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ASSOCIATIONS BETWEEN NEIGHBORHOOD AVAILABILITY AND INDIVIDUAL CONSUMPTION OF DARK-GREEN AND ORANGE VEGETABLES AMONG ETHNICALLY DIVERSE ADULTS IN DETROIT

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Abstract

Diets rich in dark-green and orange vegetables have been associated with a reduction in chronic diseases. However, most Americans do not consume the number of daily servings recommended by the 2005 Dietary Guidelines for Americans. An increasing number of studies suggest that changes to the neighborhood food environment may be critical to achieving population-wide improvements in eating. The objective of this study was to examine the relationship between observed neighborhood availability and individual consumption of dark-green and orange vegetables among low- to moderate-income and ethnically diverse adults in Detroit. This study used a cross-sectional design that drew upon a 2002–2003 community survey and 2002 in-person audit of food stores. A total of 919 adults (mean age 46.3 years, 52.2% female) including African Americans (56.7%), Latinos (22.2%), and whites (18.7%) residing in three Detroit communities participated in the survey. Two-level weighted, hierarchical linear regression was used to analyze the data. On average, survey respondents ate 0.61 daily servings of dark-green and orange vegetables. Residents of neighborhoods with no stores carrying five or more varieties of dark-green and orange vegetables were associated with an average of 0.17 fewer daily servings of these foods compared with residents of neighborhoods with two stores carrying five or more varieties of dark-green and orange vegetables ($P=0.047$). These findings suggest that living in a neighborhood with multiple opportunities to purchase dark-green and orange vegetables may make an important contribution toward meeting recommended intakes.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST:

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Diets rich in dark-green and orange vegetables have been associated with a reduction in chronic diseases such as cardiovascular disease, certain cancers, and type 2 diabetes (1). These protective effects are generally credited to the additive and synergistic effect of antioxidants and other nutrients found in these vegetables (2–4). The importance of consuming dark-green and orange vegetables is underscored by the Healthy People 2010 guidelines, which include an objective to increase the proportion of individuals aged 2 years and older who eat at least one daily serving (5). The US Department of Agriculture also included a specific recommendation for dark-green and orange vegetable intake in the 2005 Dietary Guidelines for Americans (6,7). In general, 0.6 to 0.9 servings of dark-green vegetables and 0.4 to 0.6 servings of orange vegetables per week are recommended for adults (6,7). Yet, recent research indicates that intakes of dark-green and orange vegetables among Americans do not meet recommendations (5,7–9). Among adults aged 19 years and older, average daily servings of dark-green vegetables ranged from a low of 0.1 for adults aged 19 to 30 years to a high of 0.3 for men aged 51 to 70 years and women aged 31 to 70 years (7). For orange vegetables, the average daily servings among subpopulations ranged from a low of 0.1 for men aged 19 to 50 years and women aged 51 to 70 years to a high of 0.2 for all other adults (7).

Eating behavior is complex and is influenced by factors at multiple levels, including individual factors (i.e., demographic, cognitive, behavior, and biologic) and social (e.g., peer interactions and social support), physical (e.g., restaurants and workplace), and macro-level (e.g., food policies and societal norms) environments (10). Dietetics practitioners have traditionally focused their research and intervention efforts at the individual level. Yet, increasingly, researchers are emphasizing the need for environmental and policy strategies that increase the availability of nutritious foods to support individuals in making healthy food choices (10, 11). Research has found associations between neighborhood availability of retail food stores and eating patterns among residents, even after controlling for individual-level characteristics (12–21). Most of these studies have relied on store type (e.g., supermarkets) as a proxy for the supply of nutritious foods (13,16,18,20), despite research showing neighborhood differences in the food supply after accounting for store type (22–25). Of those studies using observed measures of food availability, the majority have found that greater neighborhood availability of nutritious foods is associated with higher intakes across demographically diverse groups (12,14,15,17,19,21).

