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Changes in Diet after Introduction of a Full Service Supermarket in a Food Desert

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Abstract

Placing full-service supermarkets in food deserts (areas with limited access to healthy foods) has been proposed as an important policy strategy to confront inequalities in healthy food access. Capitalizing on a natural experiment, we enrolled n=1,372 randomly selected households from two comparable neighborhoods, one of which received a full-service supermarket in 2013. We looked at the impact on residents' diet, perceived access to healthy foods and satisfaction with one's neighborhood as a place to live. Baseline data was collected in 2011, and follow-up in 2014. Relative to the comparison neighborhood, we found a net positive change in the intervention neighborhood in overall dietary quality, total kilocalories, added sugars, and solid fats, alcohol and added sugars (SoFAAS). However, we did not observe differential improvement in fruit and vegetable intake, whole grain consumption or body mass index (BMI). Regular users of the new

supermarket had significantly improved perceived access to healthy foods compared to others, but use of the new supermarket was not related to dietary changes or to improvements with neighborhood satisfaction. Our study is the first to our knowledge to have found significant improvements in multiple dietary outcomes and neighborhood satisfaction among residents of a food desert, following the opening of a supermarket. Our study supports the Healthy Food Financing Initiative and other policies that incentivize food retail venues to locate in food deserts, but we recommend further efforts proceed with caution until research has clarified the mechanisms through which diet is improved and associations with weight status/obesity have been observed.

BACKGROUND

The obesity epidemic may partly be explained by geographic differences in food availability within the United States.[1] To address this, many policy solutions have focused on eliminating "food deserts," or neighborhoods with limited access to healthy food options.[2] Residence in a food desert has been associated with the consumption of an unhealthy diet and increased risk of obesity.[3, 4] It has been argued that supermarkets provide access to a variety of healthy, lower-calorie affordable foods and that the absence of a nearby supermarket increases reliance on convenience stores and fast food outlets[5] thereby increasing consumption of discretionary calories. Some studies have shown that access to a supermarket is associated with a reduced likelihood of obesity. [6–8]

Residents of low-income, minority, and rural neighborhoods have limited spatial, or physical, access to grocery stores and therefore less physical access to healthful food.[1, 9–11] 23.5 million people in the United States live in low-income areas (areas where more than 40 percent of the population has income at or below 200 percent of Federal poverty thresholds) that are more than 1 mile from a supermarket or large grocery store. [12]

African Americans are four times more likely to live in a neighborhood without a full-service supermarket than are Whites.[1, 11–15] This finding has been proposed to explain why African-American adults in particular are 1.5 times more likely than White adults to be obese.[16]

The Healthy Food Financing Initiative (HFFI), part of the federal Farm Bill, aims to increase the availability of healthy and affordable foods in U.S. neighborhoods that currently lack such options. Since 2011, the federal government has invested more than $500 million through one-time financing assistance to efforts that include the opening of full-service supermarkets (FSS) in food deserts. Some public health experts have promoted this strategy as a way to improve residents' food purchasing behaviors and diet.[17]

Few U.S. studies have actually examined the impact of opening a full service supermarket in a food desert on food purchasing and diet. One study in Philadelphia found no significant change in fruit and vegetable intake or body mass index (BMI) of residents after the opening of a supermarket.[18] However, there were differences in perceived access to healthy food options. In New York City, Elbel and colleagues assessed the impact of a new supermarket on household food availability and children's dietary intake and did not find any consistent changes in either outcome.[19] Both studies, however, had small sample sizes, limited

measures of dietary intake, and few measures of contextual factors and additional outcomes that might explain or illuminate their findings, for example, what was sold at new markets, how people used them, and whether other neighborhood stores changed.

Given the large government investment to increase access to supermarkets, and no positive findings from existing evaluations, there is a need for more rigorous studies that can inform whether such policies can address poor diets among food desert residents, and if so, how. This paper tests the impact of a new HFFI-funded supermarket in a low-income food desert on adult residents' diet, obesity (measured by BMI), and perceived access to healthy food. We use comprehensive measures of dietary intake, a large sample size, measures of shopping behavior and perceived access to healthy food, and extensive data on changes in the food environment.

Prior studies may also have overlooked a key factor other than shopping that might change with the introduction of a supermarket: neighborhood satisfaction. Some research has found an association between perceptions of one's neighborhood and health.[20–22] We reasoned that a change in neighborhood satisfaction stemming from the opening of a supermarket might explain changes in diet independent of changes in shopping patterns or provide an indication of other potential health benefits of the store apart from improved diet.

METHODS

Study Design and Participants

The Pittsburgh Hill/Homewood Research on Eating, Shopping and Health (PHRESH) study used a quasi-experimental longitudinal design to investigate the effect of opening an HFFI-funded full-service supermarket in an intervention neighborhood compared to a comparison neighborhood with no plans to open a full-service supermarket. Data collection efforts included extensive surveys of a randomly selected cohort of residents that included detailed 24-hour dietary recalls. The two neighborhoods were socio-demographically and geographically matched and had similar food environments at baseline: the intervention neighborhood (Hill District) was approximately 1.37 square miles (population of approximately 10,219), and the comparison neighborhood (Homewood) was approximately 1.45 square miles (population of approximately 8,300). Yet the neighborhoods were isolated from one another by geographic features that made it difficult to travel between them including steep hills and patterns of busways.

