The Impact of Food Deserts on Food Insufficiency and SNAP Participation among the Elderly

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Abstract:

Residents of neighborhoods with limited access to grocery stores may face greater barriers to obtaining adequate food for a healthy diet than residents with better access. Low-income elderly may be uniquely affected by these so-called "food deserts" due to limited transportation options, strong attachments to local neighborhoods, fixed incomes, and physical limitations in food shopping. Using 2006 and 2010 Health and Retirement Study (HRS) data linked to Census tract level measures of food deserts, this study measures whether living in a food desert affects food and material hardship, participation in food assistance programs, and food spending of elderly adults. In both cross-sectional and fixed effects regressions of elderly residents of urban counties, we find little evidence that living in a food desert affects these outcomes. We do, however, find that individuals that live in a food desert and do not own a vehicle are 12 percentage points more likely to report food insufficiency. Our findings suggest that seniors without vehicles in food deserts may be the most vulnerable to limited food store access.

The U.S. Department of Agriculture (USDA) estimates that in 2010 more than 18 million persons, including almost 5 million elderly, lived in a food desert: a low-income Census tract where a substantial number or share of residents had low levels of access to a grocery store (Economic Research Service (ERS), 2013). A growing number of policy efforts seek to reduce the population with limited food access. One motivation underlying these efforts is that limited access to nutritious food choices is thought to be related to poor health and economic well-being.

In addition to reduced food access due to distance, the food choices made by food desert residents may be limited further by food prices and travel costs. Because supermarkets tend to have the lowest food prices (Hausman and Leibtag, 2007; Kaufman et al., 1997), residents of neighborhoods without supermarkets may face greater difficulty affording adequate food due to higher food prices in the smaller stores nearby. Some food desert residents may overcome obstacles to healthy and/or less expensive food choices by traveling farther to reach healthier options at lower average prices. Traveling to other neighborhoods, however, increases the travel and time costs of food acquisition. As a result, living in a food desert may not only affect diet quality, but also the risk of food hardship, household budget tradeoffs, and the need for food assistance programs.

Elderly residents of food deserts may be particularly susceptible to the detrimental effects of food deserts. Strong neighborhood attachments may make the elderly more likely than other demographic groups to remain in a neighborhood after food retailers leave and a changing food environment may pose a particular hardship. With restrictions in driving, walking, and/or using

public transit, some elderly may experience extremely high travel costs to access the stores outside of their immediate neighborhood.[1] Higher food prices and travel costs, in combination with fixed incomes, could result in the elderly acutely experiencing food access limitations that result in food insufficiency.

This food hardship may not be adequately addressed by the Supplemental Nutrition Assistance Program (SNAP), the primary nutritional assistance program to address food insufficiency, because the additional income from SNAP benefits may be offset by higher food prices and/or greater travel costs. If true, limited access to food retailers may be one explanation for low SNAP take-up rates among the eligible elderly – 35.1 percent of eligible elderly individuals participate in SNAP, compared to 75.6 percent of eligible non-elderly adults – and increased reliance on subsidized meal programs, such as the Meals-on-Wheels program (Eslami et al. 2012).

Understanding the effects of food deserts on well-being is of substantial policy importance. Across all levels of government, policies to improve food access range from new supermarket development to mobile fruit and vegetable retailers.[2] In FY2013, the federal government devoted roughly $314 million to improve food access and support healthy food retail development through existing programs to spur community development.[3] This effort was formalized in the Agricultural Act of 2014 (the 2014 Farm Bill) as the Healthy Food Finance Initiative, which authorized $125 million in funding to improve access to nutritious food. State and local governments also allocated resources toward improving food access in underserved

communities. As these policies evolve, it is important to ensure they are well-targeted and meet the goal of improving the diet and food adequacy of low-income consumers.

A better understanding of food hardship and use of food assistance among the large and growing elderly population is also important for improving food policy, including the $74 billion spent in FY2012 on SNAP benefits. Elderly individuals are less likely to participate in SNAP than other demographic groups, despite fixed incomes and more generous program rules that should increase the use of food assistance. For example, in FY2012, only 9.0 percent of SNAP participants were elderly (age 60 or over) and 7.7 percent of benefits were claimed by elderly individuals (USDA 2014). While the elderly tend to have lower food insecurity rates than other populations, between 2001 and 2005, 11.4% of the elderly faced some type of food insecurity Ziliak et al. 2008. Even more striking, however, the number of elderly at-risk for hunger grew 88% between 2001 and 2011 (Ziliak and Gundersen 2013).

