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Understanding Consumer Preferences for Nutritious Foods: Retailing Strategies in a Food Desert[1]

Dave D. Weatherspoon[Ⓘa], James F. Oehmke[b], Marcus A. Coleman[c] and Lorraine J. Weatherspoon[d]

[a]*Professor, Agricultural, Food and Resource Economics, 213c Justin S. Morrill Hall of Agriculture, 446 West Circle Dr.,, Michigan State University, East Lansing, Michigan, 48824, USA*

[b]*Professor Emeritus, Agricultural, Food and Resource Economics, 202 Justin S. Morrill Hall of Agriculture, 446 West Circle Dr., Michigan State University, East Lansing, Michigan, 48823,USA*

[c]*Dean of Students, Southern University and A&M College, Smith-Brown Memorial Union, Suite 206 500 Jesse Stone Ave., PO Box 13405, Baton Rouge, Louisiana, 70813, USA*

[d]*Associate Professor, Food Science and Human Nutrition, 140 G.M. Trout FSHN Building Michigan State University, East Lansing, Michigan, 48824, USA*

Abstract

Demand and access to affordable, nutritious food are major concerns in food deserts. Primary data from Detroit, Michigan was analyzed to understand demand for fresh fruits and vegetables (FFV) as a proxy for determining the factors that influence healthy food consumption. Logistic analysis showed that those who could not afford FFV, or share food with others had a lower propensity to consume FFV and that consumers who shop frequently, eat healthy, are food secure, or are able to travel to suburban supermarkets had a higher propensity to consume FFV. Recommendations for policy makers and retailer strategies are detailed.

Keywords: food desert, fresh fruit and vegetable consumption, consumer demand

Ⓘ Corresponding author: Tel: + 1.517. 353.9850
Email: D. D. Weatherspoon: Weathe42@msu.edu
J. F. Oehmke: oehmkej@gmail.com
M. A. Coleman: marcus_coleman@subr.edu
L. J. Weatherspoon: weathe43@msu.edu

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Introduction

Demand and access to affordable, nutritious food is at the forefront of the food desert problem, a growing concern in the U.S. Food deserts have the peculiar feature that nutritious food is scarce, or, if available, it is usually of low quality and sold at exorbitant prices (Lewis et al. 2005; Moore and Roux 2006) Not having access to nutritious food increases risk for diet-related problems such as obesity and associated co-morbidities or mortality (U.S. Department of Health and Human Services 2001;(Freedman et al. 1999; Glenny et al 1997; Kitzmann and Beech 2006; and Centers for Disease Control 2009a). Cummins and Macintyre (2006) and Diez-Roux, Link and Northridge (2000) found that living in a low-income or deprived area is associated with a poor diet (more specifically high fat, high calorie diets that are low in fruit and vegetables) and the prevalence of morbidities, such as obesity. Chen and Snyder (2009) establish the links from food deserts to malnutrition to obesity to morbidity. Because obesity and co-morbidities have reached epidemic proportions and continue to increase (Flegal et al. 2010) there is "a growing need to develop public health policies and innovative intervention strategies to increase retail availability of fresh fruits and vegetables (FFV) in disadvantaged communities" (Hosler et al. 2008), as well as retail strategies that provide these consumers with affordable and nutritious food choices while providing profits for the entire food supply chain, in particular the retailers. Developing retail strategies for these disadvantaged areas may holistically seem philanthropic in nature (Seelos and Mair 2007), but there is immense symbiotic profit potential in this U.S. market segment.

Bitler and Haider (2010) conclude that most of the literature on U.S. food deserts examine the definitions of food deserts and food access, but none specifically examine why they exist or the direct impact they have on affected populations nor the potential for firms looking for new market opportunities. Specifically, the lack of knowledge about the determinants of demand for nutritious foods among poor, ethnic populations, and populations of color limits the ability of both public- and private-sector interventions to replace unhealthy consumption of high calorie foods with nutritious foods. Consequently, an understanding of the demand for nutritious foods in a food desert is a prerequisite to addressing the impact on poor urban consumers' nutritional status, as well as providing a basis to target the untapped profit potential for food retail firms in these areas.

Selling FFV, as well as other nutritious foods, in a food desert presents a potential new retail opportunity for food retailers. Understanding demand for FFV is the first step in aiding retailers to develop effective food retail strategies for food deserts. The critical issues for retailers are:
1) is there demand for healthier food products in a food desert; 2) what is the best mechanism by which nutritious foods can be offered in a food desert; and 3) will these products be profitable in such a setting? Detroit is selected as a study site because it is arguably one of America's worst food deserts in terms of size and number of people impacted, and the fact that it was ranked the 5th most obese city in 2009 at the time of data collection. The obesity rates in the metropolitan Detroit area continue to grow with over 30% of the population being obese in 2011, equivalent to those of the "fattest state, Mississippi in 2012" (Ruiz 2007; Centers for Disease Control 2009b). FFV consumption has been shown to be associated with healthier weights and positive health outcomes (Ford and Mokdad 2001; Bazzano et al. 2008; He et al. 2004). Investigating these critical issues will aid in understanding the viability of supermarkets, small grocers, non-

governmental organizations and other supply chain entrants in food deserts who wish to market healthier food products.

The objectives of this paper are to: 1) understand the nature of demand for fresh fruit and vegetables in a Detroit, MI food desert area; and 2) determine the factors that influence the consumption of fresh fruit and vegetables. The next section puts Detroit's food desert in context and supports the necessity for primary data collection to fully understand consumer behavior. The data collection and the general trends are subsequently discussed. The method section incorporates the procedures and estimation methods with which the data were analyzed. Regression results and implications are presented next. The last section concludes with implications for policy makers and retailers.

Detroit's Food Desert in Context

Food deserts are environments that do not have the variety of foods that society has come to expect from a flourishing community, primarily because they lack supermarket chains that usually provide quality, affordable, and nutritious food options (e.g. Lewis et al.2005; Moore and Roux 2006). In 2007 it was estimated that Detroit had 500,000 people living in a food desert (Gallagher 2007) with no full-service supermarket chains operating within the 139 square mile city (one national retailer and one regional retailer opened stores within Detroit's city limits in 2013). Most inner-city Detroit residents rely on convenience, liquor, or other non-mainstream grocery stores for food (Gallagher 2007). These "fringe retailers" focus on high-calorie, high-fat and/or salty snack foods and sugary drinks, and are located on average 0.2 miles from the household; mainstream grocers, including small independent grocers, are located two to three times that distance(Gallagher 2007). Low income families are disproportionately impacted by this dire healthy food access situation. In 2007, 92% of Detroit's food stamp retailers were gas stations, liquor stores, party stores, dollar stores, bakeries, pharmacies, convenience stores, and other fringe food retail venues (Gallagher 2007) that offer limited, if any, nutritious food choices.

