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How Does Food Availability Affect Food Selection?



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by

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Submitted to The Department of Economics

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College as a whole.

Hunter D. Bailey

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Abstract

The purpose of this study was to determine if there was a link between the availability of fresh produce in low income areas and the selection of these foods by consumers. Prior research suggests the existence of “food deserts,” areas where fresh produce is not readily available at a reasonable quality and price. It was hypothesized that a combination of firm transportation costs and opportunity costs as well as consumer budgets and ability to secure transportation would result in areas where consumers were willing to purchase fresh food but unable to due to a lack of availability. The data used to conduct this research came from the Center for Disease Control’s Behavioral Risk Factor Surveillance System. The BRFSS is a telephone survey featuring general health-related questions and including geographic information as well as information on income and amount of food consumed. Results show that residents in rural areas consume fewer fruits, vegetables, beans, and legumes even when accounting for income, education, and general demographic information. Results also show that individuals in the highest income bracket consume more fruits and vegetables than those in lower income brackets, and that amount of fruits and vegetables consumed increases with education. The reduced consumption found in rural residents could possibly indicate a food desert area however more detailed study would be required to prove this conclusively.

Introduction

Improving health has become a national focus in the 21st century. Numerous organizations have striven to make advancements in nutritional education and development. These programs stress a balanced diet filled with nutritional fruits and vegetables, and assume that the only barrier separating consumers from a healthy lifestyle is taste and preferences. Unfortunately, for many Americans today there is a much larger barrier separating consumers from healthy choices: availability. Many communities exist in "food desert" areas without easy access to fresh produce or healthy food options. Consumers in these communities are frequently unable to attain healthy foods at a price that fits in their budget. These communities are usually made up of low-income and minority individuals, and exist in dense urban areas or sparsely populated rural towns. Reasons for the lack of access vary, but high transportation costs and low demand for expensive produce could be influences on firm supply decisions. There are also a larger amount of fast food restaurants and other unhealthy alternatives in these areas.

The purpose of this study is to find a relationship between food availability in these communities and the diet of community residents. The current hypothesis is that the lack of food availability in these food desert communities will be associated with increased intake of unhealthy foods and a reduced amount of fruit and vegetable intake when compared with the national average. Consumers in these areas will likely feel that they are unable to achieve a balanced and healthy diet given their income level and the price and availability of healthy foods.

Literature Review

In order to begin discussing any relationship between food availability and food choice, it is imperative to study prior research on food markets, relationships between income and food selection, factors relating to food availability, and food choice as it relates to nutritional value, among other topics. This literature review section will attempt to synthesize the current available research relating to the effect of food availability on diet. The first three articles focus on food selection from supermarkets, grocery stores, and other non-restaurant food vendors. They explore the relationship between food selection and factors like income, availability, and shopping for children. The final two articles focus on "fast-food" restaurant selection, the presence of these restaurants in high and low income areas, and the effect that calorie labelling has on consumers within these restaurants. All five articles provide insight into the discussion of how food availability affects food choice.

Do the Poor Pay More for Food? Item Selection and Price Differences Affect Low-Income Household Food Costs

Kaufman, MacDonald, Lutz and Smallwood (1997) wanted to determine empirically if low-income families pay a higher price for food compared to average or high-income families. Firms that sell food vary widely from corner shops in metropolitan areas to massive supermarkets in the suburbs. Food availability and selection also differs widely across neighborhoods and geographic areas. The challenge in answering this question is developing a market basket that can be used to compare the real expenditures spent by consumers on food, as well as the type of product that consumers select.

The article makes extensive use of consumer surveys as well as store surveys. Specifically it examines the Bureau of Labor Statistics' Consumer Expenditure Survey (CES) as well as the U.S. Department of Agriculture's Nationwide Food Consumption Survey (NFCS). The CES provides the data used for developing the market basket for the Consumer Price Index and was used in this article to examine how low-income families allocate their spending across food groups compared with the average household. The NFCS uses both all-income and low-income samples and collects quantities and monetary value of food consumed. The authors also determined where food stamps were redeemed to get an idea of what store types low-income families were using to do their shopping.

Before getting into the purchasing habits of individual consumers the authors make some conclusions regarding the varying nature of food selling firms. They conclude that large supermarkets are able to offer lower prices and a wider selection than smaller firms due to economies of scale working to their advantage. These supermarkets are then more likely to be located in suburban areas for a multitude of reasons including the physical space required as well as the demographic makeup of suburban areas. Low-income families tend to live in central cities and rural areas, both of which contain many small grocery stores that tend to have higher prices. Stores in larger cities have higher operating costs and the retail space available is much smaller than in suburban areas, and stores in rural areas cater to a much smaller population and have higher costs per unit sold. The data suggest that these small stores charge an average of 10 percent more than supermarkets. This means that, when taking all types of grocery stores into account, low-income families will typically be exposed to higher prices for the same good than average, regardless of where they choose to shop. The results suggest that this increase is small,

about one percent, but it is a statistically significant pricing difference related to consumer income.

By examining consumer purchasing habits the authors found that low-income consumers tend to spend less per unit on food items than average for nearly every major food category, even though they face a higher price for food items. In 1992 the poorest 20 percent of households spent $1,249 per person on food compared to $1,997 per person in the wealthiest 20 percent. This may seem counterintuitive however the data show that low-income consumers will make substitutions for inferior goods to offset the price. There are also some foods that seem to be much more sensitive to income. For example, in 1992 the wealthiest income group spent $12 more per person on beef than the lowest group however low-income households spent $35 per person on ground beef when high-income families spent only $32. Conversely, the highest income group paid nearly double for sirloin steak that year than the lowest income group. Wealthier households also tend to spend more money eating away from home; the poorest 20 percent of Americans spent 24 percent of their food budget eating away from home compared to 40 percent spent by the wealthiest 20 percent. So, while low-income Americans may be spending around the same dollar amount on food as anyone else, this perceived equality is primarily due to shopping practices and accepting potentially inferior substitutes. Additionally there is a huge difference in percentage of income spent on food, which makes sense because food is a necessity and economic theory suggests that as income increases the proportional amount spent on necessities decreases.

The authors describe the three empirical findings in the conclusion of the paper. First, low-income households likely face slightly higher prices than the national average. Second, low-income households spend less per unit on foods that they buy. And third, supermarket pricing

data reveals that per unit prices of a good are different based on package size as well as a per unit price difference between “store brand” and “name brand” products, an expected result. The following article does much to illustrate the lack of access that may be contributing to the increased expenses for low-income families.

Fruit and vegetable access in four low-income food deserts communities in Minnesota

Hendrickson, Smith, and Eikenberry (2006) investigate the availability of fresh produce in both rural and urban low-income areas located within the state of Minnesota. The introduction references prior literature that highlights the health value of fresh produce (Ness and Powles, 1997) as well as research that suggest low-income minority individuals consume less fruits and vegetables than what is recommended (Kratt et al., 2000). Previous research also suggests that low-income populations have higher morbidity and mortality rates (Olson, 1999) a statistic that may be correlated to the previously referenced unhealthy eating habits. The authors hypothesize that one obstacle low-income minority consumers may face is the limited availability of fresh produce and other healthy food items within their areas. Their study examines the actual foods available in these communities by surveying the food on store shelves. They also use focus groups and surveys to obtain consumer perceptions on food availability.

To begin this study researchers selected four communities, two rural and two urban, based on four criteria. The criteria include: limited access to grocery stores as identified by the North American Industry Classification System’s codes; higher than state-average poverty levels; having urban influence codes, as defined by the Economic Research Service of 1 (urban) or 7, 8, or 9 (rural); and finally, civic engagement around food issues. To determine areas with a lower than state-average income researchers reviewed 1997 property estimates for all families in

Minnesota counties, school districts, small area estimates, and neighborhoods. They then narrowed their search to areas identified as “food deserts.”

