The Relationship Between Perceptions of the Food Retail Environment and Health

By

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Abstract

As literature of the factors contributing to obesity continue to increase, it is critical to take a closer look at the role of the environment, and specifically the food retail environment. We conducted a systematic review of the literature to analyze the relationship between perceptions of the food retail environment and food-seeking behavior and health. In conducting our review, we searched the MEDLINE database for relevant research and found nine papers to include in the review. Our analysis of the current literature showed mixed results of the relationship between perceptions of the food retail environment and health and food-seeking behavior. The mixed results were likely due to large differences among the studies in the measures used to assess perceptions and outcomes. Because some studies did show significant associations, we conclude that at least some perceptions can indeed affect food-seeking behavior and health. Unfortunately, the current literature does clearly describe the relationship. In order to better understand this relationship, it will be important for future studies to use standardized measures to assess perceptions and outcomes. Most of the papers included in our review analyzed the relationship between perceptions and food-seeking behavior. Every paper we found used secondary data to analyze the relationships. The lack of studies conducted with primary data on the relationship between perceptions of the food retail environment and weight status lead to our original research study.

In this study, we aimed to identify and determine the extent of influence that perceived indicators of the food retail environment can have on obesity and body mass index (BMI). We conducted a cross-sectional study using a self-administered internet-based survey that we designed. The survey collected information about perceptions of the food retail environment and demographic information. BMI and obesity status was calculated using self-reported height and weight from the survey items. The study sample consisted of employees and students at the University of North Carolina at Chapel Hill. 191 survey respondent were included in our final
analysis of the data. We assessed the relationship between perceptions and weight status using linear and logistic regression models. The models were adjusted for the sociodemographic variables race, age, sex, income and education. In our analysis of perceptions of neighborhood characteristics and weight status, no relationship was found. However, we did find significant associations between perceptions of food product characteristics and weight status. Availability of a variety of fruits and vegetables and high quality of fruits and vegetables were associated with the decreased odds of being obese and with having a lower BMI. Perceiving that food at respondents’ primary food store was rotten was associated with higher BMI. Lastly, Availability of low-fat dairy products was associated with lower odds of being obese. The systematic review and original research paper add to the current literature of association between the food retail environment and obesity. Increased knowledge of the factors contributing to the obesity epidemic will help to reverse the trend of growing obesity rates.
The Influence of Perceptions of Food Retail Environments on Health and Health Behaviors: A Systematic Review

Abstract

As obesity rates in the United States continue to rise, focus on the role of the environment has expanded. Researchers have recognized that perceptions of the food retail environment may influence food-seeking behavior and health. This study aims to analyze this relationship as evidenced by the current literature. Articles were retrieved through a systematic literature search of the MEDLINE database. Nine papers were included this review. The indicators for perceptions of the food retail environment varied greatly among the studies. Some studies assessed perceptions of food establishments and others assessed perceptions of food products. Indicators of perceptions included cost, variety, quality, satisfaction, and walking distance. Outcomes assessed included fruit and vegetable consumption, fast food consumption, BMI, and purchase frequency. There was no consensus among the articles on the relationship between perceptions of the food retail environment and outcomes, possibly due to the high heterogeneity. The highly variability of the independent variables and dependent variables contributed to much of the heterogeneity. The positive results of a few of the studies leads us to believe that some perception do in fact influence food-seeking behaviors and health, however, current literature does not yet reveal the full extent of this relationship. As research moves forward, it will be important to develop a standardized methodology of assessing perceptions of the food retail environment. Collective information on both objective and subjective measures of the food retail environment will be critical in combating obesity.
Introduction

The United States is currently facing an obesity epidemic. Over the past five decades, the prevalence of obesity has risen steadily from 15.8% in 1962 to 36.1% in 2010. This trend has been present in men and women across all ethnic groups, ages, education levels and socioeconomic statuses. Obesity is related to many health problems including cardiovascular disease, stroke, diabetes, hypertension and cancer. In order to combat the increasing rates of obesity and obesity-related health problems, clinicians, public health specialists, and community leaders have implemented various interventions. Some of the strategies in combating obesity include surgery, medications, behavioral interventions such as nutritional and exercise programs, and school- and work-based interventions. The importance of the environment on obesity was recognized decades ago, but only recently, due to the ineffectiveness of current intervention strategies on curtailing trends in obesity prevalence, has there been a shift in focus from the individual level to the population level. It is now widely accepted that obesogenic environments are obstacles in the success of many intervention programs. Obesogenic environments are environments that promote obesity in various ways such as increasing availability and access to unhealthy food retail establishments, facilitating consumption of high-calorie and high-fat foods, decreasing access to healthy foods (especially fruits and vegetables), and promoting a sedentary lifestyle. The past decade has seen an explosion in studies that focus on the contribution of the built environment to obesity. Some of this research focuses on factors that discourage exercise, such as neighborhood safety, walkability, and availability of parks and trails. Other researchers are studying how the food retail environment prevents individuals from engaging in healthy diets. A large number of these studies were dedicated to learning about the influences of objective measures of the food retail environment. They have focused on variables such as network distance to food establishments (determined by Geographic Information Systems), healthy food availability (determined by store audits) and
availability of particular types of food establishments (determined by community audits or commercial databases).\textsuperscript{14–17} Although such objective measures of the food retail environment are important to study, perceived measures of the food environment also have important implications for combating the obesity epidemic. Given the recent growth of literature on the influence of perceptions of the food retail environment, in this paper we (1) present a systematic assessment of the literature that focuses on perceptions and (2) provide recommendations for future research.
Methods

The purpose of this systematic review was to evaluate for the extent of and analyze the content of the current literature on perceptions of the food retail environment. Specifically, we sought to evaluate the literature on the evidence of how perceptions of the food retail environment correlate with behaviors and health. We were interested in behaviors related to food-seeking behavior, such as frequency of visiting food establishments, and behaviors related to food consumption.

Search Strategy:

We began our systematic review with a literature search. In order to find search terms to use for the literature search, we performed a background literature search and analyzed the articles for their use of subject terms and MeSH terms. We then used these search terms to search through the MEDLINE database. Our literature search consisted of the terms [(“Food Retail Environment” or “Retail Food Environment” or “Food Environment” or “Food Access” or “Food Supply”* or “Neighborhood Food Environment” or “Food Access”) AND (“Perceptions” or “Opinion” or “Attitude” or “Health Knowledge, Attitudes, Practice”*)]. The search was limited to articles since 2000 and the English language. As obesity prevalence and the food retail landscape continue to change, the role of the food retail environment changes as well. In order to better capture the influence of the present food retail environment, we limited articles to those published after 2000.

Article Selection:

Articles that appeared in the search were screened by their titles first to determine if they were relevant. Those articles found to relevant were reviewed by abstracts to determine their eligibility. Articles were excluded if they clearly did not meet inclusion criteria or if they met exclusion criteria. For the articles that were not excluded by abstract and those for which the eligibility could not be properly assessed based on abstract, we reviewed the full article. Based

*Indicates MeSH Term
on a full article reviews, we determined the final list of articles to be included in this systematic review. Several criteria were used to determine eligibility of the articles: (1a) assessed the effect of perceptions of the local food retail environment on behaviors and measures of health status; (1b) behaviors assessed were of food-seeking behavior or food consumption behavior; (2) performed a quantitative analysis; (3) measured perceptions through surveys or interviews; and (4) was conducted in the United States. The literature search, screening of results, and full article reviews were performed by a single reviewer.

In developing the search strategy, we wanted to focus on the various effects that perceptions of food retail environments have on behaviors and health status. We found appropriate search terms for use in our systematic review search strategy based on a preliminary background literature search. Although it may have been possible to broaden the search results by using a variety of other search terms, we found these terms were not directly related to our topic of interest. Studies from outside of the United States were excluded because social and environmental factors vary widely between countries. Consequently, it would be unclear if results were relevant and interpretation of said results to the United States would be difficult.

