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Socio-economic status, neighborhood food environments and consumption of fruits and vegetables in New York City

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Abstract

Objective—Recommendations for fruit and vegetable consumption are largely unmet. Lower socio-economic status (SES), neighborhood poverty and poor access to retail outlets selling healthy foods are thought to predict lower consumption. The objective of this study was to assess the inter-relationships between these risk factors as predictors of fruit and vegetable consumption.

Design—Cross-sectional multi-level analyses of data on fruit and vegetable consumption, socio-demographic characteristics, neighborhood poverty and access to healthy retail food outlets.

Setting—Survey data from the 2002 and 2004 New York City Community Health Survey linked by residential zip code to neighborhood data.

Subjects—15,634 adult survey respondents.

Results—Overall 9.9% of respondents reported eating 5 servings of fruits or vegetables in the day prior to the survey. Among women the odds of eating 5 servings increased with higher income and among men and women with higher educational attainment. Compared to women with less than a high school education, the OR was 1.12 (95% CI 0.82, 1.55) for high school graduates, 1.95 (95% CI 1.43, 2.66) for those with some college education and 2.13 (95% CI 1.56, 2.91) for college graduates. The association between education and fruit and vegetable consumption was significantly stronger for women living in lower versus higher poverty Zip codes (p for interaction <0.05). The density of healthy food outlets did not predict consumption of fruits or vegetables.

Conclusions—Higher SES is associated with higher consumption of produce, an association that, in women, is stronger for those residing in lower poverty neighborhoods.

INTRODUCTION

High fruit and vegetable consumption has been shown to be protective against cardiovascular disease^(1, 2) and Type II diabetes^(3–5), and it correlates with low body mass index (BMI)^(6, 7). Given the striking increase in obesity in the United States in recent years⁽⁸⁾, it comes as no surprise that fruit and vegetable consumption is low and, by some measures at least, is declining⁽⁹⁾. Higher individual or household socio-economic status (SES) is consistently associated with fruit and vegetable consumption; however, the role of neighborhood contextual factors is less well understood^(10, 11). Recent research has highlighted neighborhood resources, in particular the food environment, as potential influences on healthy behaviors such as fruit and vegetable consumption^(12, 13). There is some evidence that neighborhood SES is associated with consumption of a healthy diet⁽¹⁴⁾, that low-income neighborhoods have fewer supermarkets and other food outlets selling healthy foods^(15–18), and that access to supermarkets or large grocery stores is associated with healthy diets⁽¹⁹⁾ or consumption of fruits and vegetables^(20–25). However, the evidence has not been uniformly positive, with some studies finding null effects for these neighborhood contextual measures^(25, 26).

Although most studies have examined the independent effects of individual- and neighborhood-level characteristics, it is possible that individual- and neighborhood-level factors interact in predicting healthy behaviors such as diet^(10, 27). Individual income and education may provide economic resources and/or knowledge that motivates or enables healthy behavior, but these individual characteristics may not be expressed as such unless those individuals have access to a supportive environment. For instance, a high-SES individual who lives in a “food desert” may have the resources to purchase healthy foods but lack the opportunity to do so. Previous research found evidence of interactions between individual- and neighborhood-level SES in predicting BMI⁽²⁸⁾. The inverse association observed between higher individual-level SES and BMI was significantly stronger in low poverty as compared to high poverty neighborhoods, suggesting that in high poverty neighborhoods there were barriers to the actualization of the advantages afforded by a higher SES.

The current study conducts a parallel analysis to determine whether individual- and neighborhood-level SES interact to predict fruit and vegetable consumption. In addition, associations between neighborhood food access and fruit and vegetable consumption are assessed, and analyses are conducted to determine whether disparities in neighborhood food access explain interactions between individual- and neighborhood-level SES.

