Published in final edited form as:

Ann Epidemiol. 2017 December ; 27(12): 771–776. doi:10.1016/j.annepidem.2017.10.011.

Can the introduction of a full-service supermarket in a food desert improve residents' economic status and health?

Andrea S. Richardson, MPH, PhD^{a,*}, Madhumita Ghosh-Dastidar, PhD^a, Robin Beckman, MPH^a, Karen R. Flórez, PhD^b, Amy DeSantis, PhD^a, Rebecca L. Collins, PhD^a, and Tamara Dubowitz, ScD^a

^aRAND Corporation, Health Division, Pittsburgh, PA

^bCUNY Graduate School of Public Health and Health Policy, New York, NY

Abstract

Purpose—To estimate the impacts of a new supermarket in a low-income desert, on residents' economic status and health.

Methods—We surveyed a randomly selected cohort in two low-income Pittsburgh neighborhoods before and about 1 year following the opening of a supermarket. We used difference-in-difference approach to test changes across the two neighborhoods in residents' food security, United States Department of Agriculture Supplemental Nutrition Assistance Program and Special Supplemental Nutrition Program for Women Infant and Children participation, employment, income, and self-reported health/chronic disease diagnoses.

Results—We observed declines in food insecurity (-11.8% , $P < .01$), Supplemental Nutrition Assistance Program participation (-12.2% , $P < .01$), and fewer new diagnoses of high cholesterol (-9.6% , $P = .01$) and arthritis (-7.4% , $P = .02$) in the neighborhood with the new supermarket relative to residents of the comparison neighborhood. We also found suggestive evidence that residents' incomes increased more (\$1550, $P = .09$) and prevalence of diabetes increased less in the neighborhood with the supermarket than in the comparison neighborhood (-3.6% , $P = .10$).

Conclusions—Locating a new supermarket in a low-income neighborhood may improve residents' economic well-being and health. Policymakers should consider broad impacts of neighborhood investment that could translate into improved health for residents of underserved neighborhoods.

Keywords

Economics; Epidemiology; Neighborhood/place; Poverty; Public health

Background

Research examining associations between poverty and poor health has largely focused on individuals' economic status. Recent work identified links between neighborhood economics

*Corresponding author. Health Division, RAND Corporation, Pittsburgh, PA 15213. arichard@rand.org (A.S. Richardson).

The authors have no conflicts of interest to disclose.

and health (e.g., mortality) [1,2]. Neighborhood characteristics that have been tied to health include educational quality, access to social and economic services, and access to healthy foods [3]. Yet, the evidence is not fully consistent with respect to cardiometabolic health (e.g., obesity) [4–7], and we have limited understanding of why these neighborhood factors are associated with health and have causal influence.

Establishing causal evidence for neighborhood effects on individuals is difficult. Residential selection (i.e., individuals typically choose their neighborhoods) limits our ability to disentangle the individual from context. Factors affecting preferences (or constraints) regarding where to live may also play a role in individual health and wealth. Most research on neighborhood health effects [8] is based on cross-sectional or aggregate data that cannot account for residential selection.

One approach to reduce residential selection bias is randomly assigned residence. Moving to Opportunity for Fair Housing (MTO) Demonstration Program randomized low-income families to receive no rental assistance housing vouchers, unrestricted housing vouchers, or vouchers to use in higher income neighborhoods. MTO aimed to isolate causal neighborhood effects net of unmeasured background differences [9] on “employment, income, education, and well-being” [10]. Since MTO’s implementation, findings suggest that moving to economically improved areas has both positive and negative impacts on health and economic outcomes [9,11–13]. Inconsistent findings could relate to length of follow-up, relocation timing, or the act of moving itself. Few randomized studies have been able to assess resident well-being in association with neighborhood improvement or decline (vs. moving into a socioeconomically different neighborhood) [14].

