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New Neighborhood Grocery Store Increased Awareness Of Food Access But Did Not Alter Dietary Habits Or Obesity

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ABSTRACT National and local policies to improve diet in low-income US populations include increasing physical access to grocery stores and supermarkets in underserved neighborhoods. In a pilot study that evaluated the impacts of opening a new supermarket in a Philadelphia community considered a "food desert"—part of the Pennsylvania Fresh Food Financing Initiative—we found that the intervention moderately improved residents' perceptions of food accessibility. However, it did not lead to changes in reported fruit and vegetable intake or body mass index. The effectiveness of interventions to improve physical access to food and reduce obesity by encouraging supermarkets to locate in underserved areas therefore remains unclear. Nevertheless, the present findings suggest that simply improving a community's retail food infrastructure may not produce desired changes in food purchasing and consumption patterns. Complementary policy changes and interventions may be needed to help consumers bridge the gap between perception and action. The replication of our findings in other settings and research into the factors that influence community residents' receptivity to improved food access are urgently required.

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Excess body weight is a major threat to health, driven primarily by associations with type 2 diabetes, cardiovascular disease, and some cancers.[1,2] The underlying cause for the recent and rapid increase in the prevalence of obesity in the US population is thought to be environmental,[3] with changes in the food system acting as one of the primary drivers for weight gain.[4] This suggests that population-level approaches to obesity prevention should include environmental interventions to reduce energy intake and improve diet quality as part of a wider strategy to reduce the prevalence of obesity.[5,6]

A review of the existing evidence suggests that residents of African American and low-income neighborhoods have poor access to healthy food, and that residing in these neighborhoods is an important risk factor for an unhealthy diet in the United States.[7–10] Therefore, interventions in the food environment are thought to have potential as effective strategies for creating population-level improvements in eating behavior.

Structural interventions to improve access to healthy food in underserved areas are a major component of recent US policy initiatives.[11] One major initiative is the $400 million Healthy Food Financing Initiative, a central component of a range of interventions promoted by the White House Task Force on Childhood Obesity.[12,13] Such interventions are based on the idea that encouraging supermarkets and grocery stores to open in underserved neighborhoods will translate into improvements in individuals' diets and lead to a reduction in diet-related health problems.

These policies are grounded in a long-standing and consistent observational evidence base in the United States that suggests that lack of access to supermarkets is associated with poor diet and an increased risk of chronic disease (including obesity).[8] However, there is hardly any evidence for the effectiveness of interventions to improve access to healthy food.[11,14,15] In addition, no formal experimental studies have been published in the United States that directly tested the impact of food retail development on food access, diet, and diet-related diseases such as obesity.

The only two published evaluations of the impact of food retail development interventions on fruit and vegetable intake were relatively small studies undertaken in low-income communities in Glasgow, Scotland, and Leeds, England—studies that had mixed results.[16–18] The Leeds study reported an increase in fruit and vegetable consumption, especially for people with the lowest levels of consumption at baseline. However, this study lacked a control group. The Glasgow study, a controlled study, found no net increases in fruit and vegetable intake after allowing for changes in the control group.

The Healthy Food Financing Initiative is modeled on the Pennsylvania Fresh Food Financing Initiative, a similar public-private intervention aimed at encouraging the introduction of supermarkets in underserved areas by providing grants and loans to defray the infrastructure costs of new grocery stores. The Pennsylvania program has been viewed as a success: Eighty-eight new or expanded fresh food retail outlets have been developed, improving access to healthy food for an estimated 500,000 children and adults.[19] To date, however, there has been no formal evaluation of the program's effectiveness in improving diet and reducing obesity.

This article reports the results of a pilot study that evaluated the impact of improving food access by opening a new supermarket in a low-income, predominantly black community in Philadelphia that was classified as a "food desert" by the Department of Agriculture's Food Access Research Atlas prior to the improved access.[20]

The delivery of a new supermarket in this community was part of the large-scale implementation of the Pennsylvania Fresh Food Financing Initiative, which was implemented in eighty-eight locations across the state. The effects on the following three outcomes were assessed: body mass index (BMI), daily fruit and vegetable intake, and perceptions of food accessibility.