METHODS

Data for this study come from the 2002 and 2004 New York City (NYC) Community Health Survey (CHS) which is a random-digit dial telephone survey conducted annually by NYC’s Department of Health and Mental Hygiene (DOHMH)^(29–31). The 2002 (N=9,672) and 2004 (N=9,580) CHS surveys asked, “How many total servings of fruit and/or vegetables did you eat yesterday?” and the count of servings was recorded. The CHS is modeled after the Behavioral Risk Factor Surveillance System as a surveillance tool for health behaviors and conditions. The CHS sampling frame is based on United Hospital Fund (N=34) neighborhoods, which are administrative units comprised of two to eight contiguous Zip codes and are used for health surveillance and resource planning. Using the respondent’s self-reported residential Zip code, the 2002 and 2004 CHS data were pooled and linked to

geospatial data on Zip code level socio-demographic and built environment characteristics. Several Zip codes with low residential populations, and thus few CHS respondents, were merged with larger neighboring Zip codes to preserve the anonymity of the data. In instances where there were several neighboring Zip codes to which a small Zip code might be merged, Zip codes with the most similar socio-demographic characteristics were chosen as the merge partner. Zip code-level sample weights for the pooled 2002 and 2004 data were estimated by DOHMH using constrained raking to race/ethnicity and age and sex totals from the 2000 Census.

Analysis data on reported consumption were dichotomized to indicate those reporting eating 5 or more servings per day versus those eating less than 5 servings per day. This approach follows a commonly used threshold in public health interventions⁽³²⁾ and in the research literature⁽³³⁾. Individual-level measures of SES from the CHS were the ratio of family income to the Federal poverty threshold (US\$17,603 for a family of four) and educational attainment. The individual-level data collected in the CHS were augmented with several variables defined at the Zip code level. Three variables derived from the 2000 Census data reflected the neighborhood ethnic and economic context: (1) poverty rate, defined as the proportion of households below the federal poverty level; (2) percent of residents reporting black as their race; and (3) percent of residents reporting Hispanic as their ethnicity. Additionally as described previously, using 2005 Dun & Bradstreet business listing data, a measure of Zip code-level access to retail outlets selling healthful foods was created; the sum of supermarkets, fruit and vegetable markets and health food stores divided by the land area of the Zip code, a density measure that is conceptualized as access to “healthy food outlets.”⁽³⁴⁾ Previous work in NYC has shown that higher access to healthy food outlets is associated with lower BMI and obesity^(34, 35).

Multilevel models were estimated with individual characteristics of survey respondents treated as the level 1 variables and Zip code characteristics treated as level 2 variables. Statistical analyses of the cross-sectional data were performed using HLM 6, called from Stata 11. Multilevel logistic regression models were estimated to predict the odds that an individual consumed five or more servings of fruit and vegetables in the previous day. All multilevel models also included a random intercept for each Zip code, and adjusted for Zip code level sampling weights and survey year. Gender, age, race/ethnicity, marital status, and an indicator variable for the presence of children under the age of 18 in the household were individual-level variables thought to potentially act as confounders and were included in all models. Initial analyses were conducted in the overall sample and then stratified by sex.

To investigate the role of neighborhood poverty in modifying the relationship between individual-level SES and consumption of fruit and vegetables, separate analyses were conducted for those living in low-poverty and high-poverty Zip codes. Zip codes with a poverty rate above the median (18.8% in our sample) were classified as high-poverty; the balance was classified as low-poverty. A formal test of whether associations between individual-level SES indicators and fruit and vegetable consumption varied by Zip code poverty status (low-poverty versus high-poverty) was obtained from an interaction model which included; an ordered categorical variable for ratio of personal income to poverty level and an ordered categorical variable for educational attainment, an indicator variable for residence in a high versus low-poverty Zip code, interaction terms for each of the two ordered categorical individual-level SES variables and residence in high versus low-poverty Zip codes. The interaction model also included covariates for potential confounders described above and was run for the overall sample and for men and women separately. The p-value from the interaction terms were used to test whether the estimated increase in odds of eating 5 or more servings per unit change in the categorical predictor variables differed by Zip code level poverty status.

Additional analyses were conducted to determine whether the density of healthy food outlets was associated with consumption of fruit and vegetables and whether the density of healthy food outlets explained interactions between individual-level socio-economic status indicators and Zip code-level poverty status. The density of healthy food outlets was categorized using quartile cut points from the overall distribution across Zip codes.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the [name of the ethics committee removed for blinding]. Verbal informed consent was obtained from all subjects for the CHS phone survey.

