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Socioeconomic factors associated with diet quality and meeting dietary guidelines in disadvantaged neighborhoods in the Southeast United States

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ABSTRACT

Objective: To examine diet quality and dietary intake among residents of disadvantaged neighborhoods in the Southeast United States (U.S.) and to examine associations between dietary and socioeconomic factors.

Design: We examined baseline data from an evaluation study of a healthy food access initiative. Participants were recruited from two urban settings comprising seven neighborhoods of high household poverty (17% to 62%). Participants completed in-person interviews with measures of education, household income, and food security and one unannounced 24-hour dietary recall by telephone with trained registered dietitians. Food desert residence was coded based on U.S. Census data. Proportions meeting 2010 Dietary Guidelines for Americans and Healthy Eating Index 2010 (HEI-2010) scores were computed. Associations between dietary variables and participant's education, household income, food security, and food desert residence were tested.

Results: Participants ($n = 465$) were predominantly African American (92%), women (80%), and overweight or obese (79%), and 52 ± 14 years of age. Sixty-three percent had low or very low food security, and 82% lived in census tracts of low income and low access to supermarkets (urban food desert). HEI-2010 scores averaged 48.8 ± 13.1. A minority of participants met dietary guidelines. Diet quality was lower among participants with lower education and among those from food insecure households ($p < .05$). Household income and food security were positively associated with meeting several dietary guidelines ($p < .05$). Food desert residence was unrelated to diet variables.

Conclusions: In this disadvantaged population, significant nutritional concerns were observed, and socioeconomic factors were associated with diet quality and meeting dietary guidelines. Interventions must address broader economic, social, and policy issues such as access to affordable healthy foods.

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Introduction

Poor diet is a major cause of preventable mortality, and combined with physical inactivity, may overtake tobacco as the leading cause of death (Mokdad et al. 2004). While nutrition education is a necessary approach to dietary change, it is not sufficient. There is growing evidence that the local food environment is associated with food access, dietary intake, and diet quality (Moore et al. 2008; Walker, Keane, and Burke 2010). Although lower income residents (SNAP recipients) have similar knowledge and awareness of the importance of diet as higher income residents (Mancino and Guthrie 2014), residents who live in neighborhoods characterized by social, economic, and environmental disadvantage tend to have less access to supermarkets and healthy food options, greater access to fast food restaurants and less healthy food options, higher food insecurity, and poorer diet quality than those in neighborhoods of relatively higher advantage (Larson, Story, and Nelson 2009). These types of environments may contribute to obesity and health disparities (Coogan et al. 2010). Factors such as how well food keeps, convenience, and price have been voiced as particularly important among lower income residents (Mancino and Guthrie 2014).

A low-income, low food access ('food desert') urban census tract is defined as one where at least 20% of the population is below the federal poverty level and at least 33% of the population lives one or more miles from a supermarket (U.S. Department of Agriculture Economic Research Service 2015a). Typically these areas are characterized by high poverty and high percentages of racial and ethnic minority residents (Dutko, Ver Ploeg, and Farrigan 2012). Access to healthy foods is more limited in these communities relative to communities not classified as low-income, low-access (Walker, Keane, and Burke 2010). Despite the seeming importance of access to healthy foods, associations between proximity to supermarkets and density of food outlets and dietary intake are inconsistent (Moore et al. 2008; Caspi et al. 2012; Hattori, An, and Sturm 2013; McInerney et al. 2016; Ver Ploeg and Rahkovsky 2016; Kelli et al. 2017). Furthermore, the small number of natural experiments conducted to date that have examined whether introducing a supermarket into a food desert impacts dietary intake, purchasing behavior, or body mass index have yielded mixed findings (Wang et al. 2007; Sadler, Gilliland, and Arku 2013; Cummins, Flint, and Matthews 2014; Dubowitz, Ghosh-Dastidar, et al. 2015; Elbel et al. 2015; Rogus et al. 2018).

Food insecurity is a significant problem in disadvantaged communities, and especially among low-income households and households headed by non-Hispanic Blacks and Hispanics (Coleman-Jensen et al. 2016). National data in the United States (U.S.) and Canada have shown that food insecurity is associated with less healthy diets (Kirkpatrick et al. 2012; Leung et al. 2014) and high proportions of obesity (Pan et al. 2012). Nackers and Appelhans found that food insecure households with children had a higher presence of obesity-promoting foods (Nackers and Appelhans 2013). Downstream consequences of food insecurity and subsequent poor diet quality are seen across the life course, including childhood obesity (Eisenmann et al. 2011; Kaur, Lamb, and Ogden 2015), markers of metabolic syndrome (Holben and Taylor 2015), and adult obesity, particularly in women (Franklin et al. 2012).

Income, race, and education also relate to diet. Using data from the National Health and Nutrition Examination Survey (NHANES), Kirkpatrick and colleagues found that

higher income was associated with higher levels of adherence to most food group recommendations, and non-Hispanic Blacks were the least likely to meet recommendations (Kirkpatrick et al. 2012). Higher levels of education, in contrast, have also been associated with greater diet variety (Conklin et al. 2014) and quality (Raffensperger et al. 2010; Backholer et al. 2016) in large representative samples.

Although national data are useful for illuminating individual factors related to diet, they do not characterize the dietary patterns of specific subgroups. In particular, studies using dietary recall measures to examine the diet quality and proportion who meet dietary recommendations in groups of extreme deprivation are lacking. Such neighborhoods are typically characterized by multiple overlapping risk factors – including poor food access; racial segregation, with a high proportion of low income, ethnic and racial minority residents, many who receive SNAP benefits; no reliable transportation for food and services; and reliance on community food sources (Ver Ploeg et al. 2009; Coleman-Jensen et al. 2015, 2016). These neighborhoods, which are the most vulnerable and face the greatest challenges for meeting health recommendations, merit in-depth study.

This paper examined the proportion of participants meeting dietary guidelines and the diet quality (assessed with 24-hour dietary recalls) in a unique and large sample of predominantly African American women from disadvantaged neighborhoods in the Southeast U.S. We also examined whether meeting dietary guidelines and diet quality differed by socioeconomic factors (educational attainment, household income, food security, food desert residence). These analyses provided an opportunity to examine how socioeconomic factors relate to diet in vulnerable neighborhoods at high risk for chronic disease.

Methods

Setting and data collection

Participants were recruited between November 2013 and May 2014 from geographically defined areas in two South Carolina cities as part of an evaluation of a community food hub. Seven neighborhoods located mainly within seven census tracts were the focus for recruitment (6 were USDA-designated food deserts). Recruitment boundaries were extended by one mile into 12 adjacent census tracts to match residents' self-identified neighborhood boundaries for tracts with household poverty at least as low as that of the state (16%). Twelve of all 19 tracts were USDA-designated food deserts (U.S. Department of Agriculture Economic Research Service 2015a). Across the 19 tracts, household poverty ranged from 16.7% to 62%, and the African American population ranged from 28% to 98%.