In this study the authors defined food deserts as “urban areas with 10 or fewer stores and no stores with more than 20 employees.” There were a total of 14 stores in the two urban areas selected, and a total of nine stores in the rural areas. This was determined by inserting store addresses into geographic information software. The stores in urban areas were mostly corner markets or ethnic stores that tended to be small and many lacked air conditioning or refrigeration, as well as the retail space necessary to stock a wide variety of foods. The stores in rural areas were on average larger than the urban stores and more closely resembled a smaller chain grocery store. These stores also contained air conditioning and refrigeration, as well as greater shelf space. In these rural food desert communities market, not space, seemed to be a limiting factor. The authors point out that each rural area surveyed only had one medium to large size grocery store, with a much smaller selection than the average supermarket. The only other food stores in existence were small gas stations or general stores.

To identify the area of each rural community the authors used county boundaries. Neither of the counties used were adjacent to metropolitan areas, and both contained between 2,500-10,000 residents. Census tract neighborhood data was used to identify the two urban areas selected, one located in North Minneapolis and the other in South Minneapolis. To determine the final criteria, civic engagement, researchers conducted interviews with community members about food activity. Some of the community members interviewed included political leaders, nutrition program directors, and health care providers living and working in the communities. All communities were rated on a 1-7 scale based on activity of individuals and groups committed to

solving food problems in their community. Some of the activities that increased ratings included: food shelves, food coalitions, and community gardens.

Once the communities were chosen researchers developed a survey to determine if the selected community residents were able to afford the foods needed to meet government nutritional guidelines without severely impacting household finances. The foods included in the survey were separated into eight major categories: fresh fruit; fresh vegetables; canned and frozen fruit and vegetables; fresh breads, cereals, and other grain products; fresh meat and meat alternatives; canned and frozen meat and meat alternatives; fats and oils; and sugar and sweets. The authors note that the survey originally contained a classification for organic or sustainable goods, however there were so few stores that carried these products they were unable to gather sufficient data on organic products. The food items that were included in the survey were selected due to their inclusion in the Thrifty Food Plan (TFP), a government meal plan that uses 12 age and gender appropriate market baskets as a guideline for nutritional and low cost choices based on the Food Guide Pyramid.

Once the guidelines for the survey were established, the lowest price per unit for each food item found in each store was recorded. The average price per pound of each food was then compared against the TFP market basket prices per pound for May 2002, considered to be the countrywide average. To ensure accurate data, the surveys were conducted during the same season as the TFP basket surveys. No substitutions were allowed and no additions were made. All food items included were judged based on the unit of measure available, quantity, and price. If a TFP food item was not available, it was given a score of zero. Food quality was established using the expiration date of the food item. For items that did not have an expiration date, such as fresh fruits and vegetables, a subjective measure was used. Data were collected from 14 of 15

grocery stores in the two urban study zones (one burned down prior to collection), and nine stores in the two rural zones. Researchers also collected data from two large chain grocery stores outside of the research area to compare prices, quality, and quantity of foods available in areas not designated as food deserts.

To establish consumer perception, researchers conducted 15 focus groups made up of nutrition professionals, community leaders and community residents. The topics included access to food sources and food assistance programs as well as healthy eating and food choices. All participants were asked to fill out a survey pertaining to the quality and price range of foods found in their local community stores. These surveys also revealed which food outlets participants visited the most and how often participants went grocery shopping. Each food outlet was rated on quality of food (from poor to great) as well as price range of food (inexpensive to very expensive). Finally, participants were asked what method of transportation they used to get to the store.

Results show significant differences between food desert neighborhoods and those with average access to food outlets. In the one urban area studied 53 percent of the foods examined were significantly more expensive than the market basket price, in the other urban location 32 percent of studied foods were significantly more expensive. Only one type of food was significantly less expensive than the market basket price in both areas. Apples were only available in 1 urban store and broccoli was not available in any urban stores. Rural areas were closer to but still above average in terms of food pricing. 11 percent and 21 percent of foods examined in each respective location were significantly more expensive than the market basket price, and only one food was significantly less expensive. The data also show that two-thirds of the significantly more expensive foods in rural communities were not staple foods; while the

opposite was true in urban areas. Urban areas also contained a markedly limited amount of fresh fruits and vegetables, neighborhood stores that did sell produce usually only stocked one or two of each item and those items were usually given a poor quality rating.

Consumer focus group and survey data support the food outlet survey findings. Consumers in both urban and rural communities report low quality and high priced food and cite convenience and support for local businesses as major reasons for not shopping other places. Urban residents in particular report lack of transportation as a factor. In the two urban communities surveyed 50 percent of those surveyed report walking to the store, and 22.5 percent report taking the bus. Conversely, in the rural areas surveyed 90 percent of residents report driving to the store for groceries. Participants in both rural and urban communities disagreed with the following statements: “Healthy food choices in my community are affordable”; “People in my community never go hungry”; and “I would eat healthier food if the community stores offered more healthy options.”

The article concludes that low-income residents in urban and rural areas do experience barriers to obtaining healthy food. Many food options in these areas are significantly more expensive than average, and the fresh produce that is available is usually of low quality. Residents of these areas, especially urban areas, also experience transportation problems that prevent them from exiting their food desert on a regular basis. The paper calls on civic leaders to address problems associated with food access in their communities. Lack of access to nutritional options like fresh fruits and vegetables can have lasting consequences on consumers and their families, as this next article shows.

The Role of Availability as a Moderator of Family Fruit and Vegetable Consumption

Kratt, Reynolds, and Shewchuk (2000) investigate the availability of fruits and vegetables within the family home and how that might affect dietary habits of primary school-aged children. Prior research shows that elementary-school children are frequently targeted by large interventions to improve diet while in school (Havas et al. 1994). These studies routinely use the school cafeteria to make changes in order to provide students with more healthy options and hopefully improve dietary habits. Prior research also shows that parents are frequently incorporated into programs designed to improve diet, through parental education or action (Crockett ,1989). The authors reference a study that shows that the availability of fruits and vegetables in the home has little relationship to obesity among parents (Coates ,1978); however this research is very outdated and says little about the dietary habits of children. Referencing a focus group study that shows most children prepare their own meals for school (Baranowski, 1993), the authors make the claim that a lack of fruit and vegetable availability may contribute to poorer dietary choices among school-age children. They also hypothesize that because children frequently snack, a higher availability of fruits and vegetables may lead to healthier nutrition habits. Finally, the authors mention a correlation between socioeconomic status and poorer nutritional quality, but make the claim that federally-funded programs like the free breakfast program and national school lunch program do much to alleviate the differences in diet. Despite advances in nutrition within the school system, there is also research that found that the odds ratio for inadequate fruit and vegetable intake increase as socioeconomic status decreased (Neumark-Sztainer, 1996). Using this prior research, the authors determine to investigate whether fruit and vegetable availability is a moderator of consumption.

The authors used a sample of 1,698 families who were included in the 1994 baseline assessment for the High 5 Alabama project, an initiative funded by the National Cancer Institute's 5-a-Day for Better Health program designed to encourage Americans to eat five or more servings of fruits and vegetables each day. Out of the 1,698 families, 1,625 fourth grade children and 1,292 parents provided baseline data. Researchers included all parent-child combinations that had submitted a complete dietary analysis for both parent and child. Participants were then stratified by the number of fruits and vegetables that parents reported were available in their home the previous week. Each stratum was then divided into an initial subsample and a confirmation sample used to validate the initial results.

Information about fruit and vegetable availability was acquired using a previously developed questionnaire given to parents. The questionnaire asked about availability in the home during the previous week and was broken up into three sets: the availability of generic types of Fruits and vegetables; the availability of the 11 most commonly eaten fruits and 11 most commonly eaten vegetables; and finally, the location and preparation of fruits and vegetables in the home. The authors used the answers to calculate a single score based on yes answers. The scores ranged from 0-29 out of a possible 31. Based on these answers participants were divided into three groups: low availability, medium availability, and high availability.