RESULTS

Overall, 15,634 (81%) of those surveyed provided complete data for all covariates and the fruit and vegetable consumption question and provided residential Zip code information (see Table 1 for descriptive statistics and bivariate analyses). The proportion of respondents reporting eating five or more servings of fruits and vegetables was quite low – only 10.8% of women and 8.6% of men did so.

Table 2 gives results from a multilevel model applied to the full sample and to men and women separately. These results showed that individual characteristics that are associated with disadvantage – low income, low education, and minority status – were all strongly predictive of reduced fruit and vegetable consumption. The trend of increasing odds ratios for consumption of 5 servings of fruit and vegetables across categories of income was quite pronounced in females. In men there was not a pronounced trend; however compared to those in the lowest income group, those in the top income tier were significantly more likely to consume 5 servings of fruit and vegetables per day. The association between educational attainment and consumption of 5 servings of fruit and vegetables was similar in men and women. Overall none of the Zip code-level socio-demographic variables were associated with consumption of fruits and vegetables.

Table 3 presents results for the association between consumption of 5 servings of fruit and vegetables per day and individual-level income and education, estimated separately for those living in low- and high-poverty Zip codes. The goal of this stratification was to assess whether neighborhood context modified the association between individual-level measures of SES and consumption of 5 servings of fruit and vegetables. Among women, increasing income categories were associated with higher odds of consumption of 5 servings of fruit and vegetables for only those living in low-poverty Zip codes; however the formal test of interaction between individual level income and Zip code poverty did not reach statistical significance. A similar trend of increasing odds across categories of education was observed among women, which was significantly stronger for those living in low- versus high-poverty Zip codes. Among men, associations between income and consumption of 5 servings of fruit and vegetables were similar in low- and high-poverty Zip codes, however higher educational attainment predicted consumption for only those living in high-poverty Zip codes, although the formal test of interaction between individual education and Zip code poverty did not reach statistical significance.

Table 4 presents the association of produce consumption with individual-level income and education and Zip code-level density of healthy food outlets, overall and with stratification, by gender and Zip code poverty. The goal of these analyses was to determine whether Zip code-level access to retail outlets selling healthier foods predicted fruit and vegetable consumption and reduced the associations between fruit and vegetable consumption and individual-level income and education. The results showed that increasing quartiles of

healthy food outlet density were not associated with produce consumption in the full sample or in analyses stratified by gender and Zip code poverty level. Comparing results in Table 4 to those in Table 3, adjustment for access to retail outlets selling healthy foods did not appear to alter the associations between personal income and produce consumption or between education and produce consumption, and did not diminish differences in OR by strata of low versus high Zip code poverty.

In sensitivity analyses components of the healthy food outlets measure, the density of supermarkets and the density of fruit and vegetable markets, did not predict fruit and vegetable consumption. Analyses of the fruit and vegetable consumption as a continuous variable produced results consistent with those presented here.

DISCUSSION

Self-report of consumption of five or more servings of fruits and vegetables in the past day is relatively uncommon in NYC, with only 10% of study subjects reaching this threshold. By way of reference, the national average in 2002 for women was 29.3% and was 20.2% for men ⁽³⁶⁾. Furthermore, strong disparities were observed in the prevalence of fruit and vegetable consumption by individual-level income and educational attainment. Among women the trend of increasing fruit and vegetable consumption with increasing educational attainment was significantly stronger for those living in low poverty and compared to high poverty Zip codes. However, Zip code-level access to healthy food outlets was not associated with fruit and vegetable consumption in the previous day, did not explain associations between individual-level SES and diet, and did not explain interactions between educational attainment and Zip code level poverty observed among women.