**Data Analysis:**

In conducting our review, we abstracted the following information from the articles: study design, setting, study population and demographic information, number of participants, measures of perceived food retail environment, outcome reported, and associations found between perceptions and outcome. For the studies which collected information on many different measures of perception and outcome measures, we only abstracted data where independent variables were of perceptions of the food retail environment and dependent variables were of food-seeking behavior, food consumption behavior and measures of health status. Many of the studies conducted analyses that compared various perceptions to each other or simply reported baseline data of perceptions and outcomes. Results that did not pertain
In our analysis, we compare the measures of perceptions and outcome measures used in the various studies. We then compare the results of the studies based on the outcome measures used in each study. Lastly, we discuss the quality of studies.
Results

Literature Search:

In total, we found 418 potential articles from our MEDLINE search strategy. After limiting the search to the English language and papers since 2010, we were left with 324 titles. Screening the titles eliminated 94 studies, 91 which were not found to be relevant and three which were duplicates. After reading through the abstracts of the remaining 230 articles, we were left with 34 articles that potentially met our eligibility criteria. We subsequently reviewed the full text of the 34 articles and were ultimately left with seven articles that met all criteria. Additionally, two articles cited in references or appearing as “suggested articles” from the databases were included. Many of the studies reported on multiple results, some of which were not pertinent to the primary aim of this systematic review. While we included studies that reported on multiple results, we only analyzed the data that was directly relevant to our primary research objectives. The literature search process can be seen in the Appendix (Figure 1).

Data Extraction:

In total, we found nine papers that met all of the eligibility criteria and were included in this review. Table 1 contains a list of the articles included in this review and provides additional background information from the studies. Most of the articles reviewed focused on the adult population. One paper focused on an adolescent population. All of the studies we examined were cross-sectional studies that obtained some data, if not all data, from surveys. The survey methodology differed among surveys with five using telephone surveys and the other four using written surveys.

Perception of Access:

The studies analyzed in this review collected a variety of measures pertaining to perceptions of the food retail environment. The measures included perceptions of travelling to establishments, frequency of visits to establishments, “ease” of access to various types of food
products, variety or selection for food products and establishments, freshness of food products, quality of food products, and cost of food products. An overview of studies and the independent variables measured in each study can be found in Table 2 (this table also contains information on dependent variables and a summary of the results of each study). The most commonly assessed measures were those assessing travel, quality, freshness, and variety. Seven articles collected data on traveling to establishments, either in the form of time or distance to travel, the presence of establishments, or the ease of accessing establishments. Six of the articles collected data on quality and freshness. Four of those six articles focused on the quality or freshness of food products (predominately fruits and vegetables), one of the articles focused on the quality of grocery stores, and the last article asked respondents about the quality of both grocery stores and food products. Five of the articles collected data on variety. Each of those five articles asked respondents about the variety of food products in a particular store or in the respondents’ neighborhoods, but one also asked about a variety of food retail establishments in the neighborhood. The analysis of the measures also varied between studies. While some of the studies analyzed the relationship of each measure to the outcome, others aggregated the measures into a single sum score.

**Outcome Measures:**

The outcomes in the studies analyzed in this systematic review were much less varied than the measures of perceptions of the food retail environment. The main outcome in most of the studies was either BMI or consumption of fruits and vegetables. Other outcomes measured included consumption of other food or beverages and frequency of food product purchasing from establishments. All of the studies used self-reported data for outcomes, except for the study by Gustafson et al., in which the researchers measured the height and weight of respondents.
Data Analysis: Weight Status

Three of the studies included weight status as an outcome. The study by Boehmer et al. found that those who perceived walking time to the nearest supermarket to be greater than 30 minutes had increased odds of being obese than those who perceived the walking time to be less than 10 minutes (OR = 1.8 [95% CI = 1.3-2.4]). They also analyzed the relationship between quality or variety of fruits and vegetables available at respondents’ primary food store and weight status, but found no association (OR = 0.95 [95% CI = 0.74-1.24]). In a 2008 study by Casey et al., researchers analyzed the how the perceived access to produce and low-fat food products was associated with obesity, but did not find a relationship (OR = 1.02 [95% CI = 1.00-1.05]). Availability was represented by a sum score of 5 questions that asked about the ease of purchasing, quality, and variety of fruits and vegetables and low-fat products at respondents’ primary food stores. The final study assessing obesity was conducted by Gustafson et al. They compared weight status to three perceived measures: 1) healthy food availability in the respondents’ neighborhoods, 2) healthy food availability at respondents’ primary food stores, and 3) perceived access to primary food stores. Healthy food availability was represented by a sum score of questions regarding the variety and quality of various food products, including fruits and vegetables, low-fat products, and brown breads. Access to the primary food store was determined by the perceived length of time and distance to the store. In a regression model, no relationship to BMI was seen when comparing those with high perceived healthy food availability to low perceived healthy food availability, at either the neighborhood level (β = -0.28 [95% CI = -3.45 - 2.90]) or primary food store level (β = 1.22 [95% CI = -0.22, 2.67]). No relationship was seen between weight status perceived access to primary food stores either (β = -0.83 [95% CI = -2.39 - 0.73]).

Data Analysis: Fruit and Vegetable Consumption

Similarly to the studies which focused on weight status, the results were mixed for the studies in which the outcome of interest was fruit and vegetable consumption. For our
evaluation, we divided these studies into three groups in order to aid with the interpretation of the results. The first group of studies are those that have results comparing perceived access to food establishments to fruit and vegetable consumption. The second set of studies contain results of the association between perceived characteristics of food products and fruit and vegetable consumption. Quality, variety, and cost of the food products were the main characteristics analyzed. The third group consists of studies that use a sum score derived from questions about both access to food establishments and characteristics of food products and compare this sum score to fruit and vegetable consumption. A few studies compared both analyzed both perceived access to food establishments and characteristics of food products, but did not aggregate the scores into a single value. We present the results of those studies independently in the first and second group.

Studies by Flint et al., Sharkey et al., Lucan et al., Gustafson et al., and Caspi et al. report results that belong to the first group. These results show the relationship between perceived access to food establishments and fruit and vegetable consumption. Although the studies probed at accessibility in different ways, in each study, the questions pertained to having food establishments close to the respondents’ homes. Models from the study by Sharkey et al. showed the belief of having many grocery stores in the community is associated with consumption of more daily servings of fruits and vegetables compared with the belief of having few available grocery stores ($\beta = 0.299-0.342$ [p = 0.010 – 0.024]). Caspi et al. had similar results with models showing that those who believed supermarkets were within walking distance consumed $\frac{1}{2}$ more servings of fruits and vegetables daily than those who did not think there were supermarkets within walking distance ($\beta = 0.48-0.51$ [p < 0.0001]). The studies by Flint et al., Gustafson et al. and Lucan et al. did not find associations between access to food establishments and fruit and vegetable consumption.