To determine fruit and vegetable intake during the study, parents and students completed 24-hour diet recalls. An approximately equal number of students completed a diet recall each day of the week, through face to face interviews as well as telephone calls. Students recalled everything they ate within the 24- hour period and used two dimensional food models to approximate portion size. This information was inserted into Nutrition Data System software. This allowed researchers to calculate servings of fruits and vegetables by gram-weight. Foods that contained

large amounts of added fat, salt, or sugar (including potato chips, French fries, popcorn, and fruit flavored drinks among other things) were not counted as fruit and vegetable servings. Parental intake was determined by asking two questions: the average number of fruit and vegetable servings the parent ate per week over the past year. These responses were converted to servings per day to match up with the student responses.

Once the data was collected, the authors developed a model using parent and child psychosocial variables to determine influences on fruit and vegetable consumption. These psychosocial variables were determined through questionnaires issued to both parents and students and included things like parent and child knowledge, parent and child self-efficacy, as well as the outcome expectations for increased fruit and vegetable consumption. The authors used multigroup structural equation modeling (MSEM) as the tool used to test their hypothesis that availability was a moderator for consumption. This procedure evaluated whether the contribution of each independent variable (the psychosocial variables) differs or is the same across each of the three availability groups. MSEM also assesses goodness of fit of the theoretical model and compares it to the actual data to produce a single outcome.

The results suggest that availability could be a moderating variable for intake. Additional factors that affect intake come from psychosocial variables that differ in each intake group. In the high intake group parent fruit and vegetable consumption as well as parent psychosocial variables–outcome expectations, self-efficacy, and knowledge–were all significant. This means that the psychosocial makeup of parents did contribute to the fruit and vegetable intake of children. In the lower availability groups these variables were not significant, meaning there was no relationship between parent behavior and child fruit and vegetable intake. For children, the psychosocial variables were not significant across all three availability groups; however, child

fruit and vegetable intake was heavily determined by which availability group the child was in. This means that fruit and vegetable availability certainly contributes to child consumption. Without access to healthy options, consumers may turn to unhealthy and cheap food alternatives. The next two articles show how the fast-food industry may be capitalizing on a lack of affordable healthy food in low-income areas.

Fast Food, Race/Ethnicity, and Income: A Geographic Analysis

Block, Scribner, and DeSalvo (2004) seek to establish a link between the geographic location of fast-food and income as well as race. The introduction briefly touches on the rapidly expanding obesity epidemic as well as the increasing prevalence of the fast-food industry. The authors' prior research included Morland et. Al. (2002), a study that found that no such correlation had been established however they felt that this topic needed to be revisited. They chose to conduct their experiment in Orleans Parish, with "parish" being the Louisiana term for a county. Orleans Parish roughly encompasses the city of New Orleans, so the authors were able to examine a multitude of neighborhoods with widely varying median incomes as well as racial makeup.

To begin, the authors had to first define fast-food restaurants. They established a metric of three characteristics that define a fast-food restaurant: expedited food service, takeout business, and limited or no wait staff. Chain restaurants that met two of these three characteristics were included in the experiment. Once the classification system was established the researchers used a mixture of sanitation department logbooks, local yellow pages, and restaurant locator search engines in order to find all locations that met the fast-food criteria. Overall 155 fast-food restaurants from 14 different franchises were included.

Once the restaurants were identified and located they were mapped using geographic information system software. This software allowed the experimenters to overlay census tract data in order to isolate specific neighborhoods. The neighborhoods used were restricted to those with more than 500 people with a density of greater than 2,000 people per square mile. Neighborhoods also had to contain more than 200 alcohol outlets per 1,000 people. The authors used alcohol outlets as an indicator for commercial activity. Due to Louisiana state law, information on where alcohol is sold is readily available through the liquor license program. Also, since alcohol is sold at many outlets in Louisiana (gas stations, grocery stores, restaurants, etc.) it makes a good indicator for commercial activity. Researchers also added a "shopping area" by including one mile buffer zones around each neighborhood. The paper justifies this by stating: "In fact, 62 percent of the census tracts have no fast-food restaurants located directly within their borders. However, only 2 percent of the shopping areas with 1-mile buffers have zero fast-food restaurants."

After mapping all fast-food restaurants and neighborhood data the researchers ran a multiple regression in SPSS, a statistical analysis program. Fast food restaurant density (FFRD) was set as the dependent variable and was assessed after controlling for other environmental variables. These independent variables were: alcohol outlet density, presence of highways, and median home value. These were all included because they might influence the placement of a fast-food restaurant.

The results show that there is a statistically significant relationship between fast-food restaurant density and income as well as density and percentage of black residents. The regression shows that for every 10 percent increase in FFRD there is a 4.8 percent decrease in the median household neighborhood income and a 3.7 percent increase in the percentage of black

residents. Another multiple regression was run to determine how many more fast-food restaurants are located in majority black neighborhoods compared to white neighborhoods. The results show that neighborhoods that were 80 percent black had 2.4 fast-food restaurants per square mile compared to 1.5 restaurants per square mile in white neighborhoods.

In the discussion section the authors comment on the fact that race is a more powerful predictor of fast-food restaurant location than income, and that more convenient access in black neighborhoods leads to more consumption by residents in those neighborhoods and may be correlated to an increase in obesity among the black population. They mention that other research has shown correlation between neighborhood demographics and exposure to goods that may contribute to negative health. For example, liquor store are also more common in black and low-income neighborhoods. Alternatively, prior research suggests that consumer goods associated with healthy choices, such as supermarkets with more healthy and organic options, are more common in high-income and predominately white neighborhoods.

Some of the limitations of the study revolve around the exclusion of certain restaurants from the model. It is possible that the researchers may have missed some restaurant locations or failed to include restaurants in the fast-food category that could accurately be described as fast-food restaurants. The authors were also unable to establish the directionality of the relationship between fast-food and demographics. This means that neighborhood demographics could possibly be shaped by the availably of certain restaurants, or that restaurants could just be established in targeted areas based on sales data (e.g., McDonald's restaurants may have higher profits in predominately black neighborhoods, so McDonald's will choose to expand into areas that have a high black population). The authors suggest that future studies take on a more longitudinal approach to the question and track demographics and business locations over time to

prevent this shortcoming. They also suggest examining different regions to avoid a geographical bias towards fast-food consumption. Overall the paper does show a clear and significant correlation between fast-food restaurants and income that may be contributing to the obesity epidemic in low-income and minority populations.

Calorie Labeling And Food Choices: A First Look At The Effects On Low-Income People In New York City

Elbel, Kersh, Brescoll, and Dixon (2009) set out to examine New York City's recent mandate to require chain restaurants to post calorie information about their menu items. The mandate was implemented on July 19, 2008, and requires all restaurant chains with 15 or more locations in New York City to visibly post the calorie content of all menu items in a font and style similar to the description of the menu item. Their prior research varies widely in results. An NYC Department of Health and Mental Hygine study examined food purchases at Subway restaurants (which voluntarily posted calorie information) and found that customers who saw the information consumed an average of 52 fewer calories than those who did not (Bassett et al. 2007). Unfortunately, the study was unable to establish whether this was a result of health-conscious consumers choosing lower calorie options because of their already established preferences. Another recent experiment using a random sample of consumers found that menu labeling did not decrease calories ordered or consumed, and that some males ordered more calories when calorie labels were displayed (Harnack 2008). Due to generally weak results in similar previous studies, the authors set out to design a new experiment that focuses on low income residents.