Although the literature suggests that neighborhood food availability may play an important role in fruit and vegetable consumption, extant research is limited in at least two ways. First, few studies have gone beyond using store type as a proxy for the supply of nutritious foods to examine relationships between directly observed availability and individual intake of fruits and vegetables. Second, little is known about the relationship between neighborhood availability and individual intake of dark-green and orange vegetables specifically, despite their health benefits. The purpose of this study, therefore, was to examine the relationship between observed neighborhood availability and individual consumption of dark-green and orange vegetables among low- to moderate income and ethnically diverse adults in Detroit, MI. It was hypothesized that greater availability of dark-green and orange vegetables would be associated with higher consumption of these foods.

METHODS

Setting

This study was conducted in three large geographic communities in Detroit, MI, where residents experience excess mortality due to cardiovascular disease compared to the state and the nation (26–28). Similar to other urban communities, Detroit residents have limited

access to stores that sell nutritious foods, and this is particularly true in low-income, predominantly African-American communities (14,15,25,29). Once a thriving and prosperous city, Detroit has experienced population out-migration and economic disinvestment since the 1950s (28,30). Economic restructuring and a history of policies and practices that facilitated movement of employers and whites – but not African Americans – to suburban neighborhoods are among the factors that have shifted the city's racial composition, employment opportunities, and access to resources such as supermarkets (28,29,30–33).

Study Design and Sample

This community-based participatory research study used a cross-sectional design and drew upon two data sources. The first data source was a 2002–2003 community survey of a stratified proportional probability sample of 919 African-American, Latino, and non-Hispanic white adults aged 25 years residing in eastside, southwest, or northwest Detroit (28). The survey was developed and conducted by the Healthy Environments Partnership, a community-based participatory research partnership that examines environmental factors associated with cardiovascular disease risk and inequities (28). The overall response rate (number of completed interviews from the number of households in the sample estimated to have an eligible respondent) was 55%. Interviews were completed with 75% of households in which an eligible participant was identified (34). Participants were nested within 146 Census blocks. All participants provided written informed consent and received \$25 for their participation. The University of Michigan Institutional Review Board approved all study protocols. The second data source was a 2002 in-person audit of 80 fresh fruits and vegetables at 304 food stores located in the involved communities, conducted by two graduate students (including second author) and one community resident (25).

Measures

Dark-Green and Orange Vegetable Intake—Dark-green and orange vegetable intake was measured using an interviewer administered, modified Block Food Frequency Questionnaire (35) in which participants were asked to evaluate their individual food intake. Dark-green and orange vegetables were defined as sweet potatoes, yams, carrots, greens (i.e., collard greens, mustard greens, or spinach), kale, broccoli, and winter squash (i.e., pumpkin, acorn squash, and butternut squash). Standard serving-size pictures were used to improve participants' estimations of the portion sizes they consumed. Daily servings of dark-green and orange vegetables were calculated using a two-step procedure. First, reported intake frequencies, ranging from “never” to “every day,” were converted into daily frequencies using the following weights: “almost never” = 0, “2 to 3 times per month” = 0.1, “1 to 3 times per week” = 0.29, “4 to 6 times per week” = 0.71, and “every day” = 1. Second, serving size was coded between 0.5 to 1.5 servings. For each item, daily servings were then calculated by multiplying the frequency of reported intake for each item by its portion size.

Neighborhood Availability of Dark-Green and Orange Vegetables

Drawing on prior research (36–38), neighborhood was defined as a 0.5-mile radial buffer from participants' census block centroids (geometric centers). To assess availability of dark-green and orange vegetables, food stores (i.e., all sizes of grocery stores, convenience stores, stores without gasoline, meat markets, fresh produce and meat markets, and liquor stores) were first identified from a list provided by the Michigan Department of Agriculture (25,39). Next, through in-person audits (25), store locations were confirmed and availability of 16 fresh dark-green and orange vegetables was assessed: sweet potatoes, yams, carrots, collard greens, mustard greens, turnip greens, spinach, kale, broccoli, pumpkin, acorn squash,

butternut squash, spaghetti squash, buttercup squash, green leaf lettuce, and romaine lettuce. Neighborhood availability of dark-green and orange vegetables was measured as a count of the number of stores in the neighborhood that carried five or more varieties of dark-green or orange vegetables. (Five was used as the cutoff point to define stores with a selection of dark-green and orange vegetables from which to choose because it was the mean number of varieties of dark-green and orange vegetables available across the stores.) The number of stores carrying five or more varieties ranged from zero to two; therefore, dummy variables were used in the analysis: presence of two stores (reference category), one store, and no store that met this criterion.