The finding of associations between individual-level SES and produce consumption are consistent with prior work. Using NHANES data, Casagrande and colleagues showed that individuals with higher income and more education were substantially more likely to meet USDA guidelines for fruit and vegetable consumption ⁽⁹⁾. Two prior studies have utilized multilevel analyses to consider both individual- and neighborhood-level indicators of SES as predictors of fruit and vegetable consumption. Using NHANES III data, Dubowitz and colleagues found in a multilevel model that Census tract-level SES and individual-level education and family income were each positively associated with fruit and vegetable consumption ⁽¹⁰⁾. A study of women living in suburban Melbourne, Australia found that associations between education and fruit and vegetable consumption persisted after controlling for individual- and neighborhood-level factors ⁽³⁷⁾. In particular, they found that the neighborhood-level food environment, measured by the density of stores selling fruit and vegetables, did not predict fruit and vegetable consumption or explain the education gradient in consumption ⁽³⁷⁾. A subsequent analysis of these data showed that neighborhood-level disadvantage was associated with lower consumption of vegetables, but that variation in the neighborhood food environment did not account for this association ⁽²⁷⁾. In our analyses, high Zip code-level poverty did not predict fruit and vegetable consumption after control for indicators of individual SES.

Research has also examined associations between the food environment and consumption of a healthy diet, with most but not all studies finding that neighborhood-level measures of access to healthy food outlets are associated with higher consumption of fruits and vegetables ⁽²⁵⁾. However, in the current analysis, the density of healthy food outlets in the Zip code of residence did not predict consumption of five servings or more of fruits and vegetables and did not alter the effect estimates for associations between individual SES and produce consumption. More research is needed to understand whether these inconsistent

findings reflect differences in measurement and study design or true heterogeneity of effects across population or geographic context.

Analyses of interactions between individual-level SES and neighborhood-level poverty were motivated by a previous finding of interactions between individual- and Zip code-level measures of SES in predicting BMI ⁽²⁸⁾. This finding could reflect the greater availability of resources for healthy living, such as supermarkets or recreational facilities, in higher SES neighborhoods, which allow individuals to translate their individual SES into healthy diet and physical activity behaviors. Here, we tested whether similar interactions existed in predicting fruit and vegetable consumption, and whether access to healthy food outlets explained any such interactions. Overall, the pattern of associations between individual-level SES indicators and fruit and vegetable consumption by strata of Zip code-level poverty paralleled those observed for BMI, although in most cases the differences in stratum specific results did not meet criteria for statistical significance. However for education, the association between increasing level of education and produce consumption was significantly stronger for women living in low- as opposed to high-poverty Zip codes. For men, contrary to expectations, the association between education and fruit and vegetable consumption was larger in high-poverty neighborhoods. Although it remains plausible that neighborhood environments play a role in allowing individuals to translate socioeconomic resources into healthy behaviors, the Zip code-level analyses presented here do not strongly support such an interaction.

The primary strength of this study is the large sample of subjects surveyed in a manner designed to be representative of the adult population of NYC. The DOHMH developed the CHS to monitor the prevalence of priority health conditions and behaviors, to identify public health issues and to inform the design of health interventions and policies. The incorporation of neighborhood-level data into the extant CHS datasets will provide new insights into the distribution and causes of diseases and health behaviors across the City. A primary limitation of this work is the cross-sectional study design, which limits causal inference. A second limitation is the use of a large and variably-sized neighborhood area, the Zip code area (median area: 3.92 Km²), which was the smallest spatial identifier available in the survey data. Because NYC is a pedestrian-oriented environment in which only half of all households own vehicles, smaller neighborhood areas may provide more valid indicators of available neighborhood resources. Prior work in NYC showing associations between neighborhood food environments and BMI and diet used substantially smaller neighborhood definitions, including; Census tracts with a median area of 0.18 Km² and 0.50 mile street network buffers with a median area of 1.2 Km² (26, 34, 35, 38). Zip code areas may represent a suboptimal spatial unit for this kind of analysis, both because of their larger size and because of boundary effects when Zip code boundaries align with the street center lines of major commercial thoroughfares where retail food outlets often cluster. A third limitation is that the CHS survey is designed to provide health surveillance data on key indicators, similar to the CDC's BRFSS, and does not provide in-depth measures of diet. The survey used a single question about the number of servings of fruit and vegetables consumed during the day prior to the CHS telephone interview. Finally, our measure of access to food outlets selling fruit and vegetables did not account for the specific availability or quality of produce in those settings.