In addition to belonging in the first group, the studies by Flint et al., Lucan et al., Sharkey et al. and Gustafson et al., presented results belonging to the second group in which perceived
characteristics of food products are compared to fruit and vegetable consumption. Models from the analysis by Sharkey et al. showed that daily servings of fruits and vegetables consumed were fewer in those believing they had a poor or fair variety fruits and vegetables to select from at their primary food store than those believing they had a better selection from which to choose (β = 0.399–0.412 [p = 0.036 – 0.043]). The study by Flint et al., Lucan et al., and Gustafson et al. found no relationships between fruit and vegetable consumption and the variety, quality and cost of fruits and vegetables.\textsuperscript{19,21,22}

The study by Blitstein et al. belongs to the third group as their analysis aggregated measures of store access and food product characteristics into a sum score. Blitstein et al. found an increased odds of consuming three or more daily servings of fruits and vegetables in those who agreed that they were satisfied with their food retail environment than those who did not agree (OR = 2.13 [95% CI = 1.16, 3.93]). There was an even higher odds (OR = 4.42) when comparing those who strongly agreed with being satisfied to those who did not agreed. The satisfaction scale was a variable that combined measures of variety of food products, quality of food products, and access to food retail establishments.\textsuperscript{25}

**Data Analysis: Food Purchasing Behavior**

Lucan et al. compared perceived food product characteristics and supermarket accessibility to fast food consumption. Their results demonstrated perceptions of poor availability, poor accessibility, and poor produce quality each were associated with more frequent eating at fast food restaurants over the previous week (IRR = 1.31 [p < 0.001], 1.05 [p = 0.04], 1.20 [p < 0.001], respectively).\textsuperscript{21} Hearst et al. attempted to determine how the perceived access to various food retail establishments (as determined by perceived walking time to various food establishments) correlated with purchasing of sugar sweetened beverages, food at convenience stores, and fast food restaurants. The food retail establishment types present in their analysis included convenience stores, supermarkets, fast food restaurants, coffee places, and non-fast food restaurants. Their results showed respondents’ living within 1-5 minutes
walking time of food retail establishments had more daily purchases of sugar sweetened beverages than those who had to walk more than 30 minutes to the nearest establishments (β = 0.50-0.84 [p < 0.05]). Additionally, results showed that Individuals who lived 1-5 minutes walking time from the nearest supermarket frequented fast food restaurants more often than those who lived more than 30 minutes walking time from the nearest supermarket (β = 0.32 [p < 0.01]). Interestingly, living 21-30 minutes walking time from supermarkets was associated with visiting fast food restaurants more often as well (β = 0.36 [p < 0.01]). No association was found between convenience store food purchasing and perceived proximity to any food retail establishment.
Discussion

The studies analyzed in this systematic review have mixed results. Of the three studies that compared perceptions of the food retail environment to weight status, only one showed significant results. Of the seven studies that compared perceptions to fruit and vegetable intake, only four found significant associations. There are many factors that may be contributing to the conflicting results of the studies in this systematic review.

One of the more striking factors is the inconsistency of measures used to assess perceptions of the food retail environment. As we have seen throughout this review, some studies analyzed characteristics about available food products, others focused on access to food establishments, and a few even assessed the characteristics of the food establishments themselves. Even within these broad categories, the specific questions that studies focused on were widely variable. Regarding the characteristics of food products, possible features of interest included variety, quality, and cost. The food product itself also varied; some studies focused on fruits and vegetables and others on a variety of low-fat products. Regarding access to food establishments, possible measures of access included time to travel to establishments, distance to establishments, and abundance of establishments with a particular radius. Furthermore, studies varied on which food retail establishments were included and whether they analyzed data about neighborhood food establishments or a particular establishment that respondents most frequently visited. This inconsistency in measures also applies to outcome measures. For instance, one of the studies that assessed weight status measured the height and weight with a stadiometer and scale\textsuperscript{19} while the other two used self-reports\textsuperscript{23,24}. Fruit and vegetable intake was also measured differently among the studies. Survey items regarding intake differed in their recall period, wording, and definitions of servings. One of the surveys used the term “produce,”\textsuperscript{24} and another study told respondents not to count potatoes in their listing of vegetables serving and fruit juice in their listing of fruit servings\textsuperscript{27}. 
The lack of standardized methodology makes interpretation of the combined results difficult, if not impossible. The results from studies in this review already contrasted. Nearly half of the studies found statistically significant association between perceptions of the environment and behaviors or health status, but the other half did not find significant associations. While the lack of standardization may have been a large factor behind the conflicting results, there are many other factors that make interpretation of the results difficult.

The internal validity of many of these studies is significantly limited. Out of the studies that reported response rates, one had a rate of 94%\textsuperscript{25}, but four others reported rates between 47% and 65%. It is possible that those who chose to respond to the surveys were different than those who did not respond to the surveys. Many of the studies failed to adequately describe the process used to recruit samples from the study population; this was likely due to the nature of the studies themselves. A few of the studies describe their use of a random-digit dial in order to recruit participants to complete surveys.\textsuperscript{21–23,26} A strong point of the studies were their sample sizes. Only a single study had a sample size of less than 200.\textsuperscript{29} Most of the other studies had sample sizes greater than 500.

Incomplete models are another factor that could be behind the conflicting results. The food retail environment is a complex system and current literature has not yet discovered every variable that contributes to the food retail environment. There are many potential confounders and although the studies ran models to account for the confounders, the analyses only took a few potential confounders into account. Unmeasured variables that influence food consumption behaviors and weight status would be left out of models and could lead to conflicting results.

Another important difference among the papers are the populations recruited in each of the studies. The study populations varied in income level, weight status, race, and whether the whether they lived in rural, suburban, or urban settings. It is possible that the results seen in this systematic review differ not only because of variances in the measures and incomplete models, but also because perceptions of the food retail environment have different effects on behaviors
and health status depending on the population of interest. The diverse populations in these studies also make it difficult to extrapolate the findings from each study to other settings.

A final note about the studies is the methodology behind data collection that was used. In performing the researchers were predominately using secondary data that was collected for other purposes. Most of the data was obtained from interventional studies that collected baseline survey information from participants at the beginning of the interventional study. When collecting primary data, researchers would have the ability to collect the full extent of data they would find useful. Using secondary data blocks researchers’ abilities to analyze all of the information in which they are truly interested. Consequently, using this secondary data ensured that researchers were not be able to control for many additional variables that literature has shown to relate to the food retail environment, weight status, and food-seeking behavior.

Future studies on the food retail environment should focus on collecting primary data. The questionnaires should be designed explicitly to assess perceptions of the food retail environment. This should additionally be backed by standardized questionnaire items so that future studies would be comparable to one another. Despite the limitations that have been encountered, this systematic review imparts many important lessons. First, it demonstrates that individuals’ beliefs are able to have important effects on their behaviors. Second, it highlights that perceptions of the food retail environment can influence consumption patterns and health status. Third, it sheds light on the on the complexity of the food retail environment so that we are able to better design future interventions. As we continue to combat the obesity epidemic, these lessons will help guide toward a healthier future. We can use the information from the studies analyzed in this systematic review and from future studies to help develop policies and implement public health interventions that will begin to curb the obesity rates in the United States and around the world.
References:


Tables and Figures:

Figure 1. Literature Search

Search Strategy:
One term from Group A
+ One term from Group B

Group A:
Food Retail Environment
Food Access
Food Supply
Retail Food Environment
Neighborhood Food Environment
Food Availability

Group B:
Perceptions
Opinion
Attitude
Health Knowledge, Attitudes, Practice

Results from MEDLINE Search
418

Limited search to English language and last 14 years: 94 Excluded

Results from MEDLINE Search
324

Articles screened by title: 91 Not relevant 3 Duplicates

Articles requiring abstract review
230

Papers excluded by abstract review: 194 Did not meet eligibility criteria

Papers requiring full review
34

Additional papers included from citations and database suggestions: 2 meeting criteria