Study Data And Methods

STUDY DESIGN AND PARTICIPANTS We used a controlled pre-post quasi-experimental longitudinal design to collect data from a representative sample of residents of two Philadelphia neighborhoods, the intervention site and a comparison site. The neighborhoods were matched according to race or ethnicity, income, and demographic profile. They were in contiguous census tracts that included the main supermarket for each neighborhood. Both were considered underserved "food deserts" before the intervention.[20]

Both neighborhoods were three miles square. Households in the neighborhoods were no more than a mile and a half from an existing supermarket in each area. To eliminate contamination—that is, the use of the supermarket in the intervention area by respondents in the comparison area—we chose a comparison neighborhood that was located about three miles from the intervention neighborhood.

Residents of the intervention neighborhood received a new 41,000-square-foot supermarket and were considered the intervention group. Residents of the comparison neighborhood did not receive a supermarket and were the comparison group. At follow-up, the number of supermarkets in the comparison neighborhood remained unchanged, and there was an increase of one supermarket (the intervention supermarket) in the intervention neighborhood. Full details are provided in Appendix 1.[21]

The baseline period for data collection was June–September 2006. We used a random-directory-listed and random-digit-dialing survey of a representative sample of residents in each of the two neighborhoods. The follow-up period was June–November 2010. The newly built supermarket opened in December 2009, giving a post-intervention period of at least six months before we collected follow-up data.

To be eligible for the study, households at baseline had to be located in one of the two selected neighborhoods and to have a primary food shopper age eighteen or older residing in the household. Respondents received $20 for participating.

The baseline sample contained 1,440 respondents and a response rate of 47.2 percent (intervention group $n = 723$, response rate: 47.4 percent; comparison group $n = 717$, response rate: 47.0 percent). The follow-up sample contained 656 of the 1,440 baseline respondents and a response rate of 45.5 percent (intervention $n = 311$, response rate: 43.7 percent; comparison $n = 345$, response rate: 48.9 percent). There were no significant differences in response rates or attrition between the intervention and comparison neighborhoods at baseline or follow-up.

The analyses presented here are based on subsets of the overall sample using a complete case approach for the outcomes and covariates of in-

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terest. Pennsylvania State University's Office of Research Protection approved the study.

OUTCOME MEASURES AND COVARIATES As noted above, data on the following three primary outcomes were collected: BMI, fruit and vegetable intake, and perceptions of food access. BMI was calculated using the standard equation—weight (in kilograms) divided by height (in meters) squared—based on self-reported height and weight. It was used as a continuous measure.

Mean fruit and vegetable intake was assessed using the Block Food Frequency Questionnaire.[22,23] This tool captured the consumption of ten fruits and twelve vegetables during the previous month. Standardized algorithms were used to compute total daily fruit and vegetable intake.[24] The questionnaire has good concurrent validity when compared with dietary records.[25] To be consistent with past research and to limit the influence of outliers, intake was measured only up to fifteen items per day.[26]

Perceptions of food accessibility were assessed using a five-item scale that captured the extent to which each respondent considered grocery stores, and the fruit and vegetables sold in his or her neighborhood, to be expensive, of good quality, and of sufficient variety. Possible values ranged from 5 to 25, with higher values representing better access. Only respondents who completed all five items were given a summary score for overall perceptions of food accessibility. The five individual items were also investigated as outcomes. See Appendix 1[21] for further details.

The covariates were age (in years), sex, self-identified race or ethnicity (white, black, Hispanic, or other), presence of children younger than twelve in the household (yes or no), household income (less than or equal to $40,000 or greater than $40,000 per year), high school graduate (yes or no), labor-market status (employed, unemployed, or inactive—that is, not employed and not looking for work) and mode of transport for food shopping (private or public transport).

STATISTICAL ANALYSES Differences between the intervention and comparison groups were estimated using difference-in-differences on an intention-to-treat basis—that is, the intervention was assigned to all residents—and adopters versus nonadopters. The intention-to-treat analyses assessed the community-level effect, whereas analyses of adopters versus nonadopters focused on the direct impact on people who used the new supermarket.