In conclusion, the results show that higher individual-level SES is associated with higher odds of eating five or more servings of fruits and vegetables per day. Patterns of cross-level interactions between individual- and Zip code-level measures of SES seen in prior analyses of BMI were also observed here, although most of the interaction effects did not reach statistical significance. Zip code-level disparities in access to stores selling healthy foods did not predict consumption of fruits and vegetables or explain the disparities across individual

SES. These results affirm the importance of individual SES, particularly education, in healthy behavior patterns while providing further evidence about the role of neighborhood environments. Further studies are needed that examine additional measures of availability and quality of fruits and vegetables, and whether disparities in neighborhood access to healthy food at smaller geographic levels are predictors of fruit and vegetable consumption.

Abbreviations

CHS	Community Health Study
NYC	New York City
DOHMH	Department of Health and Mental Hygiene

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Table 1

Survey respondents' demographic characteristics and bivariate associations with consumption of 5 servings of fruit and vegetables per day

Variable	Full Sample N=19,252	OR from Bivariate Analyses (95% CI)	Females N=11,452	OR from Bivariate Analyses (95% CI)	Males N=7,800	OR from Bivariate Analyses (95% CI)
Consume 5 Fruit and Vegetables / day						
Yes	9.5%		10.3%		8.3%	
No	86.5%		85.9%		87.5%	
Missing	4.0%		3.8%		4.2%	
Gender						
Male	40.5%	1				
Female	59.5%	1.36 (1.18, 1.57)				
Missing	0%					
Race/Ethnicity						
Hispanic	25.7%	1	27.3%	1	23.4%	1
White	41.1%	3.12 (2.56, 3.81)	38.5%	3.92 (3.03, 5.07)	45.0%	2.36 (1.67, 3.33)
African American	24.1%	1.32 (1.05, 1.67)	26.2%	1.60 (1.20, 2.14)	21.0%	1.00 (0.64, 1.58)
Asian	6.5%	1.52 (1.06, 2.18)	5.4%	1.91 (1.16, 3.16)	8.1%	1.22 (0.69, 2.14)
Other race/ethnicity	2.6%	2.23 (1.31, 3.80)	2.6%	2.48 (1.38, 4.47)	2.5%	1.97 (0.98, 3.96)
Missing	0%		0%		0%	
Age Groups						
18-24 years	9.5%	1	8.9%	1	10.3%	1
25-44 years	41.5%	0.90 (0.70, 1.16)	40.8%	1.22 (0.87, 1.72)	42.4%	0.65 (0.45, 0.96)
45-64 years	29.8%	1.14 (0.88, 1.48)	29.5%	1.65 (1.17, 2.32)	30.3%	0.73 (0.48, 1.12)
65+ years	17.6%	1.12 (0.86, 1.46)	18.9%	1.54 (1.06, 2.24)	15.9%	0.75 (0.51, 1.11)
Missing	1.6%		1.9%		1.1%	
Income to Poverty Ratio						
Below poverty line	13.1%	1	14.2%	1	11.5%	1
100-199% of poverty	18.1%	1.37 (1.02, 1.84)	19.0%	1.44 (1.01, 2.04)	16.8%	1.29 (0.79, 2.10)
200-399% of poverty	22.2%	1.82 (1.34, 2.46)	22.2%	2.03 (1.43, 2.87)	22.0%	1.57 (1.00, 2.48)
400-599% of poverty	14.5%	2.32 (1.74, 3.09)	13.6%	2.95 (2.08, 4.19)	15.8%	1.72 (1.14, 2.56)
Above 600% of poverty	17.4%	3.46 (2.62, 4.57)	14.6%	4.60 (3.35, 6.31)	21.6%	2.54 (1.68, 3.85)
Missing	14.7%		16.4%		12.3%	

