Fruit and Vegetable Intake in African Americans
Income and Store Characteristics

Shannon N. Zenk, PhD, Amy J. Schulz, PhD, Teretha Hollis-Neely, BA, Richard T. Campbell, PhD, Nellie Holmes, Gloria Watkins, Robin Nwankwo, MPH, RD, CDE, Angela Odoms-Young, PhD

Background: The purpose of this study was to examine whether the characteristics of retail food stores where African-American women shopped mediated the association between their income and intake of fruits and vegetables. Food store characteristics included store type (supermarket, specialty store, limited assortment store, independent grocer), store location (suburbs, city of Detroit), and perceptions of the selection/quality and affordability of fresh produce for sale.

Methods: The analysis drew upon data from a probability sample of 266 African-American women living in 2001 in eastside Detroit, which had no supermarkets. Structural equation modeling was used to calculate a path model of direct and indirect effects.

Results: Women shopping at supermarkets and specialty stores consumed fruit and vegetables more often, on average, than those shopping at independent grocers. More positive perceptions of the selection/quality, but not affordability, of fresh produce at the retail outlet where they shopped was positively associated with intake, independent of store type and location as well as age, per capita income, and years of education. The results suggested an indirect association between income and fruit and vegetable intake; women with higher per capita incomes were more likely to shop at supermarkets than at other grocers, which in turn was associated with intake.

Conclusions: Previous studies have shown that few supermarkets are located in the city of Detroit, a symptom of economic divestment over the past several decades. Results of this study suggest this may have negative implications for dietary quality, particularly among lower-income women.

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Introduction

Research has documented a protective effect of fruit and vegetable intake against a number of chronic diseases, including certain cancers, ischemic stroke, and coronary heart disease.[1–6] People with higher incomes and greater educational attainment tend to consume more fruit and vegetables than those who are less affluent and less educated.[7–10] In addition, recent published studies have suggested that closer proximity to a chain supermarket is positively associated with fruit and vegetable intake or overall dietary quality.[11–13]

These studies on relationships between supermarket proximity and diet imply that having a supermarket nearby facilitates the purchase of healthy foods (e.g., fresh produce), either during major shopping trips or to restock between major purchases. Indeed, larger food stores generally have better availability and selection, superior quality, and lower prices when compared to smaller food stores.[14–18] Availability,[19–21] quality,[22–23] and prices[24–28] of foods influence food purchasing decisions and dietary practices.

Low-income and predominately African-American neighborhoods may have particularly poor access to healthy foods. Several studies have shown that supermarkets are less accessible in low-income neighborhoods when compared with higher-income neighborhoods,[17,29–32] and in predominately African-American neighborhoods relative to racially heterogeneous and predominately white neighborhoods.[32,33] One study found that the distance to the nearest supermarket was similar among the least economically disadvantaged

From the Program in Cancer Control and Population Sciences (Zenk), and Department of Epidemiology and Biostatistics (Campbell), University of Illinois at Chicago, Chicago, Illinois; Department of Health Behavior and Health Education, University of Michigan (Schulz), and University of Michigan Medical School (Nwankwo), Ann Arbor, Michigan; Detroit Department of Health and Wellness Promotion (Neely), and East Side Village Health Worker Partnership (Holmes, Watkins), Detroit, Michigan; Public and Community Health Program, Northern Illinois University (Odoms-Young), DeKalb, Illinois

Address correspondence and reprint requests to: Shannon N. Zenk, Institute for Health Research and Policy, University of Illinois at Chicago, 1747 W. Roosevelt Rd., M/C 275, Chicago IL 60608. E-mail: szenk@uic.edu.

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African-American and white neighborhoods in metropolitan Detroit, whereas among the most economically disadvantaged neighborhoods, the nearest supermarket was significantly farther away in neighborhoods in which African Americans resided than in white neighborhoods.[34] Additionally, some, but not all, studies have indicated that even among stores of the same type, those located in economically disadvantaged and inner-city neighborhoods have less availability, more limited selection, and higher prices of foods for sale than those in more affluent and suburban neighborhoods, respectively.[14–17,30,35–39]

These studies raise several questions. Is the type of store at which people shop associated with dietary quality? Does access to retail outlets that are larger and that have superior selection, quality, and affordability of healthy foods help to explain why people with higher incomes tend to have better overall dietary quality? In neighborhoods with limited availability of supermarkets, do people with more individual resources (e.g., income, automobile) have better access to supermarkets outside their neighborhood? To begin to address these issues, we drew upon data from a sample of African-American women residing in an economically disadvantaged community with no supermarkets.