This study uses data collected from New York City before and after the labeling mandate was introduced. It also uses similar data from Newark, New Jersey in order to provide a comparison location. New York City was chosen because of the recent labelling mandate whereas Newark has not instituted any such policy, but does have a demographically similar makeup as New York City. The authors focused their attention on low-income minority populations due to the increased risk of obesity and health problems associated with this group (Chou, 2004). The collected data measures calories purchased at fast-food restaurants as well as the percentage of consumers who noticed and responded to the posted calorie information.

Researchers first selected restaurants representing four of the largest fast-food chains in the two surveyed areas: McDonald's, Burger King, Wendy's, and KFC. They then found restaurants located within lower-income neighborhoods that were largely made up of minority groups, mostly African American and Latino. They then used six sets of population-level characteristics (population size, age, race/ethnicity, poverty level, obesity rates, and diabetes rates) to match two NYC neighborhood restaurant to one Newark restaurant of the same chain and in a demographically similar area. The final tally consisted of five restaurants in Newark and 14 in New York.

To collect data, researchers visited each restaurant during lunch or dinner hours for around 2.5 hours at a time. This occurred over a two-week period beginning July 8, 2008, before the mandate was implemented. Each consumer was approached as they entered the restaurant and asked to bring their receipts back and answer questions (consumers were compensated $2 for participating). Four weeks after labeling was introduced data were collected in the same way from the same restaurants. Researchers recorded the nutritional value of each meal according to the corporate website and consumer's receipts. Calories, saturated fat, sodium, and sugar

information was recorded and entered into a spreadsheet. In addition to nutritional data a survey that included age, sex, race, and education information was given to participants. The survey also asked if food was taken “to go” as well as whether the responders noticed any calorie information and whether this information influenced their food choices. Once all data were collected the authors examined the mean differences for all nutrition variables across the pre-labeling and post-labeling period. They also examined the influence of noticing calorie information on food choice.

Results show that the New York City labeling mandate did result in an increase of responders who noticed caloric information. Around 15 percent participants surveyed in New York noticed calorie information before the mandate compared to 54 percent after the mandate. This number did not change in the comparison area of Newark. After the labeling mandate, New York City saw an increase in percentage of responders that used the information to make choices about their meal. 27.7 percent of New York responders who noticed calorie labels used that information to make their choice, compared to less than 5 percent of Newark responders. The mean number of calories purchased did not change in Newark, and surprisingly increased in New York City from 825 to 846 per person. Similar results were found for saturated fat, sodium, and sugar. Purchasing habits did not seem to differ by sex, race, or age.

During the discussion of the paper the authors note that two significant changes resulted from the mandate: the number of participants who reported seeing the posted calorie information, and the number of participants who used caloric information to make choices about their purchases. There was no significant change in the amount or nutritional value of the food consumed. The authors suggest that the labelling mandate could “set the stage” for future efforts to improve nutrition education, but that the mandate in itself is not sufficient to change the habits of the

surveyed population. They note that because the study only focuses on low-income and minority groups there may be evidence elsewhere that different populations are responding differently to labeling.

Summary

The above articles illustrate a clear disparity between individuals in high and low income areas when it comes to food availability and cost. Kaufman, MacDonald, Lutz and Smallwood (1997) shows that low income individuals do face a significant price difference when purchasing food items and that the purchasing habits of these individuals differs from high income individuals. Hendrickson, Smith, and Eikenberry (2006) identifies multiple geographic areas that can be considered food deserts, areas where fresh produce is either not readily available or available at a poorer quality or significantly higher cost when compared to high income areas. Of course taste preferences do play a role in consumer food selection, and it is possible that this lack of availability results from the lack market incentives to stock shelves with fresh produce. Kratt, Reynolds, and Shewchuk (2000), however, shows that availability could possibly be a moderating variable for intake, especially among families.

Block, Scribner, and DeSalvo (2004) shows that low-income urban areas that could be potential food deserts also contain a significantly greater number of fast food restaurants per square mile. Just as above, this correlation could be the result of a different set of taste preferences held by low income individuals. However, it is possible that low-income families turn to fast-food restaurants because of a lack of readily available and reasonably priced fresh food. Elbel, Kersh, Brescoll, and Dixon (2009) highlights that low income and minority individuals did not change their selection behavior in response to caloric labelling information,

suggesting that these individuals are aware of the health risks associated with high-calorie foods, and are either unwilling or unable to change their behavior as a result of this information.

All five articles together create a picture highlighting many of the problems faced by consumers in low-income communities. What little fresh produce is available for sale is located in grocery stores that can be difficult to reach without reliable transportation and is likely more expensive and of lower quality. There are also many more fast-food outlets compared to average offering unhealthy meals that can be cheaper and more convenient, which may be causing consumers to neglect the poor nutritional value of these meals even when presented with calorie information. The next section will explore some of the underlying causes that may go into shaping these food desert communities and the choices of both food-selling firms and their consumers.

Theory

There are a myriad of economic factors that play into food availability on the side of both producers and consumers. For food selling firms, potential revenues must be weighed against varied expenses like transportation and procurement costs, as well as the opportunity costs that arise from limited shelf space and storage space in retail outlets. Consumers make a variety of preference decisions to determine not only which products to buy but also which retail outlet to purchase these products from. These decisions can be based on short-term factors like the consumer's current method of transportation, income, and location, as well as long-term factors like age, race, gender, or taste preferences acquired throughout the life of an individual consumers. These preferences can be influenced by varying factors like culture, education, and

upbringing and play a critical role in food selectin. It is important to take all of these factors into account when searching for a relationship between food availability and food selection.

Transportation Costs

Location selection is critically important to the success of a firm. For supermarkets, proper location planning includes choosing a large enough consumer market while minimizing transportation costs. Since supermarkets are constantly receiving shipments of product in many different forms, transportation and transportation costs are very important to the success of a firm. O'Sullivan (1996) describes firms defined by their transportation cost as transfer oriented firms. In order to be successful these firms must select locations that can minimize transportation costs while supporting as large of a market as possible. Total transportation costs can be divided into procurement cost and distribution cost. Procurement cost is the cost associated with transporting raw materials or goods from the factory to the firm. Distribution cost is the cost of transporting the output of the firm to the consumer (O'Sullivan 1996). It may be extreme to categorize food vendors as transfer oriented firms; however there is no denying that transportation cost is a major factor in calculating firm expenses. For supermarkets, procurement costs refer to all products and raw materials the supermarket purchases to sell. These goods can vary widely, from fragile fruits and vegetables with a brief shelf life to durable canned goods that can last for years. Distribution costs would refer to the costs associated with transporting those goods to the consumer.

For many firms, especially larger chain grocery stores, procurement costs are not a huge issue. Most chain grocery stores own and operate their own distribution systems that are located close to raw materials and can very easily accommodate may varieties of goods. The

transportation cost of transporting goods to these distribution centers is very small compared to the revenue made from selling the goods. Smaller grocery stores may not own their own distribution centers but may still have access to centers that cater to smaller stores. Very few stores get all of their products delivered directly from the producer to the retail outlet.

If most firms have access to distribution centers that keep procurement costs low across the board, that makes distribution cost the major cost variable in firm placement. Specific to grocery stores, distribution cost refers to the cost associated with transporting goods from distribution centers to the retail outlet, the store goods are purchased from. Logically, one can assume that distribution costs are much higher for outlets located in urban areas when compared to outlets in suburban areas. Outlets located in suburban areas are likely to be closer to distribution centers, cutting down on transportation time and cost. Firms with large suburban outlet locations also have access to much more space and are better able to accommodate product deliveries. These outlets are usually located right off of major highways, have ample parking for delivery trucks, and multiple loading docks capable of servicing multiple deliveries simultaneously. They also have larger back rooms capable of holding more product, this means that deliveries happen less frequently at a lower cost than smaller urban outlets.