The Hill District and Homewood were both predominantly African-American (about 95 percent of the population categorized themselves as African American), and median household income was <$15,000/household for both neighborhoods. Prior to any changes, the nearest supermarket was, on average, 1.73 miles (st dev. .35) from Hill District residents and 1.45 miles (st dev. .35) from residents of Homewood. Distance was computed as the shortest network driving distance from residents' homes to the closest full-service supermarket (regardless of whether the resident reported shopping there). Baseline data were collected from May through December, 2011; follow-up data collection was from May through December, 2014. In October 2013, the Hill District gained a full-service supermarket.

We drew our sample from a list of addresses generated by the Pittsburgh Neighborhood and Community Information System (PNCIS), with sampling in the intervention neighborhood stratified by distance to the planned full-service supermarket. Trained residents from each neighborhood were employed as recruiters and data collectors, and went door-to-door to each address to enroll the household's primary food shopper (this person had to be over age 18 for the household to be eligible).

At baseline, 4,002 addresses were randomly selected; data collectors determined 2,900 of those addresses were inhabited. Of the 1,956 addresses at which they were able to reach a household member, 1,649 (84.3 percent) were eligible to participate, and 1,434 (87.0 percent of those eligible) agreed to do so. We eliminated 62 (4.3 percent) of the baseline surveys because they were not sufficiently complete to be usable, leaving a final baseline sample of 1,372. At follow-up, we were able to re-interview 831 (65.3 percent) of the 1,273 individual households that remained eligible to participate. Reasons for ineligibility included death (n=52), physical or mental health condition that prevented the resident from completing an interview (n=22), moved out of state (n=18), and moved within the neighborhood, but the new address could not be found (n=6).

At baseline and follow-up, participants responded to a 60 minute survey that included questions about healthy food access in their residential neighborhood, food purchasing practices such as where residents shopped and how often, transportation used for food shopping trip, and socio-demographic characteristics. Dietary intake was collected through a 24-hour recall administered during the interview and then again 7 to 14 days later. The interviewer measured the height and weight of each participant at the conclusion of each interview.

Participants received $25 for completion of the survey and first dietary recall and an additional $15 for completion of a second dietary recall. Between baseline and follow-up, participants received postcards, phone calls and invitations to town hall meetings where findings from baseline data were presented. All study protocols were approved by the institution's Institutional Review Board (IRB).

Limitations to this study

This study was set in two low-income, racially isolated urban neighborhoods; therefore, findings may not be generalizable to other food deserts with residents who have different socio-demographic profiles. In addition, because recruitment and enrollment into the study was done in-person, less mobile residents (i.e., households without children and older residents) were more likely to respond and enroll in the study. Furthermore, attrition among participants in our cohort was relatively high; however, our analysis carefully adjusted for observable characteristics associated with sample loss to overcome this limitation. An additional concern is that, in spite of geographic features making this unlikely, *both* neighborhoods might have been influenced by introduction of the market. However, at follow-up, there were no residents from the control neighborhood who reported shopping at the new supermarket in the intervention neighborhood. In addition to supermarket expenses, our food expenditure measure includes food away from home and dining out and thus may not be particularly sensitive to shifts in cost based on shopping. Finally, the timing of the

follow up, which was between 9 and 14 months after the store opened, may not have allowed for sufficient time to pass between the opening of the store and changes in health outcomes such as BMI or obesity status.

Measures

Diet was assessed diet with the automated self-administered 24-hour dietary recall (ASA-24), which collects data on all food and beverages consumed in the 24 hours prior to completion.[23] From the dietary recalls, we computed Healthy Eating Index-2010 (HEI-2010)[24] scores to measure *overall dietary quality* based upon compliance with the United States Dietary Guidelines for Americans. We calculated a single HEI-2010 score based on the two days of intake, calculating per person scores.[25] HEI can range from 0 to 100, with higher scores indicating better diet quality. As general guidance, a score of greater than 80 indicates a good diet, a score of 51–80 reflects a need for improvement in the quality of the diet, and a score of 51 is reflective of a poor diet. Recent estimates show an average of 57.2 for the U.S. population, and 55.0 among Non-Hispanic Blacks.[26] We also calculated daily total kilocalories (Kcals/day) percent total fat intake (percent of total fat Kcal/day); added sugar intake (teaspoons/day); intake of solid fats, alcoholic beverages and added sugars (SoFAAS) (percent of Kcal/day); fruit and vegetable intake (servings/day); and whole grain intake (ounces/day).

Body mass index (BMI) (or weight in kg/height in m^2) was calculated from interviewer-measured height and weight (respondents were measured without shoes). Interviewers measured height to the nearest eighth inch using a carpenter's square (triangle) and an 8-foot folding wooden ruler marked in inches. Weight was measured to the nearest tenth of a pound using the SECA Robusta 813 digital scale.