With the recent Great Recession reducing the wealth and employment prospects of many people at or near retirement, food hardship and need for food assistance will likely increase. If food access limitations are related to food insufficiency or encourage older Americans to shift from entitlement programs like SNAP to non-entitlement programs such as subsidized meals, those at-risk for hunger will be more vulnerable to both the Congressional budget process and the ability of non-profit food providers to meet their needs.

In this paper, we utilize the 2006 and 2010 waves of restricted-use Health and Retirement Study (HRS) data to document the relationship between food store access and food insufficiency,

household budget tradeoffs, food assistance participation, and food spending for a sample of low-income elderly adults living in urban census tracts. To preview our findings, we find little evidence that food deserts are associated with food or material hardship or receipt of food assistance programs. However, for those that don't own a vehicle, we find a strong effect of living in a food desert on food insufficiency—those living in food deserts that do not own a vehicle were 12 percentage points more likely to report food insufficiency than otherwise similar food desert residents that owned a vehicle. Individuals living in food deserts without a vehicle were 8 percentage points more likely to skip a meal due to lack of financial resources, but, this was imprecisely estimated. Our results suggest that elderly food desert residents who lack a personal vehicle may be particularly susceptible to poor food access and reducing food hardship may require greater attention to transportation needs.

We make several contributions to the growing literature on the effect of food deserts. To our knowledge, we are the first to examine the effects of food deserts on the elderly and among the first to address the relationship between food deserts and food sufficiency. We also provide the first examination of both 2006 and 2010 food desert data, which allows us to exploit longitudinal data on both individuals and their food environments to examine changes in the food environment over time. In doing so, we are able to overcome a notable shortcoming of prior work by controlling for a key individual-level (as opposed to a neighborhood-level) indicator of access—whether the household faces transportation difficulties. Thus, our results can be used to understand not only the mechanisms through which limited food access affects food acquisition, receipt of food assistance programs, and budget crowd out, but also how the elderly may be uniquely affected by food deserts.

The remainder of the paper proceeds as follows: the next section discusses the conceptual mechanisms through which food access limitations affect food insufficiency and participation in food assistance programs, as well as summarizes the literature on these topics. Then, the data and methodology used in the study are explained, the results are summarized and conclusions are discussed.

Conceptual Framework and Previous Literature

The literature on food deserts and, more generally, the food environment primarily examines the purchase and consumption decisions of so-called "healthy food", such as fruits and vegetables, and diet-related health outcomes, including diet quality and body weight. The food environment and food deserts are hypothesized to affect these outcomes because they affect availability, prices, and nutritional composition of the baskets of food available to households. The literature has paid little attention to other outcomes that could be related to the food environment, including food sufficiency and use of food assistance.[4]

Food sufficiency and use of food assistance use are important for understanding how food deserts affect well-being. Previous work finds that food insufficiency and food insecurity, the official measure of food hardship in the U.S., have negative consequences for individuals. Inadequate food and the coping mechanisms individuals adopt, such as consumption of food with little nutritional value, reduce health (Gundersen and Ribar 2011). Among the elderly, food insecurity reduces nutrient intake (Bhattacharya et al. 2003; Lee and Frongillo, 2001; Ziliak et al., 2008), lowers body mass index (BMI) (Bhattacharya et al. 2004), results in fair or

poor health (Lee and Frongillo, 2001; Ziliak et al., 2008), and is associated with limitations in Activities of Daily Living (ADLs) (Ziliak et al. 2008).[5]