Covariates—Individual-level socio-demographic covariates considered theoretically relevant were included in the analysis: age, sex, race/ethnicity (i.e., African American, Latino, non-Hispanic white), education (<12 years, 12 years, >12 years), annual per capita household income (i.e., household income divided by number of individuals in household): <\$4,500, \$4,500 to \$7,500, \$7,501 to \$16,200, >\$16,200), car ownership (i.e., owns or leases automobile, does not own or lease automobile), home ownership (i.e., owns home, does not own home), marital status (not currently married, currently married), and length of neighborhood residency in years.

Data Analysis

In preparation for analysis (28), multiple imputation procedures derived from Bayesian models were used to impute missing values for the individual-level data (40). The imputation was performed by using the %IMPUTE macro that is available in the SAS add-in IVEware software (version 0.2, 2009, Software Survey Methodology Program at the University of Michigan's Survey Research Center, Institute for Social Research, Ann Arbor). To account for the complex sample design, weighted descriptive statistics were calculated for each variable (28). Descriptive statistics were computed for the overall sample (n=919) and for individuals living in neighborhoods with no store, one store, or two stores carrying 5 varieties of dark-green and orange vegetables. *F* tests were computed to assess the statistical significance of the difference in socio-demographic characteristics across neighborhood availability of dark-green and orange vegetables. Two-level weighted, hierarchical linear regression models were estimated using restricted maximum likelihood (HLM 6.04, 2006, Scientific Software International, Lincolnwood, IL). Hierarchical regression models allow for the inclusion of multiple levels of data (e.g., individuals and neighborhoods) in one model and account for non-independence among individual responses (40,41). In this analysis, individual socio-demographic characteristics of survey participants were included in Level 1 of the model. Neighborhood availability of dark-green and orange vegetables was included at Level 2. Dark-green and orange vegetable intake was regressed on neighborhood availability of dark-green and orange vegetables and individual-level covariates. Where appropriate, Level 1 independent variables were grand-mean centered in the analysis (41).

RESULTS

As shown in Table 1, the average age of participants was 46 years and approximately half were female. None of the socio-demographic characteristics varied by number of stores carrying five or more varieties of dark-green and orange vegetables. Overall, participants' dark-green and orange vegetable consumption averaged 0.61 daily servings.

Table 2 presents multilevel regression results, adjusting for individual socio-demographic characteristics. Residents living in neighborhoods with no store carrying five or more varieties of dark-green and orange vegetables averaged 0.17 fewer daily servings of these

foods compared with those living in neighborhoods with two stores carrying five or more varieties of dark-green and orange vegetables ($P=0.047$). Living in a neighborhood with one store carrying five or more varieties of dark-green and orange vegetables was associated with an average of 0.10 fewer daily servings of dark-green and orange vegetables compared to living in a neighborhood with two stores carrying five or more varieties of these foods. This relationship was not statistically significant ($P=0.331$).

DISCUSSION

To our knowledge, this is the first study to examine the relationship between directly observed neighborhood availability of dark-green and orange vegetables and individual consumption of these foods. In a low- to moderate-income sample of ethnically diverse adults living in urban communities, we found that individuals residing in neighborhoods with multiple opportunities to buy dark-green and orange vegetables consumed 0.17 more daily servings of these foods compared with individuals living in areas with no neighborhood store selling five or more varieties of dark-green and orange vegetables. Individuals residing in a neighborhood with one store vs. no store selling five or more varieties of dark-green and orange vegetables also consumed more daily servings of these foods, though this relationship was not significant. The effect of 0.17 additional daily servings of dark-green and orange vegetables is relatively small. Yet, in the context of the US adult population's mean intake of dark-green and orange vegetables – about 0.2 to 0.5 total servings per day (7) – as well as current recommendations of one to 1.5 daily servings (6,7), our findings suggest that living in a neighborhood with more options to purchase these foods may make an important contribution toward meeting the recommendations found in the Dietary Guidelines for Americans (6).