Traveling to the suburbs to shop at a mainstream supermarket chain has its challenges, which compounds the problem. Detroit has an inadequate public transportation system and many of its residents in the poor areas do not have access to a vehicle. Public transportation in Detroit is limited to a small, light-rail train covering a three mile loop in the downtown area and a limited number of bus routes connecting Detroit with suburban areas (Weatherspoon et al. 2013). From the primary study location in Detroit at the time of data collection in 2009, it took 56 to 66 minutes to reach the nearest Meijer's (a regional supermarket chain that has several hypermarkets in the Detroit metro area) and 72 minutes or more to reach the nearest Wal-Mart Supercenter[2]. Each of these trips requires walking to the bus stop and making a transfer to a second bus, which adds additional travel time and transaction costs (Weatherspoon et al. 2013). For persons suffering from health complications that limit mobility, accessibility to nutritious foods is further compromised.

[2] Google Maps.

During the study period (2009), job loss, economic deterioration, and increases in food prices placed additional stress on already strained household food budgets in Detroit. Sunnucks (2009) and Isidore (2008) show that the Detroit metropolitan area lost over 135,000 jobs. *Forbes* named Detroit as one of the fastest dying cities (Zumbrun 2008). For example, between 2000 and 2008, 111,232 inhabitants fled from the Wayne County, Michigan area with collateral associated job losses of 13,518 (Adelaja et al. 2009). There were also 6,448 new foreclosures in the city between August 2009 and February 2010 (Southeast Michigan Council of Governments). Detroit is comprised of 59 square miles of abandoned buildings and vacant land, an area the size of San Francisco (Gallagher 2009). In addition, many schools in the city were closed, in receivership, and/or have been assigned an emergency manager by the Governor of Michigan. With families having to travel further for work, school, and food, living in Detroit's food desert areas is becoming more expensive from a financial and time perspective.

Piety Hill, the specific study area, is part of the greater Detroit area and is located north of Mid-Town. Weatherspoon et al. (2012, 2013) provide great detail of the area and how the collaborative non-profit grocer originated. U.S. census data shows that the census tract study area lost 35% of its population from 2000 to 2010 (U.S. Census). Piety Hill has a mean income lower than 95.6 % of U.S. neighborhoods and a childhood poverty rate of 38%, higher than 89.9% of U.S. neighborhoods. The poverty rate exceeds 60% for the 18–64-year age-group and the unemployment rate exceeds 34% (Data Driven Detroit 2013). The neighborhood contains numerous abandoned, occupied and/or burnt buildings in various states of disrepair. The Piety Hill community is a predominantly African-American neighborhood (which is representative of the racial demographic of inner-city Detroit), where most of the residents are elderly, low income (median household income is $20,150[3]), and lack personal transportation (which is similar to most of inner-city Detroit). In 2009, Piety Hill was serviced by an independent grocer, one small, non-profit fresh produce retailer (Peaches & Greens, which operates a retail store and a produce truck that services the community), and approximately 27 liquor/convenience stores. Prior to Peaches & Greens opening, this neighborhood depicted the extreme definition of a food desert, where consumers had little access to affordable, quality healthy food products.

It is unclear whether the Piety Hill and broader Detroit food deserts are a consequence of limited demand for nutritious foods, general economic decline, or supermarket chains choosing to abandon the city. The literature does, however, link residence in food desert-like areas to under-consumption of nutritious foods, specifically FFV. Lavin (2005) found a positive association between FFV access and consumption, as well as consumption and access to a variety of nutritious foods in general. Hendrickson, Smith and Eikenberry (2006) show that the absence of quality, affordable food for low-income residents prevents or diminishes the ability to choose foods that help maintain a healthy lifestyle in Minnesota.

Similarly, the literature relevant to retail strategies to improve consumer options in food deserts and supportive public policy is not pellucid. Short, Guthman and Raskin. (2007) argue that small, full service markets, well-dispersed in several low income neighborhoods, can and do provide a

[3] The estimated median household incomes are cited from http://www.city-data.com/zips for 2008. It is important to note that this zip code expands beyond the boundaries of the Piety Hill neighborhood. But given the gap in data, this is the only information available.

wide variety of culturally acceptable foods at relatively low prices, but are cautious about product quality and actual affordability based upon the low-income demographic they may serve. Similarly, Raja Ma, and Yadav (2008) state that policies supporting small, high-quality grocery stores may be a more efficient strategy for ensuring access to and demand for healthful foods in predominately low income, inner-city, minority neighborhoods. Rose et al. (2009) show that living in a food desert essentially raised the cost of access to food, either through higher prices at corner stores, increased consumption of fast foods, or transportation costs to supermarkets. Mobley (2006) shows that the presence of convenience stores is associated with higher obesity rates among low-income women; and that the presence of supermarkets is associated with lower obesity rates. Morland et al. (2002) found that for inner-city African American neighborhoods, FFV intake increased by 32% for each additional supermarket in the area. This small-store option has been embraced by the Obama administration, which funded 632 corner stores in Philadelphia to stock fresh fruits and vegetables, with the intent to help turn a food desert into a food oasis (Kliff 2012).

The question is then; will urban food desert consumers consistently purchase and consume FFV if they have adequate access? The answer for this particular population is not obvious from the literature. The causal relationships between food deserts and under-consumption of nutritious foods are not well understood, despite the clear associations between the two. In particular, it is unclear whether food options are not available in food deserts because residents cannot (for reasons other than access, such as low income) or will not consume nutritious foods, or whether the lack of access to nutritious foods is the primary cause of under-consumption of FFV. Multiple studies have found factors such as price, access, income, education, gender, age and transportation to be significantly related to the consumption of FFV across the U.S. (e.g. Dibsdall et al. 2003; Rose and Richards 2004; Havas et al. 1998; Casagrande et al. 2007; Zenk et al. 2005; Cassady, Jetter and Culp 2007; Powell et al. 2007a; Pearson et al. 2005). In these studies the typical defining characteristics of U.S. urban food desert residents are: low income, low education, and lack of personal transportation, similar to the Detroit inner city scenario for low income citizens. However, few studies examine the direct relationship between access to and demand for nutritious foods, and consumption in food deserts. Part of the insufficient literature comes from the lack of private retail data, and access restrictions on public data such as Supplemental Nutrition Assistance Program (SNAP) data (i.e. the Michigan Department of Human Services does not share SNAP data).