However, advocacy efforts to increase access to food retailers with healthy food options motivated the federal government to incentivize full-service supermarkets (FSSs) to locate in low-income areas with limited access to fresh products and foods. The Healthy Food Financing Initiative (HFFI) (S.1926, H.R. 3525), launched in 2010 was inspired, in part, by the Pennsylvania Fresh Food Financing Initiative (PFFFI). The PFFFI was a state-level public-private partnership that financed supermarket development projects; job creation and local tax revenue were some of the economic advantages that resulted from the PFFFI [15]. In addition to affecting food access, opening a FSSs may foster community economic development by introducing employment opportunities, generating tax revenues, and increasing foot traffic to support additional stores [16]. An analysis of economic impacts on communities where new supermarkets opened in low-income communities found increases in home values [17]. The grocery industry and PolicyLink reported that opening new supermarkets in underserved areas provides jobs to local residents [18]. If a new FSS improves neighborhood or resident socioeconomic status, it might influence residents’ health by increasing residents’ means (e.g., employment) [18,19] to make healthier lifestyle choices. Studies of FSS investments provide an opportunity to explore possible causal effects of improved neighborhood economics on health.

In 2013, a low-income predominantly African-American Pittsburgh neighborhood received a new FSS. Capitalizing on this natural experiment opportunity, we enrolled randomly selected households from the neighborhood that was to receive the new supermarket

(intervention) and from a sociodemographically similar neighborhood (comparison), before the FSS opening [20]. Relative to the comparison neighborhood, we found that selected dietary behaviors and neighborhood satisfaction significantly improved among residents in the intervention neighborhood after the FSS opening. However, the use of the FSS was not related to either the dietary changes or to the improvements in neighborhood satisfaction [20]. This left the question open—exactly how did the FSS influence diet?

One possibility is that the FSS represented an investment in the neighborhood, improving neighborhood economic status, spurring additional neighborhood upgrades (e.g., housing conditions improved), and perhaps also improvements in residents' individual economics [21]. If so, these changes may have wrought broader changes in residents' health, beyond the improved diet we previously observed [22,23]. In this article, we examine this possibility, testing for changes in resident economic status and health in the intervention neighborhood (where the FSS opened) relative to the sociodemographically similar comparison neighborhood, over the same period. We drew on multiple economic and health indicators present in the FSS evaluation study data set.

Methods

Study design and participants

Pittsburgh Hill/Homewood Research on Eating, Shopping and Health (PHRESH) study used a quasi-experimental prepost design to investigate the effects of opening a HFFI (S.1926, H.R. 3525) supported FSS. We compared two neighborhoods, Hill District (intervention neighborhood) and Homewood (comparison neighborhood). The two neighborhoods were chosen to match in terms of (1) proportion of the neighborhood that is African-American (about 95 percent of the population in each categorized themselves as African-American), (2) physical proximity to food retail including full-service grocery stores (prior to the opening of the FSS in the Hill), and (3) neighborhood socioeconomic status (median household income was <\$15,000/household in both). In addition, both neighborhoods lie in the same broad geographic area, but Homewood is approximately 6 miles from the Hill District, which limited the possibility of contamination of the control group. The Hill District experienced the FSS (October 2013) opening after baseline data collection (May through December, 2011) and before our follow-up survey (May through December, 2014). Interviewers administered surveys to a randomly selected cohort of residents in both neighborhoods. Our sampling approach, recruitment, and eligibility have been described in detail [20,24]. Briefly, we used a parcel-level property information system managed by the University of Pittsburgh Center for Social and Urban Research to sample nonvacant residences. In total, the primary food shopper from each of 831 households completed a baseline and a follow-up assessment. All study protocols were approved by the institution's Institutional Review Board.