Conversely, transportation to smaller urban outlets presents many logistical problems that result in a higher cost. Urban outlets are going to be located far from rural and suburban distribution centers,

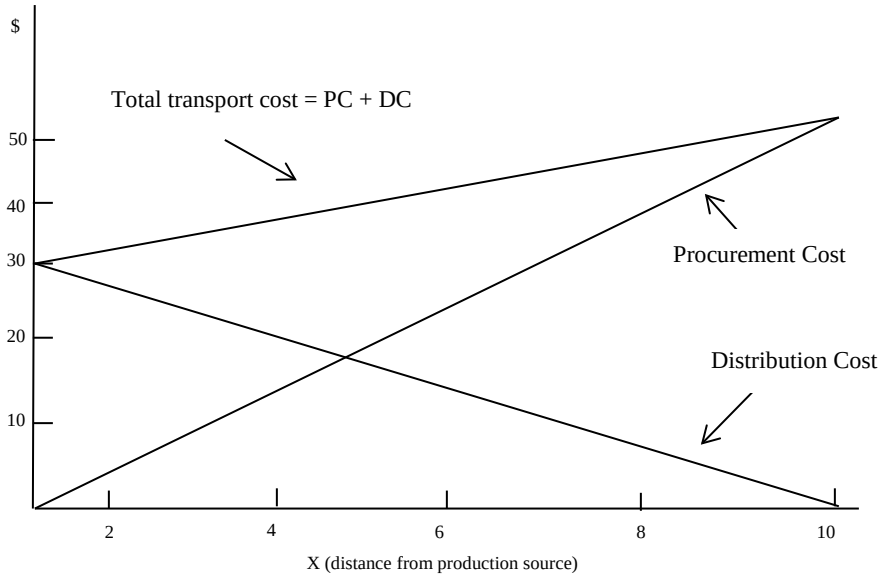


Figure 1: Transportation Costs. Note that as distance from the Y-axis increases, the size of the market increases as well.

increasing transportation time and cost. Many of these outlets are located in densely populated areas with small roads that may not be able to accommodate larger delivery vehicles. Many of these stores only have one loading dock, and other can only accommodate deliveries through a front or back door. The lack of proper refrigeration and storage in small urban outlets means that firms can only order what they believe they can sell within the allotted shelf time. Fresh produce becomes an increasingly risky good to carry; if produce isn't sold within the relatively short shelf time it becomes a sunk cost and must be disposed of. Thus, these firms rely on constant delivery of products that are only meant to remain in the store for a short period of time. More deliveries means higher distribution costs for the small firms.

When taking this information into account, it seems logical that firms will expand to areas with a lower transportation cost. Figure 1 shows total transportation costs for a resource oriented firm. As the distance from the raw materials increases, procurement cost increases due to higher transportation cost, and distribution cost decreases due to the increased market in larger population areas. While a firm located at the Y-axis, the production source, would have the lowest transportation costs, it would also be located in an area without a large market, meaning revenue would be lower as well. A firm that wants to minimize transportation cost and maximize their potential market should be located close enough to its distribution area to easily receive deliveries, as well as close enough to a population area to achieve higher market saturation. A firm located in a suburban population center would minimize transportation costs, maximize market share, and provide a higher profitability.

A review of prior literature shows that food selection can also be influenced by taste. Low-income consumers are likely to make different food selections than the national average, even

when controlling for availability. There is a fundamental difference in demand that can be explained using basic microeconomic ideals like budget, preference, and demand.

Budget Constraints

Microeconomic preference models frequently use a two good system to analyze preferences. This may seem insufficient at first; there are a wide variety of foods that could be considered "good foods," however for the purpose of this topic food can be separated into two goods available for purchase: fresh foods and non-fresh foods. Designating good 2 as all non-fresh foods means that good 2 is a composite good, a combination of anything else a consumer might want to purchase other than fresh produce. This separation allows for a preference analysis on the food category that most frequently appeared in prior literature as either unavailable or too expensive for purchase. If fresh food is set on a Y-axis of a graph and non-fresh food is set on an X-axis, then all points greater than (0,0) show a bundle, or a combination of the two goods that a consumer can purchase.

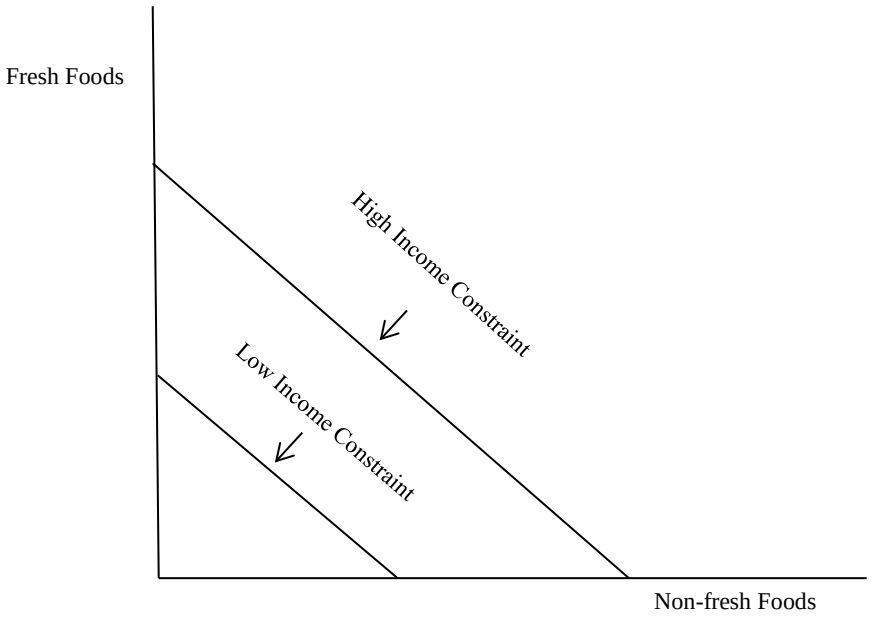


Figure 2: Budget Constraint for Low-Income and High Income Individuals

The first step in creating a preference model is plotting a budget constraint for low income and high income populations. Figure 2 shows these budget constraints plotted on a graph with produce on the Y-axis and other foods on the X-axis. The budget constraint shows the maximum

amount of money the consumer has to spend on food. Consumers in the low-income group will have a smaller budget than average, so their budget constraint is lower on the graph. In order to maximize utility, consumers on both the low-income and high-income budget constraints will want to consume a combination of fresh produce and other foods that lie directly on their budget constraint line (Varian, 2014).

Consumer Tastes

Budget constraints only account for consumer income and the price of goods; they do not show any information about consumer preferences. To determine preferences an indifference curve must be utilized. An indifference curve is a line segment that contains a set of bundles that are all equally preferred by the consumer. In this case, an indifference curve would show bundles made up of fresh produce and other foods that provide an equal amount of utility for the consumer. Figure 3 shows the budget constraints of low income and average individuals with normal indifference curves added. To consumers, any space above the indifference curve would be considered a better bundle, and any space below the curve would leave the consumer less happy. Keep in mind that consumers can still only purchase bundles up to their budget constraint, so some bundles on the indifference curve will be too expensive for the consumer to afford (Varian, 2014). Figure 3 shows a model in