Perceived access to healthy foods was assessed through a series of 10 questions on a 5-point (strongly agree-strongly disagree) scale about the ease of buying, selection, quality, and price of fruits, vegetables, whole grain foods and low-fat items in their neighborhood.[18, 27, 28]

Neighborhood satisfaction was measured with the question, "All things considered, would you say you are very satisfied, satisfied, dissatisfied, very dissatisfied, or neutral - neither satisfied nor dissatisfied with your neighborhood as a place to live?"[29]

Food purchasing practices were measured with several items. **Store-type for food shopping**. We asked all participants at baseline and at follow-up "When you want to buy food, how often do you go to [the following types of stores]" with regard to a list of store types: dollar store, discount grocery store, supercenter, wholesale club, specialty grocery store, full-service supermarkets, meat or seafood market, fruit and vegetable store or farm stands, and drug store. Examples of local stores were provided for each. We chose these categories based on definitions from the Food Marketing Institute (FMI) and the North American Industry Classification System (NAICS), and confirmed categories with our Community Advisory Boards, which was comprised of key resident stakeholders within each neighborhood. The response scale was never, occasionally, sometimes, or often. We asked about their mode of transportation for major food shopping trip, which was

categorized as drive, jitney (i.e., unregulated taxi), public transport, “get a ride”, or other (e.g., walk).

We collected information on **frequency of major food shopping** (“How many times did you visit the store you frequent most for major food shopping in the past month?”) and **weekly food expenditures per person** using an open-ended item (“Approximately how much do you spend on food each week?”), which was adjusted by household size.

Use of the new supermarket. At the follow-up survey only, we asked Hill District residents how often they visited the new supermarket since it opened. Response options were “more than once per week,” “once per week,” “2–3 times per month,” “once per month,” “a few times,” “once or twice,” “never.” Those who reported shopping at the new store once per month or more were classified as regular users.

Sociodemographic measures included race/ethnicity, age, gender, total household income, marital status, educational attainment, children in the household, and number of years lived in the neighborhood.

Statistical Analyses

We examined comparability of the two neighborhood cohorts at baseline across a variety of measures. For our main analyses, we computed for each outcome (i) the average difference between baseline and follow-up values in the intervention group, (ii) the average difference between baseline and follow-up values in the comparison group, and (iii) a difference-in-difference estimator indicating how the changes in the intervention group over time compared with those in the comparison group. In these analyses, we employed an *intention-to-treat* approach, comparing differences in average outcomes for the entire intervention group with those in the comparison group, regardless of whether they used the new supermarket. Each value was tested to determine if it was significantly different from zero.

To help clarify the basis for our difference-in-difference results, within the intervention neighborhood cohort, we also compared changes among regular users of the new supermarket compared to others. Linear regression predicted, in turn, each of the dietary outcomes of interest, BMI, perceived access to healthy foods, and neighborhood satisfaction. To correct for pre-existing differences between those who chose to use the new supermarket and others in the neighborhood, we controlled for linear and quadratic terms of age, gender, household income, indicator of children of household with children, education level (‘high school’, ‘some college’, ‘college’, with ‘less than high school’ as reference category), and marital status (‘married’, ‘separated’, with not married as reference category) in these equations.

For the same reason, we examined whether changes in weekly food expenditures, frequency of major food shopping, and use of different types of food stores were related to change in diet across both neighborhoods. To do so, we conducted a series of linear regressions to separately predict each dietary outcome with significant change in intervention neighborhood compared to its comparison, controlling for neighborhood.

Analyses were performed using Proc SurveyReg and Proc Surveyfreq in the statistical software SAS, version 9.2, with analyses weighted to account for sample attrition between baseline and follow-up to ensure that results generalize to the baseline sample. Attrition weights were the inverse probability of response at follow-up and estimates included all of the socio-demographic and additional baseline characteristics as predictors.

RESULTS

Characteristics of Study Participants

Study participants were predominantly female (75 percent), non-Hispanic African American/Black (95.2 percent), not married (82.7 percent), and low-income (median household income was $13,608) (Exhibit 1). Median age at baseline was 53.3 years; and 28.2 percent of the cohort had one or more children in the household. Average BMI of the sample was 30.5 and 77.4 percent of the sample met criteria for overweight (25–29.9 BMI) or obese (30+ BMI).

On average, the baseline HEI score was 48.4 (out of 100). HEI-2005 scores are 57.2 in the U.S. population, and 55.0 among non-Hispanic Blacks. Also, baseline daily Kcal intake was 1796/day; percent of daily total fat intake (as a percent of total Kcal) was 36.4; percent daily teaspoons of added sugar was 14.6; SoFAAS consumption was 33.2 percent of daily calories; residents consumed 2.3 daily servings of fruits and vegetables; and average whole grain consumption was 0.58 oz per day.

At baseline, nearly all residents (99.1 percent) said they shopped at a full-service supermarket at least occasionally. Of all the different store types, the least frequented were specialty grocery stores and neighborhood stores.