The food assistance safety net, including SNAP, exists to reduce the prevalence of food insecurity and poor diet and nutrition. The best evidence that takes into account the self-selection of who participates in SNAP suggests that SNAP reduces food insecurity (Caswell and Yaktine 2013; Gundersen and Oliveira 2001; Nord, 2013; Nord and Prell, 2011; Wilde and Nord 2005, Ratcliffe et al., 2011; Yen et al. 2008). Still, the effectiveness of SNAP in reducing food insecurity and food insufficiency likely depends on the accessibility of retailers where participants can redeem benefits.[6] Additionally, food insecurity is not solely a result of low income (DeMarco and Thorburn, 2009; Gundersen and Ribar 2011; Mammen et al. 2009; Ziliak et al. 2008; Ziliak and Gundersen, 2009). More than half of elderly with incomes above poverty experienced some problem obtaining adequate resources for food and these problems are correlated with age, race, living arrangements, education, and geography (Ziliak et al. 2008).

Food prices are one channel through which the food environment could affect food hardship. Most previous research on how the food environment affects food prices focuses on the cost of different food items, especially fruits and vegetables, or the cost of a basket of foods in neighborhoods that differ by store access, store type, income, and race/ethnicity. There is good evidence that supermarkets and supercenters offer more variety and lower prices than other types of stores but mixed evidence on how food prices vary across different stores and neighborhoods and across subpopulations of interest (Broda et al., 2009; Cassady et al., 2007; Chung and Myers,

1999; Hayes, 2000; Hausman and Leibtag, 2007; Hendrickson et al., 2006; Kaufman et al., 2007).[7] Thus, holding income constant, greater access to a full service retailer like a supermarket may allow households to purchase a larger quantity of food and, therefore, may be less susceptible to food hardship.

Higher food prices could affect food security and food sufficiency, but previous work has only looked at geographic areas much larger than the neighborhood. At the county level, Bonnano and Li (2012) find that food security is negatively correlated with the number of medium and large grocery stores per capita, as well as the number of smaller food stores per capita. Gregory and Coleman-Jensen (2013) find that variation in food prices across regions of the U.S. affect the prevalence of food security among SNAP recipients. Other costs, however, may also be important – for example, budget tradeoffs such as those faced by low-income households facing high heating or cooling costs, result in reduced caloric intake and increased risk of food insecurity (Bhattacharya et al. 2003; Nord and Kantor 2006). Thus, if food prices are higher in food deserts, it could increase food insufficiency and/or crowd out expenditures on other household necessities.

In addition to the price of food items, individuals also face time and travel costs with food acquisition. If food prices are higher inside than outside of food deserts, savvy consumers may travel to access lower prices outside their neighborhood and purchase greater quantities of food (or a greater variety or quality). For example, the Community Development Financial Institutions Fund (CDFI Fund) estimates that residents of areas with limited supermarket access spend, on average, $1,120 annually on food products outside their neighborhood (CDFI Fund 2012). Broda

et al. (2009) found that consumers with low income (between $8,000-$30,000 per year) pay the lowest prices for the same grocery items, while consumers with very low incomes (less than $8,000) pay 0.5 to 1.3 percent more. Those with the highest incomes pay the most. While only suggestive, Broda et al. (2009) indicates that some lower income consumers can access lower price food retailers, but the poorest may not be able to access stores with the lowest prices.

One reason that some do not access stores with the lowest prices is that travel to lower costs stores can be costly. Using 2007 data from New Orleans, Rose et al. (2009) estimate the difference in the combined travel and time costs to the nearest supermarket for those in Census tracts with poor supermarket access and those with good supermarket access. Estimated differences in travel and time costs range from just over $5 to almost $60 depending on the travel mode for each trip. These costs are not trivial and could reduce resources available for food, and thus, may force tradeoffs that may increase food hardship. Feather (2003) calculates that improving store access for SNAP recipients would create welfare gains ranging from $500 million to $1 billion.

The food environment may also affect the decision to participate in food assistance programs, particularly SNAP and subsidized meals programs like Meals-on-Wheels. A lack of affordable retailers where benefits can be redeemed makes the program less attractive to potential participants and may encourage residents to rely on subsidized meal programs.[8] High prices at neighborhood retailers decrease the purchasing power of SNAP benefits, and, possibly, hinder its ability to reduce food insufficiency. On the other hand, SNAP benefits could be used to free

up other household resources to make travel to stores that are farther away more feasible (Andrews et al., 2013).