Papers excluded by full review: 27 Did not meet eligibility criteria

Studies included in systematic review
9

*Indicates MeSH Term
<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Study Design</th>
<th>Setting</th>
<th>Study Population</th>
<th>n</th>
<th>Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blitstein</td>
<td>2012</td>
<td>CS, Interviewer-administered questionnaire</td>
<td>6 low-income Chicago neighborhoods</td>
<td>Parents of 3-7 yo children who participated in the 5-4-3-2-1 Go! Campaign</td>
<td>495</td>
<td>78.8% Female 66% White</td>
</tr>
<tr>
<td>Boehmer</td>
<td>2006</td>
<td>CS, Telephone Survey</td>
<td>13 rural communities in MO, TN, AK</td>
<td>Adults living within 2 mi of walking trail who were enrolled in a physical activity intervention</td>
<td>2210</td>
<td>74.4% Female 93.4% White</td>
</tr>
<tr>
<td>Casey</td>
<td>2008</td>
<td>CS, Telephone Survey</td>
<td>12 rural communities in MO, TN, AK</td>
<td>Adults living within 2 mi of walking trail who were enrolled in a physical activity intervention</td>
<td>826</td>
<td>90.1% Female 95.2% White</td>
</tr>
<tr>
<td>Caspi</td>
<td>2012</td>
<td>CS, Interviewer-administered survey</td>
<td>3 urban cities in the greater-Boston area</td>
<td>Adults living in low-income housing development sites enrolled in the Health in Common Study</td>
<td>828</td>
<td>80.6% Female 87% White</td>
</tr>
<tr>
<td>Flint</td>
<td>2013</td>
<td>CS, Telephone Survey</td>
<td>2 Philadelphia food desert neighborhoods</td>
<td>Adults enrolled in the Philadelphia Neighborhood Food Environment Study</td>
<td>1263</td>
<td>78.2% Female 7.9% White</td>
</tr>
<tr>
<td>Gustafson</td>
<td>2011</td>
<td>CS, Telephone Survey</td>
<td>6 NC Counties</td>
<td>Low-income, women 40-64 yo, with a BMI of 27.5-40</td>
<td>189</td>
<td>100% Female 60% White</td>
</tr>
<tr>
<td>Hearst</td>
<td>2012</td>
<td>CS, Self-administered survey</td>
<td>Minneapolis-St. Paul metropolitan area</td>
<td>Adolescents enrolled in the IDEA and ECHO study</td>
<td>634</td>
<td>51.4% Female 93.8% White</td>
</tr>
<tr>
<td>Lucan</td>
<td>2012</td>
<td>CS, Telephone Survey</td>
<td>1 urban, 4 suburban counties in SE Pennsylvania</td>
<td>Adults who completed the Public Health Management Corporation’s 2004 Household Health Survey</td>
<td>10,450</td>
<td>65.9% Female 87.4% White</td>
</tr>
<tr>
<td>Sharkey</td>
<td>2010</td>
<td>CS, Mail Survey</td>
<td>6 rural counties in Brazos Valley, TX</td>
<td>Seniors &gt; 60 yo</td>
<td>582</td>
<td>68.2% Female 85.2% Non-minorities</td>
</tr>
</tbody>
</table>

CS, Cross-Sectional; BMI, Body Mass Index
<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Independent Variables</th>
<th>Dependent Variables</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blitstein</td>
<td>2012</td>
<td>Satisfaction with PFS, Cost of F/V</td>
<td>F/V Intake</td>
<td>Increased satisfaction with PFS associated with increased F/V Intake</td>
</tr>
<tr>
<td>Boehmer</td>
<td>2006</td>
<td>Access (travel time) to food establishments, Quality, variety of fruits and vegetables in PFS</td>
<td>BMI</td>
<td>Farther proximity to SM is associated with higher risk of obesity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No association between quality or variety of fruits and vegetables and BMI</td>
</tr>
<tr>
<td>Casey</td>
<td>2008</td>
<td>Access to produce and low-fat food</td>
<td>BMI</td>
<td>Access to produce and low-fat food had no association with BMI</td>
</tr>
<tr>
<td>Caspi</td>
<td>2012</td>
<td>SM within walking distance</td>
<td>F/V Intake</td>
<td>Increased access to SM was associated with increased F/V intake</td>
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<tr>
<td>Flint</td>
<td>2013</td>
<td>Variety of grocery stores, Quality of grocery stores, Variety of F/V available, Quality of F/V available, Cost of fresh F/V</td>
<td>F/V Intake</td>
<td>Variety and quality of grocery stores and F/V and cost of F/V were not associated with F/V intake</td>
</tr>
<tr>
<td>Gustafson</td>
<td>2011</td>
<td>PFS access (travel time/distance) &quot;Healthy Food&quot; availability in PFS and in neighborhood</td>
<td>BMI, F/V Intake</td>
<td>PFS access and neighborhood and store &quot;Healthy Food&quot; availability not associated with BMI or F/V Intake</td>
</tr>
<tr>
<td>Hearst</td>
<td>2012</td>
<td>Access to food establishments (CS, SM, FFR, coffee places) as determined by walking times to establishments and by number of food establishments within 10 minutes of home</td>
<td>Purchase frequency</td>
<td>Increased access to food establishments associated with increased Sugar-sweetened beverage purchasing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>There was no association between access to food establishments and purchasing food at convenience stores</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increased walking time to supermarkets was associated with decreased fast food purchasing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Availability, access, and quality were not associated with F/V Intake</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Poor availability, SM access and grocery quality was associated with increased consumption at FFR</td>
</tr>
<tr>
<td>Lucan</td>
<td>2012</td>
<td>Access to SM, Neighborhood Availability of F/V, Quality of Groceries</td>
<td>F/V Intake, FFR Consumption</td>
<td>Fewer grocery stores or less variety of F/V in the community associated with less F/V Intake</td>
</tr>
<tr>
<td>Sharkey</td>
<td>2010</td>
<td>Access to grocery stores, Variety of F/V</td>
<td>F/V Intake</td>
<td>Fewer grocery stores or less variety of F/V in the community associated with less F/V Intake</td>
</tr>
</tbody>
</table>

PFS, Primary Food Store; BMI, Body Mass Index; F/V, Fruits and Vegetables; SM, Supermarkets; CS, Convenience Stores; FFR, Fast Food Restaurants
Do Perceptions of the Food Retail Environment Correlate with Weight Status?

Abstract

The aim of this study was to identify and determine the extent of influence perceived indicators of the food retail environment have on obesity and BMI. The study design was a cross-sectional internet-survey for which we designed a questionnaire that obtained demographic information and information about perceptions of the neighborhood food retail characteristics and food product characteristics. Survey items assessing the neighborhood characteristics measured access to fruits and vegetables, low-fat food, healthy food, and fast food restaurants, and overall satisfaction with the neighborhood food establishments. Survey items assessing food products focused on respondents’ primary food retail store and obtained information on access to fruits and vegetables and low-fat food products, variety and quality of fruits and vegetables, and cost of food products. We used self-reported height and weight to calculate BMI and determine obesity status. The study sample consisted of employees and students at the University of North Carolina at Chapel Hill. We analyzed data on 191 participants. Linear and logistic regression were adjusted for the race, age, sex, income and education. We found no significant associations between the outcomes and perceptions of neighborhood characteristics. Perceptions of high availability of a variety of fruits and vegetables and high quality of fruits and vegetables at respondents’ primary food retail store were associated with the decreased odds of being obese and lower BMI. Additionally, perceptions of rotten food at the primary food retail store was associated with higher BMI and perceptions of the high availability of low-fat dairy products was associated with lower odds of obesity status. This study contributes to a growing body of literature on the role food retail
environments have on health and suggests that perceptions of the food retail environment can influence weight status.
Introduction