Recruitment occurred through an initial and a follow-up mass mailing addressed to the 'family food shopper.' Because random digit-dialed (RDD) sampling in low-income communities with high reliance on *pre-paid* cell phones is problematic (McGeeney 2015; Pew Research Center 2015), as is RDD sampling within specific census tracts, we obtained lists of the 6136 residential addresses in the study area from Survey Sampling, Inc. Besides the mailings, extensive active and passive recruitment methods were used, including face-to-face outreach, written, and electronic community contacts. More study details and methods are described elsewhere (Ma et al. 2017; Sharpe et al. 2017).

To be eligible, participants had to be: at least 18 years of age; shoppers for at least half of the household's food; residents of the study area for at least 3 weeks per month; residents

of non-institutional settings; and free of impairments that would preclude in-person and telephone interviews (accommodations permitted). They also had to have no plans to move outside the study area. One person per household, the primary food shopper, could participate. The main reason for study ineligibility among those screened was living outside the geographic boundaries of the study (54% of ineligible, 12% of those screened) or geographic eligibility could not be verified (22% of ineligible; 5% of those screened). The Institutional Review Board of the University of South Carolina approved the study.

Procedures

Interviewers followed a standardized verbal script and provided a written information document during the consent process. After obtaining verbal informed consent, interviewers administered measures (described below) at the research field offices and community centers. To prepare for a later 24-hour dietary recall, participants also received a 20-minute training in portion size estimation using a Food Portion Visual (Weber et al. 1997), with the addition of food models, dishes, and utensils. After the in-person visit, participants completed one unannounced 24-hour dietary recall by telephone within two weeks. Participants received a $15 gift card for each of the two interviews and a list of community resources and services (e.g. medical, mental health, social, and food services in the community).

Measures

Dietary intake

Registered dietitians trained in the University of Minnesota's Nutrient Data System for Research (NDSR) protocols conducted the dietary recall interviews. The multi-pass, 24-hour dietary recall methodology has established validity and reliability (Posner et al. 1982; Jonnalagadda et al. 2000).

Dietary data were collected and analyzed using NDSR software version 2013 and 2014 (Nutrition Coordinating Center 2014). Serving sizes and referent intake levels were defined by the NDSR manual and listed in the 2010 Dietary Guidelines for Americans (U.S. Department of Agriculture and U.S. Department of Health and Human Services 2010), guidelines in effect when data collection began. We calculated the proportion of participants who met dietary guidelines for: % kilocalories (kcals) from total fat, saturated fat, trans fat, protein, and carbohydrates; fiber (grams/day); fruit (cups/day); vegetables (cups/day); fruits and vegetables (cups/day); whole grains (≥50% of total grains); dairy (cups/day); sweetened beverages (servings/day); and sodium (milligrams/day).

Diet quality

The Healthy Eating Index 2010 (HEI-2010) (Guenther et al. 2013, 2014) contains 12 components, 9 focused on adequacy and 3 on moderation, each worth 5–20 points. HEI-2010 scores can range from 0 to 100, with a higher score indicating a higher quality diet.

Sociodemographic and health characteristics

Sociodemographic characteristics included sex, race, marital status, age, educational level, past year's annual household income category, receipt of SNAP in the past year, household size, self-reported health conditions, and measured body mass index (kilograms/meters^2) based on staff-assessed height and weight using a professionally calibrated Seca electronic scale and a Seca stadiometer.

Food security status

Food security status in the past 12 months was derived from the USDA Household Food Security questionnaire (Bickel et al. 2000). Four food security categories were created (U.S. Department of Agriculture Economic Research Service 2015b). For analyses, participants with high and marginal food security were classified as food secure, and participants with low and very low security were classified as food insecure.

Food desert residence

Each participant's address was entered in the U.S. Census Bureau website to identify the corresponding census tract number. Then, using the U.S. Department of Agriculture's Food Access Research Atlas, each census tract was classified as to whether it met the criteria of being in a food desert, defined as an urban census tract where at least 20% of the population is below the federal poverty level and at least 33% of the population lives 1 or more miles from a supermarket (U.S. Department of Agriculture Economic Research Service 2015a).

Data analysis

For the first set of analyses, the proportion of the sample meeting each of the 12 dietary guidelines was the dependent (outcome) variable. Separate logistic regression models tested whether education, income, food security, and food desert residence (independent variables) were associated with these 12 dependent variables. Because the dietary guidelines for total fat, carbohydrates, and protein indicate a recommended lower and upper limit, additional analyses also tested whether the proportion below or above these three guidelines differed by group. The proportion in some of the dependent variable categories was low, and thus there was potential concern of low statistical power. As a result, all models were also re-run using the continuous dietary variable (e.g. cups/day of dairy intake rather than proportion meeting dairy dietary guideline). Because results were highly consistent with the logistic models, data are not reported.

For the second set of analyses, the continuous measure of diet quality was the dependent variable. Separate linear regression models tested whether each of the four socioeconomic independent variables were associated with this dependent variable.

All models adjusted for age and sex. SAS version 9.4 (SAS Institute Inc., Cary, NC) was used.

Results

Sample characteristics

A total of 527 participants provided informed consent and completed the baseline interview; of these, 465 completed the 24-hour dietary recall and were included in this paper.

Sociodemographic and health-related characteristics appear in Table 1. The majority of participants were women, African American, not married or living with partner, overweight or obese, and lived in a food desert. The mean age was 52.3 years.

Proportion meeting dietary guidelines and diet quality

As shown in Table 2, less than 20% of the sample met dietary guidelines for trans fat, fiber, fruits, vegetables, fruits and vegetables, whole grains, dairy, and sodium, and less than 50% met dietary guidelines for total fat, saturated fat, carbohydrates, and sweetened beverages, while 89% met guidelines for protein. The mean HEI-2010 score was 48.8 ± 13.1 out of 100. Table 3 presents unadjusted means and proportions for each of the dietary variables by sociodemographic characteristics.

Table 1. Sample characteristics ($N = 465$).

Characteristic	[a]Missing (n)	Mean ± SD (Min, Max)
Age, years	0	52.33 ± 14.19 (19, 94)
Household size, number	0	2.30 ± 1.41 (1, 11)
Children ≤ 18 years living in household, number	0	0.58 ± 1.05 (0, 8)
Body mass index, kg/m2	4	32.56 ± 8.67 (15.86, 75.36)
Characteristic		% (n)
Women	0	80.22 (373)
Race	0	
Black / African American		92.04 (428)
White		5.59 (26)
More than one race / Other		2.37 (11)
Hispanic/Latino Ethnicity	0	0.86 (4)
Marital status	1	
Never married		37.28 (173)
Married or living together		16.16 (75)
Separated, Widowed, or Divorced		46.56 (216)
Total yearly household income	12	
$0–9999		46.58 (211)
$10,000–19,999		32.67 (148)
$20,000+		20.76 (94)
Education	0	
Less than high school		30.32 (141)
High school		37.42 (174)
Some college and above		32.26 (150)
Food security status	0	
Very low food security		30.75 (143)
Low food security		32.26 (150)
Marginal food security		20.22 (94)
High food security		16.77 (78)
Resided in food desert	0	82.15 (382)
Household with SNAP participation, %	2	63.71 (295)
Body mass index, kg/m^2	4	
Underweight		1.52 (7)
Normal weight		19.31 (89)
Overweight		23.43 (108)
Obese		55.75 (257)
Self-reported health conditions		
Hypertension	0	60.22 (280)
Arthritis	1	46.77 (217)
Diabetes	2	28.29 (131)
Heart disease	0	10.32 (48)
Heart attack	1	5.39 (25)
Kidney disease	2	4.97 (23)

Note: kg = kilograms; m = meters; SNAP = Supplemental Nutrition Assistance Program.

