores to fail, stimulate changes in price, or prompt changes to stocking and inventory practices in other local food stores, thereby changing food availability and prices indirectly. These potential changes may be positive or negative. One study found that the opening of a Wal-Mart supercenter, which sets grocery prices significantly lower than its competitors (Leibtag, 2006), decreased prices by 6–7% for national brand goods and by 3–8% for private label goods in other grocery stores in New England (Volpe and Lavoie, 2008).

1.3. What's new about this study?

In this paper, we evaluate the impact of a supermarket opening in a 'food desert' (Economic Research Service, 2012) on residents' food accessibility and neighborhood food availability and prices. We draw on additional data from PHRESH (Dubowitz et al., 2015) obtained through in-store audits of the entire food retail environment in two urban neighborhoods at two time points. Both neighborhoods were predominantly African-American and without a supermarket at the start of the study. One of the two neighborhoods experienced major food system change with the opening of a full-service supermarket after the initial audit and before the follow-up; the other neighborhood was highly similar to the first but did not experience this change, providing a comparison that can account for 'secular' trends, or any independent, long-term trends, in local food marketing. In addition to food store audits, surveys were conducted with a random sample of households before and after the supermarket opening.

Using the audits and surveys, we tested the following hypotheses: relative to secular trends in the comparison neighborhood (Homewood), opening a supermarket in the Hill District will: (i) improve resident geographic access by a significant reduction in distance to any supermarket, and residents' place of regular food shopping; (ii) increase the availability of healthy foods; (iii) increase the availability of unhealthy foods; and (iv) lower prices of healthy and unhealthy foods (due to competition from a larger grocery) in the Hill District (intervention neighborhood). In addition, we explored changes in the store environment (e.g. orderliness). We conjectured that competition among stores may lead to improvements along this dimension. We evaluated orderliness and hypotheses ii through iv using two analyses involving different samples of food stores. In the first approach, we include all stores open at each assessment. This analysis addresses the question of what the impact of the supermarket opening is on the environment of each neighborhood as a whole (i.e., it accounts for the opening or closing of other stores in response to the new supermarket, as well as the supermarket itself). The second approach shines a spotlight on one important aspect of these changes in more detail. In it, we only included stores that were open before and after the supermarket opening. This analysis assesses the impact of the supermarket opening on offerings and prices of other stores in the area.

2. Methods

2.1. Study design

PHRESH is a five-year study of two urban 'food deserts' – both lacked a supermarket at baseline, and residents' lacked access to healthy foods (Economic Research Service, 2012). The intervention neighborhood (Hill District) is approximately 3.55 km^2 (1.37 square miles) with a population of 10,000, and the control (Homewood) is approximately 3.76 km^2 (1.45 square miles) with a population of 8000. The two neighborhoods were similar with over 90% African Americans, and half of households reporting an annual income below $10,000. Boundaries of the neighborhoods correspond to 'official' city neighborhoods, and also align with resident-defined neighborhoods within the City of Pittsburgh. Neighborhoods in the city are comprised of multiple census tracts and boundaries of the census tracts align with neighborhood boundaries. Colloquially, the five neighborhoods comprising what we call the Hill District are referred to as one Hill District neighborhood. Our control neighborhood includes Homewood (divided into three smaller official neighborhoods) and Larimer. A new supermarket opened in the Hill District in October 2013, the first in three decades. Study protocols were approved by the RAND Human Subjects Protection Committee.

The PHRESH study surveyed a random sample of household primary food shoppers in the two neighborhoods prior to (between May and December 2011) and again twelve months after (between May and December 2014) the supermarket opening. The household sample was drawn from a complete list of residential addresses generated by the Pittsburgh Neighborhood and Community Information System, with stratified sampling conducted in the intervention neighborhood. Out of 4002 sampled addresses, 2900 households were inhabited. A household member was contacted at 1956 addresses, with up to ten attempts per household; 1372 households completed a baseline survey. The analysis in this paper includes 746 households that completed both a baseline and a follow-interview, and continued to live in the same neighborhood.