Change in Diet, Body Mass Index, Neighborhood Satisfaction and Perceived Access to Healthy Foods

Exhibit 2 provides the results of our main difference in difference findings (see Appendix Table 1 for additional details).[25] This analysis revealed positive differential effects on several components of diet, perceived access to healthy foods, and neighborhood satisfaction, but no change in BMI, consumption of fruits and vegetables, or consumption of whole grains. In the intervention neighborhood, we saw a decrease in consumption of total Kilocalories (by 222 Kcal/day), added sugars (−2.75 tsp/day) and SoFAAS (−1.4 percent/day). In contrast, these either remained the same or increased in the comparison neighborhood (difference-in-difference p-values < .01). Unexpectedly, consumption of fruits and vegetables and whole grain foods declined in both neighborhoods. These shifts were statistically indistinguishable from one another (difference-in-difference p-values = .36 and .51, respectively). Consistent with these more specific findings, overall dietary quality (i.e., HEI) declined in the comparison neighborhood but not significantly so in the intervention neighborhood. The neighborhood difference in HEI scores was marginally significant (p = .05).

BMI did not change in the intervention neighborhood, and increased slightly in the comparison neighborhood (p=.02) although the difference-in-difference estimate was not

significant. We observed no significant changes in the rate of overweight or obesity in either neighborhood, or any differential change across the neighborhoods.

There were substantial improvements in the intervention neighborhood for all measures of perceived access to healthy foods. While there were some small, occasionally significant improvements among these measures in the comparison neighborhood, all difference in differences were significantly greater in the intervention neighborhood (all $p < .0001$). Neighborhood satisfaction improved significantly in the intervention neighborhood but not the comparison and the difference in differences was significant.

Association Between Regular Use of the New Supermarket and Outcomes

If the observed relative improvements in diet, perceived access to healthy foods, and neighborhood satisfaction among residents of the intervention neighborhood were due to the new supermarket, we might expect to see greater improvement among those who regularly used the store compared to those who did not. Among Hill District residents, 368 (68.3 percent) were classified as regular users and 171 (31.7 percent) were either nonusers or had visited only a few times since opening. Exhibit 3 compares changes in each outcome by store-user status findings (see Appendix Table 2 for additional details).[30] Although changes were in expected directions for total daily Kcal, added sugars, SoFAAS, and neighborhood satisfaction, use of the supermarket was not significantly associated with any of these outcomes. We did, however, see significant differences between users and non-users in terms of perceived access to healthy foods. For almost all questions around access to fruits and vegetables, whole grains and low-fat products, users of the store had a bigger positive change over non-users. A series of sensitivity analyses classifying store use differently (e.g., using an ordinal measure of use or with other thresholds for “user”) did not change these findings appreciably.

Associations Between Changes in Food Purchasing Practices and Changes in Diet

Given that changes in diet did not appear to be associated with use of the new supermarket, we sought other factors that could potentially explain the observed pre-post changes in dietary outcomes (Exhibit 4). We examined changes in weekly food expenditures, major food shopping frequency, and changes in types of food stores where food is purchased as potential factors that may explain change in diet. We found only one significant association; as shown in Exhibit 4, increased shopping frequency at a discount grocery store predicted an increase of .09 or about 1 percent of daily percent of total fat intake ($p<.05$).

DISCUSSION

Using a rigorous design that accounted for potential confounders and secular trends and included two 24-hour dietary recalls, our study found a net positive change in some aspects of diet, perceived access to healthy foods, and neighborhood satisfaction among food desert residents whose neighborhood acquired a new full-service supermarket. Although improvements in perceived access to healthy foods were significantly greater among regular users of the new supermarket compared to infrequent and nonusers, changes in diet and neighborhood satisfaction occurred in the intervention neighborhood regardless of frequency

of supermarket use. These improvements were also unassociated with any observed changes in other food purchasing practices or with changes in BMI.

Also contrary to our hypothesis (and the intentions of policy makers) that a supermarket would improve neighborhood residents' consumption of produce, consumption of fruits and vegetables declined after the new supermarket opened, and did so in equal measure to the comparison neighborhood. One potential reason for this overall secular trend may be that almost all residents of both neighborhoods shopped prior to *and* after the new store's opening at food retail venues that do not aggressively market or incentivize purchasing of produce.

Other aspects of diet did improve, relative to the comparison. Overall dietary quality, as reflected by HEI, declined in the comparison neighborhood but not significantly so in the intervention neighborhood (presumably because of introduction of the market). The decline in the comparison suggests a secular trend. We cannot be sure of the reason for this trend, but note that it may be specific to the region or to low-income African-Americans. At baseline, both neighborhoods had HEI scores nearly 10 points below the national average and several points below the U.S. average for Blacks; thus, they represent a subpopulation of the U.S. with particularly significant need and where dietary trends may be worsening.

We also saw significant improvement (differences in differences) in several specific areas: in total caloric intake, added sugars, and SoFAAS. Caloric intake, added sugars and SoFAAS could potentially be easier components of diet to change than fruit and vegetable consumption. For the most part, they reflect decreases in food intake. There have also been recent public health campaigns focused on reducing sugar intake and contact with these may have influenced residents' choice of strategies for improving their diets.[31] Such policies and their population effects have been highlighted by Kasangra et al in their report on policies and efforts in New York City that may have also gained more national attention.[32]

In spite of these shifts, a key goal of the Healthy Food Financing Initiative was not achieved. We observed no improvement in weight status. However, the 9 to 14 month follow-up to the grocery store introduction may have been insufficient to observe such changes, which should follow from change in diet.