Table 2. Dietary intake, proportion meeting 2010 dietary guidelines, and diet quality for the total sample ($N = 465$).

Dietary Intake Variable	Guideline	Mean (SD)	Min, Max	% Met Guideline
Fat, % kilocalories (kcals)	20–35% kcals	34.61 (9.61)	0.45, 60.77	47.31
Saturated fat, % kcals	<10% kcals	11.13 (4.10)	0, 28.88	43.66
Trans fat, % kcals	0% kcals	1.09 (0.84)	0, 5.25	0.22
Protein, % kcals	10–35% kcals	17.01 (6.14)	0.64, 38.75	89.46
Carbohydrate, % kcals	45–65% kcals	48.12 (11.73)	12.30, 99.99	49.68
Fiber, grams/day	[a]Dependent on age and gender	13.57 (8.55)	0, 54.73	10.32
Fruits, cups/day	[a]Dependent on kcals	0.67 (0.98)	0, 5.78	16.56
Vegetables, cups/day	[a]Dependent on kcals	1.11 (1.07)	0, 7.34	16.34
Fruits and vegetables, cups/day	[a]Dependent on kcals	1.78 (1.55)	0, 10.55	10.97
Whole grains, % of total grains	≥50% of total grains	10.08 (18.75)	0, 100	10.32
Dairy, cups/day	[a]Dependent on kcals	0.99 (1.24)	0, 8.00	8.17
Sweetened beverages, servings/day	0 drinks	1.90 (2.57)	0, 30.00	30.97
Sodium, milligrams/day	[a]Dependent on race and health status	3127.62 (1752.45)	58.67, 11533.44	16.99
Healthy Eating Index 2010	N/A	48.77 (13.08)	19.00, 97.00	N/A

Note: For % kcals from fat, 46.67% of the total sample exceeded guidelines and 6.02% were below guidelines. For % kcals from protein, 0.86% exceeded guidelines and 9.68% were below guidelines. For % kcals from carbohydrates, 8.60% exceeded guidelines and 41.72% were below guidelines. N/A = not applicable.

[a]See Appendices 5 and 7 and page 21 of the 2010 Dietary Guidelines for Americans (U.S. Department of Agriculture and U.S. Department of Health and Human Services 2010).

Associations between socioeconomic variables and the proportion meeting dietary guidelines

Results of the logistic regression models that predict the proportion meeting dietary guidelines appear in Table 4. Results are presented for the independent variables of educational attainment, income, food security, and food desert residence. Neither educational attainment nor food desert residence were significantly associated with meeting any of the 12 dietary guidelines.

Compared to the highest income referent group (≥$20,000), the lowest income group (<$10,000) was less likely to meet the carbohydrate guideline (61% vs. 45%). Specifically, more participants in the lowest income group were below the carbohydrate guideline than participants in the highest income group (47% vs. 32%, OR = 2.05, CI: 1.21–3.47). Compared to the highest income referent group, the lowest income group was also less likely to meet fruit (24% vs. 12%) and combined fruit and vegetable (20% vs 8%) guidelines. In addition, compared to the highest income referent group, the $10,000 to $19,999 income group was less likely to meet the vegetable (23% vs. 11%), combined fruit and vegetable (20% vs 10%), and sodium (22% vs 12%) guidelines.

Compared to the food secure referent group, the food insecure group was less likely to meet guidelines for carbohydrates (55% vs 46%). Specifically, the food insecure group was more likely to be below the dietary guidelines for carbohydrates than the food secure group (46% vs 35%, OR = 1.66, CI: 1.12–2.46). Although the test of meeting total fat guidelines did not differ by food security status, the food insecure group was more likely than the food secure group to be above guidelines for total fat (51% vs 40%; OR 1.58, 95% CI: 1.07–2.33). Food insecure participants were also less likely than food secure participants to meet the whole grain guidelines (8% vs 15%).

Table 3. Dietary Intake, Proportion Meeting 2010 Dietary Guidelines, and Diet Quality by Sociodemographic Variables

	Education			Income			Food security		Food desert	
Dietary Variable	<High school ($n = 141$)	High school ($n = 174$)	Some college ($n = 150$)	<$10,000 ($n = 211$)	$10,000–$19,999 ($n = 148$)	≥$20,000 ($n = 94$)	Food insecure ($n = 293$)	Food secure ($n = 172$)	Food desert ($n = 382$)	Not food desert ($n = 83$)
Fat, % kcals										
Mean	34.79	34.94	34.05	35.25	34.73	32.52	35.28	33.46	34.46	35.31
(SD)	(10.65)	(9.28)	(8.96)	(9.78)	(10.05)	(8.25)	(9.73)	(9.31)	(9.72)	(9.10)
% Met Guideline	43.97	50.00	47.33	47.39	44.59	55.32	44.37	52.33	48.19	47.12
Saturated fat, % kcals										
Mean	10.99	11.38	10.96	11.23	11.23	10.51	11.41	10.65	11.01	11.66
(SD)	(4.55)	(3.77)	(4.05)	(4.26)	(4.02)	(3.65)	(4.18)	(3.95)	(4.18)	(3.70)
% Met Guideline	46.10	39.66	46.00	41.71	41.89	53.19	41.61	47.09	37.35	45.03
Protein, % kcals										
Mean	16.72	16.87	17.44	17.16	16.64	17.25	17.14	16.78	16.99	17.10
(SD)	(6.41)	(5.71)	(6.37)	(5.86)	(6.46)	(6.49)	(6.16)	(6.10)	(6.28)	(5.45)
% Met Guideline	84.40	91.38	92.00	91.00	85.14	91.49	89.76	88.95	90.36	89.27
Carbohydrate, % kcals										
Mean	48.09	47.99	48.31	47.17	48.61	49.91	47.33	49.46	48.27	47.45
(SD)	(13.06)	(10.87)	(11.46)	(11.51)	(12.59)	(10.71)	(11.65)	(11.78)	(11.84)	(11.29)
% Met Guideline	48.23	46.55	54.67	45.02	50.00	60.64	46.42	55.23	48.19	50.00
Fiber, grams/day										
Mean	12.87	13.48	14.33	13.01	13.60	14.52	13.52	13.65	13.53	13.74
(SD)	(8.62)	(8.28)	(8.79)	(8.32)	(7.65)	(9.76)	(8.67)	(8.37)	(8.66)	(8.08)
% Met Guideline	10.64	11.49	8.67	10.43	10.81	9.57	10.58	9.88	8.43	10.73
Fruits, cups/day										
Mean	0.56	0.64	0.80	0.56	0.68	0.87	0.65	0.68	0.65	0.72
(SD)	(0.86)	(0.89)	(1.15)	(0.86)	(0.98)	(1.15)	(0.96)	(1.01)	(0.92)	(1.20)
% Met Guideline	14.89	16.09	18.67	12.32	17.57	24.47	17.06	15.70	19.28	15.97
Vegetables, cups/day										
Mean	1.01	1.13	1.19	1.02	1.10	1.27	1.14	1.07	1.12	1.09
(SD)	(1.12)	(1.08)	(1.02)	(1.01)	(1.09)	(1.14)	(1.05)	(1.11)	(1.10)	(0.97)
% Met Guideline	16.31	16.09	16.67	16.11	11.49	23.40	16.72	15.70	16.87	16.23
Fruits and vegetables, cups/day										
Mean	1.57	1.77	1.98	1.57	1.79	2.14	1.79	1.75	1.77	1.81
(SD)	(1.54)	(1.50)	(1.60)	(1.36)	(1.60)	(1.75)	(1.51)	(1.62)	(1.54)	(1.63)
% Met Guideline	10.64	8.05	14.67	7.58	10.14	20.21	10.58	11.63	9.64	11.26
Whole grains, % of total grains										
Mean	9.11	9.71	11.45	9.62	9.99	11.99	7.55	14.33	10.02	10.34
(SD)	(19.79)	(16.41)	(20.37)	(17.79)	(17.59)	(22.98)	(15.59)	(22.53)	(18.99)	(17.70)
% Met Guideline	11.35	8.62	11.33	9.95	9.46	13.83	7.85	14.53	9.64	10.47