Figure 1 displays the conceptual model tested in this study. The hypotheses follow:

1. Shopping at a supermarket (vs independent grocer), shopping in the suburbs (vs the city), and higher ratings of selection, quality, and affordability of fresh produce at the store where they shopped will be directly and positively associated with fruit and vegetable intake.
2. Shopping at a supermarket and in the suburbs will be indirectly associated with greater intake through better perceived selection, quality, and affordability of fresh produce for sale.
3. Income will be positively associated with fruit and vegetable intake both directly and indirectly by increasing access to supermarkets and suburban stores, and thus to a better selection of high-quality, affordable fresh produce.

Control variables included years of education and age. Because income confounds human capital with raw purchasing power, controlling for education allowed for a more transparent examination of purchasing power on store location, store type, and intake. Age was controlled because in some previous studies it was correlated with both income and intake.

Methods

Setting and Sample

The setting for this study was a geographically defined area of Detroit's eastside, a community that was 97% African American, and had 35% of households reporting incomes below the poverty line in 2000. Community residents participating in the East Side Village Health Worker Partnership (ESVHWP) identified inadequate access to fresh produce as a barrier to healthy eating in eastside Detroit.[40] Indeed, an observational study of the larger eastside Detroit community revealed no chain supermarkets, 13 independent grocery stores (9 large and 4 small), and 93 liquor stores for ≥90,000 residents.[41] In comparison, a nearby racially heterogeneous (African-American and white), middle-income community had 19 grocery stores, including 8 chain supermarkets, and only 18 liquor stores for approximately 78,000 residents. Eastside Detroit also averaged significantly poorer-quality fresh produce for sale at stores than the comparison community.[41]

A 2001 follow-up survey, conducted by the ESVHWP, of women living in eastside Detroit provided data for this study. The original 1996 survey involved a probability sample of women living in eastside Detroit (n =700), 97% of whom self-identified as African-American. The completed interview rate was 81%. In 2001, the ESVWHP attempted to reinterview all respondents still living in Detroit (n =456) and completed interviews with 80% (n =365). The analyses reported in this paper include African-American respondents residing in the original study area in 2001, and who had no missing data for any study variable (n =266). Path model results including

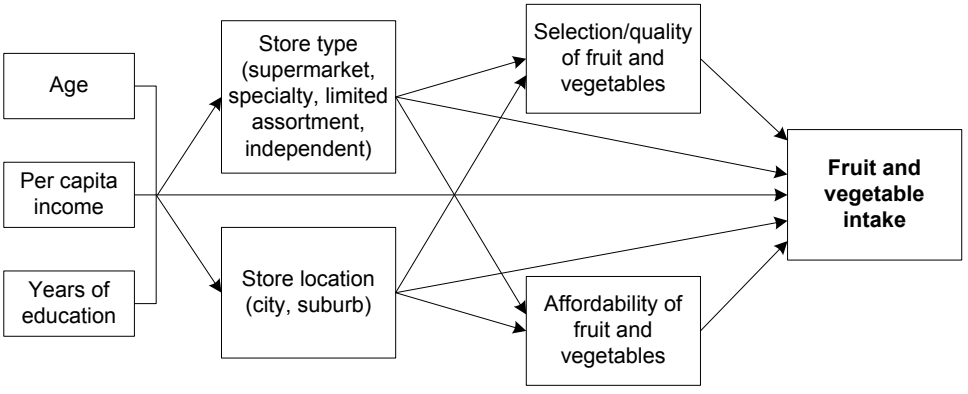

Figure 1. Conceptual model of food store characteristics as mediators of relationships between income and fruit and vegetable intake.

women who had moved out of the study area (n =60) were similar to those presented here.

Measures

Sociodemographics. Age was measured in years. Number of years of education measured educational attainment. Annual family income was measured on a ten-point scale, from <$2,000 (1) to >$50,000 (10); the midpoint of each category was used ($60,000 for the upper category). Annual family income divided by the number of people in the household estimated per capita income; the analysis used the natural log of per capita income.