A statistically significant difference-in-differences value shows that the rate of change over time in the outcome variable was different between the intervention and control groups, indicating an intervention effect. Analyses were performed using the DIFF module[27] in the statistical software Stata, version 12.

We report the results of three sets of analyses undertaken for each outcome (BMI, daily fruit and vegetable intake, and perceptions of food access). In the event of a significant difference-in-differences value ($p < 0.05$), we adjusted for age, sex, race or ethnicity, presence of children, household income, education, employment status, and mode of transport. A full description of the enrollment procedures and analytical approach is provided in Appendix 1.[21]

LIMITATIONS The study has important limitations. It is a pilot study in a single intervention community, and the sample was not large. The sample was also predominantly black, a group considered to be the most at risk in the US population for poor access to healthy food. However, the sample was representative of the resident population in the study neighborhoods, which had high proportions of university students and older retired people who had lived in the neighborhood for a long time.

The longitudinal design meant that the study sample would be older than the neighborhood population at follow-up, because study participants would have lived in the study sites for four additional years. In addition, the composition of the study sample meant that the generalizability of our findings to other settings with different sociodemographic profiles might be limited.

The study might be underpowered, particularly for analyses of adopters versus nonadopters (see Appendix 1[21] for further details), which reduces our ability to make robust statements about effectiveness. This has implications for the design of future studies: Sample size calculations should not be undertaken on an inten-

tion-to-treat basis but should consider the likely rate of adoption of the intervention in the exposed community.

A three-year delay in the new grocery store's construction generated a significant gap between baseline and follow-up. The influence of other unknown interventions of events, such as other health promotion programs or the recession, that might be associated with our outcomes cannot be ruled out.

Food-buying habits and BMI might be slow to change. Thus, the short follow-up period might limit our ability to detect an intervention effect.

The Block Food Frequency Questionnaire might not include all culturally relevant foods for the study population.[28] Future research should also investigate all components of diet, not just fruit and vegetable intake. In addition, self-reported BMI might be prone to systematic error,[29] although the measure has been validated for use in adults.[30,31]

Study Results

Respondents were predominantly female, black, high school graduates, and either unemployed or economically inactive, with an annual household income of less than $40,000 (Exhibit 1; for more details, see Appendix 2, Exhibit 1).[21] We found no significant differences (based on *z* tests) in socioeconomic and demographic characteristics between the overall samples at baseline and follow-up and the subsamples of respondents used to model each of the three outcomes. This suggests that imputation was unnecessary.

Forty-seven percent of the overall sample resided in the intervention neighborhood—a pattern that also applied across the subsamples. Only 26.7 percent of the residents of the intervention area adopted the new supermarket as their main store, and just 51.4 percent used it for any food shopping. No resident of the comparison area reported using the new supermarket in the intervention area, which indicates that contamination of the comparison sample did not occur.

INTENTION-TO-TREAT ANALYSES There were no significant difference in differences for BMI ($p = 0.56$) or daily fruit and vegetable intake ($p = 0.84$) in unadjusted analyses between residents of the intervention and comparison neighborhoods (Exhibit 2). For perceptions of food accessibility, we found a significant improvement from baseline to follow-up in the summary score and for each of the five individual items, which persisted after adjustment for covariates. Respondents perceived grocer choice and quality and fruit and vegetable choice and quality to have improved, and the cost of fruit and vegetables was perceived to have decreased.

ADOPTERS VERSUS NONADOPTERS In unadjusted analyses of respondents who adopted the new supermarket as their main store, there were no significant improvements in BMI ($p = 0.60$), fruit and vegetable intake ($p = 0.47$), or perceptions of food accessibility ($p = 0.98$) as a result of the new supermarket (Exhibit 3). For individual items in food accessibility scale, only perceptions of fruit and vegetable choice showed a significant improvement. After we adjusted for covariates, that improvement was attenuated but remained significant.