Without private retail and quality public data, it is difficult to understand consumer demand for nutritious foods. This lack of data clouds the judgment of supermarket chains seeking to enter this environment since there are no reliable sources to put into their location models to determine if they should/ should not invest in a food desert area. These areas could represent a growing profitable market opportunity in the U.S. This paper focuses on latent demand approaches to determine consumer preferences for FFV in a food desert setting, to address this knowledge gap. This approach allows for the consideration of barriers to consumption if FFV are readily available. The study results allow both retailers and public policy makers to understand the market potential for healthy food, such as FFV, and establish a basis for the creation of effective strategies/policies to ensure sufficient access to quality nutritious food for urban poor.

Food Desert Survey Data

A survey instrument was designed to gather information on household characteristics, environmental characteristics, food access and affordability, and food consumption patterns. The household characteristic questions included demographic (household size, composition, age, etc.), food storage and preparation ability, tastes and preferences, perception of food consumption adequacy relative to healthy levels, shopping frequency, access and affordability questions related to availability and quality of FFV, transportation options, and income (employment and other). Environmental characteristics included distance to nearest food store, ease of access to respondents' three most preferred stores, perceived safety in travel to the store, ability to store and prepare fruit and vegetables, and access to public transportation, among others. Food access and affordability questions included directly asking about fruit and vegetable affordability, questions relating to reduced fruit and vegetable consumption due to price/income issues, food quality, and use of food assistance (governmental and non-governmental). Food consumption patterns were surveyed by including the fruit and vegetable food frequency component of the National Health and Nutrition Examination Survey instrument (National Health and Nutrition Examination Survey 2012).

Pre-testing of the survey was conducted first with a group of faculty and graduate students at Michigan State University that were familiar with the study area and then with a group of local Central Detroit Christian staff who lived and/or worked in the study area. Pre-testing included a focused discussion to establish face validity with each of the two groups. The survey questionnaire is available from the authors upon request.

The data were collected in November and December of 2009 in the Piety Hill community of Detroit. At this time, Peaches & Greens was still in the start-up phase, just one year old and attempting to figure out how to market FFV to a community that had not had local access to affordable quality FFV for decades. This new concept took time to gain traction in the neighborhood with 90% of the respondents saying that they had never shopped at Peaches & Greens, largely because they did not know of the store.

The survey was administered by trained interviewers to adult participants (individuals over 18 years of age). To assist in data collection efforts, the Central Detroit Christian (CDC) staff coordinated with the authors in organizing several data collection sites, which primarily included their retail location, headquarters, and a local community event they sponsored. Because CDC works with the poor and the local event included food distribution, conducting surveys at these venues likely resulted in a representative sample of the social makeup, but at the lower end of the income spectrum. For example, respondents 'median income from all sources of $500-700/month, put them below median levels of $20,150/year for the local population. There were a total of 161 respondents in the sample population where 85.3% were African American, 76.6% were female, 64% were between 35 and 64 years of age, 94.5% were receiving SNAP benefits (EBT food assistance cards), 56% had consistent access to a vehicle, and 79% had at least one minor living in their household. In comparison, the census tract data showed a composition of 92.3% African Americans, 49.7% females, and 50% were 35 – 64 years of age (Data Driven Detroit 2013).Therefore, the study sample (approximately 10% of the local census tract

population) was older, poorer, had more females and less African Americans. Representative data on fresh fruit and vegetable consumption for Detroit are not available for comparison.

Given the challenges inherent in collecting quality data in an urban food desert, it is also important to note several successful strategies implemented by the authors: 1) partnering with a trusted community organization, 2) data collection in a high foot traffic area, and 3) enlisting recognizable and trusted individuals from the community to legitimize the survey team to the participants. It is critical that respondents trust the stated purpose of the research to facilitate participation. For participation, respondents received a $5 gift certificate for FFV and a full size grocery bag of Michigan red apples from Peaches & Greens.

A summary of the household level data in terms of household and environmental characteristics, and food access and affordability categories are provided in Appendix A. It is notable that in this location 31.1% of the respondents believed that they ate plenty of FFV for a healthy diet. One of the pertinent findings is that almost half of the respondents had difficulty storing FFV at home. The primary reasons for this included the lack of secure storage and/or the facilities to prepare the produce for consumption. The majority of respondents lived and shared food with others: 84.5% of the participants lived with someone else; 80% of those who lived with others lived with their children/grandchildren and shared food with them; 16% of those who lived with others lived with other relatives; and, only 7% of the respondents lived with non-relatives. Two-thirds of the respondents shopped only 2-3 times or less per month where the national average is 1.7 times per week (Food Marketing Institute 2012). Only 23% of the respondents shopped specifically for FFV when they purchased food.

Interestingly, concerns for personal safety when shopping was not a concern for this community. A greater concern was they did not like their local store and 28.1% had transportation issues. The food access variable of distance to their primary store, with a mean distance of 2.55 miles, reinforces that the respondents did not like the offerings of the local grocer closest to their census tract.

Just over half of the respondents found FFV to be too expensive which is not surprising considering the average earnings and total income from all sources reported in see Appendix A. The use of emergency food options such as food banks and church food giveaways were important for food security in this neighborhood. Fifteen percent of the respondents stated they sometimes too often do not get enough food to eat.

Method

A stepwise approach was used to determine the factors that influence FFV consumption behavior. First descriptive analysis of FFV consumption was used, followed by ANOVA of various contributing factors, and then several multivariate regressions were estimated.

Selection of explanatory variables was determined in some cases by the number of non-blank responses received. In particular, significant proportions of respondents chose not to answer questions about income (i.e. 112 provided a total income question response and only 69 reported wage earnings). It was anticipated these would be sensitive questions among low income

populations. Consequently, a two-step approach was used to analyze questions of interest. First, bivariate statistical procedures were used to determine the relationships between food consumption and each of a variety of explanatory variables. For those variables that had a large sample size and were randomly distributed, logistic regression analysis of the dichotomous food consumption variable was used to quantify changes in the likelihood that the respondent would eat FFV approximately every day.

Logistic regression analysis of the dichotomous food consumption variable was performed for several models. There are two reasons for estimating and presenting multiple models. The first is that regression is a parametric technique, and estimated effects can be sensitive to parameterization, including the selection of independent variables. The second is that for some survey datasets, including this one, respondents preferred not to answer all questions as stated earlier (non-response to some questions is typical, e.g. Zenk et al. (2005) found that only 266 of 456 (58%) Detroit survey respondents completed an entire questionnaire related to fruit and vegetable consumption (Rose and Richards 2004). Consequently, including those explanatory variables significantly reduces usable sample size, raising the possibility that estimated coefficients may be sensitive to the subsample used in the regression. By estimating multiple models which include different variables (and therefore different usable sample sizes), the reader can observe the degree to which the estimated effects do or do not depend on model parameterization and variable selection. Estimated effects that are robust across models are typically considered to be reliable estimates.