Food-store characteristics. Respondents provided the name and location (closest street intersection) of the place where they purchased the most food for themselves and their families. Stores were classified by location (city of Detroit vs suburbs) and by type, based on name recognition and guided by definitions from the Food Marketing Institute.[42] Supermarkets included full-line grocers, supercenters, and wholesale clubs associated with a national or regional chain (≥11 stores).[42] (Results of analyses excluding wholesale clubs from this category were similar.) Full-line grocers carry groceries, meat, and produce (e.g., Kroger).[42] Supercenters have ≥40,000 square feet of selling area, and an expanded selection of nonfood products (e.g., Super Kmart).[42] Wholesale clubs require membership, and offer varied selection but limited product variety (e.g., Sam's Club).[42] Specialty stores included fruit and vegetable markets and meat markets. Limited-assortment stores included low-priced grocers that provide a limited number of items, including few if any perishables (e.g., Save-A-Lot).[42] Independent grocers were defined as full-line grocers not affiliated with a chain.

Respondents rated the selection, quality, and affordability of fresh fruit and vegetables at the store where they shopped. Single items ranging from "poor" (1) to "excellent" (4) measured selection and quality. A single item ranging from "very affordable" (1) to "not at all affordable" (4) measured affordability; responses were reverse coded so that higher scores correspond to more positive perceptions. (Because selection and quality were collinear in preliminary regression models, the mean of the two items was used.)

Fruit and vegetable intake. The fruit and vegetable module from the 2001 Behavioral Risk Factor Surveillance System Survey measured frequency of fruit and vegetable intake.[43] Ten was used as the maximum number for nine women reporting more than that number.

Data Analysis

In 2004, Mplus 3 estimated a path model of direct and indirect effects using maximum likelihood (Muthen & Muthen, Los Angeles CA, 2004). Standard errors are robust to non-normality.[44] Three goodness-of-fit statistics evaluated fit of the path model. The chi-square test is mean and variance adjusted for non-normality.[44] A nonsignificant chi-square test indicates a good fit, although this is difficult to achieve with larger sample sizes.[45] A root mean squared error of approximation (RMSEA) of <0.05 indicates a good fit.[46] Finally, the comparative fit index (CFI) can range between 0 and 1, with a value above 0.95 indicating a good fit.[47]

Results

Descriptive Statistics

The mean age was almost 49 years (Table 1). The mean years of education were 12.01. A third had not completed high school, and 6% had a college degree. The median annual family income was $17,500. The women consumed fruit and vegetables an average of 3.70 times daily; 23.7% consumed produce five or more times daily. Mean ratings of selection/quality and affordability ranged from 1 to 4, with a mean of 3.27 and 3.18, respectively.

The women reported 45 different stores as the primary place that they purchased food; 44.4% of these stores were in Detroit. Most shopped at an independent grocer or supermarket (Table 2). Among the women shopping in Detroit (n =183), 76.5% frequented independent grocers and 15.8% frequented supermarkets. In contrast, among the suburban shoppers (n =83), 85.5% frequented supermarkets and none frequented independent grocers. The women lived approximately 2.5 miles from the nearest Detroit supermarket, and 4 miles from the nearest suburban supermarket (based on the straight-line distance from the centroid, or geometric center, of the study area to the nearest supermarket).

Direct Effects

Table 3 presents direct effects of per capita income, years of education, and food-store characteristics (store

Table 1. Descriptive statistics for study variables (n=266)

	Mean	Median	Standard deviation	Minimum	Maximum
Age	48.57	44.84	16.30	23	94
Years of education	12.01	12.00	2.40	3	17
Annual family income ($)	20,556	17,500	15,515	1000	60,000
Natural log per capita family income	8.65	8.84	1.01	5.12	10.71
Rating of selection/quality of fresh produce at store where shop for groceries	3.27	3.00	0.71	1	4
Rating of affordability of fresh produce at store where shop for groceries	3.18	3.00	0.58	1	4
Number of times fruits and vegetables consumed daily	3.70	3.24	2.42	0.04	10.00

Table 2. Number and percentage of respondents by store type and store location

	Supermarket	Specialty store	Limited-assortment store	Independent grocery store	Total
City of Detroit					
n	29	6	8	140	183
% within type	29.0	85.7	42.1	100.0	
% within location	15.8	3.3	4.4	76.5	
Suburbs					
n	71	1	11	0	83
% within type	71.0	14.3	57.9	0	
% within location	85.5	1.2	13.3	0	
Total					
n	100	7	19	140	266

type, store location, and ratings of selection/quality and affordability of fresh produce) on frequency of fruit and vegetable intake. Higher per capita income was associated with shopping at a supermarket relative to other grocers ($p<0.01$), but not with shopping in the suburbs, controlling for age and educational attainment. More years of education were associated with shopping at a supermarket (vs other grocers) ($p<0.01$) and in the suburbs (vs the city) ($p<0.05$), adjusting for age and per capita income.