We combined a thorough neighborhood examination by trained-resident data collectors combing the streets, with input from community stakeholders, to create a listing of all stores selling any food at both time points. All stores in this analysis are within the boundaries of their respective neighborhoods. Stores present at both assessments were audited twice; stores that closed and new stores at follow-up were audited once. We completed in-store audits of 30 food stores in the two neighborhoods. Stores were categorized using definitions from the Food Marketing Institute (FMI) and the North American Industry Classification System (NAICS); we initially classified stores into one of 11 categories. To simplify, we further reduced these categories to the following three categories: (i) **supermarkets** are large regional or national chain owned stores; (ii) **convenience stores** are small chain stores with or without a gas station (e.g. Get Go, AM/PM, Shell Station), neighborhood stores are small individual/locally owned stores, drug stores, or dollar stores with limited assortment of low-priced and perishable items (e.g. Family Dollar); and (iii) **other stores** such as fruit and vegetable stores, and meat or seafood markets (Bureau, 2007).

The audit tool was adapted from the Bridging the Gap (BTG) Food Store Observation Form, which has demonstrated high validity and

reliability (Rimkus et al., 2013). Four composite measures of food availability (fruits and vegetables, healthy food, unhealthy food, junk food), two measures of food price (staple food price, junk food price), and one composite measure of store environment were derived.

2.2. Measures

2.2.1. Distance to store

Study participants were asked for their home address, as well as the name and location of the regular place of food shopping by asking "*what is the name and address of the main store where you most often do your major food shopping?*" Addresses of all study participants and food stores were geocoded using the ArcGIS 10 U.S. Streets Address Locator (Esri, Redlands CA). Because 92% of respondents reported leaving from home, street network distances in miles were derived from each respondent's home address to (a) the nearest supermarket and (b) the food retail store he/she reported as their regular place of food shopping, using the shortest route participants could drive along the existing road network.

2.2.2. Fruit and vegetable availability

The availability of 22 fresh fruits and vegetables commonly consumed in the U.S. population and culturally-specific items commonly consumed in African American populations was assessed at each store (Grigsby-Toussaint et al., 2010). We counted the number of fresh fruits and vegetables (maximum of 22) to generate a count of *fruit and vegetable availability*.

2.2.3. Healthy and unhealthy food availability

We assessed the availability of healthy and unhealthy alternatives for 11 standard food items: (i) milk (whole or low fat), (ii) cheese (whole milk or low fat), (iii) yogurt (whole or low fat), (iv) beef (regular or lean), (v) chicken (dark or white), (vi) bread (white or whole wheat), (vii) rice (white or brown), (viii) pasta (white or wheat), (ix) cereal (high or low sugar), (x) chips (regular or baked), and (xi) juice (flavored or 100% fruit juice). We counted the number of healthy and unhealthy alternatives to generate measures of (i) *healthy food availability* and (ii) *unhealthy food availability*. We also derived a measure of *relative availability* as the ratio of number of healthy to unhealthy items (Zenk et al., 2014).

2.2.4. Junk food availability

We assessed the availability of nine junk foods: family-size chips, individual-size chips, family-size spicy chips, individual-size spicy chips, individual-size soda, individual-size diet soda, snack cakes, cookies, and chocolate candy.

2.2.5. Food prices

The *staple price index* is the sum of prices of four items commonly available including: (i) one dozen eggs, (ii) half-gallon of whole milk, (iii) 20-ounce loaf of white bread, and (iv) 15–18-ounce box of high-sugar (i.e., with 6 g or more sugar per serving) cereal. The *junk food price index* is the sum of the least expensive soda unit price multiplied by 67.6 ounces for a two-liter family-size bottle, and the least expensive price for an 11-ounce bag of chips. Due to inflation – the general fall in the purchasing power of money over time – the shelf prices of foods tend to rise each year. To correct for this phenomenon, we computed inflation-adjusted changes over time by holding the value of the U.S. dollar constant at November 2014.

2.2.6. Store environment

Orderliness (Izumi et al., 2012), was a count of nine binary items: (i) no people loitering or hanging out, (ii) no panhandling, (iii) no shopping cart guard rails, (iv) no security guard, (v) no bars on doors or windows, (vi) no bullet-proof or plexiglass at check out, (vii) no security mirror, (viii) no graffiti on building, and (ix) no garbage at store entrance. Values range from 0 to 9 with higher scores indicating more order.