Variable	Full Sample N=19,252	OR from Bivariate Analyses (95% CI)	Females N=11,452	OR from Bivariate Analyses (95% CI)	Males N=7,800	OR from Bivariate Analyses (95% CI)
Education						
< High School	16.5%	1	17.8%	1	14.6%	1
High school graduate	25.2%	1.50 (1.09, 2.06)	26.1%	1.58 (1.08, 2.29)	23.9%	1.40 (0.80, 2.45)
Some college	21.5%	2.56 (1.84, 3.57)	21.6%	2.79 (1.93, 4.05)	21.2%	2.25 (1.31, 3.86)
College graduate	35.8%	3.83 (2.84, 5.16)	33.5%	4.24 (2.95, 6.10)	39.3%	3.38 (2.14, 5.34)
Missing	1.0%		1.0%		1.0%	
Marital Status						
Not married	62.5%	1	67.5%	1	55.3%	1
Married	36.5%	1.10 (0.96, 1.27)	31.5%	1.33 (1.11, 1.61)	43.8%	0.90 (0.73, 1.11)
Missing	1.0%		1.0%		0.9%	
Survey Year						
2004	49.8%	1	50.4%	1	51.1%	1
2002	50.2%	0.90 (0.78, 1.05)	49.6%	0.86 (0.72, 1.02)	48.9%	0.98 (0.77, 1.24)
Missing	0%		0%		0%	
Any children under 18 in the household						
No	61.8%	1	58.3%	1	67.9%	1
Yes	37.8%	0.58 (0.50, 0.68)	41.7%	0.52 (0.43, 0.62)	32.1%	0.65 (0.50, 0.83)
Missing	0.4%		0.4%		0.4%	

Abbreviations: OR odds ratio, CI confidence interval

Table 2

Results of multi-level regression analyses of socio-demographic characteristics and consumption of 5 servings of fruit and vegetables per day

	Full Sample OR ^I (95% CI)	Females Only OR ^I (95% CI)	Males Only OR ^I (95% CI)
Sex			
Male	1	-	-
Female	1.48 (1.32, 1.65)	-	-
Race/Ethnicity			
Hispanic	1	1	1
Non-Hispanic White	1.82 (1.50, 2.21)	1.94 (1.51, 2.49)	1.71 (1.25, 2.33)
Non-Hispanic Black	1.16 (0.93, 1.45)	1.36 (1.02, 1.81)	1.00 (0.70, 1.44)
Asian	1.11 (0.85, 1.42)	1.19 (0.85, 1.67)	0.96 (0.65, 1.43)
Other	1.80 (1.30, 2.48)	1.89 (1.24, 2.87)	1.90 (1.14, 3.16)
Age groups			
18–24 years	1	1	1
25–44 years	0.72 (0.60, 0.87)	1.00 (0.78, 1.29)	0.49 (0.37, 0.65)
45–64 years	0.86 (0.70, 1.04)	1.26 (0.97, 1.64)	0.54 (0.40, 0.74)
65+ years	0.83 (0.66, 1.04)	1.25 (0.93, 1.68)	0.53 (0.36, 0.77)
Income to poverty ratio			
Below poverty line	1	1	1
100–199% of Poverty	1.23 (0.98, 1.54)	1.25 (0.95, 1.67)	1.16 (0.81, 1.67)
200–399% of Poverty	1.41 (1.13, 1.75)	1.52 (1.15, 2.01)	1.20 (0.84, 1.73)
400–599% of Poverty	1.41 (1.12, 1.78)	1.64 (1.23, 2.20)	1.11 (0.75, 1.63)
Above 600% of Poverty	1.80 (1.43, 2.27)	2.11 (1.57, 2.83)	1.42 (0.98, 2.07)
Education			
< High school	1	1	1
High school graduate	1.19 (0.92, 1.52)	1.12 (0.82, 1.55)	1.23 (0.83, 1.85)
Some college	1.90 (1.49, 2.42)	1.95 (1.43, 2.66)	1.90 (1.28, 2.81)
College graduate	2.23 (1.75, 2.84)	2.11 (1.55, 2.87)	2.56 (1.73, 3.78)
Marital status			
Unmarried	1	1	1
Married	1.17 (1.03, 1.32)	1.30 (1.12, 1.51)	1.06 (0.86, 1.31)
Survey year			
2004	1	1	1
2002	0.85 (0.76, 0.95)	0.80 (0.69, 0.92)	0.93 (0.78, 1.12)
Any children in the household			
No	1	1	1
Yes	0.73 (0.64, 0.84)	0.72 (0.61, 0.85)	0.77 (0.62, 0.97)
Zip Code Level Variables Poverty Rate			
Below the median	1	1	1
At or above median	0.89 (0.75, 1.07)	1.00 (0.80, 1.26)	0.77 (0.59, 1.00)
Proportion Black	0.76 (0.54, 1.06)	0.72 (0.47, 1.11)	0.80 (0.47, 1.35)