Results

Table 1 shows the frequency of FFV consumption for 152 of the 161 respondents. The questionnaire included eight positive responses for this question plus “don’t know” and “refused”. Only 7.3% of the respondents come close to meeting the USDA recommended dietary guidelines of 2-3 servings of fruit and 3-5 servings of veggies per day depending on type (U.S.D.A. and U.S.D.H.H.S. 2010). Approximately 28% of this population consumes FFV five or more times per week, but what is of concern is that over a third of this population consumes FFV less than once per week.

Due to small cell counts (five of the eight cells have counts less than 20), a decision was made to create a dichotomous variable taking the value of zero if the respondent consumed FFV four times per week or less and the value one if the respondent consumed FFV 5-6 times per week or more. This decision represents the visual break between the cell counts for cells [2]-[4] and the cell counts for [5] and [6]; it also represents a break between those who usually (5-6 times per week) or always consumed FFV on a daily basis, and those who did not. In subsequent discussion, it is interpreted as representing (with a value=1) those respondents who consumed FFV most (days) or every day.

Table 1. Frequency of Fresh Fruit and Vegetable Consumption

Variable	Frequency Count	Frequency Percentage
Consume fresh fruit and vegetables (152 responses)		
[1] 1 time per month or less	15	9.9
[2] 2-3 times per month	37	24.3
[3] 1-2 times per week	28	18.4
[4] 3-4 times per week	30	19.7
[5] 5-6 times per week	17	11.2
[6] Once or twice per day	14	9.2
[7] 3 to 5 times per day	8	5.3
[8] 6 or more times per day	3	2.0
Consume fresh fruit and vegetables at least 5-6 times per week		
NO (=0)	110	72.4
YES (=1)	42	27.6

A number of potential explanatory variables were difficult to include in the regression analysis because of low numbers of responses. ANOVA was used to ascertain whether the dichotomous FFV consumption variable was randomly distributed across the cells for these categorical variables. The null hypothesis of random distribution was rejected ($p < .10$) for income, average earnings, frequency of access to a vehicle, dislike of fruits and vegetables, and two food security variables (see Table 3), indicating that these variables were correlated with and/or caused FFV consumption. These results are used to help inform the logistic regression model and results.

Table 2. ANOVA of Fresh Fruit & Vegetable Consumption and Limited Response Explanatory Variables

Categorical Variable	ANOVA of daily fresh fruit and vegetable consumption
Income	F = 2.57, P = .0173**
Average earnings	F = 2.66, P = .0234**
Frequency of access to a vehicle	F = 2.38, P = .0548*
Dislike fruits and vegetables	F = 4.43, P = .0369**
Dislike nearby store	F = 0.66, P = .4173
Delayed shopping for any reason	F = 2.71, P = .1019
Food Security (categorical)	F = 4.48, P = .0049***
Food Security (dichotomous)	F=11.96, P = .0007***

*** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level

Five logistic regression models were estimated and reported in Table 3. All models performed well, with Wald $\chi 2$ tests showing the joint significance of the explanatory levels at p-values of .0005 or smaller. The pseudo R2s range from .26 to .61, which demonstrate excellent goodness-of-fit for logistic regression models. Incidence ratios (IRs) and p-values are reported for each variable. The IR show the effect of the variable on the likelihood of consuming FFV most days or every day. An IR of one indicates no effect (an increase in the variable makes the likelihood of consuming FFV one time as likely as with no increase, or exactly the same); an IR less (greater) than one indicates a decrease (increase) in the likelihood of consuming FFV most or every day. Since there is a fair degree of robustness of IRs and inference across models, discussion will focus on the explanatory variables (rather than model selection).

Table 3. Predictors of Fresh Fruit and Vegetable Consumption Logistic Regression Model

	Model 1 n=142	**Model 2 n=116**	**Model 3 n=85**	**Model 4 n=85**	**Model 5 n=82**
Can't afford FFV (0-1)	.434	.326	.412	.092***	
	(.117)	(.156)	(.467)	(.002)	
Difficult storing FFV (0-1)	.271**	.242*	.082*		.061***
	(.019)	(.063)	(.075)		(.004)
Eat plenty FFV for health (0-1)	2.509*	3.038*	3.704	3.917*	3.575
	(.062)	(.061)	(.152)	(.094)	(.156)
Frequency of grocery shopping (categorical)	1.383	1.833***	2.648***	2.338**	2.836***
	(.096)	(.006)	(.009)	(.010)	(.002)
Frequency of shopping specifically for FFV (categorical)	1.306	1.282	2.581***	2.329***	2.827***
	(.202)	(.359)	(.005)	(.001)	(.001
Share food with children (0-1)	.489	.097**	.0071***	.024***	.004***
	(.206)	(.019)	(.000)	(.000)	(.001)
Live with others (count)		.545**	.3810***	.457**	.384**
		(.037)	(.008)	(.042)	(.022)
Distance1to store (continuous)			1.324***	1.221**	1.366***
			(.001)	(.021)	(.007)
Food security (0-1)					5.876*
					(.083)
Log pseudo likelihood	-60.39	-40.54	-21.66	-24.15	-19.12
Wald χ^2	26.12	27.30	30.09	32.87	28.12
Prob > χ^2	.0002	.0003	.0002	.0000	.0005
Pseudo R^2	.2594	.4148	.5793	.5310	.6143

*** is significant at the 1% level, ** is significant at the 5% level, * is significant at the 10% level

The "can't afford" variable IR was statistically significant in model 4 only. However, the IR coefficient was consistently less than one for all five models. In Model 4, the coefficient of .092 indicates that a respondent experiencing difficulty affording FFV is only 9.2% as likely as a respondent not reporting affordability difficulty to consume FFV most or every day. This result supports the ANOVA findings that income and average earnings are significantly related to FFV consumption.

Forty-eight percent of the sampled population stated they had difficulty storing their FFV at home. "Difficult storage" has IR values less than one in all models and is statistically significant in models 1-3 and 5 (it is omitted in model 4). Respondents who have difficulty storing or preparing fruits and vegetables are 6-27% as likely as a respondent not reporting storage or preparation difficulty to consume FFV most or every day.

Thirty-one percent of the respondents believe they eat enough FFV for a healthy diet. From the models they are 2.5 to 3.9 times more likely to consume FFV most or every day. The IR is statistically significant in models 1, 2 and 4.