2.3. Data analysis

The main analyses were conducted with each of two store samples – (i) the full sample of stores that were open during the pre- or post-intervention assessment (including new stores and stores closed at follow-up) to examine overall changes in the food environment including availability, prices, and store environment, and (ii) the sub-sample of stores that were open at both pre- and post-intervention (referred to hereafter as the *panel*) to test the impact of the supermarket on within-store changes in availability, prices and the store environment. The *panel* excludes the new supermarket because it was not open at baseline. A small set of additional analyses (examining distances from homes to stores) was conducted at the person level, employing the sample of study participants with both a pre- and a post-intervention survey. The primary analyses were descriptive: frequency and percentage for binary variables, and mean, standard deviation and range for continuous variables, stratified by neighborhood. When the supermarket is an outlier for certain measures (e.g. availability of specific items), the average may not capture this change due to the high prevalence of zeroes (i.e. lack of availability among other stores). However, the change affected by the supermarket will be evident in the range, which will pick up shifts in the overall distribution of the measure. We also report effect sizes (hereafter, ES) to express the amount of change in standard deviation units because statistical significance can be misleading when conducted with small sample sizes because it relies on sample size, effect size, and p level. Therefore, we recommend looking at the magnitude of effect sizes to identify practically significant results, in addition to statistical significance. A commonly used interpretation is to refer to effect sizes as small (d = 0.2), medium (d = 0.5), or large (d = 0.8) based on benchmarks suggested by Cohen (1988). To test for significant changes, we used chi-squared or McNemar's test for binary variables, and two-sample or paired t-test for continuous variables.

3. Results

Over the course of this study (i.e. three years), one of the two neighborhoods (Hill District) experienced major change in the form of a new supermarket opening. Apart from the supermarket opening, there was little change in the overall number or type of stores in either neighborhood. Hill District had 13 food stores at baseline, including 10 neighborhood stores, one chain convenience store, one dollar store and one fruit and vegetable market, as shown in Fig. 1. At post-intervention, changes in Hill District included a new supermarket and the closing of a neighborhood store, with still 13 stores. Homewood had 12 stores at baseline including 11 neighborhood or convenience stores and one meat market, and 13 stores at follow up (Fig. 1). However, there were some differences in Homewood across the two time points with two neighborhood stores closing and three new neighborhood stores opening. We did not see an effect of the new supermarket's placement on the location of store closings or openings.

Among Hill District residents, the average distance to a supermarket at baseline was 1.7 miles (Table 1) and we saw a large reduction of 0.9 miles (ES = 0.9) in average distance to a supermarket at follow up. Among Homewood residents, this statistic (1.5 miles) remained unchanged. We also saw a reduction in the distance to the regular place of food shopping among Hill District residents, with a baseline average of 3.4 miles and a decrease of 0.4 miles (ES = 0.1) at follow-up. However, this reduction was smaller than expected given the sizeable reduction in distance to a supermarket. In comparison, Homewood residents experienced a smaller decrease of 0.1 miles in distance to the regular place of food shopping over time (baseline average = 2.9 miles).