Our study is the first to our knowledge to have found significant improvements in multiple dietary outcomes and neighborhood satisfaction among residents of a food desert following the opening of a supermarket. Prior studies of supermarket effects have found improvements in perceptions of healthy food access as well as economic impacts.[18, 33] In their study of a new supermarket opening in Philadelphia, Cummins et al. found significant improvements in perceived access to healthy foods.[18, 33] The Reinvestment Fund reported on the role of store openings in bringing employment opportunity, as well as serving as an economic anchor for other new developments within low food access neighborhoods.[27] Another longitudinal study of the food environment similarly found mixed results regarding changes in the food environment and diet: Boone-Heinonen and colleagues, using 15 years of longitudinal data from the Coronary Artery Risk Development in Young Adults (CARDIA) study, found that greater supermarket availability was generally unrelated to diet quality and fruit and

vegetable intake.[34] Another recent analysis that used Nielsen data tracking food purchasing found that only a small amount of food purchase variation was explained by spatial differences in access to healthful foods. Handbury et al. found that even after controlling for spatial access, systematic socioeconomic disparities in household purchases were the most important factor in food purchasing practices. They found that even in the same store, more educated households purchase more healthful foods.[35]

In the absence of any direct associations between regular use of the supermarket and other food access behaviors and the change in diet, it is possible that other changes in the intervention community (e.g., neighborhood improvements in aesthetics) could explain changes in lifestyle of residents, including dietary habits. Other research has found associations between the perceived and objectively measured social and physical environment of a neighborhood and residential wellbeing,[36–38] although they have focused mostly on mental health outcomes. Nonetheless, the largest change between the intervention and comparison neighborhood was the opening of the new supermarket, so it is the most likely cause of the changes in diet we observed.

It seems likely that the mechanism behind the improvements in diet we observed is related to the changes in neighborhood satisfaction and perceived access to healthy foods that are also part of our results. Residents were actively involved in bringing the market to their neighborhood, and there were public discussions and marketing campaigns accompanying its opening, focusing on the need for healthy foods in the community. These may be necessary to influencing dietary choices through supermarket introduction. The new supermarket may also have stimulated economic development in the neighborhood and hope among community residents heartened by public and private investment in their neighborhood and their health.[39, 40]

Given this pattern of findings, policy makers should still consider placing markets in food deserts, but should move forward with greater caution until the mechanisms behind our observations are more firmly established. Policy makers should include the evaluation of outcomes as a key part of further financing, in order to provide additional data concerning effectiveness. This evaluation should include assessment of mechanisms that might operate at the community level (i.e. affect store users and nonusers alike), as appeared to occur in the Hill District. Measures to prioritize, given the improvements in neighborhood satisfaction we observed, include resident buy-in and advocacy for healthy food options, which may lead to feelings of empowerment and subsequently a healthier diet. Similarly, economic renewal and/or enhanced feelings of hope may be key to supermarket effects and should be measured. Finally, longer term follow-ups that provide sufficient time for change in weight status should be conducted to determine whether supermarkets can be used to address the national obesity issue, or are effective only at improving nutrition.

Conclusion

This study is the first to demonstrate that the introduction of a supermarket into a food desert can result in improvements in some components of diet among residents. Yet these changes did not appear to be due to use of the market, suggesting continued financing of such efforts is appropriate but should proceed with caution.

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Appendix

APPENDIX EXHIBIT 1

Change In Diet, Body Mass Index, Neighborhood Satisfaction and Perceived Access to Healthy Foods for Residents of Intervention and Comparison Neighborhoods, and Difference in Differences