Frequency of shopping has a positive influence on FFV consumption in all models. The IR is statistically significant in every model ranging from 38% to 184% increase in the likelihood of consuming FFV most or every day. Appendix A shows that two-thirds of the respondents shop less than three times per month, which is significantly below the national average. This is an important consideration for retailer strategies to be profitable in food desert zones.

Sharing food with children has a negative effect on FFV consumption and the measured effect is very large and statistically significant in models 2-5. Respondents who share food with children are only 0.4% to 10% as likely to consume FFV most or every day as are respondents who do not share food with children. It is possible that the adult respondents are ceding their FFV consumption to the children. However, particularly given the income and food-access status of the population, it seems more likely that respondents who share food with children are struggling to keep food on the table and are therefore substituting inexpensive, calorie-dense foods for fruits and vegetables (note that in model 5 this children effect is robust to the inclusion of a food security variable). This is of greater concern if indeed it means that both respondents and associated children are consuming too few FFV for a healthy diet. Unfortunately, the survey does not provide information on children's FFV consumption (e.g. even if the respondent does not consume FFV, children may have some access through school breakfast and lunch programs). Given the importance of childhood diets in determining lifetime healthy eating behaviors (Braveman et al. 2009; Palloni 2006), this finding merits further investigation.

Living with other people has a negative and statistically significant effect. For each additional person in the household, the respondent is only 38-54% as likely to consume FFV most or every day as are respondents who do not live with others. Anecdotal discussion with respondents indicated two potential effects: living with other people meant that food expenditures had to be stretched to cover more people, leading to higher purchases of inexpensive, calorie-dense foods; and living with others (especially extended family or in group homes) meant that others are likely to consume their FFV. Hence, such purchases and consumption are significantly lower.

Distance to the nearest store has a positive and statistically significant effect on FFV consumption. At first glance, this seems counter-intuitive and in contrast with other studies (Rose and Richards 2004) and the notion that distance matters as an accessibility indicator (Rose and Richards 2004; Zenk et al. 2004; Dean and Sharkey 2011; Inagami et al. 2006; and Laraia et al. 2004). However, recall that the sample is taken from a single neighborhood. This implies that the variation in the "Distance" variable comes not from household location but from store selection, with those households shopping at the neighborhood store (with very limited FFV selection) having a low value of "Distance" and those shopping at a large grocery store or supermarket having a high value of "Distance". Hence, this result intuitively indicates that those who are better able to access grocers and supermarkets that carry a selection of FFV (e.g. if they own or have access to a car) are more likely to consume FFV. This is evident in the fact that driving an additional mile to access a better store raises the likelihood of consuming FFV most or every day by 22-37%. This variable is included in models 3-5 and is significant in each. Previous studies have shown that closer proximity to FFV translates into increased consumption (Morland et al. 2002). This finding is key to understanding the potential market size which is calculated below.

Food security (dichotomous), defined as a positive response to we get "enough of the kinds of foods we want to eat", was introduced into the final model as an alternative to affordability of foods. Food secure respondents are nearly six times as likely as food insecure respondents to consume FFV most or every day.

Model 4 deserves additional comment as it addresses the issue of co-linearity between the variables "Can't afford FFV" and "Difficult storing FFV". Model 4 drops the storage variable from Model 3. This induces a large decrease in the estimated IR for "Can't afford FFV", indicating that consumers who cannot afford FFV are less than 10% as likely to consume FFV as those who can afford FFV; and the effect becomes statistically significant (p=.002). The IR estimates for the remaining variables are robust in size, including "Eat plenty of FFV for a healthy diet", which regains statistical significance (p=.094). This indicates that affordability is in fact a primary determination in FFV consumption.

Market Size

According to the Social Compact Incorporation (2008), using 2000 census data, Detroit residents spend an estimated $4.9 billion on retail services annually. Retail leakage was estimated at $1.5 billion, comprising roughly 30% of residents' total expenditures. At that time, a total of 81 full-service grocers captured 69% of Detroit households' grocery expenditures. Grocery leakage was estimated at $200 million and could potentially support an additional 583,000 square feet of additional grocery retail space. Overall retail leakage for full service grocery was estimated as $2.6 million annually with an estimated residential expenditures on groceries of $14.4 million annually for the Middle Woodward Census Block (Piety Hill census tract is included in this census block).

To estimate the potential market size of the census tract where Piety Hill is located, census data, ERS and Data Driven Detroit data were used to complement the model estimations (U.S. Census Bureau 2013; ERS Food Access Research Atlas 2013; Data Driven Detroit 2013). Specifically, census tract level analysis was used to estimate an approximately one mile market radius (contiguous tracts) of those that would consume fresh fruit and vegetables at least 5-6 times per week. Appendix C shows that the John C Lodge Freeway bisects the one mile radius with the Piety Hill tract (26163532400) being on the East side of the John C Lodge Freeway. Hence the estimation of the market size requires three estimations: those without cars within a one mile radius and to the East of the John C Lodge Freeway; those with a car within a one mile radius and to the East of the John C Lodge Freeway; and, those with a car within a one mile radius and to the West of the John C Lodge Freeway. The primary assumption is that without a car most potential customers would not try to cross the John C Lodge Freeway with a bag full of FFV. The potential market size for FFV in this food desert ranges from 5,573 to 6,364 customers (approximately 38% to 43% of the total population in the one mile radius) who will consume vegetables 5 or more times per week (see Appendix B for the calculations).

Powell et al. (2007b) found that 48%, 35%, 92% and 80% of the 4,404 zip codes in their urban sample had at least one available chain supermarket, non-chain supermarket, grocery store and convenience store, respectively. Each zip code had a minimum of 10,000 people. The census tracts considered in the Piety Hill analysis had a total of 14,752 people, which implies that it is

large enough to support a full service chain supermarket among other retailers. However, Powell et. al. (2007b) later show that in predominately African American neighborhoods, full service supermarket chains are present only 41% of that of White urban zip codes and that low income zip codes have significantly fewer full service supermarket chains and more small or independent grocers.

Conclusions

This study found through ANOVA that income, average earnings, frequency of access to a vehicle, dislike of fruits and vegetables, and food security were correlated with and/or increased the likelihood of FFV consumption. Logistic analysis showed that those who could not afford FFV, had difficulty storing FFV, and who shared food with children or others had a lower propensity to consume FFV. Logistic analysis also showed that consumers who shopped frequently, shop specifically for FFV, ate plenty of FFV for health purposes, were food secure, or were able to travel a further distance to shop at suburban supermarkets had a higher propensity to consume FFV.