Suburban store location was associated with significantly higher ratings of selection/quality ($p<0.001$), but not affordability, adjusting for store type (Table 3). Controlling for store location, women shopping at independent stores tended to rate selection/quality and affordability higher than supermarket shoppers ($p<0.10$ and $p<0.001$, respectively), and significantly lower than specialty store shoppers ($p<0.001$). Comparison of unadjusted means, however, showed that ratings of selection/quality tended to be higher among supermarket shoppers ($p<0.10$) (analyses not shown).

There was no direct effect of per capita income on fruit and vegetable intake (Table 3). The direct positive association between years of education and intake was marginally significant ($p<0.10$). On average, women shopping at supermarkets and specialty stores consumed fruit and vegetables 1.22 and 2.37 more times daily, respectively, than those shopping at independent grocery stores, adjusting for age, per capita income, years of education, store location, and ratings of selection/quality and affordability ($p<0.001$ and $p<0.05$, respectively). Suburban store location was not directly related to intake adjusting for the other variables. A one-unit increase in ratings of selection/quality was associated with consuming produce 0.43 more times daily, net of the other variables ($p<0.05$), although affordability was not associated with intake.

Indirect Effects

Table 4 shows results of tests for indirect effects. Both per capita income and years of education were indi-

Table 3. Direct effects on endogenous variables

	Supermarket b (SE)	Specialty store b (SE)	Limited assortment store b (SE)	Suburban store location b (SE)	Selection/quality of fresh produce b (SE)	Affordability of fresh produce b (SE)	Fruit and vegetable intake b (SE)
Age	<0.01 (<0.01)	<0.01 (<0.01)	<0.01 (<0.01)	<0.01 (<0.01)			<0.01 (<0.01)
Per capita income (natural log)	**0.09 (0.03)*****	−0.01 (0.01)	−0.02 (0.02)	0.03 (0.03)			−0.10 (0.15)
Years of education	**0.04 (0.01)*****	**0.01 (0.01)***	−0.01 (0.01)	**0.03 (0.01)****			**0.13 (0.07)***
Supermarket (I. store=0)					**−0.16 (0.08)***	**−0.26 (0.07)******	**1.22 (0.33)******
Specialty store (I. store=0)					**0.77 (0.09)******	**0.63 (0.14)******	**2.37 (1.06)****
Limited assortment store (I. store=0)					−0.23 (0.15)	**0.43 (0.11)******	0.66 (0.64)
Suburban store location (city=0)					**0.54 (.08)******	0.06 (0.07)	−0.54 (0.36)
Selection/quality of fresh produce							**0.43 (0.20)****
Affordability of fresh produce							−0.05 (0.26)

*$p<0.10$ (bolded); **$p<0.05$ (bolded); ***$p<0.01$ (bolded); ****$p<0.001$ (bolded).
b, unstandardized regression coefficients; I, independent; SE, standard error.

Table 4. Indirect effects on frequency of fruit and vegetable intake per day

	Mediator	Fruit and vegetable intake b (SE)
Per capita income (natural log)[a]	Supermarket	**0.10 (0.05)***
	Specialty store	−0.01 (0.03)
	Limited-assortment store	−0.01 (0.01)
	Suburban store location	−0.02 (0.02)
Years of education[a]	Supermarket	**0.05 (0.02)***
	Specialty store	0.03 (0.02)
	Limited-assortment store	<−0.01 (0.01)
	Suburban store location	−0.02 (0.01)
Supermarket (I store=0)	Selection/quality of fresh produce	−0.07 (0.05)
	Affordability of fresh produce	0.01 (0.07)
Specialty store (I store=0)	Selection/quality of fresh produce	**0.33 (0.16)***
	Affordability of fresh produce	−0.03 (0.17)
Limited-assortment store (I store=0)	Selection/quality of fresh produce	−0.10 (0.08)
	Affordability of fresh produce	−0.02 (0.11)
Suburban store location (city=0)	Selection/quality of fresh produce	**0.23 (0.11)***
	Affordability of fresh produce	<−0.01 (0.02)

[a]None of the indirect effects on fruit and vegetable intake via store type **and** selection/quality or affordability of fresh produce were statistically significant.
*$p<0.05$ (bolded).
b, unstandardized regression coefficients; I, independent.

rectly and positively related to frequency of intake via shopping at a supermarket ($p<0.05$). Both shopping at a specialty store (vs independent grocer) and shopping in the suburbs (vs city) were indirectly associated with greater intake through higher ratings of the selection/quality of fresh produce for sale ($p<0.05$).