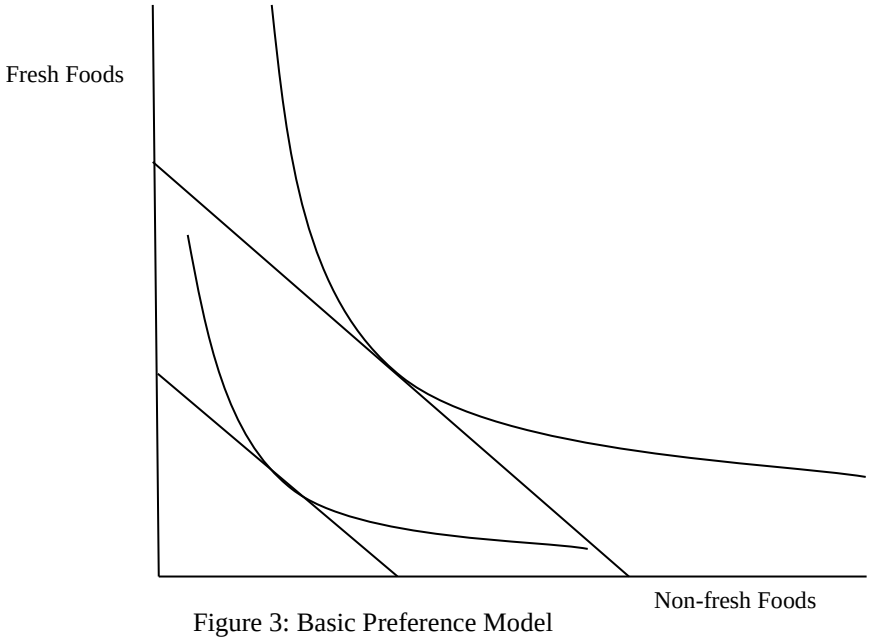


Figure 3: Basic Preference Model

which low-income and high-income individuals have the same taste preferences. If we assume that low-income individuals on average have a different set of preferences than high-income individuals then the slope of the curve representing low-income individuals would favor non-fresh foods, meaning all equally preferred bundle selections would contain less fresh produce.

After establishing a basic model including budgets and preferences it is important to make some changes that accurately reflect the subject market. Research shows that fresh produce is going to be more expensive to purchase compared to other goods. This means that the slope of the budget constraint is going to be steeper to reflect the higher prices associated with fresh produce. All consumers, regardless of income, require a certain amount of food to be satisfied. If a group of foods like fresh produce is significantly more expensive, it means that consumers may select bundles with less produce in order to satisfy their basic food requirement. Among consumers with average income this shift should not be very drastic. People with average income have more money in general to spend on food and can afford to purchase more expensive food items like fresh produce while still satisfying their total food requirement. For low-income consumers however, there will be a much larger shift away from fresh produce, resulting in very few units of produced being purchasable within the low-income budget constraint. If it is assumed that indifference curves are parallel for both income groups, meaning that food preferences are the same for both average-income and low-income consumers, then consumers on the lower budget constraint will have less food overall and significantly less fresh produce when compared with consumers on the higher budget constraint. Figure 4 shows the new model with appropriate budget constraints and indifference curves. For low-income consumers, the only bundles that are both preferred and affordable do not include fresh produce. As with Figure 3, Figure 4 shows a model that assumes low-income and high-income individuals share the same

taste preferences. If it was assumed that low-income individuals as a whole prefer less fresh produce, then the slope of the curve representing low-income individuals would be reflect that difference.

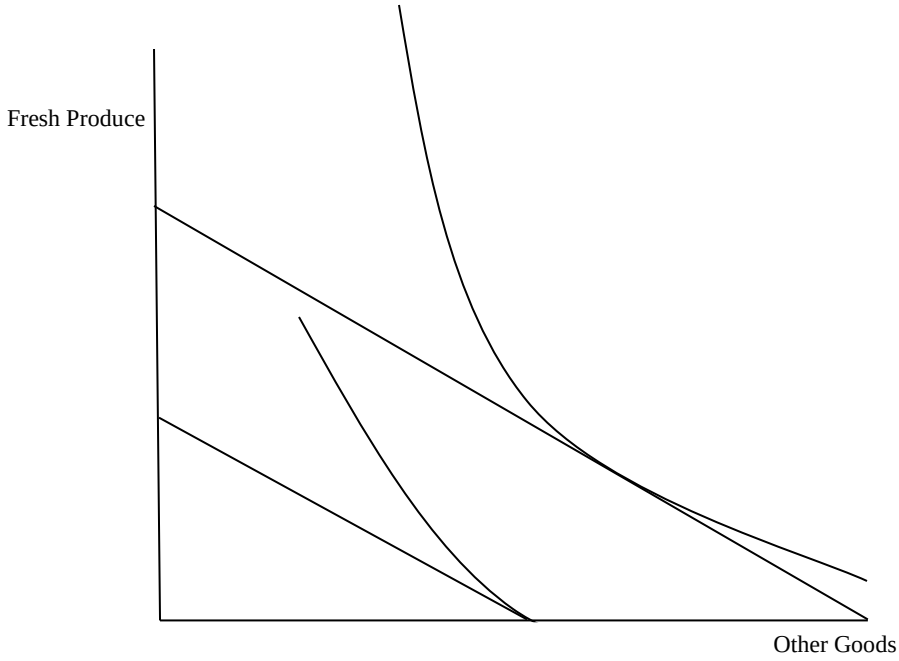


Figure 4: Demand model for groceries. Due to the high price of fresh produce, the budget constraints have been rotated outwards.

Because low income consumers cannot afford to purchase as much fresh produce, overall demand for fresh produce will be lower in markets with a large amount of low-income consumers. Firms that sell fresh produce will supply fewer units in areas where demand is low, which could include areas with a large low-income population. This lack of demand, when combined with expensive transportation and storage costs, could lead to a lack of produce availability among low-income urban areas.

To conclude, economic factors on the side of both food-selling firms and consumers can affect food selection. Firms must pursue cost-efficient decisions and attempt to cut down on expenses in order to make a profit, and consumers must act using financial and preferential guidance in order to select foods that provide them with the greatest possible utility. Of course every market will reach an equilibrium point, but it is possible that some of those market equilibriums will result in a lack of available fresh produce.

Data

In order to analyze any questions relating to food availability and food choice information is required relating to consumer demographic information, geographic location, income, and diet. The best way to acquire this data without funding or access to government records is by surveying consumers across the country. Participants must be willing to accurately disclose the above information, and the sample size must be broad enough to establish a reasonable sample of the country as a whole. The following section highlights the choice of data for this study and explains its relevance in determining how food availability affects food choice.

The data used in this study comes from the Center for Disease Control in the form of their Behavioral Risk Factor Surveillance System. The BRFSS is an annual nationwide survey conducted over telephone throughout all 50 states in the USA. The survey asks a number of questions pertaining to health risk factors and information that could influence or predict risk behavior. Due to prevalence of the survey and the nature of its questions the BRFSS has become a common tool for researchers seeking ways to promote healthy behavior.

This paper uses the 2012 BRFSS survey results. The 2012 data set is the most recent set available to the public and it includes over 400,000 respondents. Many of the survey questions were not relevant to this question; this paper will focus on respondents' demographic information, income, place or residence (metropolitan, suburban, or rural area) as well as information about average food consumption over a one month period.

To gather results on food consumption survey participants were asked a series of seven questions regarding food consumption. The question was phrased: "during the previous month, how many times per day, week, or month did you consume [food category]." The food categories

on the survey included: soda or sugary drinks, 100% fruit juice, fruits not counting juice, beans or lentils, dark green vegetables, orange vegetables, and other vegetables. In order to establish better regression variables this study combined green, orange, and other vegetables into a single variable that represented the total amount of vegetables consumed over the past month. This study also combined fruit juice and fruit consumption into a single fruit variable, and finally created a third variable combining the fruit, bean, and vegetable variables to create a single variable representing all food consumption in the previous month. A summary of these variables can be found in Table 1.

The relevant BRFSS data was used to construct three multiple regression models to gauge primarily the effects of different variables of food consumption. Model 1 is a multiple regression using metropolitan status codes provided by standard metropolitan statistical area data. Respondents were sorted into three categories based on residence: metropolitan, suburban, and rural. These are the initial independent variables. Geographic location was used as the first independent variable to gain an initial understanding of how metropolitan and rural areas compared to suburban areas in fresh food consumption. It was hypothesized that suburban residents would consume significantly more fresh produce than rural and metropolitan residents due to easier access to these items at lower costs.