Measures

Economic indicators included employment (full-time, part-time, not employed [looking for work; volunteer; student; retired; disabled; and other], don't know/refused), total household income for the prior year and number of persons it supported, participation in Supplemental

Nutrition Assistance Program (SNAP) and in Women, Infants, and Children (WIC) program within the last 12 months (yes, no, don't know/refused), and food security. The latter was measured using self-reported responses to 10-item Adult Food Security Survey Module [25,26] that incorporates questions about conditions and behaviors that characterize households when they are having difficulty meeting basic food needs. Based on standard coding procedures, we classified household food security status as high, marginal, low, or very low. We classified residents as having income below the federal poverty line (FPL) if, based on their income and household size, their income fell below that year's Census published threshold [27].

Health indicators included self-reported health (excellent, very good, good, fair, or poor), ever been told by a doctor or health professional that they have heart disease, high cholesterol, hypertension, high blood sugar, arthritis, or diabetes (yes, no, don't know/refused). Each of these conditions can be affected by changes in behavior or circumstance over a relatively short time period, and thus might be affected within the time frame of our follow up survey.

Sociodemographics included race/ethnicity (African-American/black vs. other), age, gender, marital status (married/living with partner, never married, widowed/divorced/separated), educational attainment (less than high school, high school diploma, some college/technical school, college degree), and any children in household.

Statistical analyses

To conduct analysis with the full sample of participants with baseline and follow-up assessments, we used multiple imputations to impute values for respondents with missing outcome data, at either baseline or follow-up. Multiple imputation for missing data reduces measurement error [28] and bias [29] compared to complete-case analyses. Our sample was missing data on self-reported health (0.1%), employment (0.4%), hypertension (0.6%), -heart disease (0.6%), -diabetes (0.7%), -high blood sugar (0.7%), -arthritis (1%), -high cholesterol (1.4%), WIC vouchers (2.8%), SNAP (4%), and income (11%). To compare groups with no data ($n = 680$) to those with any imputed data ($n = 151$), we used linear regression for continuous outcomes with an imputed data indicator variable as the predictor to assess statistically significant differences between those with and without missing data. We conducted a Pearson χ^2 tests for categorical outcomes. The purpose of this analysis was to assess potential bias that may be mitigated by including imputed values. In the case the two groups were different, we included indicator of nonresponse in our main analyses. Most indicators were similar across groups with two exceptions. Household income was higher by almost \$3000 ($p = 0.03$) and SNAP participation was lower (42% compared to 53%, $p = 0.02$), in the group with any versus no imputed data (i.e. those in worse economic situations more often skipped an item). Therefore, we included those with imputed data to avoid biases in our estimated outcomes.

We examined comparability of the neighborhood cohorts at baseline across sociodemographic and outcome variables. We calculated means and standard deviations (continuous variables) and percentages (categorical variables) for the study population and for neighborhood.

We dichotomized categorical outcomes: employment (full or part-time vs. not employed); SNAP participation (yes vs. no); food security (low or very low food security vs. high or marginal); self-reported health (excellent or very good vs. good, fair, or poor); and doctor-diagnosed health conditions (yes vs. no for each condition). We computed for each outcome (1) average difference between baseline and follow-up values in the intervention group, (2) average difference between baseline and follow-up values in the comparison group, and (3) a difference-in-difference estimator indicating how changes over time in the intervention group over time compared with those in the comparison group.

Analyses were performed using SAS, version 9.2, with analyses weighted to account for sample attrition between baseline and follow-up to ensure that results generalize to the random sample at baseline. Attrition weights were computed as the inverse probability of response at follow-up which was predicted using a logistic regression model including all sociodemographic and additional baseline characteristics.

Results

Characteristics of study participants

Our study sample was predominantly non-Hispanic African–American/black (95.2%), female (75%), and middle-aged (mean age at baseline was 53 years; Table 1).

On average, residents were economically disadvantaged. At baseline, only one-third reported being employed full- or part-time, relative to not employed. Households had low incomes with a mean annual household per capita income of \$13,608 and close to half (44.7%) were below the FPL. Similarly, about half reported receiving SNAP benefits; while 6% received WIC food vouchers in past year. About one-third of the households were classified as having low or very low food security.