An extensive literature examines factors influencing SNAP participation (Blank and Ruggles, 1996; Cody et al., 2007; Dickert-Conlin et al., 2011; Klerman and Danielson, 2011; Ratcliffe et al. 2011), but few studies focus on participation among the elderly or examine proximity to SNAP retailers. Studies that do consider the elderly suggest that the lower SNAP participation rates are due to lack of awareness about eligibility, (Daponte et al., 1999; Hollonbeck and Ohls, 1984; Wolfe et al., 1996; Wu, 2009), stigma (Gabor et al. 2002), low benefit levels (Gabor et al. 2002; Wu, 2009), and crowd-out from other nutritional assistance programs like subsidized meals (Wu, 2009). The elderly may also face higher costs in navigating the application process (Wilde and Dagata, 2002; Heflin and Mueser, 2010) or have less need for the program (Haider et al. 2003).[9]

Data and Methodology

We use restricted-use data from the 2006 and 2010 Health and Retirement Study (HRS). The HRS is a longitudinal survey that began in 1992 and collects data on more than 20,000 Americans over age 50 every two years. The richness of the HRS data allows us to explore a number of outcomes that could be affected by food deserts, including food insufficiency, budget crowd-out, receipt of food assistance programs, and food spending.[10] The panel aspect of the data also allows us to examine how these outcomes relate to changes in the food desert status of our sample.

Measuring the Food Environment

Several national level measures of limited food access have been developed to assist with targeting policy interventions (The Reinvestment Fund, 2012; Centers for Disease Control and Prevention, 2009 and 2011; ERS 2011 and 2013).[11] We use the food desert measure developed in 2011 by the Economic Research Service (ERS) in support of the proposed HFFI, and updated in 2013. In 2011, ERS merged 2006 food retailer data to 2000 Census tract definitions and 2000 Census income data to classify Census tracts as food deserts if they were both low-income and contained a significant number or share of residents who live far – one mile in urban areas and 10 miles in rural areas – from a supermarket (ERS, 2013).[12]

Over 6,500 Census tracts (9.6 percent of all tracts) containing 13.6 million individuals with limited access were classified as food deserts in 2006. The 2013 updated measure used 2010 food retailer data, 2010 Census tract definitions, 2010 Decennial Census data, and 2006-2010 American Community Survey data. This updated measure estimated that 8,959 Census tracts (12.3 percent of all Census tracts) were food deserts in 2010, containing more than 18 million individuals with limited access to supermarkets (ERS, 2013).

Figures 1 and 2 provide maps to show an example of our food desert measure for Dallas County, Texas in 2006 (figure 1) and 2010 (figure 2).[13] In figure 1, food desert Census tracts are shaded in pink while 2010 food desert tracts are shaded in green.[14] The number of food desert Census tracts in Dallas County increased between 2006 and 2010, a trend that is consistent with the national-level estimates. A large portion of this increase may be due to

declines in income in most areas between 2000 and 2010 arising from the Great Recession. Comparing figure 1 and figure 2, some parts of the county were food deserts in both years, but other tracts experienced change, as supermarkets closed or opened.

Methods

We choose the 2006 and 2010 waves of the HRS to match the 2006 and 2010 food desert data provided by ERS. For each wave, we select respondents who are age 60 and older, the definition of elderly in SNAP. We also limit our sample to respondents with household income at or below 200% of the Federal poverty line in the wave prior to our sample period (2004 for the 2006 sample and 2008 for the 2010 sample). This sample selection is to ensure that we have individuals that are most likely to be both SNAP eligible and at-risk for food insufficiency. It also allows us to focus on those more likely to live in Census tracts that would meet the income criteria to be considered a food desert. We expect these individuals may face greater food access barriers, compared to individuals at higher income levels.

We further restrict our samples to those living in urban areas to use a common definition of a food desert – populations living more than 1 mile from a supermarket. This captures many of those with limited food access, as almost 82 percent of those living in food deserts in 2006 were in urban areas and about 88 percent of those living in food deserts were in urban areas in 2010.