This study highlights the fact that consumers traveled to grocers specifically to purchase FFV, which indicates that there is (latent) demand for FFV in this food desert even though income and affordability are barriers to the consumption of FFV.

Implications for Policy Makers

The affordability barrier can be addressed in two ways: a) incentivize and encourage low cost healthy food providers to locate in food desert areas through tax incentives, low cost loans, distribution of free refrigerated cases, or other public support to retail outlets (this also addresses the access barrier); and b) provide year-round targeted subsidies to the consumers to increase their consumption of healthy foods. One such example, is the Double-Up Food Bucks[4] program that currently operates only a few months out of the year in Michigan. This program is essentially a voucher program that doubles the value of a dollar up to $20 when applied to purchasing Michigan produce.

The other potential barrier is the food desert residents' lack of knowledge about what comprises a healthy diet. Even if healthy food retailers were present, there would be no guarantee that consumption would increase dramatically in this area. The goal of the Expanded Food and Nutrition Education Program and Supplemental Nutrition Assistance Program-education programs is to teach families how to make economical healthy food choices. These programs may need to be tailored more specifically to this population given the challenges they face in attaining and storing healthy foods. In addition, these programs are not located in every county of the state and the approach to recruiting participants may also need to be adjusted to increase the reach of the programs.

[4] http://www.doubleupfoodbucks.org

Implications for Retailers

Rethinking food supply chains in food deserts may improve how nutritious foods are provided to low income, urban households. This process must account for the improvement of the supply of affordable, healthy foods as well as provide profits for all the supply chain participants in order to be successful. Current food supply chain structures in food deserts are not effective in ensuring sufficient access, nor are the food delivery mechanisms conducive to sustainable practices. Our results show that there is demand for FFV and that consumers' ability to shop frequently increases the probability of FFV consumption.

There are undoubtedly deterrents to FFV purchases outside the control of food retailers. Detroit provides a unique retail environment where inner-city consumers have not had adequate access to fresh and affordable products for decades. Innovative entry and maintenance strategies are needed to make retailers viable in this setting.

One potentially viable strategy would be to create more accessible "one-stop shopping" retail outlets with inexpensive, but quality fresh products for these low income consumers. Capitalizing on SNAP (EBT) transactions as well as unique programs like the Double-Up Food Bucks Program can drive foot traffic to a store. An example of innovative retailing is ShopRite in Philadelphia which has attracted urban food desert consumers to their stores by building stores within food deserts, offering banking services to the previously unbanked, and housing health clinics within the store, where consumers can get nutrition and other health counseling.

Retailers may also consider partnering with local Land Grant University Extension educators to facilitate healthy eating behavior change. Using social and other marketing strategies to enable food desert consumers to recognize the health benefits of consuming more FFV while making purchasing decisions, may aid in increasing consumption rates and could drive profits. This would be especially pertinent when children are in the home, based on this analysis. With income playing a major role in the types of food that make up the diets of food desert consumers, retail pricing and product mix strategies are paramount.

What requires more research is how to increase the frequency of shopping trips per household. The average trips per month are dramatically different from the national average. The timing of the shopping trips for this group may be associated with when their electronics SNAP benefits card has available funds. This could create a flood-drought cycle of customers and make it difficult to manage the perishable food supply chain.

This study also found that lack of food storage and appropriate facilities to prepare food were major constraints for those surveyed. Forty-eight percent of respondents in this study indicated that FFV were difficult to store/prepare at home. These factors were shown to be significant factors in the decision process of customers to purchase FFV or not. We speculate that the types of FFV consumed/purchased are heavily influenced by these same constraints. Understanding this constraint may influence retailers' marketing strategies for the various types of FFV based on storability. Hence, loss leader promotions may be totally different in these types of market areas versus in the suburbs. Using a community-based participatory approach will likely maximize the probability of success.

Given the barriers that these consumers face in purchasing fresh, healthy food products, retail strategies must be developed to entice consumers away from their normal eating habits of calorie dense products, which typically do not provide a healthy lifestyle. Improved access is the first step in this process. The market size calculations suggest that a full service supermarket could be supported in the Piety Hill area if FFV of good quality and at reasonable prices were available to consumers, particularly since 50% of the respondents did not like their local grocer and traveled on average 2.55 miles to what they considered their primary food retailer.

Limitations

This study has several limitations that should be noted. The primary survey instrument was based on recall, introducing a possible source of error. Another limiting factor is that while the study area has similar demographic characteristics to much of inner-city Detroit, cross-neighborhood comparisons in Detroit were not directly accounted for. Therefore, generalizations or predictions for the City of Detroit as a whole as well as other food deserts in the U.S. are limited.

References

Adelaja, S.,Y. Hailu and A. Gibson. 2009. *The Economic Impacts of County Population Change in Michigan*. Land Policy Institute. Michigan State University.

Bazzano, L.A. et al. 2008. Intake of fruit, vegetables, and fruit juices and risk of diabetes in women. Diabetes Care 31(7): 1311-1317.

Bitler, M. and S.J. Haider. 2010. An Economic View of Food Deserts in the United States. *Journal of Policy Analysis and Management* 30(1):153-176.

Braveman, P. and C. Barclay. 2009. Health disparities beginning in childhood: a life-course perspective. *Pediatrics* 124(Supplement 3): S163-S175.

Casagrande, S.S. et al. 2007. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *American Journal of Preventive Medicine* 32(4): 257-263.

Cassady, D., K.M. Jetter and J. Culp. 2007. Is price a barrier to eating more fruits and vegetables for low-income families? *Journal of the American Dietetic Association* 107(11): 1909-1915.

Centers for Disease Control. 2009a. Study Estimates Cost of Obesity May be as High as $147 Billion Annually. (accessed July 12, 2013). http://www.cdc.gov/media/pressrel/2009/r090727.htm.

Centers for Disease Control. (2009b). SMART: BRFSS City and County Data.(accessed October 15, 2013). http://apps.nccd.cdc.gov/BRFSS-SMART/.

Centers for Disease Control, National Health and Nutrition Examination Survey. (accessed November 13, 2013). http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm.

Chen, S., R. Florax, S.D. Snyder. 2009. Obesity in urban Food Markets: Evidence from Georeferenced Micro Data presented atAgricultural and Applied Economics Association Annual Meeting. July. Milwaukee, Wisconsin.

Cummins, S. and S. Macintyre. 2006. Food environments and obesity - neighbourhood or nation? I*nternational Journal of Epidemiology* 35(1):100-104.

Data Driven Detroit. 2013. (accessed November 14, 2013) www.datadrivendetroit.org

Dean, W.R. and J.R. Sharkey. 2011. Food insecurity, social capital and perceived personal disparity in a predominantly rural region of Texas: an individual-level analysis. *Social Science & Medicine* 72(9): 1454-1462.