Dairy, cups/day										
Mean	0.86	1.01	1.08	0.96	1.00	0.94	0.96	1.09	0.93	1.27
(SD)	(1.12)	(1.16)	(1.42)	(1.29)	(1.14)	(1.17)	(1.19)	(1.32)	(1.20)	(1.41)
% Met Guideline	7.09	8.62	8.67	7.11	8.78	8.51	7.51	9.30	9.64	7.85
Sweetened beverages, servings/day										
Mean	1.83	2.05	1.80	1.96	1.91	1.64	1.94	1.83	1.87	2.04
(SD)	(2.08)	(3.12)	(2.28)	(2.29)	(3.10)	(2.10)	(2.71)	(2.31)	(2.55)	(2.68)
% Met Guideline	31.91	29.89	31.33	29.86	33.11	29.79	31.40	30.23	30.12	31.15
Sodium, milligrams/day										
Mean	3073.87	3180.52	3116.78	3230.59	3157.78	2714.45	3216.47	2976.26	3103.67	3237.83
(SD)	(1984.48)	(1654.83)	(1636.37)	(1809.74)	(1719.50)	(1458.80)	(1751.03)	(1749.57)	(1770.13)	(1674.58)
% Met Guideline	20.57	14.37	16.67	18.48	12.16	22.34	14.68	20.93	16.87	17.02
Diet quality (Healthy Eating Index 2010)										
Mean	47.58	48.29	50.45	47.76	48.77	51.18	47.81	50.41	48.70	49.08
(SD)	(12.52)	(13.18)	(13.39)	(12.38)	(12.79)	(14.84)	(12.49)	(13.91)	(13.30)	(12.06)

Kcals = kilocalories, SD = standard deviation.

Table 4. Odds ratios for meeting 2010 dietary guidelines, by socioeconomic characteristics ($N = 465$).

	Education		Income		Food security	Food Desert
Dietary Guideline (Dependent Variables)	<High school vs. ≥some college[a]	High school vs. ≥some college[a]	<$10,000 vs. ≥$20,000[a]	$10,000–$19,999 vs. ≥$20,000[a]	Food insecure vs. food secure[a]	Food desert vs. not food desert[a]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Fat, % kcals	0.85 (0.54–1.36)	1.13 (0.73–1.76)	0.75 (0.46–1.24)	0.64 (0.38–1.08)	0.71 (0.49–1.04)	1.06 (0.66–1.71)
Saturated fat, % kcals	0.97 (0.61–1.56)	0.80 (0.51–1.25)	0.65 (0.39–1.07)	0.60 (0.35–1.02)	0.77 (0.52–1.13)	0.74 (0.45–1.21)
Protein, % kcals	0.48 (0.23–1.01)	0.93 (0.42–2.06)	0.90 (0.37–2.18)	0.52 (0.22–1.23)	1.07 (0.58–1.98)	1.10 (0.50–2.46)
Carbohydrate, % kcals	0.78 (0.49–1.25)	0.74 (0.48–1.15)	**0.50 (0.30–0.83)**	0.63 (0.37–1.06)	**0.68 (0.46–0.99)**	0.92 (0.57–1.48)
Fiber, g/d	1.14 (0.52–2.51)	1.39 (0.66–2.92)	1.31 (0.57–3.02)	1.12 (0.47–2.66)	1.10 (0.58–2.06)	0.82 (0.35–1.92)
Fruits, cups/d	0.69 (0.36–1.29)	0.84 (0.47–1.50)	**0.49 (0.26–0.93)**	0.63 (0.33–1.20)	1.12 (0.67–1.88)	1.36 (0.73–2.53)
Vegetables, cups/d	0.88 (0.47–1.66)	0.96 (0.53–1.74)	0.71 (0.38–1.33)	**0.41 (0.20–0.83)**	1.10 (0.65–1.85)	1.13 (0.59–2.14)
Fruits and vegetables, cups/d	0.64 (0.31–1.30)	0.50 (0.25–1.03)	**0.34 (0.17–0.72)**	**0.44 (0.21–0.92)**	0.91 (0.50–1.67)	0.89 (0.40–1.98)
Whole grains, % of total grains	0.93 (0.44–1.93)	0.73 (0.35–1.53)	0.78 (0.37–1.66)	0.65 (0.29–1.45)	**0.50 (0.28–0.92)**	0.97 (0.43–2.16)
Dairy, cups/d	0.87 (0.37–2.08)	0.98 (0.45–2.15)	0.72 (0.29–1.82)	1.04 (0.41–2.64)	0.80 (0.41–1.59)	1.18 (0.52–2.70)
Sweetened beverages, servings/d	0.97 (0.59–1.61)	0.92 (0.57–1.48)	1.09 (0.63–1.87)	1.18 (0.68–2.08)	1.08 (0.71–1.63)	0.99 (0.59–1.67)
Sodium, mg/d	1.22 (0.66–2.23)	0.86 (0.47–1.59)	0.89 (0.48–1.66)	**0.45 (0.22–0.90)**	0.63 (0.38–1.04)	1.04 (0.55–1.99)

Note: All models adjusted for age and gender. Trans fat models could not be estimated because only one participant met this guideline. To facilitate interpretation, boldface indicates $p < .05$. OR = odds ratio, CI = confidence interval.