In the United States (U.S.), we are currently facing an obesity epidemic. Obesity is related to many health problems including cardiovascular disease, stroke, diabetes, hypertension and cancer. Mokdad et al., found that poor diet and physical inactivity accounted for 400,000 deaths, or 16.6% of deaths, in 2000. Similarly, A 2005 study by Flegal et al. found obesity to be associated with an excess 112,000 deaths compared to normal weight. Since the 1960s, the obesity rates have increased steadily throughout the U.S. population. The prevalence of obesity has climbed from 15.8% in 1962 to 36.1% in 2010. This trend has been present in men and women across all ethnic groups, ages, education levels and socioeconomic statuses. The alarming rise in obesity has drawn increased focus from medical and public health experts who worry about the obesity-related health effects. In order to combat the increasing rates of obesity and obesity-related health problems, clinicians, public health specialists, and community leaders have implemented various solutions. Some of the strategies in combating obesity include surgery, medications, behavioral interventions such as nutritional and exercise programs, and school- and work-based interventions. Diet and exercise are generally considered effective treatment interventions to fight overweight. However, the interventions we currently use clearly are not enough as obesity rates continue to rise. Some of these interventions may work on the individual level, but are failing on the population level. The importance of environmental features affecting obesity was recognized decades ago, but only recently, due to the ineffectiveness of current intervention strategies on curtailing trends in obesity prevalence, has there been a shift in focus from the individual level to the population level. It is now widely accepted that obesogenic environments are large obstacles in the success of many intervention programs. Obesogenic environments are those environments that promote obesity through various methods such as increasing availability and access to unhealthy food retail establishments, facilitating consumption of high-calorie and high-fat foods,
decreasing access to healthy foods (especially fruits and vegetables), and promoting a sedentary lifestyle. By focusing our efforts on obesogenic environments, we might be able to prevent individuals from becoming obese. Before we can properly target obesogenic environments and work to curb obesity at the population level, we need to learn more about the specific environmental features that are promoting obesity. The past decade has seen an explosion in studies that focus on the contribution of the built environment to obesity. Some of this research focuses on factors that discourage exercise, such as neighborhood safety, walkability, and availability of parks and trails. Other researchers are studying how the food retail environment prevents communities from engaging in healthy diets. A large number of these studies were dedicated to learning about the influences of objective measures of the food retail environment. These have focused on variables such as network distance to food establishments (determined by Geographic Information Systems), healthy food availability (determined by store audits) and availability of particular types of food establishments (determined by community audits or commercial databases). Although such objective measures of the food retail environment are important to study, perceived measures of the food environment also have important implications on combating the obesity epidemic. In this study we attempt to determine how perceptions of the food retail environment affect obesity status and BMI. Three previous studies have failed to show an association between perceptions of the food retail environment and BMI. However, each of those studies conducted their analysis from secondary data collected during interventional studies. Additionally, two of the studies were conducted in rural areas and the third focused on low-income, middle-aged women. In our study, we collect primary data on perceptions about access to various food retail establishments and the availability of particular types of food products. The primary goals of this study are to (1) identify perceived indicators of the food retail environment which influence weight status, and (2) determine the extent of influence these indicators have on obesity and BMI.
Methods

This research protocol was approved by the Institutional Review Board and the Office of Human Research Ethics at the University of North Carolina at Chapel Hill and informed consent was obtained for participation in this research study.

Survey Development:

In developing the survey for use in this study, we conducted an initial literature search to find previous studies that focused on the food retail environment. The goal of the initial literature search was to discover which aspects of the food retail environment had previously been studied. It was important to uncover the factors that have previously been shown to mediate the relationship between perceptions of the food retail environment and weight so that these factors can be included in the survey and controlled for in the analysis. Using this information, we conducted a second literature search in order to find studies that used surveys to collect data on individuals. The goal of this second literature search was to ensure that survey items were worded similarly so that there would be fewer obstacles in the comparison of results from this study to the results of similar studies on perceptions of the food retail environment. As we were interested in perceptions of access to various food retail establishments and the availability of particular types of food products, our review of previous surveys was limited to those that assessed these features. There were some features of the food retail environment that have been shown to be associated with behaviors and weight, but no survey items regarding these items were found during a literature search. For these features, we created our own survey items that were structured similarly to the other survey items.

After we collected information on prior surveys, we used this information to design our own survey. The survey was an internet-based questionnaire designed and administered through Qualtrics (Qualtrics, Provo, Utah). Once the initial survey was designed, a test survey was administered to a convenience sample of 15 individuals. We attempted to obtain a diverse
sample of respondents that varied in demographic features such as age, sex, occupation and income. The respondents were asked to give feedback about the survey. In addition to any input the respondents gave themselves, they were asked specifically to comment about inconsistencies, timing and duration, and items they found confusing. We took feedback from respondents and made revisions to the survey items where necessary. The test administration and survey revision process was then repeated until test respondents and researchers were content with the survey.

**Design and Sample:**

This study was cross-sectional and collected survey data from individuals in the University of North Carolina (UNC) – Chapel Hill community. Participants were recruited through the UNC Mass E-mail system and through the UNC Health Care online newsletter. An identical recruitment letter was included for both recruitment strategies. The mass e-mail system sent an “Informational” class e-mail that contained the recruitment letter. These e-mails are received only by those students and employees who have not elected to opt-out of the “Informational” class e-mails. The recruitment letter was delivered by the mass e-mail system to 8,102 employees and 3,347 students. The number of readers of the UNC Health Care newsletter is not known. It is possible that a substantial proportion of the newsletter readers are UNC employees or students who also obtained the recruitment e-mail as well. However, some of these employees and students may have elected to opt-out of the “Informational” class mass e-mails. Additionally, the newsletter is available to those outside of the UNC community, and individuals outside of UNC may have been inadvertently recruited. The recruitment letter contained basic information about the study and provided potential participants with a link to the survey. The first page of the survey provided more details about the study, potential risks from participating in the study, and eligibility criteria. All interested participants had to be at least 18 years of age to participate in the study. Those who were eligible and still interested in
participating were able to proceed to take the survey. The survey was only administered in the English language.

**Measures:**

**Survey Assessment Tool:**

The first page of the survey simply informed participants about the purpose of the study, described the risks of the survey and obtained consent before allowing participants to continue. The rest of the survey was divided into 10 blocks. The first block consisted of questions pertaining to individuals’ food purchasing behaviors and their beliefs regarding these behaviors. This block consisted of questions regarding the types of food products respondents bought, their access to particular types of food, and their satisfaction with their current food purchasing behavior. The second block asked participants to rank priorities when deciding at which food retail establishment to shop. The third block pertained to the frequency of engaging in various food seeking behavior. The fourth block obtained information about respondents’ food retail environment. It specifically asked about products sold at food retail establishments in their neighborhoods. The fifth block was similar to the fourth but asked about the presence of particular types of establishments in the neighborhood. The next three blocks asked questions about the primary food retail store at which respondents most often shopped. The ninth block asked about respondent’s food intake and the final block obtained sociodemographic information.

The survey instrument (Appendix) was designed using questions from various studies.\(^{21-29}\) The survey consisted of 32 questions. Six of the questions had multiple items within each question. Accounting for this, the total number of items in the survey was 70. The validity and reliability of the various self-reported measures used in this survey are reported elsewhere.\(^{18,27,30-33}\) Depending on items in question, the Cronbach’s \(\alpha\) values ranged from 0.70 to 0.91 and the test-retest reliabilities ranged from 0.67 to 0.88.\(^{18,27,30-33}\)
Dependent Variables:

The primary outcome variable collected in this study was BMI. BMI was calculated as kg/m² using participants’ self-reported height and weight. Participants’ BMIs were also used to classify respondents into obesity categories. Respondents were categorized as underweight for BMI < 18.5; normal weight for BMI between 18.5 and 24.9; overweight for BMI between 25.0 and 29.9; and obese for a BMI ≥ 30.

Sociodemographic Characteristics:

The demographic variables we assessed in this study included race, gender, age, zip code, neighborhood characteristics, smoking status, alcohol consumption, marital status, education, income, number in household, employment status, student status and whether participants lived in an urban, rural, or suburban setting.