This preliminary study provides insight into the relationship between neighborhood availability and individual consumption of dark-green and orange vegetables in a diverse urban population that is at high risk for diet-related chronic diseases. At the time of this study, only nine supermarkets were located within city limits (29), despite a population of more than 950,000 residents. Thus, similar to other urban communities in cities such as Baltimore, MD, Chicago, IL, and Oakland, CA (42–44), our sample has limited options for purchasing nutritious foods at supermarkets. In such communities, neighborhood food stores could be a particularly important source of fresh produce – for fill-in or quick trips to buy perishables between major shopping trips or for participants with limited transportation (45) – and may represent an opportunity to improve health outcomes among neighborhood residents.

Study strengths include direct observation of neighborhood dark-green and orange vegetable availability – vs. relying on store type – and a focus on vegetables known to promote health. This study also has limitations. First, the cross-sectional design means that it is not possible to determine whether neighborhood availability of dark-green and orange vegetables shaped consumption or whether individual demand for these foods influenced their availability in nearby foods stores. It is likely that this relationship is bidirectional. Second, neighborhood availability of dark-green and orange vegetables may have been mischaracterized due to exclusion of canned, frozen, and dried vegetables and of other places (e.g., farmers markets) where participants may have purchased vegetables. Finally, although we controlled for several demographic characteristics that may confound the relationship between neighborhood availability and individual consumption of dark-green and orange vegetables in the analysis, it is possible that the observed relationship is spurious due to other potential confounders (e.g., individual food preferences, food assistance program participation) not included in the model. The role of such factors should be examined in future studies.

CONCLUSIONS

Our findings suggest the need for interventions to increase availability of dark-green and orange vegetables in underserved communities such as Detroit. Although further studies are needed to test the relationship between greater availability and consumption of dark-green and orange vegetables, our findings highlight potential opportunities for improving health in areas with limited access to fresh produce. Dietetics practitioners can play an important role in increasing the availability and consumption of nutritious foods in communities with limited food access by contributing their nutrition knowledge to efforts such as the Fresh Food Financing Initiative, a public-private partnership in Pennsylvania that provides loans and grants to encourage fresh food retailers to locate or remain in underserved communities (46). Because environmental changes are most effective when connected with other strategies, nutrition education is an important part of a multilevel approach to improve dietary intake (46–49).

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References

1. Van Duyn MAS, Pivonka E. Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: Selected literature. *J Am Diet Assoc.* 2000; 100:1511–1521. [PubMed: 11138444]
2. Steinmetz KA, Potter JD. Vegetables, fruit, and cancer prevention: A review. *J Am Diet Assoc.* 1996; 96:1027–1039. [PubMed: 8841165]
3. Hu F. Plant-based foods and prevention of cardiovascular disease: An overview. *Am J Clin Nutr.* 2003; 78(suppl 3):517S–520S. [PubMed: 12936943]
4. Joshipura KJ, Ascherio A, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, Hennekens CH, Spiegelman D, Willett WC. Fruit and vegetable intake in relation to risk of ischemic stroke. *JAMA.* 1999; 282:1233–1239. [PubMed: 10517425]
5. U.S. Department of Health and Human Services. [Accessed September 9, 2009] Healthy People 2010. <http://www.healthypeople.gov>
6. Dietary Guidelines for Americans. US Dept of Health and Human Services; 2005. Web site. <http://www.healthierus.gov/dietaryguidelines>
7. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc.* 2006; 106:1371–1379. [PubMed: 16963342]
8. Fox M, Cole N. Diet Quality of Food Stamp Program participants and nonparticipants measured using the Healthy Eating Index. *J Am Diet Assoc.* 2008; 108(suppl 3):A-102.
9. Johnston CS, Taylor CA, Hampl JS. More Americans are eating “5 A Day” but intakes of dark green and cruciferous vegetables remain low. *Am Soc Nutr Sci.* 2000; 130:3063–3067.
10. Story M, Kaphingst K, Robinson-O’Brien R, Glanz K. Creating healthy food and eating environments: Policy and environmental approaches. *Annu Rev Public Health.* 2008; 29:253–272. [PubMed: 18031223]