Outcome	Intervention Neighborhood (Hill District)		Comparison Neighborhood (Homewood)		Difference-in-Differences
	Baseline (SE) (*n*=571)	Change + Mean (SE) (*n*=571)	Baseline (SE) (*n*=260)	Change + Mean (SE) (*n*=260)	Change+ in HD - Change+ in HW (*n*=831)
Dietary quality (Healthy Eating Index-2010)	48.3 (0.59)	−0.39 (0.64)	48.6 (0.84)	**−2.59 (0.92)** **	**2.20** *
Mean daily intakes			1861 (53)	− 44 (51)	**−178** **
Total kilocalories	1727 (31)	**−222 (32)** ***			
Total fat as a percentage of total kilocalories (%)	36.3 (0.36)	0.35 (0.44)	36.6 (0.51)	0.51 (0.67)	−0.16
Added sugars in grams	14.3 (0.47)	**−2.75 (0.49)** ***	15.1 (0.82)	0.58 (0.92)	**−3.34** **
SoFAAS as a percentage of total kilocalories (%)	33.2 (0.46)	**−1.38 (0.56)** **	32.8 (0.63)	**1.72 (0.79)** **	**−3.11** **
Fruits and vegetables in servings	2.3 (0.07)	**−0.27 (0.08)** ***	2.4 (0.11)	−0.13 (0.12)	−0.14
Whole grains in ounces	0.62 (1.03)	**−0.08 (0.04)** **	0.50 (0.05)	−0.03 (0.06)	−0.05
Body Mass Index	30.4 (0.30)	0.13 (0.14)	30.8 (0.49)	**0.44 (0.19)** **	−0.31
Overweight or obese (%)	77.0 (1.89)	0.08 (1.17)	78.2 (2.88)	−1.42 (1.44)	1.50
Obese (%)	47.9 (2.18)	−1.52 (1.53)	49.3 (3.33)	0.34 (2.14)	−1.86
Neighborhood satisfaction (%)	66.6 (0.02)	**13.8 (2.3)** ***	55.9 (3.26)	2.64 (3.60)	**11.1** **
Perceived access to healthy foods (%)					
F&V easily accessible	16.4 (1.64)	**55.9 (2.5)** ***	22.3 (2.81)	**5.1 (3.0)** *	**50.8** ***
F&V choice	10.2 (1.27)	**56.2 (2.4)** ***	15.4 (2.31)	**7.9 (3.2)** **	**48.4** ***
F&V quality	15.6 (1.6)	**44.6 (2.5)** ***	19.3 (2.57)	**5.4 (3.1)** *	**39.3** ***
F&V cost	17.2 (1.66)	**31.0 (2.8)** ***	19.3 (2.67)	**7.3 (3.3)** **	**23.6** ***
WGP easily accessible	18.5 (1.74)	**52.6 (2.4)** ***	27.3 (3.02)	**11.0 (3.7)** **	**41.6** ***
WGP choice	12.0 (1.47)	**47.6 (2.5)** ***	14.5 (2.35)	**12.1 (3.2)** ***	**35.5** ***
WGP cost	16.4 (1.67)	**37.2 (2.5)** ***	18.1 (2.60)	**9.8 (3.4)** **	**27.4** ***
LFP easily accessible	17.2 (1.71)	**54.6 (2.45)** ***	21.9 (2.75)	**15.7 (3.5)** ***	**38.8** ***
LFP choice	12.9 (1.52)	**47.3 (2.5)** ***	13.4 (2.22)	**14.0 (3.1)** ***	**33.2** ***
LFP cost	14.0 (1.55)	**38.8 (2.45)** ***	15.8 (2.40)	**11.7 (3.0)** ***	**27.1** ***

SOURCE Authors' calculations.

NOTES * p <0.10;

** $p < 0.05$;
*** $p < 0.001$;
+ Change is computed as difference between follow up and baseline; the results on nutrient levels and types of foods describe mean reported daily intakes;

HD = Hill District; HW = Homewood; SoFAAS = Solid Fats, Alcohol and Added Sugars; F&V = fruits and vegetables; WGP = whole grain products; and LFP = low-fat products.

APPENDIX EXHIBIT 2

Comparison of Regular Users of the New Supermarket Versus Others in the Intervention Neighborhood (Hill District)

Outcome	Change+ Among Supermarket Users Mean (SE) (*n*=368)	Change+ Among Supermarket Non-Users Mean (SE) (*n*=171)	Significance Level
Dietary quality (Healthy Eating Index-2010)	−0.45 (0.73)	−0.20 (1.17)	
Mean daily intakes	−260 (38.82)	−201 (58.46)	
Total kilocalories			
Total fat as a percentage of total kilocalories (%)	0.00 (0.55)	1.08 (0.84)	
Added sugars in grams	−3.17 (0.60)	−2.37 (0.95)	
SoFAAS as a percentage of total kilocalories (%)	−1.63	−2.04 (1.08)	
Fruits and vegetables in servings	−0.32 (0.09)	−0.11 (0.24)	
Whole grains in ounces	−0.06 (0.05)	−0.09 (0.07)	
Body Mass Index	0.01 (0.16)	0.16 (0.27)	
Overweight or obese (%)	−0.28 (1.61)	0.73 (2.39)	
Obese (%)	−1.96 (1.83)	−2.98 (2.68)	
Neighborhood satisfaction (%)	13.86 (2.55)	5.14 (4.60)	
Perceived access to healthy foods (%)			
F&V easily accessible	59.8 (2.94)	48.5 (4.75)	*
F&V choice	**59.4 (2.94)**	**48.7 (4.27)**	*
F&V quality	47.1 (3.11)	41.2 (4.30)	
F&V cost	**34.8 (3.25)**	**18.9 (4.60)**	**
WGP easily accessible	**57.8 (2.94)**	**47.0 (4.44)**	*
WGP choice	50.7 (3.07)	43.7 (4.32)	
WGP cost	**42.1 (3.14)**	**27.5 (4.22)**	**
LFP easily accessible	63.0 (2.72)	44.7 (4.61)	**
LFP choice	54.5 (2.93)	38.2 (4.50)	**
LFP cost	43.4 (2.93)	28.4 (4.47)	**

SOURCE Authors' calculations.

NOTES * $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$;
+ Change is computed as difference between follow up and baseline; the results on nutrient levels and types of foods describe mean reported daily intakes;

SoFAAS = Solid Fats, Alcohol and Added Sugars; F&V = fruits and vegetables, WGP = whole grain products, and LFP = low-fat products.