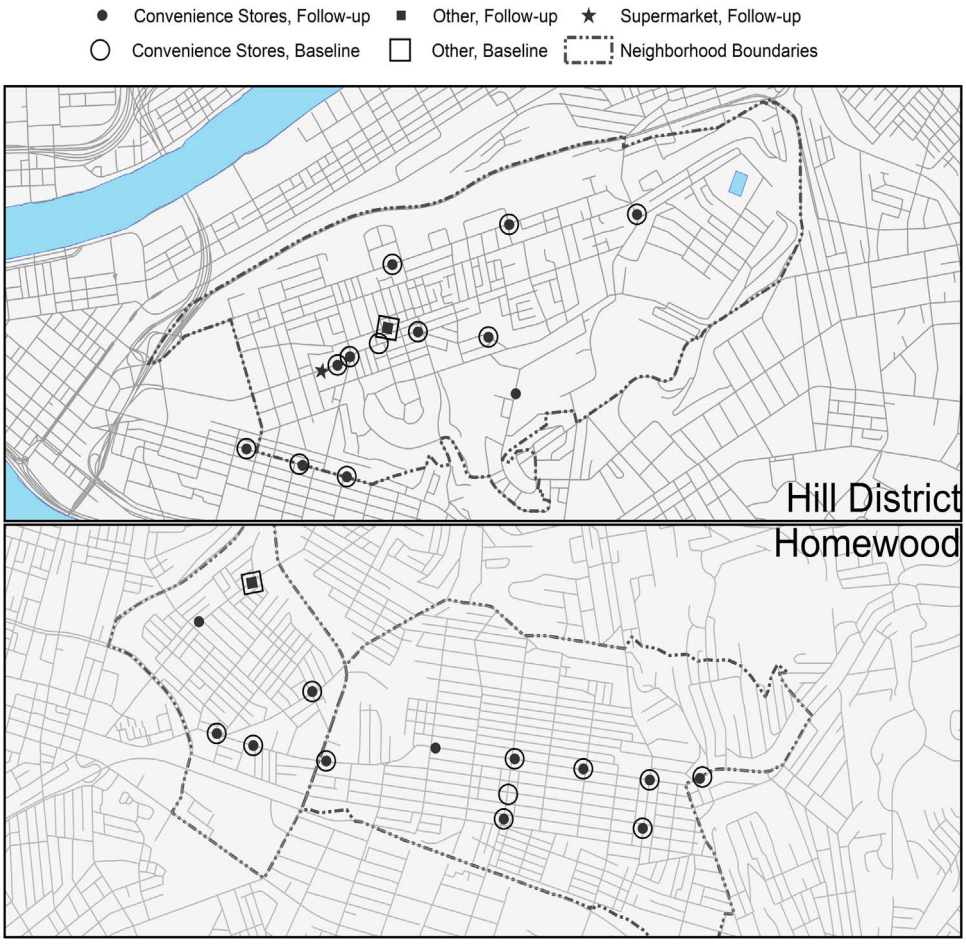

Fig. 1. Distribution of stores by type in the Hill District and Homewood at pre- and post-intervention.

Table 1
Changes in supermarket geographic access and distance to regular place of food shopping using a person-level panel.

	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Change = (post-pre)+ Mean (SD)
Hill District			
Sample size	532	532	
Distance to full-service supermarket (mi)	1.66 (0.2)	0.74 (1.0)	−0.92 ***
Distance to regular place of shopping (mi)	3.78 (4.6)	3.37 (3.3)	−0.42
Homewood			
Sample size	214	214	
Distance to full-service supermarket (mi)	1.48 (0.2)	1.48 (0.2)	0.0
Distance to regular place of shopping (mi)	2.93 (2.6)	2.82 (2.3)	−0.11

SD = standard deviation;; mi = miles; + Within-person change computed using panel of participants who completed a pre- and a post-intervention survey; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

In Table 2, we present an analysis of change in the total food environment (the full sample of stores open at each assessment). On average, 1.6 fruits and vegetables, 2.7 healthy alternatives, 5.3 unhealthy alternatives and 7.3 junk foods were available in Hill District stores at baseline (see Table 2). In the same time period, no fruit and vegetable, 2.8 healthy alternatives, 4.3 unhealthy alternatives and 7.2 junk foods were available, on average, in Homewood stores. Post-intervention, we saw an increase in the average availability (and range) of healthy and unhealthy options with 2.9 (ES = 0.3) and 1.6 (ES = 0.5) fruits and vegetables, 3.4 (ES = 0.2) and 3.5 (ES = 0.4) healthy items, 6.0 (ES = 0.4) and 5.8 (ES = 0.8) unhealthy items in Hill District and Homewood stores, respectively. However, we saw similar levels (and range) of junk food at post-intervention with 7.5 (ES = 0.1) and 6.8 (ES = −0.1) items available, on average, in Hill District and Homewood stores, respectively. The relative availability of healthy alternatives improved in Hill District from 0.48 to 0.53 (ES = 0.1); we saw similar improvement in Homewood stores (0.58 vs. 0.61, ES = 0.1).

In the Hill District, the staple price index decreased from $15.57 to $14.65 (ES = −0.4), while the junk food price index increased from $4.48 to $5.76 (ES = 1.0) (Table 3). Over the same time period in Homewood, the staple price index actually increased from $15.18 to $15.55 (ES = 0.2), and the junk food price also increased from $4.65 to $5.85 (ES = 0.7). While the store orderliness score increased by one unit (ES = 0.6) from 5.8 to 6.8 in the Hill District between pre- and post-intervention, there was a smaller change (ES = 0.3) in Homewood stores (5.7 vs. 6.2).