Residents reported poor health on several indicators. A minority reported very good or excellent health (27%), and the most common diagnoses were hypertension (50%), arthritis (40%), high cholesterol (25%), and diabetes (21%).

Across neighborhoods, residents were similar at baseline, except that Homewood (comparison group) residents were more likely to be male (30% vs. 23%, $P = .03$) than Hill District residents (intervention group).

Change in economic and health indicators

Table 2 displays mean changes and difference-in-difference findings. The intervention neighborhood experienced positive change on all economic outcomes, although it did not always reach statistical significance. Changes in the comparison neighborhood were mixed. The difference-in-difference analysis revealed positive differential effects on some economic indicators favoring residents in the intervention neighborhood. SNAP participation and food insecurity decreased in the intervention neighborhood but not in the comparison neighborhood (where SNAP participation increased and food insecurity was stable; relative change = -12% for both indicators, $P < .01$). There was also a marginally significant difference-in-difference trend for annual income (relative change \$1550, $P = .09$); income

increased for the intervention and decreased in the comparison neighborhood. Full-time employment increased in the intervention neighborhood but not significantly more so than in the comparison ($P = .63$). The proportion of residents with income below the FPL fell in both neighborhoods, and the difference in change between neighborhoods was not statistically significant ($P = .39$) nor were differences in WIC participation.

All changes in chronic disease status were necessarily in the direction of ill health, given that we used lifetime indicators of disease. Although the intervention neighborhood experienced significant increases in two conditions, hypertension and high blood sugar, the comparison neighborhood experienced increases in four. The difference-in-difference comparison was statistically significant for high cholesterol ($P = .01$), reflecting a relative increase of 10% ($P = .01$) in the comparison neighborhood (and no significant change in the intervention). Similarly, reports of arthritis increased in the comparison by 10% but not significantly so in the intervention neighborhood (relative change = -7.4% , $P = .02$). The difference-in-difference fell short of significance for diabetes, where increases were also significant in the comparison neighborhood and not the intervention (relative change = -3.6% , $P = .10$). Reports of hypertension increased significantly and similarly in both neighborhoods (relative change = 0.5% , $P = .87$).

Discussion

Using a quasi-experimental design with a randomly selected cohort in intervention and comparison neighborhoods, we found that the introduction of a FSS in a neighborhood that previously did not have FSS may have positively impacted resident economic status and health. Our findings suggest that residents living in the intervention neighborhood saw greater reduction in food insecurity and SNAP participation, and a slower growth in diagnosed high cholesterol and arthritis incidence, relative to the comparison neighborhood. In addition, we found evidence that incident diabetes may also have slowed and residents' incomes increased in the intervention more than in the control neighborhood.

Prior studies of supermarket effects on residents have largely focused on dietary changes and perceived access to healthy foods [20,30,31] and not economic well-being and health impacts. Yet, supermarkets can potentially influence economic outcomes among residents by providing jobs or catalyzing changes that result in increased wages, real estate equity, and social cohesion [32].

We saw a suggestive increase in employment for Hill District residents, but we did not detect a difference compared to change in Homewood. The Reinvestment Fund states that supermarkets can also provide a place for community members to meet and socialize [33]. Indeed, being centrally located can attract people and retailers, thereby increasing nearby home values. In a case study of Hillsboro, Oregon greater spatial accessibility to all retailing (including food stores) was associated with higher home values [34].

One potential downside to neighborhood investment is that gentrification, in the form of increased property values, can result in higher property taxes/rent that force low-income residents to move. In our study, after the FSS opened, 90% of intervention and 84% of

comparison study neighborhood residents remained at their same address. Of the movers, less than 5% left their neighborhood. Thus, we see no evidence that residents were pushed out by improvements. It is important to keep in mind that this may not always be true when a new FSS is introduced.