Model 2 contains the metropolitan, suburban, and rural independent variables and adds income as an independent variable via eight dummy variables representing income categories. Income was added in order to view the varying consumption rates of low income and high income individuals and also to clean up the location variables and account for multicolinearity that may occur between geographic location and income. With this model it was hypothesized that the number of vegetables consumed would increase as income increased, and that the

coefficient on suburban geographic area would remain high. If respondents in rural and metropolitan areas did not consume as many vegetables as suburban individuals even when accounting for income, it would suggest the likelihood of food desert areas.

Model 3 uses all of the previously mentioned variables and adds the following new independent variables: age, education, weight, number of adults in the respondents household, number of children in the respondents household, and gender. Including demographic variables like age and gender helps to better classify the data. Number of children and adults in the household can also offer insight on the purchasing habits of families; it was hypothesized, as suggested by Elbel, Kersh, Brescoll, and Dixon (2009), that individuals with children would be more likely to consume more vegetables. Education was included as a way to gauge taste preferences. As individuals become more educated they tend to learn more and more about nutrition and become more understanding of the value of fruits and vegetables. Subsequently, it was hypothesized that as individuals became more educated, they would choose to consume more fruits and vegetables. In this model, if rural and metropolitan respondents still consumed less fruits and vegetables overall when controlling for demographics, income, and education when compared to suburban residents, it would suggest that there was a significant lack of availability in those regions.

Each of the models was run three times, each time using a different dependent variable. The first three regressions feature number of vegetables consumed per month as the dependent variable. The second three regressions feature number of fruits consumed per month as the dependent variable. The final three regressions feature all foods consumed per month as

	Number Of Observations	Mean	Standard Dev.	Min	Max
Fruits	46616	40	35	0	660
Vegetables	46249	47	33	0	530
All Food	44896	95	59	0	1190

Table 1: Summary of Food Consumption Variables

the dependent variable, this is a combination of fruits and vegetables consumed as well as amount of beans and lentils consumed during an average month

Table 2: Effect on Number of Vegetables Consumed Per Month

Vegetables	Model 1	Model 2	Model 3
Urban Resident	**0.195**	**0.727**	**0.282**
	(0.510)	**(1.900)**	**(-0.690)**
Rural Resident	**-2.450***	**-1.243***	**-0.224**
	(-5.870)	**(-2.970)**	**(-0.500)**
Income <$10,000		**base**	**base**
Income $10,000-15,000		**-3.967***	**-0.791**
		(-4.850)	**(-0.750)**
Income $15,000-20,000		**-3.814***	**-0.873**
		(-5.150)	**(-0.870)**
Income $20,000-$25,000		**-3.514***	**-0.976**
		(-5.030)	**(0.316)**
Income $25,000-35,000		**-1.246**	**1.002**
		(-1.910)	**(0.289)**
Income $35,000-50,000		**1.077**	**2.536***
		(1.770)	**(2.740)**
Income $50,000-75,000		**3.013***	**3.890***
		(5.140)	**(4.230)**
Income > $75,000		**6.666***	**6.367***
		(13.370)	**(7.140)**
Age			**0.089***
			(6.450)
High School Dropout			**-4.785***
			(-6.920)
High School Grad			**base**
College Grad			**7.434***
			(18.000)
# of adults in home			**0.425**
			(1.860)
# of Children in home			**0.398**
			(1.890)
Weight			**-0.026***
			(-5.910)
Females			**8.179***
			(20.630)
R-squared Value	**0.0011**	**0.0141**	**0.0490**
Number of Observations	**39,007**	**39,007**	**37,256**

Asterisks denote coefficients significant to 95 percent. t-values are recorded in parentheses.

Table 3: Effect on Number of Fruits Consumed Per Month

Fruits	Model 1	Model 2	Model 3
Urban Resident	**0.412**	**0.724**	**0.405**
	(1.040)	**(1.820)**	**(-1.010)**
Rural Resident	**-4.587***	**-3.872***	**-3.202***
	(-10.640)	**(-8.920)**	**(-7.290)**
Income < $10,000		**base**	**base**
Income $10,000-15,000		**-2.642***	**-0.933**
		(-3.110)	**(-1.080)**
Income $15,000-20,000		**-1.315**	**0.064**
		(-1.720)	**(0.080)**
Income $20,000-25,000		**-2.109***	**-1.247**
		(-2.910)	**(-1.690)**
Income $25,000-35,000		**-0.567**	**0.048**
		(-0.840)	**(0.070)**
Income $35,000-50,000		**-0.362**	**0.326**
		(0.570)	**(0.500)**
Income $50,000-75,000		**-0.614**	**-0.121**
		(1.010)	**(-0.190)**
Income > $75,000		**4.160***	**2.223***
		(8.050)	**(3.880)**
Age			**0.119***
			(9.020)
High School Dropout			**-3.917***
			(-6.060)
High School Graduate			**base**
College Grad			**7.071***
			(17.600)
# of Adults in Home			**0.227**
			(1.010)
# of Children in home			**1.263***
			(6.030)
Weight			**-0.051**
			(-11.880)
Females			**4.037***
			(10.350)
R-squared Value	**0.0011**	**0.0141**	**0.0490**
Number of Observations	**39,303**	**39,303**	**37,540**

Asterisks denote coefficients significant to 95 percent. t-values are recorded in parentheses.

Table 4: Effect on Number of all Vegetables, Fruits, Beans, and Lentils Consumed Per Month.

All Foods	Model 1	Model 2	Model 3
Urban Resident	0.772	1.641*	0.883
	(1.110)	(2.380)	(1.270)
Rural Resident	-6.894*	-4.900*	-3.446*
	(-9.120)	(-6.460)	(-4.510)
Income < $10,000		base	base
Income $10,000-15,000		-6.268*	-2.382
		(-4.200)	(-1.580)
Income $15,000-20,000		-5.123*	-1.962
		(-3.810)	(-1.440)
Income $20,000-25,000		-5.492*	-3.441*
		(-4.320)	(-2.670)
Income $25,000-35,000		-2.310	-0.853
		(-1.950)	(-0.710)
Income $35,000-50,000		1.628	1.462
		(1.470)	(1.290)
Income $50,000-75,000		4.033*	2.348*
		(3.790)	(2.120)
Income > $75,000		11.353*	6.822*
		(12.510)	(6.820)
Age			0.216*
			(9.420)
High School Dropout			-9.07*
			(-7.960)
High School Grad			base
College Grad			15.636*
			(22.480)
# Of Adults in Household			1.253*
			(3.230)
# Of Children in Household			2.223*
			(6.150)
Weight			-0.083*
			(-11.050)
Females			11.953*
			(17.650)
R-squared Value	0.0036	0.0078	0.0322
Number of Observations	37811	37811	36160

Asterisks denote coefficients significant to 95 percent. t-values are recorded in parentheses.

Results

In Model 1 of Table 2 results show that residents of rural areas consume 2.45 less vegetables per month when compared to suburban residents and that these results are statistically significant. In this model urban residents actually consume slightly more vegetables than suburban residents however these results are insignificant. Rural results are as hypothesized, however it was expected that urban residents would also consume less vegetables than suburban residents.

Model 2 of Table 2 shows similar results in the Urban and Rural variables. Rural residents still consume significantly less vegetables when accounting for income and results on urban residents are still insignificant. Coefficients on the income dummy variables were unexpected and both support and refute the previous hypothesis. The most surprising result comes from the base income dummy variable, respondents that make less than $10,000 a year. Respondents in these categories consume more vegetables than the respondents in the subsequent four categories, individuals who make between $10,000 and $35,000 annually. As expected, respondents in higher income brackets consume more vegetables per month as income increases and this is statistically significant in the two highest income brackets. Also, other than the base income variable, each increase in income bracket comes with an increase in vegetables consumed.