To measure how residing in a food deserts affects the various outcomes of interest, we estimate the following equation:

$$1) \quad Outcome_{ics} = \alpha + \beta_1 FoodDesert_c + \beta_2 NoVehicle_i + \beta_3 Indiv_i + \beta_4 CensusTract_c + \delta_s + \varepsilon_{ics}$$

where *i*, *c*, and *t* index household, Census tract, and time respectively. *Outcome* is one of the outcomes of interest and *FoodDesert* is the dichotomous variable of interest that indicates that the household is observed to live in an area the USDA designates as a food desert in the relevant year. The variable *NoVehicle* reflects households that do not report owning a vehicle in the relevant year. While vehicle ownership may potentially be endogenous to household preferences and residential location, it best captures additional limitations households face in accessing food due to lack of transportation.

The outcomes we consider relate to food and material hardship the respondent reports having experienced at any time since the last interview (roughly two years): food insufficiency, skipped meals, and skipped prescription drugs. Each of these measures is based on the respondent reporting that the primary reason for their behavior was a lack of financial resources. Food insufficiency is measured by the respondent reporting that anyone in the household was unable to purchase enough food due to lack of financial resources. Skipped meals and skipped prescription drugs each reflect that the respondent reports that anyone in the household skipped meals and skipped purchasing prescription drugs, respectively, due to lack of financial resources.

We also measure receipt of two food assistance programs: SNAP and subsidized meals. Our hypothesis is that residing in a food desert has an ambiguous effect on SNAP receipt while subsidized meal receipt may reflect both lack of financial resources and lack of access to food retailers. Finally, we examine the natural logarithm of the household's weekly food spending to

determine if those in food deserts spend more to meet their food needs. For weekly food spending, we total the amount spent on food consumed at home each week, the amount spent on food delivered, and the amount spent on food eaten away from home.

We control for other factors that may be related to either the food desert status of the Census tract or the outcomes of interest, including the respondent's characteristics and the characteristics of the local economic environment. The matrix *Indiv* contains the demographic and economic characteristics of the respondent and the household: respondent's gender, marital status, age, age squared, race, number of children ever had, employment status, whether the employment requires physical exertion, and whether the respondent has at least some college education; the real income (in thousands of dollars) of the household and the size of the household. We also include a proxy for whether the respondent has a child living within 10 miles to control for the potential assistance a family member may provide in accessing food and transportation.

The matrix *CensusTract* controls for characteristics of the local economic environment, including county unemployment rate, portion of the Census tract composed of non-whites, and Census tract poverty rate for senior households (age 65 and over). We also include the housing price index of the metropolitan statistical area (MSA) from the Federal Housing Finance Agency to control for housing prices (and likely rents). When comparing across time, the housing price index will also control for local trends in housing prices that are related to the severity of the Great Recession in each MSA. Finally, state fixed effects, δ, control for other time invariant characteristics of the state.

We estimate equation 1 in two ways. First, we use a cross-sectional approach by estimating the model separately in 2006 and 2010 for all households that meet our sample selection criteria in the relevant year. We also create a balanced panel with individuals that meet our sample selection criteria in 2006 and are also observed in the HRS in 2010. This is our preferred approach. With the balanced panel, we can include individual fixed effects to identify the effect of food deserts off of changes in the food desert status of an individual's Census tract over time. All estimates are weighted by the appropriate HRS weight. In all models, we utilize robust standard errors and, for the household panel models, cluster standard errors at the individual level.

Our approach contributes to the literature by improving on the methodologies used in prior studies. The individual fixed effects control for key individual-level (as opposed to a neighborhood-level) indicators of food access. Our balanced panel model controls for time invariant food preferences and food habits that play an important role in food choices and dietary outcomes, as well as residential location decisions that may depend on unobservable preferences for local amenities such as grocery stores.[15] With individual fixed effects, we also control for any time invariant mobility or other limitations that create difficulties in food acquisition. Many previous studies fail to control for individual factors that may affect the level of food access, particularly car ownership which increases the set of available stores (see Ignami et al., 2009; Rose and Richards, 2004 for exceptions).