In addition to economic improvements, Hill District residents reported fewer new cases of high cholesterol and arthritis than did the comparison neighborhood. Diabetes diagnoses also increased significantly among Homewood residents, but did not for Hill District residents, although the difference between the two neighborhoods' changes was only marginally significant. All these changes in health outcomes could potentially be due to dietary changes. Specifically, reduced diet quality, increases in solid fats, alcohol and added sugars that we found among the comparison group in our previous study [20] could increase cholesterol [35], arthritis [36], and diabetes symptoms.

Notably, the new supermarket did not impact dietary changes through use nor did it seem to directly impact residents' employment status or incomes [20]. The economic improvements in food insecurity and SNAP participation we observed are stark indicators of poor socioeconomics and may be sensitive to economic improvements. However, reduced SNAP participation could also indicate that residents who needed SNAP failed to apply a negative outcome rather than an improvement. Among residents we categorized as SNAP eligible (based on income and household size), we observed similar declines in SNAP participation in both neighborhoods. Thus, it appears that our findings are due to differential change in eligibility, rather than participation, across the two neighborhoods.

Our study was set in two low-income, racially isolated urban neighborhoods; therefore, findings may not be generalizable to other neighborhoods with residents who have different socio-demographic profiles and may even differ according to characteristics of individuals (e.g., gender, age, and socioeconomic status) within the two study neighborhoods. We lacked detailed health measures (e.g., biomarkers) and economic status; therefore, further research should examine changes using measures that can capture nuanced aspects of health and economic well-being. Due to construction delays, baseline data were collected two years before the FSS opened. Accordingly, changes in either neighborhood preceding the opening could have impacted neighborhood comparability. To address this issue, we took advantage of a sister study that collected data in 2012 on a subset of relevant outcomes. We performed difference-in difference tests for changes between 2011 and 2012 for SNAP participation ($P = .63$), income ($P = .31$), income below federal poverty level ($P = .15$), and employment ($P = .14$). None of the difference-in-differences across neighborhoods were significant, which supports the conclusion that improvements occurred after the supermarket opened. Follow-up timing may not have allowed for sufficient time to pass between the store opening and changes in economic and health outcomes. Lastly, the study was originally designed to detect changes in energy consumption and body mass index; thus, it may be underpowered to detect changes in economic outcomes. However, we were able to use multiple imputation so that we could include the full sample in the analyses. Available missing-data methods make a missing-at-random assumption [37] which is plausible with more variables in the imputation model [38], and we included eleven.

Despite these limitations, our study provides evidence that supermarkets may improve aspects of residents' lives beyond diet for low-income African-Americans. We capitalized on a natural experiment using a randomized design that was less vulnerable to residential selection. In so doing, we shed light on some positive sequelae of investing in neighborhoods in the form of a new FSS, but much more needs to be learned about how and why these changes take place.

Public health implications

Policymakers should consider the broader beneficial impacts of economic development that could translate into improved health for residents in underserved neighborhoods.

Acknowledgments

The authors express sincere appreciation and gratitude to La'Vette Wagner, field coordinator of the Pittsburgh Hill/ Home-wood Research on Eating, Shopping, and Health (PHRESH) study and the data collection staff. The authors thank the Hill House Association, Operation Better Block, and Homewood Children's Village. Without their participation, the study could not have happened.

Funding was provided by the National Cancer Institute (R01CA164137 "Impact of Greenspace Improvement on Physical Activity in a Low Income Community") and National Cancer Institute (R01CA149105 "Does a New Supermarket Improve Dietary Behaviors of Low-Income African Americans"). All authors have participated in conception and design or analysis and interpretation of the data; drafting the article or revising it critically for important intellectual content; and approval of the final version.