11. Larson NI, Story MT, Nelson MC. Neighborhood environments: Disparities in access to healthy foods in the US. *Am J Prev Med.* 2009; 36:74–81. [PubMed: 18977112]
12. Bodor JN, Rose D, Farley TA, Swalm C, Scott SK. Neighborhood fruit and vegetable availability and consumption: The role of small food stores in an urban environment. *Public Health Nutr.* 2008; 11:413–420. [PubMed: 17617930]
13. Morland K, Wing S, Diez Roux A. The contextual effect of the local food environment on residents' diets: The Atherosclerosis Risk in Communities Study. *Am J Public Health.* 2002; 92:1761–1767. [PubMed: 12406805]
14. Zenk SN, Schulz AJ, Hollis-Neely T, Campbell RT, Holmes N, Watkins G, Nwankwo R, Odoms-young A. Fruit and vegetable intake in African Americans: Income and store characteristics. *Am J Prev Med.* 2005; 29:1–9. [PubMed: 15958245]
15. Zenk SN, Lachance LL, Schulz AJ, Mentz G, Kannan S, Ridella W. Neighborhood retail food environment and fruit and vegetable intake in a multiethnic urban population. *Am J Health Promot.* 2009; 23:255–264. [PubMed: 19288847]
16. Laraia BA, Siega-Riz AM, Kaufman JS, Jones SJ. Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Prev Med.* 2004; 39:869–875. [PubMed: 15475018]
17. Franco M, Diez Roux AV, Nettleton JA, Lazo M, Brancati F, Caballero B, Glass T, Moore LV. Availability of healthy foods and dietary patterns: The Multi-Ethnic Study of Atherosclerosis. *Am J Clin Nutr.* 2009; 89:897–904. [PubMed: 19144728]
18. Moore LV, Diez Roux AV, Nettleton JA, Jacobs DR. Associations of the local food environment with diet quality—A comparison of assessments based on survey and geographic information systems. *Am J Epidemiol.* 2008; 167:917–924. [PubMed: 18304960]
19. Fisher BD, Strogatz DS. Community measures of low-fat milk consumption: Comparing store shelves with households. *Am J Public Health.* 1999; 89:235–237. [PubMed: 9949755]
20. Rose D, Richards R. Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. *Public Health Nutrition.* 2004; 7:1081–1088. [PubMed: 15548347]
21. Cheadle A, Psaty BM, Curry S, Wagner E, Diehr P, Koepsell T, Kristal A. Community-level comparisons between the grocery store environment and individual dietary practices. *Prev Med.* 1991; 20:250–261. [PubMed: 2057471]
22. Baker E, Schootman M, Barnidge E, Kelly C. The role of race and poverty in access to foods that enable individuals to adhere to dietary guidelines. *Prev Chronic Dis.* 2006; 3:A76. [PubMed: 16776877]
23. Cassady D, Jetter KM, Culp J. Is price a barrier to eating more fruits and vegetables for low-income families? *J Am Diet Assoc.* 2007; 107:1909–1915. [PubMed: 17964310]
24. Horowitz CR, Colson KA, Hebert PL. Barriers to buying healthy foods for people with diabetes: Evidence of environmental disparities. *Am J Public Health.* 2004; 94:1549–1554. [PubMed: 15333313]
25. Zenk SN, Schulz A, Israel BA, James SA, Bao S, Wilson ML. Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan. *Ethn Dis.* 2006; 16:275–280. [PubMed: 16599383]
26. Age-adjusted death rates for ten leading causes by race and sex, Detroit city, Wayne county residents, Michigan. Michigan Department of Community Health; 2007. Web site http://www.mdch.state.mi.us/pha/osr/chi/Deaths/leadadj/ADJMCD.asp?DxId_3&CoName_Detroit%20City&CoCode_1749
27. Age-adjusted death rates for ten leading causes by race and Sex: Michigan residents. Michigan Department of Community Health; 2007. Web site. http://www.mdch.state.mi.us/pha/osr/chi/Deaths/leadadj/Adjstate.asp?DxId_0&CoName_Michigan&CoCode_0
28. Schulz AJ, Kannan S, Dvorchak JT, Israel BA, Allen A 3rd, James SA, House JS, Lepkowski J. Social and physical environments and disparities in risk for cardiovascular disease: The Healthy Environments Partnership conceptual model. *Environ Health Perspect.* 2005; 113:1817–1825. [PubMed: 16330371]

29. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. *Am J Public Health*. 2005; 95:660–667. [PubMed: 15798127]
30. Sugrue, TJ. *The Origins of the Urban Crisis: Race and Inequality in Postwar Detroit*. Princeton, NJ: Princeton University Press; 1996.
31. Farley, R.; Danziger, S.; Holzer, HJ. *Detroit Divided*. New York, NY: Russell Sage Foundation; 2000.
32. Glaeser, EL.; Vigdor, JL. *Racial Segregation in the 2000 Census: Promising News*. Washington, DC: Brookings Institution; 2001.
33. Schulz AJ, Williams D, Israel B, Lempert L. Racial and spatial relations as fundamental determinants of health in Detroit. *Milbank Q*. 2002; 80:677–707. [PubMed: 12532644]
34. Schulz AJ, Zenk S, Odoms-Young A, Hollis-Neely T, Nwankwo R, Lockett M, Ridella W, Kannan S. Healthy eating and exercising to reduce diabetes: Exploring the potential of social determinants of health frameworks within the context of community-based participatory diabetes prevention. *Am J Public Health*. 2005; 95:645–651. [PubMed: 15798125]
35. [Accessed February 24, 2010] Questionnaires and screeners: Block '98 food frequency questionnaires. NutritionQuest. Web site.
http://www.nutritionquest.com/products/questionnaires_screeners.htm
36. Saelens BE, Sallis JF, Black JB, Chen D. Neighborhood-based differences in physical activity: An environmental scale evaluation. *Am J Public Health*. 2003; 93:1552–1558. [PubMed: 12948979]
37. Echeverria SE, Diez Roux AV, Link BG. Reliability of self-reported neighborhood characteristics. *J Urban Health*. 2004; 81:682–701. [PubMed: 15466849]
38. Kirtland KA, Porter DE, Addy CL, Neet MJ, Williams JE, Sharpe PA, Neff LJ, Kimsey CD Jr, Ainsworth BE. Environmental measures of physical activity supports: Perception versus reality. *Am J Prev Med*. 2003; 24:323–331. [PubMed: 12726870]
39. Michigan Department of Agriculture. [Accessed February 11, 2010] homepage.
<http://www.michigan.gov/mda>
40. Rubin, D. *Multiple Imputation for nonresponse in Surveys*. New York, NY: Wiley; 1987.
41. Raudenbush, DSW.; Bryk, DAS. *Hierarchical Linear Models: Applications and Data Analysis Methods*. 2. Thousand Oaks, CA: Sage Publications; 2002.
42. Examining the impact of food deserts on public health in Chicago. Mari Gallagher Research and Consulting Group; Web site.
http://www.mari Gallagher.com/site_media/dynamic/project_files/Chicago_Food_Desert_Report.pdf
43. Treuhart, S.; Hamm, MW.; Litjens, C. [Accessed March 1, 2010] Healthy food for all: Building equitable and sustainable food systems in Detroit and Oakland.
<http://www.policylink.org/atf/cf/%7B97C6D565-BB43-406D-A6D5-ECA3BBF35AF0%7D/Healthy%20Food%20For%20All-8-19-09-FINAL.pdf>
44. Franco M, Diez Roux AV, Glass TA, Caballero B, Brancati FL. Neighborhood characteristics and availability of healthy foods in Baltimore. *Am J Prev Med*. 2008; 35:561–567. [PubMed: 18842389]
45. Wiig K, Smith C. The art of grocery shopping on a food stamp budget: Factor influencing the food choices of low-income women as they try to make ends meet. *Public Health Nutr*. 2008; 12:1726–1734. [PubMed: 19068150]
46. Flournoy, R. [Accessed May 21, 2010] Healthy food, healthy communities: Promising strategies to improve access to fresh, healthy food and transform communities.
http://www.policylink.org/atf/cf/%7B97c6d565-bb43-406d-a6d5-eca3bbf35af0%7D/HFHC_SHORT_FINAL.PDF
47. Glanz K, Yaroch AL. Strategies for increasing fruit and vegetable intake in grocery stores and communities: Policy, pricing, and environmental change. *Prev Med*. 2004; 39(suppl):S75–S80. [PubMed: 15313075]
48. Song H-J, Gittelsohn J, Kim M, Suratkar S, Sharma S, Anliker J. A corner store intervention in a low-income urban community is associated with increased availability and sales of some healthy foods. *Public Health Nutr*. 2009; 12:2060–2067. [PubMed: 19402943]