Results

Summary Statistics

Table 1 presents the summary statistics of our sample of low-income elderly urban residents in 2006 and 2010, by food desert status in column 1 through column 4. In both 2006 and 2010, elderly residents of food deserts were less likely to be white and slightly younger than those who did not reside in a food desert. In both years, those in food deserts were less likely to have at least some college education than those who did not reside in food deserts (18.8% compared with 24.1% in 2006 and 19.9% compared with 31.2% in 2010). Food desert residents also had lower annual household incomes than those who did not reside in a food desert (a difference of approximately $4,000 and $6,000 in 2006 and 2010, respectively). These differences are fairly large considering we have limited our sample to households at or below 200% of the poverty level in the prior wave and suggest the food desert residents have less income than those that do not live in a food desert. We also see increases in real household income between 2006 and 2010 for all samples. This increase can be explained by cost of living adjustments in Social Security between 2006 and 2010 which were greater than inflation.[16]

Elderly residents of food deserts live in Census tracts with a greater share of minorities and greater elderly poverty rates than those who were not in food deserts, although the difference in 2010 is much smaller than the difference in 2006. In addition, elderly residents of food deserts live in counties with slightly higher unemployment rates than those who do not live in food deserts. Food desert areas also had lower housing price index measures in both 2006 and 2010. These differences are expected because food deserts are, in part, defined by income. In 2006, elderly residents of food deserts were less likely to be married than those not in food deserts, while in 2010, those in food deserts were more likely to be females. Otherwise, there were small or no differences or between elderly residents of food deserts compared with those who did not

live in a food desert in terms of household size, the percentage that work, the percentage that do physical work, and the percentage that do not own a vehicle.

Finally, to provide a sense of the sample's functional and cognitive limitations by food desert status, we examine the Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) that the respondent is unable to accomplish independently by his or herself.[17] We find more functional limitations for those living in a food desert in 2006 compared to those not in a food desert in 2006. Overall, however, the percentage of sample members that cannot perform ADLs or IADLs independently does not change much from 2006 to 2010, which suggests that the disability status of our sample over the study time period is fairly stable.

In table 1, we also use the balanced panel to compare the observable characteristics of elderly individuals whose food desert status changed between 2006 and 2010 in columns 5 and 6. The food desert status of a neighborhood could change for several reasons, including one or more stores opening and/or closing, changes in the location of where people live relative to existing stores, and changes in the income of neighborhood residents.[18]

Column 5 of table 1 presents the characteristics of those living in Census tracts classified as food deserts in 2006 but not living in Census tracts classified as food deserts in 2010. In other words, these individuals experience improving access to food retailers between 2006 and 2010. For some characteristics, these individuals look better off than those who were in food deserts in 2010: they are more likely to be married, live in counties with lower unemployment rates and percent of seniors in poverty, have higher housing price indices reflecting better housing price

trends, and have better cognitive and functional status. However, they also have slightly lower vehicle ownership rates, live in Census tracts with greater shares of minorities, and have lower annual incomes than residents of food deserts in 2010. As only 4.25 percent of our balanced sample moved between 2006 and 2010, these changes likely reflect rapid changes in the conditions of Census tracts in which these respondents lived.

Column 6 of table 1 presents the characteristics of those experiencing declining access to food retailers: respondents living in a Census tract not classified as a food desert in 2006 but classified as food deserts by 2010. Residing in a tract that became a food desert is associated with lower levels of economic well-being than respondents who were not in a food desert in 2010. The exceptions to this are that residents of areas that became food deserts by 2010 are more likely to be white, live in Census tracts with a smaller share of minorities, have higher rates of vehicle ownership and are more likely to have a child within 10 miles. However, these households do tend to look better than all residents of food deserts in 2010, suggesting that, in general, these "new" food desert Census tracts may be areas that have seen a recent decline in socio-economic characteristics between 2006 and 2010, perhaps driven by the economic changes occurring from the Great Recession.

Descriptive statistics for the outcomes of interest are presented in table 2. Columns 1 through 4 provide these outcomes by food desert status in both 2006 and 2010. Residents of food deserts in 2006 report higher rates of food-related distress: almost 13 percent reported food insufficiency over the past 2 years and roughly 5 percent report skipping meals. Interestingly, in 2010, those in food deserts were almost equally likely to be food insufficient as those not in a food desert.