Focusing on just the panel of stores that were open at both pre- and post-intervention (Table 3), we found that within-store availability decreased by 0.5 fruits and vegetables (ES = −0.3), 0.3 healthy alternatives (ES = −0.1), 0.1 unhealthy alternatives (ES = −0.1) and 0.1 junk foods (ES = −0.1) on average, in the Hill District. During the same period, availability increased by 0.9 fruits and vegetables (ES = 0.5), one healthy alternative (ES = 0.5) and 1.8 unhealthy alternatives (ES = 1.0), on average, in the Homewood store panel. There was no change in junk food availability, however. While the relative availability of healthy items decreased by 0.1 units (ES = −0.2) in the Hill District panel, it increased by 0.1 units (ES = 0.3) in the Homewood panel. In the Hill District panel, we saw a reduction of 40 cents in the staple price index (ES = −0.2), and an increase of $1.41 (ES = 1.1) in the junk price

Table 2
Overall changes in food availability, price and store environment in the Hill District and Homewood.

	Stores open at pre-intervention		Stores open at post-intervention		Change = (post−pre)[+]
	Mean (SD)	Range	Mean (SD)	Range	Mean
Hill District stores	N = 13		N = 13		
Availability					
Fruits/vegetables (max. = 22)	1.6 (4.7)	[0, 17]	2.9 (6.0)	[0, 20]	1.30
Healthy food (max. = 11)[a]	2.7 (1.7)	[0, 5]	3.4 (2.7)	[0, 11]	0.69
Unhealthy food (max. = 11)[b]	5.3 (2.2)	[0, 9]	6.0 (2.5)	[0, 10]	0.69
Junk food (max. = 9)[c]	7.3 (2.5)	[0, 9]	7.5 (2.4)	[0, 9]	0.23[*]
Relative availability (0–1)[d]	0.48	[0, 1]	0.53	[0, 1]	0.05
Price					
Staple price index[e] ($)	15.57 (2.2)	[11.80, 19.99]	14.65 (2.9)	[11.03, 22.46]	−0.92
Junk price index[f] ($)	4.48 (1.0)	[2.71, 6.12]	5.76 (1.0)	[4.13, 7.78]	1.28[***]
Environment					
Orderliness (max. = 9)[g]	5.8 (1.7)	[3, 8]	6.8 (1.8)	[3, 9]	1.0[**]
Homewood stores	N = 11		N = 13		
Availability					
Fruits/vegetables (max. = 22)	0.0 (na)	[0, 0]	1.6 (3.0)	[0, 10]	1.62[*]
Healthy food (max. = 11)[a]	2.8 (1.9)	[0, 6]	3.5 (1.2)	[1, 6]	0.72
Unhealthy food (max. = 11)[b]	4.3 (1.8)	[1, 7]	5.8 (1.5)	[2, 7]	1.57[**]
Junk food (max. = 9) [c]	7.2 (1.3)	[4, 9]	6.8 (2.3)	[0, 9]	− 0.33
Relative availability (0–1)[d]	0.58	[0, 0.9]	0.61	[0.4, 1.0]	0.03
Price					
Staple price index[e] ($)	15.18 (1.6)	[13.61, 18.20]	15.55 (3.1)	[12.11, 22.91]	0.37
Junk price index[f] ($)	4.65 (0.9)	[3.67, 6.27]	5.85 (1.5)	[2.99, 7.69]	1.20[*]
Environment					
Orderliness (max. = 9)[g]	5.7 (1.6)	[3, 8]	6.2 (2.1)	[0, 8]	0.43

Sig. = significance; SD = standard deviation; na = not available. [+] Includes all stores open at either time point including those that closed at follow-up or opened after the baseline assessment.

[*] $p < 0.10$.

[***] $p < 0.01$.

[**] $p < 0.05$.

[a] No. of healthy foods out of low fat milk, low fat cheese, low fat yogurt, lean beef, white chicken, whole wheat bread, brown rice, wheat pasta, low sugar cereal, baked chips and 100% fruit juice.

[b] No. of unhealthy foods out of whole milk, regular cheese, whole milk yogurt, regular beef, dark chicken, white bread, white rice, regular pasta, high sugar cereal, regular chips and flavored juice.