49. Gittelsohn J, Suratkar S, Song H-J, Sacher S, Rajan R, Rasooly IR, Bednarek E, Sharma S, Anliker JA. Process evaluation of Baltimore healthy stores: A pilot health intervention program with supermarkets and corner stores in Baltimore City. *Health Promot Pract*. 2010; 11:723–732. [PubMed: 19144859]

Socio-demographic characteristics of all participants (n=919) and for participants living in neighborhoods with no store, one store, and two stores carrying 5 varieties of dark-green and orange vegetables, in a study examining the relationship between observed neighborhood availability and individual consumption of dark-green and orange vegetables among low- to moderate-income and ethnically diverse adults in Detroit, MI

Table 1

Characteristic	Overall (n=919)	No. of Stores Carrying 5 Varieties of Dark-Green and Orange Vegetables			P value
		No store (n=583)	1 store (n=212)	2 stores (n=124)	
Age (mean±SE) ^a	46.3±0.8	46.7±0.8	45.3±2.5	45.8±1.9	0.700
Female (%)	52.3	53.1	49.5	52.7	0.584
Race/ethnicity (%)					
African American	56.8	61.1	72.4	11.6	0.078
Latino	22.2	16.1	12.3	66.2	
White	18.8	20.3	13.1	21.0	
Education (%)					
<12 y	36.9	37.6	24.8	53.7	0.066
12y	29.1	27.7	36.2	24.1	
>12y	32.8	33.7	38.3	20.1	
Annual per capita household income ^b (%)					
<\$4,500	25.1	24.6	23.8	29.8	0.584
\$4,500–7,500	27.4	27.9	25.2	28.6	
\$7,501–16,200	25.2	25.1	24.9	26.2	
>\$16,201	22.3	22.4	26.1	15.3	
Owens					
automobile (%)	67.1	65.4	68.9	71.9	0.469
Owens home (%)	48.5	49	45.3	51.4	0.533
Married (%)	26.4	25.1	24.1	35.9	0.356
Years of neighborhood residence (mean±SE)	18.2±0.7	18.9±0.8	17.4±1.8	16.3±1.5	0.411

^aSE=standard error

^b Annual per capita household income=household income divided by number of individuals in household.

Table 2

Multilevel regression results of the association between neighborhood availability and daily intake (servings) of dark-green and orange vegetables, controlling for individual socio-demographic characteristics, in a study examining the relationship between observed neighborhood availability and individual consumption of dark-green and orange vegetables among low- to moderate-income and ethnically diverse adults in Detroit, MI

No. of stores carrying 5 varieties of dark-green and orange vegetables	$\beta \pm SE^a$	Predicted mean daily intake (servings) of dark-green and orange vegetables ^b	P value
No store (n=103)	-.17 ±	0.08 0.82	0.047 *
One store (n=25)	-.10 ±	0.10 0.89	0.331
Two stores (n=18)	Reference 0.99		

^aSE=standard error.

^bMean dark-green and orange vegetable intake is adjusted for individual socio-demographic characteristics (age, sex, race/ethnicity, education, annual household income adjusted for number of individuals living in household, marital status, car ownership, number of years of neighborhood residence, and home ownership).

* P<0.05