This may reflect the poor economy in 2010, compared to 2006, as food insufficiency rates in 2010 among all respondents were higher than the rates in 2006. The portion of the sample that skipped meals due to lack of resources increased slightly in 2010 for both those who lived in food deserts and those who did not. There were almost no differences in the portion of households that skipped a prescription due to lack of financial resources over the past 2 years between 2006 compared with 2010, nor were there differences across those in food deserts compared with those not in food deserts over either year.

In both 2006 and 2010, elderly food desert residents are more likely to report receipt of the food assistance programs we examine – SNAP and subsidized meals – than those not living in food deserts. In 2006, 17 percent of respondents living in food deserts report SNAP participation while in 2010, 21 percent of respondents living in food deserts participated. In contrast, in 2006, 11 percent of respondents not living in a food desert report receiving SNAP and in 2010, 14 percent did. Fewer households report receiving subsidized meals than report receiving SNAP but differences across food desert status are slight. In both 2006 and 2010, approximately 6 percent of households living in food deserts reported subsidized meal receipt. Among those who do not live in a food desert, roughly 5 percent report receiving subsidized meals.

In columns 5 and 6 of table 2, we compare these outcomes for those experiencing a change in the food environment between 2006 and 2010. Those in improving food environments (column 5) were less likely to be food insufficient, skip meals or prescriptions because of a lack of resources, and participate in SNAP than residents of food deserts in 2010 (column 3). In contrast, those in worsening food environments (column 6) were better off on average than the

overall 2010 sample in terms of food insufficiency, skipping meals, and skipping prescription drugs. Those experiencing worsening food environments were less likely to receive subsidized meals but more likely to receive SNAP than elderly residents of food deserts in 2010.

Food and Material Hardship

Table 3 presents the results from estimating equation 1. Column 1 and column 2 present cross-sectional estimates for the sample of households in 2006 and 2010, respectively. In both 2006 and 2010, residing in a food desert is not correlated with either food insufficiency or skipping meals due to lack of resources. For both outcomes, the point estimates are economically small and statistically insignificant. Likewise, residing in a food desert is not related to skipping prescription drugs due to financial resources in either year.

It is possible that the lack of correlation between living in a food desert and food or material hardship results from the cross-sectional approach where we cannot control for individual, time-invariant characteristics that lead to bias. We address this critique in column 3 of table 3 by using a fixed effects approach that exploits the variation in food deserts over time. Using this specification and our balanced sample of respondents, we find that living in a food desert remains uncorrelated with self-reported food insufficiency, skipping meals or skipping prescription drugs due to lack of resources. Point estimates for each outcome are negative and statistically insignificant. Overall, we find little evidence to support a relationship between living in a food desert and food or material hardship.

Food Assistance Receipt

We next estimate the relationship between living in a food desert and receiving food assistance. Estimates, in the middle panel of table 3, suggest no important relationship between residing in a food desert and receiving SNAP in the cross-sectional models (columns 1 and 2). The fixed effects model that exploits the variation in food desert status over time suggests a larger increase in SNAP receipt (3.7 percentage points) associated with a change in food desert status (e.g. for those who were not in a food desert in 2006 but were in 2010), although it is imprecisely measured (p-value=0.20).

We conclude that households that are not within close proximity to a supermarket or large grocery store are not significantly more or less likely to receive SNAP than those with better access, although a larger dataset might achieve more precise estimates. Thus, either the lack of easy access to a food retailer is not an impediment to SNAP take-up, or the lack of purchasing power of SNAP benefits exactly offsets the additional need for the program due to higher food prices.

Turning to receipt of subsidized meals, also in the middle panel of table 3, we do not find a relationship between food desert status and receipt of subsidized meals in the cross sectional estimates (columns 1 and 2). In contrast, our fixed effects specification suggests living in a food desert is associated with a statistically significant 4.1 percentage point decrease in the likelihood of subsidized meal receipt. Because food desert residents, by definition, live in areas with less access to full-service grocery retailers, this relationship for subsidized meals is somewhat surprising. One possible explanation is that those living in a food desert also have less access to

non-profit meal providers. This could be particularly true for those experiencing a worsening food environment between 2006 and 2010. These individuals may not seek assistance because they may be unfamiliar with social service agencies that provide subsidized meals. Additionally, as a result of the Great Recession, these social service agencies were overwhelmed with both increased need and declining financial support, perhaps making it difficult for agencies to reach all those who could potentially benefit from assistance.