Dibsdall, L.A. et al. 2003. Low-income consumers' attitudes and behaviour towards access, availability and motivation to eat fruit and vegetables. *Public Health Nutrition* 6(2):159-68.

Diez-Roux, A.V., B.G. Link and M.E. Northridge. 2000. A multilevel analysis of income inequality and cardiovascular disease risk factors. *Social Science & Medicine* 50(5): 673-687.

Double up Food Bucks Program. (accessed November 14, 2013). http://www.doubleupfoodbucks.org

ERS Food Access Research Atlas. (accessed November 1, 2013). http://www.ers.usda.gov/data-products/food-accessresearch-atlas.aspx.

Flegal, K.M. et al. 2010. Prevalence and Trends in Obesity Among US Adults, 1999-2008. *Jama-Journal of the American Medical Association* 303(3): 235-241.

Food Marketing Institute. 2012 . Supermarket Facts 2012. (accessed November 15, 2013) http://www.fmi.org/research-resources/supermarket-facts

Ford, E.S. and A.H. Mokdad. 2001. Fruit and vegetable consumption and diabetes mellitus incidence among US adults. *Preventive Medicine* 32(1):33-39.

Freedman, D.S. et al. 1999. The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa heart study. *Pediatrics* 103(6):1175-1182.

Gallagher, M. 2007. *Examining the Impact of Food Deserts on Public Health in Detroit*. Mari Gallagher Research & Consulting Group: Chicago. http://www.marigallagher.com/projects/

Gallagher, M. 2009. *Chicago 2009 Food Desert Progress Report*. Mari Gallagher Research and Consulting Group. http://www.marigallagher.com/projects/

Glenny, A.M. et al. 1997. The treatment and prevention of obesity: A systematic review of the literature. *International Journal of Obesity*.21(9):715-737.

Havas, S. et al. 1998. Factors associated with fruit and vegetable consumption among women participating in WIC. *Journal of the American Dietetic Association* 98(10): 1141-1148.

He, K. et al. 2004. Changes in intake of fruits and vegetables in relation to risk of obesity and weight gain among middle-aged women. *International Journal of Obesity* 28(12): 1569-1574.

Hendrickson, D., C. Smith and N. Eikenberry. 2006. Fruit and vegetable access in four low-income food deserts communities in Minnesota. *Agriculture and Human Values* 23(3): 371-383.

Hosler, A.S. et al. 2008. Assessing retail fruit and vegetable availability in urban and rural underserved communities. *Preventing Chronic Disease* 5(4):A123.

Inagami, S. et al. 2006.You are where you shop: grocery store locations, weight, and neighborhoods. *American Journal of Preventive Medicine* 31(1): 10-17.

Isidore, C. *Michigan's Economic Woes on the Ballot*. 2008. CNN Money. (accessed November 12, 2010). http://money.cnn.com/2008/01/15/news/economy/michigan_ economy_election/index.htm.

Kitzmann, K.M. and B.M. Beech. 2006. Family-based interventions for pediatric obesity: methodological and conceptual challenges from family psychology. *Journal of Family Psychology* 20(2):175-89.

Kliff, S. 2012 Will Philadelphia's experiment in eradicating 'food deserts' work? The Washington Post (Blog), June 8. http://www.washingtonpost.com/blogs/wonkblog/post/will-philadelphias-experiment-in-eradicating-food-deserts-work/2012/06/08/gJQAU9snNV_blog.html.

Laraia, B.A. et al. 2004. Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Preventive Medicine* 39(5): 869-875.

Lavin, M. 2005. Supermarket access and consumer well-being. *International Journal of Retail & Distribution Management.* 33(5): 388-398.

Lewis, L.B. et al. 2005. African Americans' access to healthy food options in South Los Angeles restaurants. *American Journal of Public Health* 95(4): 668-73.

Mobley, L.R. et al. 2006. Environment, obesity, and cardiovascular disease risk in low-income women. *American Journal of Preventive Medicine* 30(4): 327-332.

Moore, L.V. and A.V.D. Roux. 2006 Associations of neighborhood characteristics with the location and type of food stores. *American Journal of Public Health* 96(2): 325-331.

Morland, K., et al. 2002. Neighborhood characteristics associated with the location of food stores and food service places. *American Journal of Preventive Medicine* 22(1): 23-29.

Palloni, A. 2006. Reproducing inequalities: Luck, wallets, and the enduring effects of childhood health. *Demography* 43(4):587-615.

Pearson, T. et al. 2005. Do 'food deserts' influence fruit and vegetable consumption? - a cross-sectional study. *Appetite* 45(2): 195-197.

Powell, L.M. et al. 2007a. Access to fast food and food prices: relationship with fruit and vegetable consumption and overweight among adolescents. *Advances in Health Economics and Health Services Research* 17: 23-48.

Powell, L.M. et al. 2007b. Food store availability and neighborhood characteristics in the United States. *Preventive Medicine* 44(3):189-195.

Raja, S., C.X. Ma, and P. Yadav. 2008. Beyond food deserts - Measuring and mapping racial disparities in neighborhood food environments. *Journal of Planning Education and Research* 27(4): 469-482.

Rose, D. and R. Richards. 2004. Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. *Public Health Nutrition* **7**(8):1081-1088.

Rose, D. et. al. 2009. Deserts in New Orleans? Illustrations of Urban Food Access and Implications for Policy. University of Michigan National Poverty Center /USDA Economic Research Service Research, Understanding the Economic Concepts and Characteristics of Food Access Conference. Washington, D.C. http://www.npc.umich.edu/news/events/food-access/rose_et_al.pdf.

Ruiz, R. 2007 America's Most Obese Cities. Forbes. (accessed August 12, 2010). http://www.forbes.com/2007/11/14/health-obesity-cities-forbeslife-cx_rr_1114obese.html.

Seelos, C. and J. Mair. 2007. Profitable business models and market creation in the context of deep poverty: A strategic view. *Academy of Management Perspectives* 21(4): 49-63.

Short, A., J. Guthman and S. Raskin. 2007. Food deserts, oases, or mirages? Small markets and community food security in the San Francisco bay area. *Journal of Planning Education and Research* 26(3): 352-364.