[a]Indicates the referent group.

Associations between socioeconomic variables and diet quality

The results of the linear regression models indicated that neither household income (Model $F(4, 448) = 6.71$, $p < .0001$, $R^2 = 0.06$; Income $F(2,448) = 1.29$, $p = 0.28$; adjusted means for lowest to highest income categories: 47.42, 47.26, 49.75) nor food desert residence (Model $F(3, 461) = 7.36$, $p < .0001$, $R^2 = 0.05$; Food Desert $F(1,461) = 0.34$, $p = 0.56$; adjusted mean for those residing in a food desert was 47.79 versus 48.69 for those not residing in a food desert) were related to diet quality.

Participants with less than a high school education had poorer diet quality than those with some college or higher (46.24 versus 49.88, $p = .02$; Model $F(4,460) = 6.96$, $p < .0001$, $R^2 = .06$; Education $F(2,460) = 2.95$, $p = .05$). Those with a high school education did not have a significantly different diet quality score (47.77) than the other two education categories. Finally, the food secure group had significantly higher diet quality than the food insecure group (Model $F(3, 461) = 8.84$, $p < .0001$, $R^2 = 0.05$; Food security $F(1,461) = 4.58$, $p = 0.03$; adjusted mean for food secure residents was 49.53 versus 46.89 for food insecure residents).

Discussion

This paper reported the diet quality and proportion meeting dietary guidelines and whether these dietary variables differed by educational attainment, household income, household food security, and food desert residence among predominantly African American adults from financially disadvantaged neighborhoods in the Southeast U.S. It was notable that nearly a third reported less than a high school education, nearly half of the sample reported a yearly household income of less than $10,000, 82.2% lived in a food desert, and 63.7% received SNAP benefits. Thus, our findings are important for understanding dietary intake and quality in a sample experiencing severe deprivation, and how socioeconomic factors may relate to diet in neighborhoods that experience high rates of poverty and disease burden.

Although the majority of participants met the dietary guideline for protein, fewer than half met the dietary guideline for the rest of the guidelines. The proportion meeting dietary guidelines was particularly low for trans fat, fiber, fruit, vegetables, whole grains, dairy, and sodium (all below 20%). Neither educational attainment nor food desert residence was associated with any of the dietary guidelines. Related, a recent study of Atlanta residents found that although living in a food desert was associated with a higher burden of cardiovascular disease risk and preclinical indices of disease, these associations were driven largely by area income and individual income rather than access to healthy food (defined based on proximity to a supermarket, supercenter, or large grocery store) (Kelli et al. 2017).

Lower household income was associated with being below the dietary guidelines for carbohydrates, fruits, vegetables, and combined fruits and vegetables and above the guideline for sodium. These findings are consistent with others showing that socioeconomic status is related to dietary intake and dietary quality (Raffensperger et al. 2010; Wang et al. 2014; Backholer et al. 2016) as well as obesity (Drewnowski et al. 2014). In addition, household food insecurity was associated with excessive total fat intake, being below dietary guidelines for carbohydrates, and being less likely to eat at least 50% of grains as

whole grains. Our findings were not consistent with a systematic review reporting that the most consistent associations between food insecurity and diet quality were with fruits, vegetables, and dairy (Hanson and Connor 2014), although it is notable that only 29% of associations between food insecurity and dietary quality in adults were negative in their review.

While our hypothesis was that higher education, higher income, food security, and living outside a food desert would be positively associated with meeting the dietary guidelines, a relatively small number of such associations were found. The small number of overall associations may reflect the homogeneity in our sample that was characterized by high rates of socioeconomic disadvantage and overall low rates of meeting dietary guidelines, unlike large and diverse national samples that have shown that income is associated with meeting guidelines for most food groups (Kirkpatrick et al. 2012). It is also important to recognize that relationships between socioeconomic variables and dietary behavior are very complex. For example, some food desert research shows that increased access to larger stores (supermarkets) may not improve dietary behavior. These larger stores not only provide more healthy opportunities, but they also provide more unhealthy opportunities (Walker, Keane, and Burke 2010; Ghosh-Dastidar et al. 2017; Vaughan et al. 2017). In addition, other research shows that residents of food deserts often travel substantial distances or bypass their closest neighborhood store to shop at larger or discount grocery stores (LeDoux and Vojnovic 2013; Dubowitz, Ncube, et al. 2015; Dubowitz, Zenk, et al. 2015; Miller et al. 2016; Ver Ploeg and Rahkovsky 2016) and are more motivated by pricing of food (often lower at the stores that are further from their home) than proximity (Miller et al. 2016; Ver Ploeg and Rahkovsky 2016), making some question the merit of interventions and policy focusing entirely on improving access to healthy foods (Block and Subramanian 2015; Dubowitz, Zenk, et al. 2015).

The mean diet quality score (HEI-2010) in our sample was only 49 out of 100 possible. In NHANES 2011-2012, the mean score was 58 for adults 18–64 years and 68 for older adults (U.S. Department of Agriculture Center for Nutrition Policy and Promotion 2016). Although neither household income nor food desert residence were significantly associated with diet quality, food insecurity and lower levels of education were both associated with poorer diet quality. Our significant findings are consistent with studies using large representative samples. For example, an analysis of lower-income adults from NHANES showed that food insecurity was associated with lower diet quality (Leung et al. 2014). Thus, even in our study, which was limited to low-income neighborhoods, food insecurity and less education were associated with lower diet quality, indicating the importance of these socioeconomic factors in influencing food intake.

It is notable that meeting dietary guidelines and diet quality showed different associations with the socioeconomic variables of interest. That is, while education was associated with diet quality, it was not associated with meeting dietary guidelines for any of the 12 variables assessed. Conversely, income was associated with several dietary guideline variables but not with diet quality. When attempting to interpret these seemingly inconsistent associations, it is important to note that the HEI-2010 is a composite of 12 components. Thus, while meeting vegetable guidelines might be particularly related to a variable such as income, that component may not be enough to drive HEI-2010 scores and thus associations between income and diet quality. Conversely, differences across multiple components might differ, but not significantly, by a variable such as education, but when

combined in the HEI-2010 scores, differences are detected. Unfortunately, most studies do not report both the proportion meeting dietary guidelines and diet quality, making it difficult to compare our findings with the literature.