In unadjusted analyses of respondents who used the new supermarket as their secondary store, there were no significant improvements in BMI ($p = 0.72$) or fruit and vegetable intake ($p = 0.45$) as a result of the new supermarket (Exhibit 4). Similar to the intention-to-treat analyses, after we adjusted for covariates, we found a significant improvement from baseline to follow-up in the summary score for overall perception of food accessibility and for each of the individual items. Again, respondents perceived grocer choice and quality and fruit and vegetable choice and quality to have improved, and the cost of fruit and vegetables was perceived to have decreased.

Discussion

Few residents adopted the new supermarket as their main food store, and exposure to the new supermarket had no statistically significant impact on BMI and daily fruit and vegetable intake at six months. However, the new supermarket appeared to have a positive impact on perceptions of food accessibility for residents in the intervention neighborhood in intention-to-treat analyses, and for the residents who reported adopting the new supermarket as their secondary food store.

We found improvements in perceptions in food accessibility, arguably the first step on the hypothesized causal pathway between the intervention and our outcomes. However, these improvements did not appear translate into significant changes in daily fruit and vegetable intake or BMI.

As noted above, two UK studies evaluated the impacts of similar interventions. One before-and-after study in Leeds, which lacked a control group, reported improvements in fruit and vegetable intake, with the largest impacts seen among those with the lowest baseline intakes.[16] The second study, a controlled before-and-after quasi-experimental study undertaken in Glasgow, found no evidence for any effect on consumption patterns.[17,18,32]

EXHIBIT 1

Characteristics Of Study Participants At Follow-Up, June–November 2010

Characteristic	All (*N*=656)	Percent (SD)	Outcomes measured: BMI (*n*=619)	Percent (SD)	F&V intake (*n*=625)	Percent (SD)	Perceptions of food access (*n*=539)	Percent (SD)
SAMPLE								
Resided in area with new supermarket	311	47	294	47	294	47	247	46
Adopted new supermarket as main store	83	13	80	13	79	13	64	12
Adopted new supermarket as secondary store	160	24	152	25	153	24	128	24
BASELINE CHARACTERISTICS								
Sex								
Male	134	20	132	21	123	20	115	21
Female	521	79	486	79	501	80	424	79
Data missing	1	0	1	0	1	0	0	0
Age (years)								
Mean	54	(14.8)	54	(14.5)	53	(14.5)	53	(14.2)
Data missing	8	1	7	1	8	1	0	0
Race or ethnicity								
Black	551	84	522	84	524	84	461	86
White	56	9	54	9	54	9	49	9
Hispanic	13	2	11	2	11	2	10	2
Other	23	4	22	4	23	4	19	4
Data missing	13	2	10	2	11	2	0	0
Household income per year								
≤$40,000	417	64	393	63	394	63	360	67
>$40,000	200	30	191	31	195	31	179	33
Data missing	39	6	35	6	36	6	0	0
High school graduate								
Yes	557	85	524	85	537	86	467	87
No	98	15	95	15	87	14	72	13
Data missing	1	0	0	0	1	0	0	0
Labor-market status								
Employed	298	45	282	46	291	47	263	49
Unemployed	69	11	63	10	67	11	59	11
Inactive[a]	287	44	273	44	265	42	217	40
Data missing	2	0	1	0	2	0	0	0
Children under age 12 in household								
Yes	148	23	139	22	147	24	135	25
No	508	77	480	78	478	76	404	75
Data missing	0	0	0	0	0	0	0	0
Used public transport for food shopping								
Yes	157	24	149	24	148	24	122	23
No	499	76	470	76	477	76	417	77
Data missing	0	0	0	0	0	0	0	0
OUTCOME								
Mean	—[b]	—[b]	29.5	(6.9)	3.6	(2.4)	14.2	(4.2)

SOURCE Authors' calculations. **NOTES** Outcomes are body mass index (BMI), daily fruit and vegetable (F&V) intake, and perception of food accessibility. Numbers may not sum to totals because of missing data. SD is standard deviation. [a]Not employed and not seeking work. [b]No outcome in this column.

The findings reported here mirror those of the only previously reported controlled impact evaluations. The findings are somewhat at odds with early results from observational US studies that reported strong links between poor diet and poor access to supermarkets and grocery stores.[33]

Current cross-sectional observational work continues to support a role for the neighborhood food environment in improving diet and reducing obesity.[34] However, a small but growing body of work using longitudinal designs and larger samples suggests that poor access to food retail environments may not always be associated with poor diet and obesity in children[28,35] or adults.[29–31,36] This work may provide support for the findings presented here.