[c] No. of junk food items with maximum of 9 (e.g. including chips, soda and candy).

[d] Ratio of number of healthy to unhealthy options for 11 items.

[e] Staple food price includes a dozen eggs, half-gallon whole milk, 20-ounce loaf of white bread, 15-18-ounce box of high-sugar cereal.

[f] Junk food price includes a two-liter bottle of soda and a bag of chips.

[g] Store orderliness consisted of nine items (no people hanging out or loitering, no panhandling, no shopping cart guard rails, no security guard, no bars on doors/windows, no bullet proof or plexiglass at check-out, no security mirror, no graffiti/tagging on building or property, no garbage/litter at facility entrance).

index. In contrast, within the Homewood panel, we saw an increase in both prices – the staple price index increased by 49 cents (ES = 0.1), and the junk food price index increased by $1.07 (ES = 0.6). Finally, store orderliness improved by 0.7 units (ES = 0.3) in the Hill District panel, while this statistic remained unchanged in the Homewood panel (mean = 5.9).

4. Discussion

An underlying tenet of the Healthy Food Financing Initiative (HFFI) — a $500 million investment designed to bring affordable healthy foods to food deserts — is that opening a supermarket in the neighborhood will improve healthy food access for its residents. In this paper, we evaluated changes in the wider food retail environment in a 'food desert' (Hill District, Pittsburgh) before and after the opening of a Shop 'n Save supermarket, relative to secular trends in a matching control 'food desert' (Homewood, Pittsburgh) lacking a grocery store. Prior to the supermarket opening in the Hill District, the food environment in both neighborhoods consisted of small stores with limited availability of fresh produce. Over the course of this study, one of the two food deserts experienced major change with the opening of a supermarket after three decades without one. The supermarket opening resulted in significant improvements in geographic access to a supermarket for Hill District residents, compared to the secular trend of no change in Homewood. Contrary to expectation, we did not see a reduction of similar magnitude in distance to regular place of food shopping. This is apparently explained by a low rate of adoption of the new supermarket as residents' regular shopping venue. In a previous study report, we noted that a majority of Hill District residents shopped at a supermarket outside of the neighborhood prior to introduction of the new market, and continued to do so afterward (Dubowitz et al., 2015). This is consistent with findings of other studies, which have reported a similar lack of adoption of a new store by residents (Wang et al., 2007; Cummins et al., 2014). We can only speculate as to why this is the case, but it may be that habit has a stronger role in behavior than convenience, at least in the short term. With time, more residents may adopt the new supermarket as their regular place of food shopping.

Prior to the supermarket's opening, no stores in Homewood and only one store in the Hill District carried fruits and vegetables – the sole fruit and vegetable outlet in the Hill District had limited selection and irregular hours providing limited access. Also, there were few healthy alternatives for items such as bread, milk, and meat (well below the maximum of 11); the relative availability of healthy alternatives was less than one (implying that there were more unhealthy than healthy options); and junk food was widely available in both neighborhoods. These are consistent with previous findings that stores situated in food deserts are more likely to carry unhealthy than healthy alternatives (Treuhaft and Karpyn, 2010). At follow-up, there were more stores that carried fruit and vegetable (6 in the Hill District, 4 in Homewood), and an increase in availability of all food types in both the Hill District and Homewood. Given that both neighborhoods experienced changes of

Table 3
Within-store changes in food availability, price and store environment in the Hill District and Homewood.