References

1. Boone-Heinonen J, Diez Roux AV, Kiefe CI, Lewis CE, Guilkey DK, Gordon-Larsen P. Neighborhood socioeconomic status predictors of physical activity through young to middle adulthood: the CARDIA study. *Soc Sci Med*. 2011; 72(5):641–9. [PubMed: 21316829]
2. Subramanian SV, Chen JT, Rehkopf DH, Waterman PD, Krieger N. Racial disparities in context: a multilevel analysis of neighborhood variations in poverty and excess mortality among black populations in Massachusetts. *Am J Public Health*. 2005; 95(2):260–5. [PubMed: 15671462]
3. Diez Roux AV, Mair C. Neighborhoods and health. *Ann N Y Acad Sci*. 2010; 1186:125–45. [PubMed: 20201871]
4. Diez Roux AV, Jacobs DR, Kiefe CI. Neighborhood characteristics and components of the insulin resistance syndrome in young adults: the coronary artery risk development in young adults (CARDIA) study. *Diabetes care*. 2002; 25(11):1976–82. [PubMed: 12401742]
5. Auchincloss AH, Mujahid MS, Shen M, Michos ED, Whitt-Glover MC, Diez Roux AV. Neighborhood health-promoting resources and obesity risk (the multiethnic study of atherosclerosis). *Obesity (Silver Spring)*. 2013; 21(3):621–8. [PubMed: 23592671]
6. Diez-Roux AV, Link BG, Northridge ME. A multilevel analysis of income inequality and cardiovascular disease risk factors. *Social Science & Medicine*. 2000; 50:673–87. [PubMed: 10658848]
7. Do DP, Wang L, Elliott MR. Investigating the relationship between neighborhood poverty and mortality risk: A marginal structural modeling approach. *Soc Sci Med*. 2013; 91:58–66. [PubMed: 23849239]
8. Diez Roux AV. Investigating neighborhood and area effects on health. *Am J Public Health*. 2001; 91(11):1783–9. [PubMed: 11684601]
9. Katz LF, Kling JR, Liebman JB. Moving to opportunity in Boston: Early results of a randomized mobility experiment. *Q J Econ*. 2001; 116(2):607–54.
10. Department of Housing and Urban Development. Expanding housing choices for HUD-assisted families. Washington, D.C.: Office of Policy Development and Research (PD&R), U.S Department of Housing and Urban Development; 1996.