EXHIBIT 1

Characteristics of PHRESH Study Participants at Baseline, May–December 2011

Characteristic	All Percent, Mean (*n*=831)	Intervention Percent, Mean (*n*=571)	Comparison Percent, Mean (*n*=260)
Race/Ethnicity (%)			
African American/black	95.2	94.7	96.1
Other	4.8	5.3	3.9
Mean age in years	53.3 ✦	53.1 ✦	53.7 ✦
Gender * (%)			
Female	75.0	**77.4**	**69.8**
Mean annual household income (USD)	13,608 †	13,147 †	14,620 †
Marital status (%)			
Married/living with partner	17.7	16.3	20.7
Never married	44.0	45.5	40.6
Widowed/divorced/separated	38.3	38.2	38.6
Educational attainment (%)			
Less than high school	13.4	14.7	10.8
High school diploma	36.5	38.2	32.7
Some college /technical school	35.4	33.5	39.5
College degree	14.7	13.7	17.0
Any children in household (%)	28.2	28.1	28.6
Mean years lived in the neighborhood ***	27.0 ‡	**31.2** ‡	**17.8** ‡
When buying food, how often do you go to: (%)			
Convenience stores	54.0	52.1	58.0
Neighborhood stores	45.1	44.7	45.9
Dollar stores	75.3	74.3	77.4
Discount grocery stores ***	59.9	**52.9**	**75.3**
Supercenters	78.2	77.8	79.1
Wholesale clubs	51.2	50.6	52.5
Specialty grocery stores	30.3	28.5	34.4
Full service supermarkets ***	99.1	**99.8**	**97.3**
Meat or seafood markets	75.5	76.5	73.1
Fruit and vegetable stores/farm stands	64.8	65.2	63.8
Drug stores **	47.5	**51.2**	**39.2**
Type of store for major food shopping (%)			
Full service supermarket **	74.1	**77.2**	**67.3**
Supercenter	12.2	11.5	13.8
Fruit and vegetable store/farm stand	0.5	0.4	0.6
Discount grocery store **	4.9	**3.3**	**8.4**
Wholesale club	3.1	2.7	3.9

Characteristic	All Percent, Mean (*n*=831)	Intervention Percent, Mean (*n*=571)	Comparison Percent, Mean (*n*=260)
Other[+]	5.2	4.8	6.0
Transport to and from major food shopping store (%)			
Drive	38.9	37.0	43.0
Jitney	25.6	26.5	23.7
Public transportation	17.4	18.5	15.0
Get a ride	16.7	16.8	16.4
Other	1.5	1.2	2.0

SOURCE Authors' calculations.

NOTES * $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

[+]Neighborhood store, Specialty grocery store, meat or seafood market.

[✦]SE for All Percent, Mean (0.7); Intervention Percent, Mean (0.9); and Comparison Percent, Mean (1.3).

[†]SE for All Percent, Mean (473); Intervention Percent, Mean (567); and Comparison Percent, Mean (855).

[‡]SE for All Percent, Mean (0.8); Intervention Percent, Mean (1.1); and Comparison Percent, Mean (1.1).

Adjusted for attrition weights (Neighborhood, Gender, Age, Income below the federal poverty limit, Education, Kids in the Household, Marital status, Disability, Home ownership, Access to a Car, Self-rated health, Years lived in neighborhood, BMI, HEI, and interactions of neighborhood with covariates).

EXHIBIT 2

Change In Diet, Body Mass Index, Neighborhood Satisfaction and Perceived Access to Healthy Foods for Residents of Intervention and Comparison Neighborhoods, and Difference in Differences

Outcome	Intervention Neighborhood (Hill District)		Comparison Neighborhood (Homewood)		Difference-in-Differences
	Baseline (*n*=571)	Change + Mean (*n*=571)	Baseline (*n*=260)	Change + Mean (*n*=260)	Change+ in HD - Change+ in HW (*n*=831)
Dietary Quality (Healthy Eating Index-2010)	48.3	−0.39	48.6	**−2.59** **	**2.20** *
Mean daily intakes					
Total kilocalories	1727	**−222** ***	1861	− 44	**−178** **
Total fat as a percentage of total kilocalories (%)	36.3	0.35	36.6	0.51	−0.16
Added sugars in teaspoons	14.3	**−2.75** ***	15.1	0.58	**−3.34** **
Solid Fats, Alcohol and Added Sugars (SoFAAS) as a percentage of total kilocalories (%)	33.2	**−1.38** **	32.8	**1.72** **	**−3.11** **
Fruits and vegetables in servings	2.3	**−0.27** ***	2.4	−0.13	−0.14
Whole grains in ounces	0.62	**−0.08** **	0.50	−0.03	−0.05
Body Mass Index	30.4	0.13	30.8	**0.44** **	−0.31
Overweight or obese (%)	77.0	0.08	78.2	−1.42	1.50
Obese (%)	47.9	−1.52	49.3	0.34	−1.86
Neighborhood satisfaction (%)	66.6	**13.8** ***	55.9	2.64	**11.1** **
Perceived access to healthy foods (%)					
F&V easily accessible	16.4	**55.9** ***	22.3	**5.1** *	**50.8** ***
F&V choice	10.2	**56.2** ***	15.4	**7.9** **	**48.4** ***
F&V quality	15.6	**44.6** ***	19.3	**5.4** *	**39.3** ***
F&V cost	17.2	**31.0** ***	19.3	**7.3** **	**23.6** ***
WGP easily accessible	18.5	**52.6** ***	27.3	**11.0** **	**41.6** ***
WGP choice	12.0	**47.6** ***	14.5	**12.1** ***	**35.5** ***
WGP cost	16.4	**37.2** ***	18.1	**9.8** **	**27.4** ***