	Full Sample OR^I (95% CI)	Females Only OR^I (95% CI)	Males Only OR^I (95% CI)
Proportion Hispanic	0.70 (0.44, 1.12)	0.63 (0.35, 1.16)	0.84 (0.43, 1.65)

Abbreviations: OR odds ratio, CI confidence interval

^IOR mutually adjusted for all the predictor variables in the table

Table 3

Associations¹ between socioeconomic status and consumption of 5 servings of fruit and vegetables per day in low² and high poverty zip codes

	Full Sample		Females Only		Males Only	
	Low Poverty Zip, code OR (95% CI)	High Poverty Zip, code OR (95% CI)	Low Poverty Zip, code OR (95% CI)	High Poverty Zip, code OR (95% CI)	Low Poverty Zip, code OR (95% CI)	High Poverty Zip, code OR (95% CI)
Income to poverty ratio						
<100 of poverty	1	1	1	1	1	1
100–199% of poverty	1.40 (0.95, 2.06)	1.12 (0.85, 1.48)	1.56 (0.96, 2.55)	1.06 (0.75, 1.50)	1.21 (0.65, 2.23)	1.19 (0.75, 1.87)
200–399% of poverty	1.77 (1.23, 2.57)	1.17 (0.88, 1.55)	2.13 (1.33, 3.42)	1.13 (0.79, 1.62)	1.23 (0.68, 2.21)	1.19 (0.75, 1.87)
400–599% of Poverty	1.72 (1.18, 2.50)	1.22 (0.89, 1.68)	2.31 (1.43, 3.74)	1.17 (0.78, 1.76)	1.02 (0.55, 1.88)	1.30 (0.77, 2.18)
600% or more of poverty	2.22 (1.53, 3.22)	1.46 (1.05, 2.03)	2.92 (1.81, 4.72)	1.54 (1.01, 2.35)	1.40 (0.78, 2.51)	1.39 (0.82, 2.36)
Education						
< High school	1	1	1	1	1	1
High school graduate	0.87 (0.58, 1.30)	1.46 (1.07, 2.01)	1.23 [*] (0.71, 2.14)	1.11 (0.75, 1.65)	0.54 (0.29 – 1.01)	2.04 (1.19, 3.53)
Some college	1.68 (1.14, 2.46)	2.02 (1.47, 2.77)	2.47 [*] (1.44, 4.24)	1.64 (1.12, 2.43)	1.08 (0.61, 1.91)	2.75 (1.59, 4.75)
College graduate	2.07 (1.42, 3.01)	2.20 (1.59, 3.04)	2.81 [*] (1.65, 4.79)	1.55 (1.04, 2.31)	1.55 (0.89, 2.67)	3.54 (2.03, 6.18)

¹ All models adjust for race/ethnicity, age, marital status, any children under 18 in the household, year of interview and Zip code level racial and ethnic composition.

² Low poverty Zip codes are defined as being below the median (18.76%) of the distribution across Zip codes of the percent of population in poverty.

* Indicates that the trend of increasing OR is statistically significantly (p<0.05) larger in magnitude in low- versus high-poverty Zip codes.

Table 4

Associations¹ between socioeconomic status, density of healthy food outlets and consumption of 5 servings of fruit and vegetables per day.