Model Fit

The chi-square test for fit of the path model was 149.31 ($p<0.001$), the RMSEA was 0.26, and the CFI was 0.28.

Discussion

Limitations

This study has several limitations. First, due to the cross-sectional nature of the data, it is not possible to determine the causal ordering of relationships. The frequency of women's intake of fruit and vegetables may have influenced their decisions on where to shop and their perceptions of the selection/quality of produce for sale. Second, it is difficult to discern whether the location and type of store at which women shopped reflected different access (e.g., related to transportation) or personal preferences. However, that no suburban shopper frequented an independent grocer (vs 76.5% of Detroit shoppers) lends support to the interpretation that it may be access. A third limitation is that the data provide limited insight into the complexities of these relatively low-income women's travel and shopping patterns—how they incorporate shopping into their household and work responsibilities (such as through "trip chaining" to save time or resources), or how they navigate public transportation or secure private transportation to the store. The survey did not include questions on car ownership or transportation.

Because selection, quality, and prices of foods tend to be better at larger food outlets,[17] it is useful to distinguish larger and smaller grocers. Comprehensive data were not available for other common indicators of store size (e.g., annual sales, number of employees, square footage).[48] As a result, chain affiliation served as a proxy for store size based on evidence that chains are generally larger than independent grocers.[48] Therefore, use of chain affiliation as a proxy for larger store size and lack of differentiation between independent grocers is another limitation of this study.

Fifth, selection, quality, and affordability were measured by self-report rather than by independent observation, which may have biased results in favor of a relationship between selection/quality and intake. Sixth, findings regarding specialty stores should be interpreted cautiously due to the small number of women who shopped there ($n=7$). Seventh, store type and location were based on where respondents purchased the most food, not necessarily where they bought produce.

Finally, model fit was poor, as evidenced by the goodness-of-fit statistics. However, coefficients of a path model including the missing paths between sociodemographic characteristics (income, years of education, age) and selection/quality and affordability were the same as those presented here. Thus, non-normality due to categorical mediators (store type, location) resulted in a poor fit for the hypothesized model, and the results presented here are unbiased.

Income, Food Store Characteristics, and Fruit and Vegetable Intake

Despite the above limitations, this study contributes to an understanding of relationships between income, the char-

acteristics of stores where groceries were purchased, and fruit and vegetable intake among women living in an economically disadvantaged community. Women shopping at supermarkets and specialty stores consumed fruit and vegetables more often, on average, than their counterparts shopping at independent grocers. More positive perceptions of selection/quality, but not affordability, of fresh produce for sale were also directly and positively related to frequency of fruit and vegetable intake independent of store type and location as well as age, per capita income, and educational attainment. These findings suggest that the type of store at which the women shopped (and quite possibly to which they had access) and the selection/quality of fresh produce for sale may have influenced their fruit and vegetable intake. Given that women are often the main household food shoppers,[49] the stores and foods to which they have access may not only affect their personal nutrition, but also the nutrition of other household members. Contrary to our hypothesis, perceptions of better selection/quality and affordability did not explain why supermarket shoppers consumed more fruit and vegetables than independent store shoppers. Nonetheless, the results did suggest that shopping at specialty stores and in the suburbs indirectly contributed to greater intake due to better perceived selection/quality of fresh produce. Further research is needed to examine why shopping at a supermarket is associated with greater intake of fruit and vegetables.

Contrary to several studies,[7–10] no direct effect of income on fruit and vegetable intake was observed. This may be due to the study sample, which included women living in only one area of Detroit, with a relatively compressed range of incomes. Still, the results suggested an indirect effect—women with higher incomes were more likely to shop at supermarkets than other grocers, which in turn was positively associated with intake. Thus, even among a relatively low-income population living in a community with no supermarkets, small differences in income appear to affect access to supermarkets located outside their neighborhood, which seem to be important nutritional resources.