Our study has several limitations. The sample comprised food shoppers from geographically defined areas in two cities in South Carolina. Results may not generalize to all low-income communities. Our dietary intake data are based on one 24-hour dietary recall from each participant, which limits reliability compared to the gold standard of three interviews. Yet this approach is preferable to food frequency screeners or questionnaires that are most common in the literature. We also cannot draw conclusions about the relative impact of individual-level influences compared to neighborhood-level influences on dietary intake and quality. The seven urban neighborhoods exhibit significant levels of residential segregation. While the state's population is 28% African American, the participants lived in census tracts with 29% to 98% African American residents; for 11 of the 19 tracts, African Americans were the majority (US Census Bureau 2010). Residential segregation introduces contextual influences that require methodologically complex analyses to disentangle individual-level effects from neighborhood effects on behaviors, which are beyond the scope of this paper. Another limitation is the potential of inadequate statistical power combined with sample homogeneity in the socioeconomic variables that potentially impacted the magnitude and statistical significance of associations. These limitations are notable particularly for dietary guidelines with low attainment (e.g. dairy) and characteristics that skewed toward greater disadvantage (e.g. lower income categories). Analyses using continuous rather than dichotomous outcomes did not, however, lead to different findings, which diminishes concern regarding statistical power but not the homogeneity of the sample on the key independent socioeconomic variables of interest.

Despite these limitations, we obtained a large sample of food shoppers from low- neighborhoods in the Southeast, many of which had low food access, providing a unique opportunity to examine whether socioeconomic factors relate to diet in a vulnerable population. Furthermore, although many studies use food frequency questionnaires or brief dietary questionnaires, we used reliable and validated instruments and protocols to assess household food insecurity and dietary intake.

Implications for research and practice

In this study, residents of disadvantaged neighborhoods had unhealthy dietary intake patterns, combined with the high rates of overweight and obesity and poverty, which greatly increases their risk of premature morbidity and mortality. Further, diet quality was even lower among those residents who were food insecure and residents with lower levels of educational attainment. Nutrition education is a necessary but not sufficient approach to dietary change in these circumstances. For example, a national consumer survey found that compared to higher income residents, SNAP recipients rated their diet quality lower (indicating awareness), were as likely to know optimal vegetable intake, were as likely to report reading nutrition facts on food labels, and were more likely to rate 'nutrition' as a highly important consideration (Mancino and Guthrie 2014). Other considerations were relatively more important to SNAP recipients, including how well food keeps, convenience, and price. A recent detailed analysis of the cost of eating a MyPlate diet concluded that typical SNAP benefit levels plus the expected personal

expenditure for food would be insufficient for following these federal nutrition guidelines (Mulik and Haynes-Maslow 2017). This finding is consistent with conclusions from an earlier review of studies utilizing market basket surveys (Horning and Fulkerson 2015). Interventions in these communities must address broader economic, social, and policy issues that affect access to and affordability of healthy foods.

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References

Backholer, K., E. Spencer, E. Gearon, D. J. Magliano, S. A. McNaughton, J. E. Shaw, and A. Peeters. 2016. "The Association Between Socio-Economic Position and Diet Quality in Australian Adults." *Public Health Nutrition* 19 (3): 477–485. doi:10.1017/S1368980015001470.

Bickel, G., M. Nord, C. Price, W. Hamilton, and J. Cook. 2000. "Guide to Measuring Household Food Security, Revised." Accessed January 29, 2018. http://www.fns.usda.gov/sites/default/files/FSGuide_0.pdf.

Block, J. P., and S. V. Subramanian. 2015. "Moving Beyond "Food Deserts": Reorienting United States Policies to Reduce Disparities in Diet Quality." *PLOS Medicine* 12 (12): e1001914. doi:10.1371/journal.pmed.1001914.

Caspi, C. E., G. Sorensen, S. V. Subramanian, and I. Kawachi. 2012. "The Local Food Environment and Diet: A Systematic Review." *Health and Place* 18 (5): 1172–1187. doi:10.1016/j.healthplace.2012.05.006.

Coleman-Jensen, A., M. P. Rabbitt, C. Gregory, and A. Singh. 2015. "Statistical Supplement to Household Food Security in the United States in 2014, Ap-069." U.S. Department of Agriculture, Economic Research Service, Accessed January 29, 2018. https://www.ers.usda.gov/webdocs/publications/42812/53736_ap069.pdf?v=42487.

Coleman-Jensen, A., M. P. Rabbitt, C. A. Gregory, and A. Singh. 2016. "Household Food Security in the United States in 2015, Err-215." U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/webdocs/publications/79761/err-215.pdf.

Conklin, A. I., N. G. Forouhi, M. Suhrcke, P. Surtees, N. J. Wareham, and P. Monsivais. 2014. "Variety More Than Quantity of Fruit and Vegetable Intake Varies by Socioeconomic Status and Financial Hardship. Findings From Older Adults in the Epic Cohort." *Appetite* 83: 248–255. doi:10.1016/j.appet.2014.08.038.

Coogan, P. F., Y. C. Cozier, S. Krishnan, L. A. Wise, L. L. Adams-Campbell, L. Rosenberg, and J. R. Palmer. 2010. "Neighborhood Socioeconomic Status in Relation to 10-Year Weight Gain in the Black Women's Health Study." *Obesity (Silver Spring, Md)* 18 (10): 2064–2065. doi:10.1038/oby.2010.69.

Cummins, S., E. Flint, and S. A. Matthews. 2014. "New Neighborhood Grocery Store Increased Awareness of Food Access but Did Not Alter Dietary Habits or Obesity." *Health Affairs* 33 (2): 283–291. doi:10.1377/hlthaff.2013.0512.

Drewnowski, A., A. V. Moudon, J. Jiao, A. Aggarwal, H. Charreire, and B. Chaix. 2014. "Food Environment and Socioeconomic Status Influence Obesity Rates in Seattle and in Paris." *International Journal of Obesity* 38 (2): 306–314. doi:10.1038/ijo.2013.97.

Dubowitz, T., M. Ghosh-Dastidar, D. A. Cohen, R. Beckman, E. D. Steiner, G. P. Hunter, K. R. Florez, et al. 2015. "Diet and Perceptions Change with Supermarket Introduction in a Food Desert, but Not Because of Supermarket Use." *Health Affairs* 34 (11): 1858–1868. doi:10.1377/hlthaff.2015.0667.

Dubowitz, T., C. Ncube, K. Leuschner, and S. Tharp-Gilliam. 2015. "A Natural Experiment Opportunity in Two Low-Income Urban Food Desert Communities: Research Design, Community Engagement Methods, and Baseline Results." *Health Education and Behavior* 42 (1 Suppl): 87S–96S. doi:10.1177/1090198115570048.

Dubowitz, T., S. N. Zenk, B. Ghosh-Dastidar, D. A. Cohen, R. Beckman, G. Hunter, E. D. Steiner, and R. L. Collins. 2015. "Healthy Food Access for Urban Food Desert Residents: Examination of the Food Environment, Food Purchasing Practices, Diet and Bmi." *Public Health Nutrition* 18 (12): 2220–2230. doi:10.1017/S1368980014002742.

Dutko, P., M. Ver Ploeg, and T. Farrigan. 2012. "Characteristics and Influential Factors of Food Deserts, Err-140." U.S. Department of Agriculture, Economic Research Service, Accessed January 29, 2018. https://www.ers.usda.gov/publications/pub-details/?pubid=45017.