Social Compact Inc. *Detroit Grocery Initiative Catalyzing Grocery Retail Investment in Inner-City Neighborhoods*. 2008. (accessed November 18, 2013). http://www.socialcompact.org/

Southeast Michigan Council of Governments. 2011. Southeast Michigan Community Foreclosures, 2010. (accessed November, 2013). http://library.semcog.org/InmagicGenie/DocumentFolder/ForeclosureQuickFacts2-22-11.pdf

Sunnucks, M. 2009. Phoenix, Detroit post worst job losses among large markets. *Phoenix Business Journal* (accessed November 10, 2010. http://www.bizjournals.com/phoenix/stories/2009/04/27/daily36.html.

U.S. Census Bureau. 2010. United States Census 2010. (accessed November 1, 2013). http://www.census.gov/2010census/

U.S. Department of Health and Human Services. 2001. The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity. Rockville, MD, Public Health Service, Office of the Surgeon General.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2010. *Dietary Guidelines for Americans.* 7th Edition, Washington, DC: U.S. Government Printing Office, December. http://www.cnpp.usda.gov/DGAs2010-PolicyDocument.htm

Weatherspoon, D. et al. 2013. Price and Expenditure Elasticities for Fresh Fruits in an Urban Food Desert. *Urban Studies* 50(1): 88-106.

Weatherspoon, D. et al. 2012. Will Long Term Food Desert Consumers Purchase Fresh Fruits and Vegetables? *Choices* 27(3):1-5.

Zenk, S.N. et al. 2005. Fruit and vegetable intake in African Americans - Income and store characteristics. *American Journal of Preventive Medicine* 29(1):1-9.

Zumbrun, J. 2008. America's Fastest-Dying Cities. *Forbes* (accessed November 12, 2010). http://www.forbes.com/2008/08/04/economy-ohio-michigan-biz_cx_jz_0805dying.html.

Appendix A.

Household Descriptive Statistics

Variable	Count (pct.)
Household Characteristics	
Eat plenty FFV for health (0-1) (n=161)	50 (31.1%)
Difficult storing FFV (0-1) (n=161)	77 (47.8%)
Number of people in household you share food with (n=131)	
1	22 (16.8%)
2	31 (23.7%)
3	24 (18.3%)
4	22 (16.8%)
5+	32 (24.4%)
Share food with children (0-1) (n=161)	110 (68.3%)
Frequency of grocery shopping (n=148)	4 (2.7%)
Never	34 (23.0%)
Once a month or less	61 (41.2%)
2 or 3 times a month	16 (10.8%)
Once a week	20 (13.5%)
2 or 3 times a week	9 (6.1%)
4 or 5 times a week	4 (2.7%)
Daily	
Frequency of shopping specifically for FFV (n=147)	
Never	12 (8.2%)
Only on special occasions	20 (13.6%)
Only on special sales	12 (8.2%)
Occasionally	43 (29.2%)
Usually	26 (17.7%)
Every time or almost every time I buy food	34 (23.1%)
Environmental Characteristics	
Safety concerns (0-1) (n=96)	1 (1.0%)
Problems with shopping at local store (0-1) (n=96)	48 (50.0%)
Transportation issues (0-1) (n=92)	27 (28.1%)
Food Access & Affordability	
Can't afford FFV (0-1) (n=161)	90 (55.9%)
Average earnings (n=69)	
Less than $8/hour	16 (23.2%)
At least $8/hour but less than $10/hour	13 (18.8%)
At least $10/hour but less than $13/hour	11 (15.9%)
At least $13/hour but less than $17/hour	8 (11.6%)
At least $17/hour but less than $25/hour	2 (2.9%)
$25/hour or more	4 (5.8%)
Other	15 (21.7%)

Household Descriptive Statistics
Food Access & Affordability-*Continued*

Variable	**Count (pct.)**
Income from all sources (n=112)	
Less than $250/month	16 (4.3%)
At least $250/month but less than $500/month	25 (22.3%)
At least $500/month but less than $750/month	29 (25.9%)
At least $750/month but less than $1000/month	8 (7.1%)
At least $1000/month but less than $1500/month	18 (16.1%)
At least $1500/month but less than $2000/month	5 (4.5%)
At least $2000/month but less than $3000/month	5 (4.5%)
$3000/month or more	6 (5.4%)
Use of emergency food options (n=156)	65 (41.7%)
Food security (n=146)	
Enough of the kinds of food we want to eat	80 (54.8%)
Enough but not always the kinds of food we want	43 (29.4%)
Sometimes not enough to eat	20 (13.7%)
Often not enough to eat	3 (2.0%)

	Mean	*Std. Dev.*	*Min.*	*Max.*
Distance to primary store in miles (n=114)	2.55	3.21	0.1	15.8

Appendix B.

Potential Market Size Calculation

1. Those without cars within a 1 mile radius and to the East of the John C Lodge Freeway Market Size without transportation = (frequency of FFV consumption rate from the survey, table 2) X East Side of the John C Lodge Freeway Population (census tracts 26163511400, 26163534300, 26163532300, 26163532400, 26163533900.
   27.6% X 9215 = 2543 people
   The total potential walking population is 2543.

2. Those with a car within a 1 mile radius and to the East of the John C Lodge Freeway Market Size With Transportation, East Side = (frequency of FFV consumption rate from the survey, table 2) X East Side of the John C Lodge Freeway Population (census tracts 26163511400, 26163534300, 26163532300, 26163532400, 26163533900) X Percent of the population who has transportation X the effect on those that now have a store closer to them (logistic regressions 3-5 Distance Variable, this parameter is squared because the Distance sample mean was 2.55 miles to the nearest supermarket and now the store would be within a half mile of this population).
   2543 X .5 X 1.22^2 = 1893
   2543 X .5 X 1.37^2 = 2387

The total additional population that has transportation on the East side is from 1551 to 1742 potential customers.

3. Those with a car within a mile radius and to the West of the John C Lodge Freeway
   The difference with this calculation is that we only consider those that have transportation for those that live West of the John C Lodge Freeway. This highway is a major barrier and would require the potential customer to walk to a cross road and then to the store.

4. Market Size With Transportation, West Side = (frequency of FFV consumption rate from the survey, table 2) X West Side of the John C Lodge Freeway Population (census tracts 26163532700, 26163532600, 26163531200) X Percent of the population who has transportation X the effect on those that now have a store closer to them (logistic regressions 3-5 Distance Variable, this parameter is squared because the Distance sample mean was 2.55 miles to the nearest supermarket and now the store would be within a half mile of this population).
   27.6% X 5537 X .5 X 1.22^2 = 1137
   27.6% X 5537 X .5 X 1.37^2 = 1434
   The total additional population that has transportation on the West side is from 1137 to customers.
   The potential market size for FFV in this food desert ranges from 5573 to 6364 for customers that will consume vegetables 5 or more times per week.

Appendix C.

One Mile Radius Piety Hill Market Size with Census Tracts