Relatively few residents in the intervention

EXHIBIT 2

Differences In Body Mass Index (BMI), Fruit And Vegetable (F&V) Intake, And Perceptions Of Food Accessibility Between Residents Of The Intervention And Comparison Neighborhoods

	Difference between neighborhoods		Difference-in-differences	
Outcome	Baseline, unadjusted	Follow-up, unadjusted	Unadjusted	Adjusted
BMI	1.00	0.54	−0.46	—[a]
F&V intake	−0.16	−0.21	−0.05	—[a]
Perceptions of food access	−1.12	0.40	1.52***	1.47***
Grocer choice	−0.57	0.004	0.58****	0.57****
Grocer quality	−0.21	0.28	0.49****	0.48****
F&V choice	−0.30	0.12	0.42****	0.40***
F&V quality	−0.25	0.09	0.34**	0.33**
F&V cost	0.21	−0.09	−0.30**	−0.31**

SOURCE: Authors' calculations. **NOTES** Adjusted analyses controlled for age, sex, race or ethnicity, presence of children, household income, education, employment status, and mode of transport used for food shopping. [a]Not applicable. **$p < 0.05$ ***$p < 0.01$ ****$p < 0.001$

neighborhood in our study adopted the new supermarket as their main food store. This indicates that simply providing new food retail stores is insufficient to encourage the adoption of the new stores as residents' main food stores. Complementary initiatives to encourage the adoption of the new stores are therefore required.

Previous work has identified barriers to change, including preference for existing food stores, worries about how increased choice might affect household food budgets, community resistance to new food supermarket development, and access to informal store credit when buying food in existing stores.[32]

In our study, the site on which the new supermarket is located is community owned and operated.[37] At the planning and consultation stages, members of the community indicated their preference for having a new supermarket instead of selling the land for residential development. This suggested their readiness to use the new store and the lowering of barriers to change. However, few residents chose to shop at the store once it was open. A further investigation of the factors that might facilitate residents' adoption of new supermarkets as their main store should be undertaken.

The Pennsylvania Fresh Food Financing Initiative is a relatively simple intervention, aimed at stimulating supermarket development to increase access to large-scale supermarkets. It is generally assumed that having more supermarkets is better and will automatically offer more choice, at a more reasonable cost, to local residents, therefore giving them an incentive to change their purchasing and consumption habits.[19] However, this assumption may be unrealistic if the price and availability of food in the new store is not sufficiently different to stimulate a change in food shopping behavior—even if there

EXHIBIT 3

Differences In Body Mass Index (BMI), Fruit And Vegetable (F&V) Intake, And Perceptions Of Food Accessibility Between Respondents Who Adopted The New Supermarket As Their Main Store And Those Who Did Not

	Difference between adopters and nonadopters		Difference-in-differences	
Outcome	Baseline, unadjusted	Follow-up, unadjusted	Unadjusted	Adjusted
BMI	1.34	0.72	−0.61	—[a]
F&V intake	−0.58	−0.30	0.28	—[a]
Perceptions of food access	−0.38	0.93	1.31	1.00
Grocer choice	−0.46	−0.19	0.27	0.22
Grocer quality	0.02	0.41	0.39	0.31
F&V choice	−0.20	0.38	0.58***	0.49**
F&V quality	−0.08	0.27	0.34	0.25
F&V cost	0.33	0.07	−0.27	−0.27

SOURCE Authors' calculations. **NOTES** Adjusted analyses controlled for age, sex, race or ethnicity, presence of children, household income, education, employment status, and mode of transport used for food shopping. [a]Not applicable. **$p < 0.05$ ***$p < 0.01$

EXHIBIT 4

Differences In Body Mass Index (BMI), Fruit And Vegetable (F&V) Intake, And Perceptions Of Food Accessibility Between Respondents Who Adopted The New Supermarket As Their Secondary Store And Those Who Did Not Shop There