	Pre-intervention		Post-intervention		Change = (post−pre)[+]
	Mean (SD)	Range	Mean (SD)	Range	Mean
Hill District	N = 11		N = 11		
Availability					
Fruits/vegetables (max. = 22)	1.9 (5.1)	[0, 17]	1.4 (3.3)	[0, 11]	−0.55
Healthy food (max. = 11)[a]	2.9 (1.6)	[0, 5]	2.6 (1.6)	[0, 5]	−0.27
Unhealthy food (max. = 11)[b]	5.5 (2.2)	[0, 9]	5.5 (2.3)	[0, 8]	−0.09
Junk food (max. = 9)[d]	7.4 (2.6)	[0, 9]	7.3 (2.5)	[0, 9]	−0.09
Relative availability[c]	0.53		0.48		−0.05
Price					
Staple price index[e] ($)	15.67 (2.4)	[11.80, 19.99]	15.26 (2.8)	[12.53, 22.46]	−0.41
Junk price index[f] ($)	4.38 (1.0)	[2.71, 5.47]	5.80 (1.1)	[4.13, 7.78]	1.41***
Environment					
Orderliness[a] (max. = 9)	6.0 (1.6)	[3, 8]	6.7 (1.8)	[3, 9]	0.73
Homewood	N = 9		N = 9		
Availability					
Fruits/vegetables (max. = 22)	0.0 (na)	[0, 0]	0.9 (1.8)	[0, 5]	0.89*
Healthy food (max. = 11)[b]	2.9 (2.1)	[0, 6]	3.9 (1.1)	[3, 6]	1.00*
Unhealthy food (max. = 11)[c]	4.4 (1.9)	[1, 7]	6.2 (1.1)	[4, 7]	1.78***
Junk food (max. = 9) [a]	7.6 (0.9)	[6, 9]	7.6 (1.2)	[6, 9]	0.0
Relative availability[d]	0.55		0.63		0.09
Price					
Staple price index[e] ($)	15.28 (1.8)	[13.61, 18.20]	15.76 (3.6)	[12.12, 22.91]	0.49
Junk price index[f] ($)	4.67 (1.0)	[3.67, 6.27]	5.74 (1.7)	[2.99, 7.69]	1.07**
Environment					
Orderliness[a] (max. = 9)	5.9 (1.6)	[3, 8]	5.9 (2.4)	[3, 9]	0.0

Sig. = significance; SD = standard deviation; na = not available. [+] Includes only those stores open at both pre- and post-intervention.
[g]store orderliness consisted of nine items (no people hanging out or loitering, no panhandling, no shopping cart guard rails, no security guard, no bars on doors/windows, no bullet proof or plexiglass at check-out, no security mirror, no graffiti/tagging on building or property, no garbage/litter at facility entrance).
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.
[a] No. of healthy foods out of low fat milk, low fat cheese, low fat yogurt, lean beef, white chicken, whole wheat bread, brown rice, wheat pasta, low sugar cereal, baked chips and 100% fruit juice.
[b] No. of unhealthy foods out of whole milk, regular cheese, whole milk yogurt, regular beef, dark chicken, white bread, white rice, regular pasta, high sugar cereal, regular chips and flavored juice.
[c] No. of junk food items with maximum of 9 (e.g. including chips, soda and candy).
[d] Ratio of number of healthy to unhealthy options for 11 items.
[e] Staple food price includes a dozen eggs, half-gallon whole milk, 20-ounce loaf of white bread, 15–18-ounce box of high-sugar cereal.
[f] Junk food price includes a two-liter bottle of soda and a bag of chips; [f] junk food price includes a two-liter bottle of soda and a bag of chips.

similar magnitude, the increase in availability appears to be the effect of a secular trend. That is, the introduction of the Shop 'n Save did not increase healthy food availability more than is likely to have happened naturally, in the absence of government intervention.

Examining the amount of change, we actually did not see sizeable change in availability in the Hill District (as shown by the lack of dramatic change in the range of "fruits and vegetables availability"). Given at least one source of fruits and vegetables in the neighborhood at baseline (even though unreliable), adding a supermarket only slightly increased the range and average of the measure "fruits and vegetables availability". We don't know if this is true in other neighborhoods or food deserts without a supermarket, but it is likely that the marketing environment takes advantage of gaps in availability of food for which there is demand (a major motivation for our paper is to see if this might be true). In contrast, we do see a shift in the range of "healthy food availability" in Hill District with the range increasing from [0, 5] to [0, 11]. We also saw positive changes in "fruits and vegetables availability" in Homewood – the range increased from [0, 0] to [0, 10] with no stores within Homewood that carried fruits and vegetables at baseline. While the supermarket opening represents important changes in geographic access and may have potential to induce change, it did not appear to make a dramatic change in an environment which is dominated by other types of stores and foods. This is a possibility that the literature has largely overlooked and we think it is important to make this clear.