Given the finding that women shopping at supermarkets consumed fruit and vegetables more often on average than those shopping at independent grocers, the limited availability of supermarkets in eastside Detroit and possibly other low-income communities and communities of color[17,32–34] may adversely affect fruit and vegetable intake and consequently health, particularly among low-income women who may be unable to access supermarkets located outside their neighborhood. The lack of supermarkets in eastside Detroit is a symptom of white flight that began in earnest in the 1950s with the suburbanization of manufacturing jobs and subsequent economic divestment from this predominately African-American community.[34,50–52] Yet, central cities like Detroit are underserved by grocery retailers, with research demonstrating enormous purchasing power per square mile and large unmet demand, even in low-income neighborhoods.[53–55] Qualitative and quantitative studies in eastside Detroit, as well as in other low-income and predominately African-American neighborhoods, suggest that local grocery stores tend to have inferior quality and selection of fresh produce.[40–41,54–59]

Therefore, cultivating the development of supermarkets and specialty stores, such as fruit and vegetable markets, and improving the selection of high-quality fresh produce at grocery stores already present in low-income and African-American neighborhoods may have positive impacts on intake. Food store development could be promoted in these neighborhoods through policies that reduce store development costs (e.g., tax abatements, low-cost loans) and operating costs (e.g., improve community security) for retailers.[54,60,61] The involvement of community members in the development phase and in the long term could benefit new developments in terms of enhanced community relations, and also help to ensure that stores are responsive to community needs.[54,60,61] Research that demonstrates community demand and provides a better understanding of the perspectives of local store owners could facilitate efforts to increase the availability of high-quality fresh produce at existing stores.

Fruit and vegetable intake, and dietary patterns in general, are best understood in a social ecologic framework that recognizes these practices as a function of factors at multiple levels: individual (e.g., taste/food preferences, time and convenience to prepare, self-efficacy, nutrition knowledge)[8,22,26,61–68]; interpersonal[28,65,69–70]; home, neighborhood, and workplace environments (e.g., accessibility of food stores, food prices, availability of foods at home, and job demands and manageability)[11,24,32,63,71]; and policy (e.g., food subsidies).[72,73] Still, it is important to recognize the pivotal role of fundamental social factors, such as racial and economic segregation, in shaping behavioral influences at these other levels.[51,74–75] For example, several studies have shown that the spatial distribution of nutritional resources such as supermarkets and adverse nutritional exposures like fast food restaurants across neighborhoods follows the spatial distribution of race and wealth, creating neighborhood food environments that disadvantage African Americans and the poor.[17,32–34,76,79] Many individual-level determinants like food preferences are ultimately shaped by fundamental social factors as well. Because the food environment can affect food preferences,[80,81] and childhood eating patterns influence those held later as adults,[8,56,66,82] living in low-income or predominately African-American neighborhoods with greater access to fast food restaurants[76–78] and less access to supermarkets,[17,32–34] particularly during childhood, can hamper learning preferences for healthy foods like fruit and vegetables. Thus, challenging racial/ethnic stereotypes and prejudice, and advocating for policies that reduce racial residential segregation and accelerate the economic development of economically

What This Study Adds . . .

Recent studies have suggested that proximity to a supermarket is associated with better dietary quality.

Little is known about relationships between the characteristics of the stores where people shop and dietary patterns.

In this study, we found that African-American women who shopped at supermarkets (vs independent grocer) and who rated their store's selection/quality of fresh produce higher consumed fruit and vegetables more often.

This study provides additional evidence that supermarkets may be important nutritional resources.

disadvantaged neighborhoods may be critical for optimizing healthy eating.

Conclusion

This study suggests that poor access to supermarkets in African-American neighborhoods, a symptom of economic divestment, may have negative implications for residents' fruit and vegetable intake. The study raises many questions in need of further research. Studies including neighborhoods and individuals with greater socioeconomic diversity are needed to test relationships among income, food store characteristics (measured objectively and through self-report), and a range of other dietary behaviors. Studies including neighborhoods and individuals with more socioeconomic diversity are needed to test whether higher income confers greater benefits in terms of dietary quality to residents in low-income neighborhoods than to those in more affluent neighborhoods, with better access to retail stores. Relatively few studies have included measures of the food environment with individual- and interpersonal-level determinants and tested for mediating effects or their relative contributions to fruit and vegetable intake. This would also be an informative direction for research. Finally, there is a need for research that documents the effects of changes in the food environment over time on dietary patterns.

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