Food Shopping Behavior:

In order to assess food shopping behavior, participants indicated the extent to which they agreed with various statements. These statements asked about purchase frequency of various types of food, purchase preferences, ease in purchasing types of food, ability to buy desired food, and concern about diet and health. Additionally, participants ranked their desires when selecting where to shop for food.

Characteristics of the Food Retail Environment:

Several items in the survey were designed to obtain information about individuals’ perceptions of their neighborhood food retail environment. One set of items asked participants if they agreed with various statements regarding the availability of food in their neighborhood. A second set of items asked respondents if various types of food retail establishments existed in their neighborhood. Neighborhood was defined as a 1-mile radius around participants home. Participants also answered questions about the store at which they predominately shopped for
food. These survey items asked about travel time, the availability of various types of food products, quality of food products, and cost of food products.

**Statistical Analysis**

Individuals with one or more missing data were not included in the analysis. All statistical analyses were completed with the STATA statistical software package (STATA SE version 12.1, 2013, StataCorp LP, College Station, TX).

The associations between the perceived food retail environment and the outcomes of BMI and obesity status were assessed using various statistical tests including, chi-square, ANOVA, and multiple linear and logistic regression as appropriate. After crude results were obtained, models were adjusted for sociodemographic characteristics of race, age, sex, income and education.
Results

A total of 326 adults, 18 years or older, accessed the survey. Of the 326 people who read the first page of information on the survey, risks, and consent, 282 (86.5%) individuals proceeded to begin the survey. 91 out of 282 individuals had one or more missing data components. In total, we had complete data on 191 out of 282 individuals (67.7%) which we included in our analysis. Descriptive statistics for the study sample can be seen in Table 1. Overall, 35 respondents (18.3%) were obese and 108 were of normal weight (56.5%). The BMI ranged from 17.8 kg/m² to 51.8 kg/m² with an average of 25.5 kg/m². The mean age of the sample population was 40 years and 85.3% were at least a college graduate.

We evaluated the relationship between sociodemographic variables and the outcomes. Our analysis showed that race was significantly associated with weight status. Non-white subjects had higher odds of being obese than not obese compared to Whites (OR = 2.38, p = 0.035). Similarly, Whites had a lower mean BMI than non-Whites (p = 0.048).

Table 2 shows the association between individuals’ perceptions of their neighborhood food availability and obesity status. Both crude results and results from adjusted models are presented in the table. No association was found between obesity status and the following survey items: “many places sell fruits and vegetables”, “many places sell low-fat food products”, “many places sell healthy food choices”, “there are many fast food restaurants”, and “overall I am satisfied with the selection of food establishments available.”

In Table 3, we present the results from the analysis comparing BMI to the same neighborhood food availability perceptions. When comparing these survey items to BMI, an association was seen between BMI and the survey item assessing overall satisfaction with selection. For every point increase in agreement on the Likert scale, BMI decreased by 0.75
However, this relationship became statistically insignificant when adjusted for age, sex, race, income, and education.

In Table 4 we display the associations between individuals’ perceptions of their primary food retail store and obesity status. We examined association with the following survey items: (1) my primary food retail store has a large selection of fruits and vegetables, (2) fruits and vegetables at my primary food retail store are of good quality, (3) my primary food retail store sells fruits and vegetables that are often rotten, (4) my primary food retail store sells a variety of low-fat meats, (5) my primary food retail store sells a variety of low-fat dairy products, (6) fresh fruits and vegetables at my primary food retail store are affordable, and (7) healthy foods at my primary food retail store are affordable. In the models adjusted for sociodemographic characteristics, our analysis showed that survey items (1), (2), and (5) were associated with obesity status. As scores on the Likert scale for agreement increased for these three items, odds of obesity decreased (OR = 0.50, 0.49, 0.48; p = 0.002, 0.004, 0.023, respectively). Obesity was not associated with the other four survey items. Table 5 presents the results of linear regressions used to analyze the relationship between these same seven survey items and BMI. The adjusted models show BMI was associated with survey items (1), (2), and (3), all of which assess characteristics of fruits and vegetables at the primary food store. As scores on the Likert scale increased for these items, BMI decreased for survey items (1) and (2), and increased for item (3) (β = -1.76, -2.17, 1.26; p = 0.002, < 0.001, = 0.028, respectively).
Discussion

In this study we found that BMI was related to individuals’ perceptions of their food retail environment. This study expands on previous literature on the food retail environment. It adds to our knowledge of the factors that influence weight and contribute to obesogenic environments. The perceived indicators of the food retail environment that relate to weight status include the variety, quality, and freshness of fruits and vegetables available to the individual. In particular, we found individuals’ perceptions of their primary food retail store to have a greater influence on weight status than did perceptions regarding the individual’s neighborhood availability and access. It is important to recognize that perceptions of the food retail environment can vary between environments and populations. As objective characteristics of the food retail environment vary, it is logical that perceptions of the food retail environment will vary as well. In our study, we focus on a university-based population. Our population consisted of employees and students at the University of North Carolina – Chapel Hill. Focusing on a distinct population allows us to partially limit the variability of the objective food retail environment. Consequently, the measures perceptions of the food retail environment in this study are more likely to represent differences in the perceived environment rather than objective differences in the environment that would be present when studying multiple populations. This could account for why we did not see association between perceived neighborhood characteristics. Additionally, similar perceptions scores on various measures within the population could also account for why no relationship was seen between many perceptions and weight status.

While the results of this study contrast with previous studies that failed to show associations between perceptions of the food retail environment and weight status\textsuperscript{21–23}, there are important differences between this study and the others. The primary goal of this study was to explore the relationship between perceptions of the food retail environment and weight status whereas in the other studies, this relationship was explored using secondary data collected from
larger interventional projects. Collecting primary data allowed us to design our survey for the sole purpose of this study and conduct more comprehensive analysis than would other have been possible.

This study has several limitations. First, it did not collect objective information on the food retail environment. While we did study a limited population that could help limit variability in the food retail environment, there are still likely to be variations that could be controlled for if objective data had been collected. Second, the limited population limits the generalizability of this study. The results could be applicable to other university settings; however, more studies will need to be conducted before the true applicability of this study can be approximated. Third, while we attempted to use reliable and valid survey items in our questionnaire, we were not able to find psychometric properties for all of the items we wanted to ask in the questionnaire. Fourth, the cross-sectional design of this study does not allow us to determine cause-and-effect relationships. From this study, it cannot be assumed that poor perceptions of food availability lead to increased weight. It is just as possible that individuals who are obese subsequently develop an altered perception of their food environment.

Research on the food retail environment is still in its infancy and many improvements can be made as researchers continue to explore this topic. Major progress can be made by the development of a standardized questionnaire or at least expansion of survey items that are valid and reliable. Such standardization will allow future studies to be compared amongst each other through meta-analyses with greater ease. Lastly, future studies on the food retail environment should also capture both objective data and perceptions of the food retail environment. Both of these types of measures can influence weight status and are important to capture so data can be analyzed with appropriate controls. The expansion of literature on this topic will allow us to better combat the growing obesity problem.
References:


### Tables

#### Table 1. Sociodemographics of total sample and by obesity status

<table>
<thead>
<tr>
<th></th>
<th>Total Sample (N = 191)</th>
<th>BMI (N = 191)</th>
<th>Non-Obese&lt;sup&gt;a&lt;/sup&gt; (n = 156)</th>
<th>Obese&lt;sup&gt;b&lt;/sup&gt; (n = 35)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>164 (85.9)</td>
<td>25.5 (6.8)</td>
<td>135 (82.3)</td>
<td>29 (17.7)</td>
<td>0.572</td>
</tr>
<tr>
<td>Male</td>
<td>27 (14.1)</td>
<td>25.8 (4.8)</td>
<td>21 (77.8)</td>
<td>6 (22.2)</td>
<td></td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>155 (81.2)</td>
<td>25.1 (6.1)</td>
<td>131 (84.5)</td>
<td>24 (15.5)</td>
<td>0.035</td>
</tr>
<tr>
<td>Non-White</td>
<td>36 (18.9)</td>
<td>27.5 (7.7)</td>
<td>25 (69.4)</td>
<td>11 (30.6)</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>53 (27.8)</td>
<td>23.3 (4.4)</td>
<td>49 (92.5)</td>
<td>4 (7.6)</td>
<td>0.082</td>
</tr>
<tr>
<td>30-39</td>
<td>48 (25.1)</td>
<td>26.9 (8.4)</td>
<td>37 (77.1)</td>
<td>11 (22.9)</td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>29 (15.2)</td>
<td>26.1 (6.1)</td>
<td>24 (82.8)</td>
<td>5 (17.2)</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>39 (20.4)</td>
<td>26.7 (7.0)</td>
<td>27 (69.2)</td>
<td>12 (30.8)</td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>18 (9.4)</td>
<td>25.3 (4.4)</td>
<td>15 (83.3)</td>
<td>3 (16.7)</td>
<td></td>
</tr>
<tr>
<td>70+</td>
<td>4 (2.1)</td>
<td>24.0 (4.4)</td>
<td>4 (100.0)</td>
<td>0 (0.0)</td>
<td>0.284</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>4 (2.1)</td>
<td>23.2 (0.6)</td>
<td>4 (100.0)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Some College</td>
<td>24 (12.6)</td>
<td>26.8 (7.3)</td>
<td>16 (66.7)</td>
<td>8 (33.3)</td>
<td></td>
</tr>
<tr>
<td>College Graduate</td>
<td>67 (35.1)</td>
<td>25.5 (7.6)</td>
<td>55 (82.1)</td>
<td>12 (17.9)</td>
<td></td>
</tr>
<tr>
<td>Master's Degree</td>
<td>68 (25.6)</td>
<td>25.5 (5.7)</td>
<td>57 (83.8)</td>
<td>11 (16.2)</td>
<td></td>
</tr>
<tr>
<td>Doctorate Degree</td>
<td>28 (14.7)</td>
<td>24.9 (5.5)</td>
<td>24 (85.7)</td>
<td>4 (14.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$12,000 or less</td>
<td>10 (5.2)</td>
<td>22.3 (1.9)</td>
<td>10 (100.0)</td>
<td>0 (0.0)</td>
<td>0.121</td>
</tr>
<tr>
<td>$12,000-$34,999</td>
<td>21 (11.0)</td>
<td>(25.4 (7.2)</td>
<td>19 (90.5)</td>
<td>2 (9.5)</td>
<td></td>
</tr>
<tr>
<td>$35,000-$49,999</td>
<td>42 (22.0)</td>
<td>27.3 (7.3)</td>
<td>30 (71.4)</td>
<td>12 (28.6)</td>
<td></td>
</tr>
<tr>
<td>$50,000-$99,999</td>
<td>67 (35.1)</td>
<td>25.8 (7.1)</td>
<td>53 (79.1)</td>
<td>14 (20.9)</td>
<td></td>
</tr>
<tr>
<td>$100,000 or more</td>
<td>51 (26.7)</td>
<td>24.5 (4.9)</td>
<td>44 (86.2)</td>
<td>7 (18.3)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Non-Obese defined as BMI < 30.0

<sup>b</sup> Obese defined as BMI ≥ 30.0

*Pearson Chi-squared comparing obese to non-obese individuals
Table 2. Associations between perceptions of the neighborhood food availability and obesity status

<table>
<thead>
<tr>
<th>Perception</th>
<th>Crude OR [95% CI]</th>
<th>Adjusted OR [95% CI]</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many places sell fruits and vegetables</td>
<td>0.97 [0.76–1.25]</td>
<td>1.02 [0.79–1.33]</td>
<td>0.868</td>
</tr>
<tr>
<td>Many places sell low-fat food products</td>
<td>0.93 [0.72–1.20]</td>
<td>1.00 [0.77–1.32]</td>
<td>0.975</td>
</tr>
<tr>
<td>Many places sell healthy food choices</td>
<td>0.91 [0.70–1.17]</td>
<td>0.97 [0.74–1.28]</td>
<td>0.857</td>
</tr>
<tr>
<td>There are many fast food restaurants</td>
<td>1.08 [0.84–1.40]</td>
<td>1.08 [0.82–1.42]</td>
<td>0.603</td>
</tr>
<tr>
<td>Overall I am satisfied with the selection of food establishments available</td>
<td>0.78 [0.60–1.02]</td>
<td>0.83 [0.62–1.09]</td>
<td>0.181</td>
</tr>
</tbody>
</table>

OR, Odds Ratio; BMI, Body Mass Index

- Adjusted for race, sex, age, income, and education
- Odds of being obese for increasing agreement with statement, determined by logistic regression

Table 3. Associations between perceptions of the neighborhood food availability and BMI (kg/m²)

<table>
<thead>
<tr>
<th>Perception</th>
<th>Crude β [95% CI]</th>
<th>Adjusted β [95% CI]</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many places sell fruits and vegetables</td>
<td>-0.29 [-0.93–0.34]</td>
<td>-0.19 [-0.83–0.45]</td>
<td>0.451</td>
</tr>
<tr>
<td>Many places sell low-fat food products</td>
<td>-0.29 [-0.94–0.36]</td>
<td>-0.12 [-0.78–0.55]</td>
<td>0.547</td>
</tr>
<tr>
<td>Many places sell healthy food choices</td>
<td>-0.26 [-0.92–0.40]</td>
<td>-0.10 [-0.78–0.57]</td>
<td>0.57</td>
</tr>
<tr>
<td>There are many fast food restaurants</td>
<td>0.31 [-0.34–0.96]</td>
<td>0.24 [-0.43–0.91]</td>
<td>0.486</td>
</tr>
<tr>
<td>Overall I am satisfied with the selection of food establishments available</td>
<td>-0.74 [-1.43 – -0.06]</td>
<td>-0.63 [-1.32 – -0.07]</td>
<td>0.076</td>
</tr>
</tbody>
</table>

OR, Odds Ratio; BMI, Body Mass Index

- Adjusted for race, sex, age, income, and education
- β coefficient representing change in BMI as agreement with statement increases, determined by linear regression
- *p = 0.033
Table 4. Associations between perceptions of the primary food retail store and obesity status

<table>
<thead>
<tr>
<th>Perception</th>
<th>Crude</th>
<th>Adjusted(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR(^b)</td>
<td>OR(^b)</td>
</tr>
<tr>
<td></td>
<td>[95% CI]</td>
<td>[95% CI]</td>
</tr>
<tr>
<td>PFS has a large selection of fruits and vegetables</td>
<td>0.50 [0.33–0.77]</td>
<td>0.50 [0.32–0.78]</td>
</tr>
<tr>
<td>Fruits and vegetables at PFS are of good quality</td>
<td>0.50 [0.33–0.81]</td>
<td>0.49 [0.31–0.78]</td>
</tr>
<tr>
<td>PFS sells fruits and vegetables that are often rotten</td>
<td>1.24 [0.82–1.89]</td>
<td>1.31 [0.85–2.01]</td>
</tr>
<tr>
<td>PFS sells a variety of low-fat meats</td>
<td>0.96 [0.60–1.53]</td>
<td>0.91 [0.55–1.51]</td>
</tr>
<tr>
<td>PFS sells a variety of low-fat dairy products</td>
<td>0.52 [0.30–0.92]</td>
<td>0.48 [0.26–0.86]</td>
</tr>
<tr>
<td>Fresh fruits and vegetables at PFS are affordable</td>
<td>0.71 [0.50–1.00]</td>
<td>0.71 [0.49–1.02]</td>
</tr>
<tr>
<td>Healthy foods at PFS are affordable</td>
<td>0.74 [0.52–1.06]</td>
<td>0.75 [0.52–1.08]</td>
</tr>
</tbody>
</table>