When we looked at the effect of the supermarket opening on availability in the panel of stores that were open at both pre- and post-intervention, both healthy food availability and relative availability of healthy food decreased in the Hill District panel, going against the secular trend of greater availability in the Homewood panel. One plausible explanation is that the opening of a supermarket in the Hill District caused small 'mom-and-pop' stores to reduce their range and stock of healthy foods, more strongly segmenting the food environment into groups of healthy versus unhealthy stores. Similarly, there was a small decrease in unhealthy food availability in the Hill District panel, also going against the secular trend of an increase in the Homewood panel. Thus, the new supermarket may have inhibited increases in availability in other Hill District stores, both positive and negative, that occurred in Homewood – with a larger decline in fruit and vegetable availability than junk food availability.

When looking at food price trends in the Hill District, we found a decrease in staple prices but a sharp increase in junk food prices in the overall and panel samples. In contrast, both staple and junk food prices increased in Homewood. One plausible explanation may be that smaller Hill District stores reduced their staple prices to match and compete with the Shop 'N Save (which offered lower prices for the same items). Also, the greater increase in junk food prices in the Hill District panel, compared to the Homewood panel, may be necessary to compensate for reductions in staple food prices. Finally, we found that store orderliness improved in both neighborhoods over time, with greater improvement in the Hill District relative to Homewood.

In summary, changes to the local food environment in the Hill District had both positive and negative effects on the range and stock of foods in surrounding neighborhood stores, and an even greater

influence on the prices of staple and junk foods. These findings suggest that local food system responses to environmental change are complex and dynamic. Careful description of local environmental changes related to diet as a result of supermarket interventions is therefore needed in any future study, and such changes should be anticipated by policy makers planning to finance new markets.

In previously published analyses of the household surveys collected in the two neighborhoods studied here, some significant improvement in dietary behaviors (e.g. reduction of added sugars, empty calories) were found in the Hill District, relative to Homewood, but these improvements were not related to use of the new supermarket (Dubowitz et al., 2015). This suggests that healthy food availability may not be the causal mechanism at work. The results presented in this paper complement those and suggest a similar conclusion – given that there was no increase in healthy food availability in the intervention neighborhood, it is likely that some other mechanism, such as economic renewal, drove improvements in the Hill District residents' diet.

Although our study has important strengths, four limitations are worth noting. First, the number of stores in the two neighborhoods is small, limiting the study's statistical power for significance testing. While we conducted a census of stores in each neighborhood, the specific neighborhoods are relatively small. Although the inability to test significance is a limitation, our study provides key insights including a census of stores that would be challenging to obtain in a larger neighborhood or by studying multiple neighborhoods. Second, our price indices rely on a small number of food items. This was necessary due to the limited selection of foods available in local neighborhood stores. Third, the timing of the follow-up assessment conducted a year after the supermarket's opening may not be sufficiently long for the impact of the supermarket on the local food environment to be fully captured. This may explain the small reduction in distance to place of regular food shopping, as noted above. Fourth, this study was set in two low-income, racially isolated urban neighborhoods. Therefore, findings might not be generalizable to other food deserts.

5. Conclusions

Siting a grocery store in a food desert improved geographic accessibility of a supermarket for local residents. We found positive and negative changes in food availability, and an even greater influence on food prices in neighborhood stores. Opening a supermarket in a 'food desert' caused little improvement in net availability of healthy foods, however, challenging the underpinnings of policies such as the Healthy Food Financing Initiative. This is a critically important consideration for HFFI and similar initiatives. It will be important for healthy food initiatives to consider the total retail environment and how it might be affected by the introduction of a new store or other policies under consideration. This might mean including supports for other stores to maintain or increase their healthy offerings in the face of new supermarkets or doing so instead of introducing new supermarkets. Neighborhood-wide price supports might also be helpful. Until more is known about what works to improve healthy-food access, such interventions should be implemented with accompanying evaluation plans to ensure that they have the intended effects on communities and their residents. The natural experiment method used here is likely to be helpful in this regard, particularly if researchers are involved early on so that multiple intervention communities and comparison neighborhoods can be planned for as part of implementing change.

Future research attention should also be directed at understanding choice of shopping venue. While the HFFI assumes that residents will shop in their own neighborhoods if healthy foods are available there ("if we build it they will come"), we and other researchers have failed to find support for this assumption. It may be that change in shopping habits is slow. Other factors such as store hours, availability of particular brands or products, in-store promotions, length of checkout lines, etc., are critical to attracting shoppers. Knowledge of these influences is necessary to making healthy foods "accessible" in a manner that is meaningful to residents.

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