Eisenmann, J. C., C. Gundersen, B. J. Lohman, S. Garasky, and S. D. Stewart. 2011. "Is Food Insecurity Related to Overweight and Obesity in Children and Adolescents? A Summary of Studies, 1995-2009." *Obesity Reviews* 12 (5): e73–e83. doi:10.1111/j.1467-789X.2010.00820.x.

Elbel, B., A. Moran, L. B. Dixon, K. Kiszko, J. Cantor, C. Abrams, and T. Mijanovich. 2015. "Assessment of a Government-Subsidized Supermarket in a High-Need Area on Household Food Availability and Children's Dietary Intakes." *Public Health Nutrition* 18 (15): 2881–2890. doi:10.1017/S1368980015000282.

Franklin, B., A. Jones, D. Love, S. Puckett, J. Macklin, and S. White-Means. 2012. "Exploring Mediators of Food Insecurity and Obesity: A Review of Recent Literature." *Journal of Community Health* 37 (1): 253–264. doi:10.1007/s10900-011-9420-4.

Ghosh-Dastidar, M., G. Hunter, R. L. Collins, S. N. Zenk, S. Cummins, R. Beckman, A. K. Nugroho, J. C. Sloan, L. Wagner, and T. Dubowitz. 2017. "Does Opening a Supermarket in a Food Desert Change the Food Environment?" *Health and Place* 46: 249–256. doi:10.1016/j.healthplace.2017.06.002.

Guenther, P. M., K. O. Casavale, J. Reedy, S. I. Kirkpatrick, H. A. Hiza, K. J. Kuczynski, L. L. Kahle, and S. M. Krebs-Smith. 2013. "Update of the Healthy Eating Index: Hei-2010." *Journal of the Academy of Nutrition and Dietetics* 113 (4): 569–580. doi:10.1016/j.jand.2012.12.016.

Guenther, P. M., S. I. Kirkpatrick, J. Reedy, S. M. Krebs-Smith, D. W. Buckman, K. W. Dodd, K. O. Casavale, and R. J. Carroll. 2014. "The Healthy Eating Index-2010 Is a Valid and Reliable Measure of Diet Quality According to the 2010 Dietary Guidelines for Americans." *The Journal of Nutrition* 144 (3): 399–407. doi:10.3945/jn.113.183079.

Hanson, K. L., and L. M. Connor. 2014. "Food Insecurity and Dietary Quality in Us Adults and Children: A Systematic Review." *The American Journal of Clinical Nutrition* 100 (2): 684–692. doi:10.3945/ajcn.114.084525.

Hattori, A., R. An, and R. Sturm. 2013. "Neighborhood Food Outlets, Diet, and Obesity among California Adults, 2007 and 2009." *Preventing Chronic Disease* 10: E35. doi:10.5888/pcd10.120123.

Holben, D. H., and C. A. Taylor. 2015. "Food Insecurity and Its Association with Central Obesity and Other Markers of Metabolic Syndrome among Persons Aged 12 to 18 Years in the United

States." *The Journal of the American Osteopathic Association* 115 (9): 536–543. doi:10.7556/jaoa.2015.111.

Horning, M. L., and J. A. Fulkerson. 2015. "A Systematic Review on the Affordability of a Healthful Diet for Families in the United States." *Public Health Nursing* 32 (1): 68–80. doi:10.1111/phn.12145.

Jonnalagadda, S. S., D. C. Mitchell, H. Smiciklas-Wright, K. B. Meaker, N. Van Heel, W. Karmally, A. G. Ershow, and P. M. Kris-Etherton. 2000. "Accuracy of Energy Intake Data Estimated by a Multiple-Pass, 24-Hour Dietary Recall Technique." *Journal of the American Dietetic Association* 100 (3): 303–311. quiz 9-11.

Kaur, J., M. M. Lamb, and C. L. Ogden. 2015. "The Association Between Food Insecurity and Obesity in Children-the National Health and Nutrition Examination Survey." *Journal of the Academy of Nutrition and Dietetics* 115 (5): 751–758. doi:10.1016/j.jand.2015.01.003.

Kelli, H. M., M. Hammadah, H. Ahmed, Y. A. Ko, M. Topel, A. Samman-Tahhan, M. Awad, et al. 2017. "Association Between Living in Food Deserts and Cardiovascular Risk." *Circulation: Cardiovascular Quality and Outcomes* 10 (9): e003532. doi:10.1161/CIRCOUTCOMES.116.003532.

Kirkpatrick, S. I., K. W. Dodd, J. Reedy, and S. M. Krebs-Smith. 2012. "Income and Race/Ethnicity Are Associated with Adherence to Food-Based Dietary Guidance among Us Adults and Children." *Journal of the Academy of Nutrition and Dietetics* 112 (5): 624–635.e6. doi:10.1016/j.jand.2011.11.012.

Larson, N. I., M. T. Story, and M. C. Nelson. 2009. "Neighborhood Environments: Disparities in Access to Healthy Foods in the U.S." *American Journal of Preventive Medicine* 36 (1): 74–81.e10. doi:10.1016/j.amepre.2008.09.025.

LeDoux, T. F., and I. Vojnovic. 2013. "Going Outside the Neighborhood: The Shopping Patterns and Adaptations of Disadvantaged Consumers Living in the Lower Eastside Neighborhoods of Detroit, Michigan." *Health and Place* 19: 1–14. doi:10.1016/j.healthplace.2012.09.010.

Leung, C. W., E. S. Epel, L. D. Ritchie, P. B. Crawford, and B. A. Laraia. 2014. "Food Insecurity Is Inversely Associated with Diet Quality of Lower-Income Adults." *Journal of the Academy of Nutrition and Dietetics* 114 (12): 1943–1953.e2. doi:10.1016/j.jand.2014.06.353.

Ma, X., A. D. Liese, J. Hibbert, B. A. Bell, S. Wilcox, and P. A. Sharpe. 2017. "The Association Between Food Security and Store-Specific and Overall Food Shopping Behaviors." *Journal of the Academy of Nutrition and Dietetics* 117 (12): 1931–1940. doi:10.1016/j.jand.2017.02.007.

Mancino, L., and J. Guthrie. 2014. "Snap Households Must Balance Multiple Priorities to Achieve a Healthful Diet." Amber Waves. U.S. Department of Agriculture, Economic Research Service, Accessed January 29, 2018. https://www.ers.usda.gov/amber-waves/2014/november/snap-households-must-balance-multiple-priorities-to-achieve-a-healthful-diet/.

McGeeney, K. 2015. "Appending a Prepaid Phone Flag to the Cell Phone Sample." *Survey Practice* 8 (4): 1–8. www.surveypractice.org/article/2837.pdf.

McInerney, M., I. Csizmadi, C. M. Friedenreich, F. A. Uribe, A. Nettel-Aguirre, L. McLaren, M. Potestio, B. Sandalack, and G. R. McCormack. 2016. "Associations Between the Neighbourhood Food Environment, Neighbourhood Socioeconomic Status, and Diet Quality: An Observational Study." *BMC Public Health* 16: 984. doi:10.1186/s12889-016-3631-7.