	Difference between adopters and nonadopters		Difference-in-differences	
Outcome	Baseline, unadjusted	Follow-up, unadjusted	Unadjusted	Adjusted
BMI	1.07	0.75	−0.32	—[a]
F&V intake	−0.32	−0.10	0.23	—[a]
Perceptions of food access	−0.81	1.24	2.22****	2.05****
Grocer choice	−0.64	0.06	0.70****	0.67****
Grocer quality	−0.24	0.515	0.76****	0.72****
F&V choice	−0.27	0.429	0.70****	0.65****
F&V quality	−0.20	0.35	0.55****	0.50***
F&V cost	0.32	−0.16	−0.48***	−0.49***

SOURCE: Authors' calculations. **NOTES** Adjusted analyses controlled for age, sex, race or ethnicity, presence of children, household income, education, employment status, and mode of transport used for food shopping. [a]Not applicable. ***$p < 0.01$ ****$p < 0.001$

is the perception that food accessibility has improved.

Our findings suggest that simply building new food retail stores may not be sufficient to promote behavior change related to diet. Instead, as Kimberly Morland suggests,[38] a focus on business factors such as having a locally appropriate pricing structure, effective marketing and branding, and a clear stock policy for perishable goods such as fresh produce are important if food retail interventions are to be successful.

Thus, the development of new food retail stores should be combined with initiatives focused on price and availability that could help bridge the gap between improvements in people's perceptions of accessibility and behavior change. Such initiatives might be supported by local departments of health, which could provide targeted neighborhood-based health promotion programs in conjunction with supermarket developers to increase their effectiveness.

The effectiveness of an intervention aimed at providing new supermarkets in underserved areas is uncertain. However, changes in outcomes in adopters of the new supermarket compared to nonadopters show that the direction of change is generally positive, if not always statistically significant. This indicates that such interventions may have some utility.

Systematic reviews of intensive individually focused behavioral interventions to increase fruit and vegetable intake have reported mean increases of 0.6 to 1.13 portions per day.[39,40] The observed changes reported in the present study of 0.23–0.28 portions per day are lower than this and not statistically significant. However, that might be partly attributable to the low study power available for these analyses. Replicating at the population level the positive changes in fruit and vegetable consumption observed in our study could be important for the prevention of diet-related disease.[41]

It may not be surprising that we did not see significant changes in BMI: Our follow-up period might have been too short to detect such changes. This and other remaining uncertainties suggest that our findings urgently require confirmatory studies, with longer follow-up periods, in other locations and populations.

Conclusion

During the past two decades research has shown the negative impact of poor-quality neighborhood food environments on food access, diet, and obesity. But experimental or quasi-experimental studies of interventions designed to address these environmental risks are still rare and have not previously been undertaken in the United States. Policy makers and nongovernmental organizations have implemented policies and programs aimed at ameliorating the environmental determinants of diet despite this lack of evidence of effectiveness.

In addition to the White House Task Force on Obesity's Healthy Food Financing Initiative[12,13] and the Pennsylvania Fresh Food Financing Initiative on which it is modeled, programs such as New York City's Food Retail Expansion to Support Health (FRESH)[42] continue to be rolled out in urban areas across the United States. The assumption is that by increasing the number of commercial food retail outlets in low-income and underserved neighborhoods, residents will become healthier because they will have increased access to, and will therefore consume more of, the components of a healthy diet.

This study, the first controlled study of the subject undertaken in the United States, suggests that although such programs may improve

residents' perceptions of food accessibility, they might be less effective in changing diet and reducing obesity.

The replication of our findings in other settings is a priority. But it is also necessary to consider implementing complementary policies and interventions that might help consumers bridge the gap between improvements in perception and action leading to behavior change. Examples include food shopping and cooking skills programs, price promotions, in-store stocking policies that promote the increased availability and choice of components of a healthy diet, food and drink taxes and subsidies, and the increased availability of the components of a healthy diet in commercial settings other than supermarkets, such as markets and community food programs. ■

Simply building new food retail stores may not be sufficient to promote behavior change related to diet.

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21 To access the Appendix, click on the Appendix link in the box to the right

of the article online.
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