11. Ludwig J, Sanbonmatsu L, Gennetian L, Adam E, Duncan GJ, Katz LF, et al. Neighborhoods, obesity, and diabetes—a randomized social experiment. *N Engl J Med*. 2011; 365(16):1509–19. [PubMed: 22010917]
12. Kessler RC, Duncan GJ, Gennetian LA, Katz LF, Kling JR, Sampson NA, et al. Associations of housing mobility interventions for children in high-poverty neighborhoods with subsequent mental disorders during adolescence. *JAMA*. 2014; 311(9):937–47. [PubMed: 24595778]
13. Ludwig J, Duncan GJ, Gennetian LA, Katz LF, Kessler RC, Kling JR, et al. Neighborhood effects on the long-term well-being of low-income adults. *Science*. 2012; 337(6101):1505–10. [PubMed: 22997331]
14. Dubowitz T, Zenk SN, Ghosh-Dastidar B, Cohen DA, Beckman R, Hunter G, et al. Healthy food access for urban food desert residents: examination of the food environment, food purchasing practices, diet and BMI. *Public Health Nutr*. 2015; 18(12):2220–30. [PubMed: 25475559]
15. PolicyLink, The Food Trust, and The Reinvestment Fund. A healthy food financing initiative: an innovative approach to improve health and spark economic development; Conference: 138th APHA Annual Meeting and Exposition 2010;
16. Bell, J., Mora, G., Hagan, E., Rubin, V., Karpyn, A. Access to healthy food and why it matters: a review of the research. Oakland, CA: 2013.
17. The Reinvestment Fund. The economic impacts of supermarkets on their surrounding communities. Reinvestment Fund. Philadelphia, PA: Reinvestment Brief; 2006.
18. Flournoy, R., Treuhaft, S., Bell, J., Ellingberg, L., Rubin, V., Daniel, MH., et al. Strategies and policy opportunities to improve access to healthy food. Oakland, CA: PolicyLink and The California Endowment; 2005.
19. Bennett PR, Cherlin AJ. The neighborhood contexts in which low-income families navigate welfare reform: evidence from the three-city study. *Soc Sci Q*. 2011; 92(3):735–60. [PubMed: 25530635]
20. Dubowitz T, Ghosh-Dastidar M, Cohen DA, Beckman R, Steiner ED, Hunter GP, et al. Diet and perceptions change with supermarket introduction in a food desert, but not because of supermarket use. *Health Aff*. 2015; 34(11):1858–68.
21. Goldstein, I., Loethen, L., Kako, E., Califano, C. CDFI financing of supermarkets in underserved communities: a case study. Washington, D.C.: U.S Department of the Treasury, CDFI Fund – Research Initiative; 2008.
22. Egan M, Katikireddi SV, Kearns A, Tannahill C, Kalacs M, Bond L. Health effects of neighborhood demolition and housing improvement: a prospective controlled study of 2 natural experiments in urban renewal. *Am J Public Health*. 2013; 103(6):e47–53. [PubMed: 23597345]
23. Thomson H, Thomas S, Sellstrom E, Petticrew M. Housing improvements for health and associated socio-economic outcomes. *Cochrane Database Syst Rev*. 2013; 2:CD008657.
24. Dubowitz T, Ncube C, Leuschner K, Tharp-Gilliam S. A natural experiment opportunity in two low-income urban food desert communities: research design, community engagement methods, and baseline results. *Health Educ Behav*. 2015; 42(1 Suppl):87S–96S. [PubMed: 25829122]
25. Coleman-Jensen, A., Rabbitt, MP., Gregory, CA., Singh, A. Household Food Security in the United States in 2015. Economic Research Service; 2016.
26. Agriculture USDo. , editor. Economic Research Service. U.S. Household Food Security Survey Module: Six-Item Short Form. Washington, D.C.: 2012.
27. United States Census Bureau. Census urban area facts: most densely populated areas. Washington, D.C.: United States Census Bureau; 2010. 2010
28. Cole SR, Chu HT, Greenland S. Multiple-imputation for measurement-error correction. *Int J Epidemiol*. 2006; 35:1074–81. [PubMed: 16709616]
29. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ*. 2009; 338:b2393. [PubMed: 19564179]
30. Cummins S, Petticrew M, Higgins C, Findlay A, Sparks L. Large scale food retailing as an intervention for diet and health: quasi-experimental evaluation of a natural experiment. *J Epidemiol Community Health*. 2005; 59(12):1035–40. [PubMed: 16286490]

31. Cummins S, Flint E, Matthews SA. New neighborhood grocery store increased awareness of food access but did not alter dietary habits or obesity. *Health Aff.* 2014; 33(2):283–91.
32. Hagan, E., Riubin, V. Economic and community development outcomes of healthy food retail. Oakland, CA: 2013.
33. The Reinvestment Fund. The PA fresh food financing initiative: case study of rural grocery store investments. Philadelphia, PA: Reinvestment Fund; 2015.
34. Song Y, Sohn J. Valuing spatial accessibility to retailing: A case study of the single family housing market in Hillsboro, Oregon. *J Retailing Consum Serv.* 2007; 14(4):279–88.
35. Eckel RH, Jakicic JM, Ard JD, de Jesus JM, Miller NH, Hubbard VS, et al. 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (vol 129, pg S76, 2014). *Circulation.* 2015; 131(4):E326–E326.
36. Proudman SM, James MJ, Spargo LD, Metcalf RG, Sullivan TR, Rischmueller M, et al. Fish oil in recent onset rheumatoid arthritis: a randomised, double-blind controlled trial within algorithm-based drug use. *Ann Rheum Dis.* 2015; 74(1):89–95. [PubMed: 24081439]
37. Little, RJA., Rubin, DB. Statistical Analysis with Missing Data. 2nd. 2002.
38. Schafer, JL., Olsen, MK. College of Health and Human Development. Pennsylvania State University; 1998. Multiple Imputation for Multivariate Missing-Data Problems: A Data Analysts Perspective.