	Full Sample			Females Only			Males Only		
	All Zip codes OR (95% CI)	Low ² Poverty Zip code OR (95% CI)	High ² Poverty Zip code OR (95% CI)	Low ² Poverty Zip code OR (95% CI)	High ² Poverty Zip code OR (95% CI)	Low ² Poverty Zip code OR (95% CI)	High ² Poverty Zip code OR (95% CI)	Low ² Poverty Zip code OR (95% CI)	High ² Poverty Zip code OR (95% CI)
Income to poverty ratio									
<100% of poverty	1	1	1	1	1	1	1	1	1
100–199% of poverty	1.23 (0.98, 1.54)	1.41 (0.96, 2.07)	1.10 (0.84, 1.46)	1.57 (0.96, 2.56)	1.06 (0.75, 1.50)	1.22 (0.66, 2.26)	1.18 (0.75, 1.89)	1.22 (0.66, 2.26)	1.18 (0.75, 1.89)
200–399% of poverty	1.41 (1.13, 1.75)	1.78 (1.23, 2.58)	1.14 (0.86, 1.52)	2.13 (1.33, 3.41)	1.15 (0.80, 1.64)	1.25 (0.66, 2.26)	1.19 (0.74, 1.89)	1.25 (0.66, 2.26)	1.19 (0.74, 1.89)
400–599% of poverty	1.41 (1.12, 1.78)	1.72 (1.18, 2.52)	1.20 (0.87, 1.66)	2.29 (1.41, 3.72)	1.18 (0.79, 1.77)	1.05 (0.57, 1.94)	1.30 (0.77, 2.20)	1.05 (0.57, 1.94)	1.30 (0.77, 2.20)
600% or more of poverty	1.78 (1.42, 2.25)	2.22 (1.53, 3.22)	1.42 (1.02, 1.98)	2.89 (1.79, 4.68)	1.55 (1.01, 2.36)	1.44 (0.80, 2.59)	1.38 (0.81, 2.34)	1.44 (0.80, 2.59)	1.38 (0.81, 2.34)
Education									
< High school	1	1	1	1	1	1	1	1	1
High school graduate	1.19 (0.93, 1.53)	0.87 (0.58, 1.30)	1.46 (1.06, 2.00)	1.22 [*] (0.70, 2.13)	1.13 (0.76, 1.67)	0.55 (0.30 – 1.01)	2.03 (1.18, 3.50)	0.55 (0.30 – 1.01)	2.03 (1.18, 3.50)
Some college	1.90 (1.49, 2.42)	1.68 (1.14, 2.46)	1.99 (1.45, 2.74)	2.47 [*] (1.44, 4.24)	1.66 (1.12, 2.44)	1.09 (0.62, 1.93)	2.72 (1.57, 4.71)	1.09 (0.62, 1.93)	2.72 (1.57, 4.71)
College graduate	2.20 (1.73, 2.81)	2.05 (1.40, 2.99)	2.15 (1.56, 2.98)	2.78 [*] (1.63, 4.75)	1.56 (1.12, 2.44)	1.53 (0.88, 2.65)	3.50 (2.00, 6.13)	1.53 (0.88, 2.65)	3.50 (2.00, 6.13)
Density of healthy food stores									
Quartile 1	1	1	1	1	1	1	1	1	1
Quartile 2	0.94 (0.74, 1.19)	0.97 (0.72, 1.30)	0.91 (0.55, 1.48)	0.86 (0.59, 1.25)	0.62 (0.35, 1.10)	1.15 (0.73, 1.81)	1.71 (0.75, 3.91)	1.15 (0.73, 1.81)	1.71 (0.75, 3.91)
Quartile 3	1.06 (0.84, 1.34)	1.00 (0.73, 1.38)	1.02 (0.64, 1.62)	0.82 (0.55, 1.25)	0.92 (0.54, 1.57)	1.37 (0.84, 2.23)	1.46 (0.66, 3.24)	1.37 (0.84, 2.23)	1.46 (0.66, 3.24)
Quartile 4	1.12 (0.90, 1.38)	1.06 (0.82, 1.38)	1.09 (0.67, 1.76)	1.04 (0.75, 1.44)	0.89 (0.51, 1.54)	1.10 (0.73, 1.65)	1.73 (0.76, 3.91)	1.10 (0.73, 1.65)	1.73 (0.76, 3.91)

Abbreviations: OR odds ratio, CI confidence interval

¹ All models adjust additionally for race/ethnicity, age, marital status, number of children under 18 in the household, year of interview and neighborhood race and ethnicity.

² Low poverty Zip codes are defined as being below the median (18.76%) of the distribution across Zip codes of the percent of population in poverty.

* Indicates that the trend of increasing OR is statistically significantly (p<0.05) larger in magnitude in low - versus high-poverty Zip codes.