Miller, W. C., D. Rogalla, D. Spencer, N. Zia, B. N. Griffith, and H. B. Heinsberg. 2016. "Community Adaptations to an Impending Food Desert in Rural Appalachia, USA." *Rural and Remote Health* 16 (4): 3901.

Mokdad, A. H., J. S. Marks, D. F. Stroup, and J. L. Gerberding. 2004. "Actual Causes of Death in the United States, 2000." *Journal of the American Medical Association* 291 (10): 1238–1245.

Moore, L. V., A. V. Diez Roux, J. A. Nettleton, and D. R. Jacobs, Jr. 2008. "Associations of the Local Food Environment with Diet Quality--a Comparison of Assessments Based on Surveys and Geographic Information Systems: The Multi-Ethnic Study of Atherosclerosis." *American Journal of Epidemiology* 167 (8): 917–924. doi:10.1093/aje/kwm394.

Mulik, K., and L. Haynes-Maslow. 2017. "The Affordability of Myplate: An Analysis of Snap Benefits and the Actual Cost of Eating According to the Dietary Guidelines." *Journal of Nutrition Education and Behavior* 49 (8): 623–631.e1. doi:10.1016/j.jneb.2017.06.005.

Nackers, L. M., and B. M. Appelhans. 2013. "Food Insecurity Is Linked to a Food Environment Promoting Obesity in Households with Children." *Journal of Nutrition Education and Behavior* 45 (6): 780–784. doi:10.1016/j.jneb.2013.08.001.

Nutrition Coordinating Center. 2014. *Nutrition Data System for Research 2014 User Manual (Online Manual)*. Minneapolis, MN: University of Minnesota.

Pan, L., B. Sherry, R. Njai, and H. M. Blanck. 2012. "Food Insecurity Is Associated with Obesity among Us Adults in 12 States." *Journal of the Academy of Nutrition and Dietetics* 112 (9): 1403–1409. doi:10.1016/j.jand.2012.06.011.

Pew Research Center. 2015. "Advances in Telephone Survey Sampling." Accessed January 29, 2018. http://www.pewresearch.org/2015/11/18/advances-in-telephone-survey-sampling/.

Posner, B. M., C. L. Borman, J. L. Morgan, W. S. Borden, and J. C. Ohls. 1982. "The Validity of a Telephone-Administered 24-Hour Dietary Recall Methodology." *The American Journal of Clinical Nutrition* 36 (3): 546–553.

Raffensperger, S., M. F. Kuczmarski, L. Hotchkiss, N. Cotugna, M. K. Evans, and A. B. Zonderman. 2010. "Effect of Race and Predictors of Socioeconomic Status on Diet Quality in the Handls Study Sample." *Journal of the National Medical Association* 102 (10): 923–930.

Rogus, S., J. Athens, J. Cantor, and B. Elbel. 2018. "Measuring Micro-Level Effects of a New Supermarket: Do Residents Within 0.5 Mile Have Improved Dietary Behaviors?" *Journal of the Academy of Nutrition and Dietetics* 118: 1037–1046. doi:10.1016/j.jand.2017.06.360.

Sadler, R. C., J. A. Gilliland, and G. Arku. 2013. "A Food Retail-Based Intervention on Food Security and Consumption." *International Journal of Environmental Research and Public Health* 10 (8): 3325–3346. doi:10.3390/ijerph10083325.

Sharpe, P. A., A. D. Liese, B. Bell, S. Wilcox, B. Hutto, and J. Stucker. 2017. "Household Food Security and Use of Community Food Sources and Assistance Programs among Food Shoppers in Neighborhoods of Low Income and Low Food Access." *Journal of Hunger and Environmental Nutrition* e-pub ahead of print October 2017: 1–15. doi:10.1080/19320248.2017.1364188.

US Census Bureau. 2010. "2010 Census Demographic Profile (Dp1) Race." Accessed January 29, 2018. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1&prodType=table.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2010. "Dietary Guidelines for Americans, 2010. 7th Edition." U.S. Government Printing Office, Accessed January 29, 2018. https://health.gov/dietaryguidelines/dga2010/dietaryguidelines2010.pdf.

U.S. Department of Agriculture Center for Nutrition Policy and Promotion. 2016. "Healthy Eating Index." Accessed January 29, 2018. https://www.cnpp.usda.gov/healthyeatingindex.

U.S. Department of Agriculture Economic Research Service. 2015a. "Food Access Research Atlas: Download the Data." Accessed January 29, 2018. https://www.ers.usda.gov/data-products/food-access-research-atlas/download-the-data/.

U.S. Department of Agriculture Economic Research Service. 2015b. "Food Security in the U.S.: Measurement." Accessed January 29, 2018. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.aspx.

Vaughan, C. A., D. A. Cohen, M. Ghosh-Dastidar, G. P. Hunter, and T. Dubowitz. 2017. "Where Do Food Desert Residents Buy Most of Their Junk Food? Supermarkets." *Public Health Nutrition* 20 (14): 2608–2616. doi:10.1017/S136898001600269X.

Ver Ploeg, M., V. Breneman, T. Farrigan, K. Hamrick, D. Hopkins, P. Kaufman, B. H. Lin, et al. 2009. "Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences. Report to Congress." U.S. Department of Agriculture, Economic Research Service, Accessed January 29, 2018. https://www.ers.usda.gov/publications/pub-details/?pubid=42729.

Ver Ploeg, M., and I. Rahkovsky. 2016. "Recent Evidence on the Effects of Food Store Access on Food Choice and Diet Quality." U.S. Department of Agriculture, Economic Research Service, Accessed January 29, 2018. https://www.ers.usda.gov/amber-waves/2016/may/recent-evidence-on-the-effects-of-food-store-access-on-food-choice-and-diet-quality/.

Walker, Renee E., Christopher R. Keane, and Jessica G. Burke. 2010. "Disparities and Access to Healthy Food in the United States: A Review of Food Deserts Literature." *Health & Place* 16 (5): 876–884. doi:10.1016/j.healthplace.2010.04.013.

Wang, D. D., C. W. Leung, Y. Li, E. L. Ding, S. E. Chiuve, F. B. Hu, and W. C. Willett. 2014. "Trends in Dietary Quality among Adults in the United States, 1999 Through 2010." *JAMA Internal Medicine* 174 (10): 1587–1595. doi:10.1001/jamainternmed.2014.3422.

Wang, May C., Kara E. MacLeod, Cathy Steadman, Laura Williams, Shené L. Bowie, Denise Herd, Mia Luluquisen, and Mark Woo. 2007. "Is the Opening of a Neighborhood Full-Service Grocery Store Followed by a Change in the Food Behavior of Residents?" *Journal of Hunger & Environmental Nutrition* 2 (1): 3–18. doi:10.1080/19320240802077789.

Weber, J. L., A. M. Tinsley, L. B. Houtkooper, and T. G. Lohman. 1997. "Multimethod Training Increases Portion-Size Estimation Accuracy." *Journal of the American Dietetic Association* 97 (2): 176–179. doi:10.1016/S0002-8223(97)00046-1.