Table 1

Study population and baseline demographic characteristics by neighborhood in Pittsburgh, Pennsylvania

Characteristics	Overall, n = 831	Hill district, n = 571	Homewood, n = 260	P
Demographics				
Race/ethnicity: African–American/black versus other (%)	95.2	94.7	96.1	.60
Mean age (SE)	53.2 (0.7)	53.0 (0.9)	53.7 (1.3)	.71
Male (%)**	25.0	22.6	30.2	.03
Marital status (%)				.25
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 (%)				.11
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	—
Economic indicators				
Employment full-time or part-time (%)	34.4	34.2	34.7	.90
Median and interquartile range (IQR) of per capita annual income \$	8942 (44760–14,967)	7914 (4444–14,789)	12,115 (4569–17,304)	.15
Household income below federal poverty level (%)*	44.7	46.8	40.1	.08
Household participated in SNAP in past year (%)*	51.0	53.3	46.0	.06
Household received WIC food vouchers in past year (%)	6.2	5.2	8.3	.13
Low or very low food security (%)	33.1	34.1	30.8	.37
Health indicators				
Self-reported health rating of very good or excellent (%)	26.6	26.5	26.9	.91
Ever been told by a doctor that you have ... ? (%)				
Heart disease*	14.0	12.7	17.1	.09
High cholesterol	25.2	24.6	26.5	.59
High blood pressure or hypertension	49.6	49.8	49.0	.84
High blood sugar	17.2	15.9	20.0	.16
Arthritis	39.6	39.6	39.5	.99
Diabetes	20.9	20.7	21.5	.79

SNAP = Supplemental Nutrition Assistance Program; WIC = Women, Infants, and Children.

*
P .10 and**
P .05.

Change in economic and health outcomes for residents of intervention and comparison neighborhoods and difference in difference analysis in Pittsburgh, pennsylvania, between 2011 and 2014

Table 2

Outcome	Intervention neighborhood (n = 571)		Comparison neighborhood (n = 260)		Difference in difference	P
	Follow-up	Mean change	Follow-up	Mean change		
Economic indicators						
Respondent employment full-time or part-time (%)	37.1	2.9 *	35.9	1.2	1.7	.63
Mean per capita annual income \$	13,779	\$623	13,689	\$927	1550 *	.09
Income below federal poverty level (%)	42.7	-4.1 *	32.7	-7.4 **	3.2	.39
Household participated in SNAP in past year (%) *	47.3	-6.0 **	52.1	6.2 **	-12.16 **	.00
Household received WIC food vouchers in past year (%)	4.7	-0.5	6.7	-1.5	1	.78
Low or very low food security (%)	22.3	-12.0 ***	30.4	-0.1	-11.8 **	.00
Health indicators						
Self-reported health rating of very good or excellent (%)	24.6	-1.9	28.1	1.2	-3.1	.43
Ever been told by a doctor that you have ... ? (%)						
Heart disease	11.2	-1.4	18.5	1.4	-2.8	.23
High cholesterol	25.2	0.5	36.5	10.1 ***	-9.6 **	.01
High blood pressure or hypertension	55.2	5.4 **	54.0	5.0 **	0.5	.87
High blood sugar	19.8	4.0 **	20.2	0.3	3.7	.18
Arthritis	41.9	2.3	49.2	9.7 ***	-7.4 **	.02
Diabetes	21.8	1.2	26.2	4.9 **	-3.6 *	.10

SNAP = Supplemental Nutrition Assistance Program; WIC = Women, Infants, and Children.

* P .10,

** P .05, and

*** P .001.