In Model 3 of Table 2, geographic location variables become statistically insignificant, and previously negative significant results on the rural location variable become nearly identical to urban and suburban location variables. Coefficients on the income variables remain largely the same as they did in Model 2 and exhibit the same trends even when accounting for the new

variables. As expected, education was very statistically significant, and shows that high school dropouts consume 4.7 fewer vegetables per month on average when compared to high school grads, and that college graduates consume 7.4 more vegetables per month when compared with high school grads. This reinforces the hypothesis that individuals will choose healthier options as they become more educated. The variables representing number of adults in the household and number of children in the household were both insignificant in this model; however age and sex were significant. Individuals were more likely to consume more vegetables as they aged, and women on average consumed 8.1 more vegetables per month than men.

Moving to Table 3, where number of fruits consumed is the dependent variable, Model 1 remains largely the same. Rural residents consume significantly less fruits when compared to suburban residents and the coefficient on urban residents is still insignificant. In Model 2 of Table 3, the same anomaly exists in the base income group that was found in Table 2 and seems to be even more prevalent. Individuals in the lowest income bracket consume more fruits than individuals in all but the highest income bracket. The trend of consumption increasing with income found in Table 2 does not exist here, and the only really significant result is that individuals with the highest incomes still consume more than all other groups. The geographic variables also produce similar results; rural respondents still consume significantly less vegetables than suburban respondents.

Model 3 of Table 3 differs from the vegetable model in that the significantly negative coefficient on the rural variable remains. In Table 2 Model 3, geographic variables ceased to be significantly related to consumption, but when using fruits as the dependent variable the decreased consumption remains, even when accounting for income, education, and demographic variables. In this model income becomes insignificant on almost every level, the only significant

coefficient comes from the highest income bracket and, while still positive at 2.2, it is around half of the coefficient found in Model 2 in the same table. Education continues to be statistically significant and the variable responsible for the largest increases or decreases of consumption in the model. In contrast to Table 2, the number of adults variable and number of children variable are both significant with positive coefficients. This means that individuals with more adults or more children in their household are more likely to consume more fruits. Age, weight, and sex were all statistically significant with expected coefficients similar to Model 3 in Table 2. Overall the similarities between the two tables serve to illustrate that fruit and vegetable consumption appear to be correlated and motivated by similar factors.

Table 4 shows the consumption of all fruits, vegetables, beans, and lentils and Model 1 shows results similar to those found in the previous two tables. Of course in this table the coefficients will be larger numbers due to taking more food items into account, but the significant negative coefficient associated with rural residents is still there just as it was in Tables 2 and 3.

Model 2 in Table 4 is the first and only model to contain statistical significant coefficients for both urban and rural geographic areas. In this model, as expected, urban respondents also consume statistically fewer fruits, vegetables, and beans per month than suburban respondents. In this model income behaves as it did in Table 2. With the exception of the base income bracket, as income increases consumption also increases, and individuals in the two highest income brackets consume significantly more fruits, vegetables, beans, and lentils.

Model 3 in Table 4 presents similar results as the models in Tables 2 and 3. The rural geographic area variable retains its significance and the income variables behave largely the same way. Education is still statistically significant with the same expected signs on the

coefficients. The variables relating to number of adults and children in the household are both statistically significant with positive coefficients, and the variables relating to age, weight, and sex, all remain statistically significant with the expected signs on the coefficients.

The models produced a variety of significant results. Interestingly, rural residents consume less fruits, vegetables, and beans across all models even when accounting for income and education compared to urban and suburban residents. This suggests the possibility that food deserts could be present in these rural areas. Other than Model 2 in Table 3, results would suggest that urban residents actually consume slightly more fruits and vegetables than their suburban and rural counterparts however these are not statistically significant.

The models also provide some expected results regarding income and education. College graduates consume significantly more fruits and vegetables per month than high school graduates who in turn consume significantly more than high school dropouts, even when accounting for income and area of residence. This suggests that education has an effect on consumer preferences which would inform purchasing habits even when consumers face financial hardship or reside in an area without convenient access to healthy food. This makes sense as increased education results in a greater knowledge of nutrition and the way that food interacts with the human body. This could result in consumers altering their taste preferences in order to lead a healthier lifestyle.

The income variable behaves in an interesting way; results in models 2 and 3 across all variables suggest that as individuals make more money they will consume an increasing amount of fruits and vegetables even when accounting for education and location, however there is one

exception. Individuals in the lowest income bracket, those who make less than $10,000 annually, consume more fruits and vegetables than those who make between $10,000 and $25,000. It is hypothesized that those in the sub $10,000 income category may be receiving assistance from government or charitable programs like the USDA's supplemental nutrition assistance program (SNAP) or various nonprofit soup kitchens and food drive organizations. These organizations would focus more on serving nutritious food meaning those in the lowest income bracket would have better access to nutritious meals. It is also possible that surveyed respondents were dependent on a household breadwinner and thus listed $0 as their income even when their household could have been in the highest income bracket.

The additional variables in model 3, the largest model, behaved as expected. Age, number of children in the household, and number of adults in the household, are all statistically significantly positively correlated with increased consumption of fruits and vegetables. Females also consume more fruits and vegetables to a statistically significant degree. Weight is negatively correlated with the amount of foods consumed and is statistically significant however this may be more of an indicator of a lack fruit and vegetable consumption rather than a factor in choice.

Conclusion

Diet and food choices are complex decisions that draw from a variety of variables both short and long term. Certainly food choice draws from taste preferences that develop over a lifetime can be influenced by factors like education, upbringing, race, culture, and parent income level. There are also factors like current income, location, weight, and general health that can influence purchasing decisions in the shorter term. The results of this paper show that the contribution of many of these variables to food choice can be measured, and that the idea of a food desert is

plausible. Across all three models residents in rural areas consumed less fruits and vegetables even when accounting for education and income. Certainly more research would need to be conducted, as there are a myriad of factors at work, but the reduced consumption found in the surveyed rural areas is similar to the reduced consumption found in areas designated as food deserts.

It is likely that increasing fresh produce availability in these rural areas would not be economically viable for the firms selling the food, but the data from this paper and food desert papers mentioned in the literature review would suggest that there is an availability problem that could be solved. Government programs and charitable organizations could benefit from geographic information regarding food desert communities so that they might be better able to distribute needed food. The positive coefficient on income in higher income brackets means that consumers will purchase more and more fruits and vegetables as their income increases. This suggests that consumers are for the most part aware of the nutritious value of fruits and vegetables and can be limited by high prices, which research shows would be more prevalent in food desert areas.

While results were generally consistent with the findings of prior research, there were limitations in the study that could be overcome to produce a more accurate representation of food choice decision making. The BRFSS data provided by the CDC did include a county code variable designating the county of the survey respondent; however the coding sheet that matched a county code to the name of the county was not publically available for privacy reasons. With this data and additional time research could be done utilizing census data to build a more complete model. Instead of using just survey respondent income the study could examine the average income level of counties and compare lower income counties higher income ones.

Additionally, by utilizing GIS mapping software, it would be possible to obtain the location of food selling firms in each county as well as neighborhoods or residential areas in those counties. With that data a variable could be created that measured the average distance from a residential area to a food selling firm, which could provide more insight into how transportation affects food purchasing decisions. Finally, there were some limitations with the way the survey worded their questions as well as some questions that could have provided more insight into purchasing habits. For example, the BRFSS only asked how many fruits and vegetables the survey respondent had consumed in the previous month. Information regarding purchasing, for example the type of store used to purchase food, as well as the price of the food purchased, would enhance the depth of the study immensely.

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