OR, Odds Ratio; BMI, Body Mass Index; PFS, Primary Food Retail Store
\(^a\) Adjusted for race, sex, age, income, and education
\(^b\) Odds of being obese for increasing agreement with statement, determined by logistic regression

Table 5. Associations between perceptions of the primary food retail store and BMI (kg/m\(^2\))

<table>
<thead>
<tr>
<th>Perception</th>
<th>Crude</th>
<th>Adjusted(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β(^b)</td>
<td>β(^b)</td>
</tr>
<tr>
<td></td>
<td>[95% CI]</td>
<td>[95% CI]</td>
</tr>
<tr>
<td>PFS has a large selection of fruits and vegetables</td>
<td>-1.81 [-2.93 – -0.69]</td>
<td>-0.176 [-2.90 – -0.63]</td>
</tr>
<tr>
<td>Fruits and vegetables at PFS are of good quality</td>
<td>-2.09 [-3.23 – -0.95]</td>
<td>-2.17 [-3.32 – -1.01]</td>
</tr>
<tr>
<td>PFS sells fruits and vegetables that are often rotten</td>
<td>1.12 [0.02–2.24]</td>
<td>1.26 [0.14–2.40]</td>
</tr>
<tr>
<td>PFS sells a variety of low-fat meats</td>
<td>-0.29 [-1.49 – 0.91]</td>
<td>-0.27 [-1.48 – 0.94]</td>
</tr>
<tr>
<td>PFS sells a variety of low-fat dairy products</td>
<td>-1.13 [-2.56–0.30]</td>
<td>-1.11 [-2.53–0.32]</td>
</tr>
<tr>
<td>Fresh fruits and vegetables at PFS are affordable</td>
<td>-0.64 [-1.58–0.29]</td>
<td>-0.65 [-1.58–0.28]</td>
</tr>
<tr>
<td>Healthy foods at PFS are affordable</td>
<td>-0.57 [-1.49–0.36]</td>
<td>-0.53 [-1.46–0.39]</td>
</tr>
</tbody>
</table>

OR, Odds Ratio; BMI, Body Mass Index; PFS, Primary Food Retail Store
\(^a\) Adjusted for race, sex, age, income, and education
\(^b\) β coefficient representing change in BMI as agreement with statement increases, determined by linear regression
## Appendix

### Survey Instrument:

The following questions are about your food purchasing behavior. Please indicate the extent to which you agree or disagree with each statement.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I frequently purchase fruits and vegetables.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I frequently purchase low-fat food products.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I predominantly purchase food that I consider to be healthy.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I feel that I should purchase healthier food than I currently do.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I frequently purchase junk food.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I frequently purchase sugar-sweetened beverages.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>It is easier for me to purchase unhealthy food than healthy food.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>When I shop for food products, junk food is frequently on my shopping list.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>When I shop for food</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
products, fruits and vegetables are frequently on my shopping list.
I am able to buy the amount of healthy food that I desire.
I am able to buy the amount of fresh fruits and vegetables that I desire.
It is important to me that my food is local, chemical-free, hormone-free, or organic.
I am concerned about my access to healthy food.
I am concerned about my diet.

The following is a list of factors that may affect the store at which you choose to buy food products. Please rank the following factors in order of importance (the most important at the top and the least important at the bottom). Drag-and-drop each item to rearrange the order.

1. Location of store or distance and time to travel to the store.
2. Cost of items at the store.
3. Availability of high-quality items.
4. A wide selection of fruits and vegetables.
5. A wide selection of low-fat products.
6. Availability of foreign or specialty food.

The following questions are about the frequency of your food purchasing behavior. Please indicate how frequently you do each of the following.

<table>
<thead>
<tr>
<th>Shop for food products.</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Less than Once a Month</td>
<td>○ Once a Month</td>
<td>○ 2-3 Times a Month</td>
<td>○ Once a Week</td>
<td>○ 2-3 Times a Week</td>
</tr>
</tbody>
</table>
The following questions are about the food establishments within a 1-mile radius of your residence.

Please indicate the extent to which you agree or disagree with each statement.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many places sell fresh fruits and vegetables.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Many places sell low-fat food products.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>There are many fast food restaurants.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Many places sell alcoholic beverages.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Many places sell healthy food choices.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Overall, I am satisfied with the selection of food establishments available.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

The following questions are about the food establishments within a 1-mile radius of your residence.

Please indicate whether each of the following establishments can be found in your neighborhood.

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>I Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following questions are about the store at which you most commonly buy food products.

What is the name of the store at which you most commonly purchase food products?

What type of store is this?
- Supercenter (such as Wal-Mart or Target)
- Supermarket (such as Food Lion, Kroger, Harris Teeter, Trader Joe's, Whole Foods).
- Small grocery store
- Convenience store
- Specialty store (such as ethnic food stores, meat markets, bakeries)
- Farmers market

How do you travel to this store?
- Personal Motor Vehicle
- Public transportation
- Bicycle
- On foot
How many times a week do you visit this store?
- Less than Once a Month
- Once a Month
- 2-3 Times a Month
- Once a Week
- 2-3 Times a Week
- Daily

How many miles from your residence is this store?

How many minutes does it take you to travel to this store from your residence?

When you shop at this store, do you predominantly buy food you consider to be healthy?
- Yes
- No

The following questions are about the store at which you most commonly buy food products. You indicated that this store was [Primary Food Store Name].

Please indicate how often you purchase each of the following from [Primary Food Store Name].

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Most of the Time</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-fat products</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Whole wheat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>or whole grain</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>breads</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Junk food</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

The following questions are about the store at which you most commonly buy food products. You indicated that this store was [Primary Food Store Name].

Please indicate the extent to which you agree with each statement.

<table>
<thead>
<tr>
<th>[Primary Food Store Name] has a large selection of fruits and vegetables.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits and vegetables at [Primary Food Store Name]</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Store Name] are of good quality.</td>
<td>[Primary Food Store Name] sells fruits and vegetables that are often rotten.</td>
<td>[Primary Food Store Name] sells a variety of low-fat meats.</td>
<td>[Primary Food Store Name] sells a variety of low-fat dairy products.</td>
<td>I frequently buy fruits and vegetables from [Primary Food Store Name].</td>
<td>I predominantly buy healthy food from [Primary Food Store Name].</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following questions are about your diet.

On average, how many servings of fruit do you consume daily?
One serving is 1 baseball-sized fruit or 1/2 cup chopped fruit or fruit juice.
On average, how many servings of vegetables do you consume daily? 
One serving is 1 cup of leafy greens or 1/2 cup of other vegetables or vegetable juice.

What is your sex? 
- Male
- Female

What is your age? 

What is your height? 
Feet 
Inches

What is your weight in pounds? 

What is the zip code of your residence? 

What is your race? 
- White
- Hispanic or Latino
- Black
- Native American
- Asian
- Other

Do you smoke? 
- Yes
- No

Do you drink alcohol? 
- Yes
- No

What is the highest level of education you have completed? 
- Less than high school
- High school graduate or GED
- Some college credit
- College graduate
- Master's Degree
- Doctorate Degree

How many members are in your household (include yourself)?
How many children are in your household?

Which of the following best describes your employment status?
- Employed full-time
- Employed part-time
- Unemployed

Are you a student?
- Yes
- No

What is your household income?
- Less than $12,000
- $12,000 - $34,999
- $35,000 - $49,999
- $50,000 - $99,999
- $100,000 or more

Which of the following best describes your marital status?
- Never Married
- Married or Remarried
- Divorced
- Separated
- Widowed

How would you describe your neighborhood?
- Urban
- Suburban
- Rural