Outcome	Intervention Neighborhood (Hill District)		Comparison Neighborhood (Homewood)		Difference-in-Differences
	Baseline (*n*=571)	Change + Mean (*n*=571)	Baseline (*n*=260)	Change + Mean (*n*=260)	Change+ in HD - Change+ in HW (*n*=831)
LFP easily accessible	17.2	**54.6*****	21.9	**15.7*****	**38.8*****
LFP choice	12.9	**47.3*****	13.4	**14.0*****	**33.2*****
LFP cost	14.0	**38.8*****	15.8	**11.7*****	**27.1*****

SOURCE Authors' calculations.

NOTES * p <0.10;

** p < 0.05;

*** p < 0.001;

+ Change is computed as difference between follow up and baseline; the results on nutrient levels and types of foods describe mean reported daily intakes;

HD = Hill District; HW = Homewood; F&V = fruits and vegetables, WGP = whole grain products, and LFP = low-fat products

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EXHIBIT 3

Comparison of Regular Users of the New Supermarket versus Others in the Intervention Neighborhood (Hill District)

Outcome	New Supermarket Users		New Supermarket Non-Users		Significance Level
	Baseline (n=368)	Change+ Mean (*n*=368)	Baseline (n=171)	Change+ Mean (*n*=171)	
Dietary quality (Healthy Eating Index-2010)	48.84	−0.45	48.16	−0.20	
Mean daily intakes					
Total kilocalories	1759.15	−260	1644.48	−201	
Total fat as a percentage of total kilocalories (%)	72.33	0.00	66.66	1.08	
Added sugars in teaspoons	14.76	−3.17	13.05	−2.37	
Solid fats, alcohol and added sugars (SoFAAS) as a percentage of total kilocalories (%)	33.77	−1.63	32.20	−2.04	
Fruits and vegetables in servings	2.27	−0.32	2.26	−0.11	
Whole grains in ounces	0.62	−0.06	0.65	−0.09	
Body Mass Index	30.34	0.01	30.44	0.16	
Overweight or obese (%)	77.69	−0.28	76.22	0.73	
Obese (%)	46.95	−1.96	48.81	−2.98	
Neighborhood satisfaction (%)	69.42	13.86	66.35	5.14	
Perceived access to healthy foods (%)					
F&V easily accessible	17.43	59.8	14.83	48.5	*
F&V choice	**12.80**	**59.4**	**5.85**	**48.7**	*
F&V quality	17.75	47.1	12.17	41.2	
F&V cost	**17.14**	**34.8**	**17.03**	**18.9**	**
WGP easily accessible	**18.47**	**57.8**	**16.23**	**47.0**	*
WGP choice	13.72	50.7	8.79	43.7	
WGP cost	**16.30**	**42.1**	**14.96**	**27.5**	**
LFP easily accessible	16.17	63.0	16.93	44.7	**
LFP choice	12.62	54.5	13.12	38.2	**
LFP cost	13.71	43.4	15.77	28.4	**

SOURCE Authors' calculations.

NOTES * $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$;

+ Change is computed as difference between follow up and baseline; the results on nutrient levels and types of foods describe mean reported daily intakes;

F&V = fruits and vegetables, WGP = whole grain products, and LFP = low-fat products.

EXHIBIT 4

Associations Between Changes in Select Food Purchasing Practices and Changes in Dietary Outcomes

Survey Question	Change in HEI-2010 (Dietary Quality)	Change in Total Kcal	Change in Total Fat (percent of total Kcal)	Change in Added Sugars (teaspoons)	Change in SoFAAS✦ (percent of total Kcal)
	Beta	**Beta**	**Beta**	**Beta**	**Beta**
How often you shop for food	0.002	−0.067	0.004	−0.083	−0.041
Weekly per person expenditures for food	−0.010	0.054	0.001	0.003	0.012
When buying food, how often do you go to:					
Convenience stores	−0.011	−0.065	−0.002	0.024	0.032
Neighborhood stores	−0.011	0.010	0.028	−0.010	0.004
Dollar stores	−0.017	−0.006	**0.086** *	−0.022	−0.031
Discount grocery stores	0.066	0.062	0.014	0.009	−0.041
Supercenters	−0.004	−0.027	0.020	−0.052	−0.040
Wholesale clubs	−0.014	−0.001	0.059	−0.047	−0.004
Specialty grocery stores	−0.033	0.027	0.020	0.012	0.025
Full-service supermarket	−0.013	0.016	−0.028	0.041	−0.025
Meat or seafood markets	−0.018	0.023	0.012	0.027	0.022
Fruit and vegetable stores/farm stands	0.000	0.044	−0.023	−0.020	0.001
Drug stores	−0.024	0.005	−0.041	−0.017	−0.037

SOURCE Authors' calculations.

NOTES *p < 0.05;

** $p < 0.01$;

*** $p < 0.001$.

✦SoFAAS = Solid Fats, Alcohol and Added Sugars