Another explanation for the correlation between living in a food desert and a reduced likelihood of receiving subsidized meals could be that food desert residents do not experience difficulties in traveling to nearby food retailers because they own a vehicle. But, food desert residents that do not own a vehicle may face difficulties with food shopping. In 2006, the coefficient on not owning a vehicle – our proxy for transportation difficulties – suggests a positive and significant relationship with subsidized meal receipt. Similarly, in 2010, households lacking a vehicle were also more likely to report subsidized meal receipt. We will explore the relationship between vehicle ownership and food assistance receipt in more detail with additional specifications.

Food Spending

The final outcome considered in table 3 is food spending, measured as the natural log of weekly food spending (including spending on weekly delivered home meals and food away from home). While we do not include SNAP benefits in our food spending measure due to its endogeneity, we do include an indicator for whether the household received SNAP or subsidized meals. We find little correlation between living in a food desert and weekly food spending. In the 2006 and 2010 cross-sectional models (columns 1 and 2), the estimates are statistically insignificant and change

sign from negative in 2006 to positive in 2010. The panel estimate (column 3) is negative but does not approach conventional significance levels. Thus, we find little evidence that any increase in food prices in food deserts relates to greater food spending.

The effects of food deserts for those without a vehicle

Food deserts are only one indicator of the food access limitations that individuals within a neighborhood face. Two food desert residents may have very different levels of access if one is able to drive to a supermarket out of the neighborhood and the other is not because they do not have a car or cannot drive. We hypothesize that elderly food desert residents without a vehicle may be more adversely affected by the lack of a nearby supermarket than those who own a vehicle. This is especially true if those who do not own a vehicle face physical limitations in walking or taking public transit to the nearest food retailer.

Many of the models included in table 3 showed large and significant estimates of the coefficient for not owning a vehicle. These estimates provide suggestive evidence that not owning a vehicle (our measure of transportation difficulties) presents challenges for the elderly. Therefore, we estimate a modified version of equation 1 that interacts food desert status with vehicle ownership status to determine if there is an additional effect of living in a food desert for those elderly without a vehicle (tables 4a and 4b). We report results for each outcome of interest using a cross-sectional and a fixed effects approach. The results of these models can be used to understand the mechanisms through which limited food access affects food and material hardship, food assistance program receipt, and food spending.

We begin with food and material hardship outcomes in table 4a. Compared to respondents living in a food desert with a vehicle, those living in a food desert without a vehicle are more likely to experience food insufficiency. The interaction is positive but not statistically significant in the cross-sectional models (columns 1 and 2 of table 4a). In the fixed effects specification (column 3), respondents without a vehicle who live in a food desert are 12 percentage points more likely to be classified as food insufficient compared to food desert residents with a vehicle. The total effect of living in a food desert on the probability of food insufficiency is positive but not statistically significant (p-value = 0.52). Thus, only food desert residents without a vehicle are more likely to be at risk for food insufficiency.

In the second panel of table 4a, we present the results for skipping meals due to financial resources. In both the 2006 and 2010 cross-section, the point estimate on the interaction effect is positive, although only statistically significant in 2006 (column 1). The fixed effects model (column 3) suggests that elderly residents without a vehicle who live in a food desert are 9.6 percentage points more likely to skip meals due to financial resources compared to the residents of food deserts with a vehicle. This estimate, however, just misses conventional significance levels (p-value = 0.14). Meanwhile, the total effect of living in a food desert is not statistically significant (p-value=0.46). We interpret this as suggestive evidence that living in a food desert without a vehicle may be related to an increased likelihood of skipping meals.

The last outcome presented in table 4a is skipping prescription drugs due to financial resources. There is little evidence that living in a food desert, with or without a vehicle, is related to skipping prescription drugs due to financial resources. Point estimates for the interaction of

living in a food desert without owning a vehicle are positive in 2006 but negative in both 2010 and the fixed effects model. The total effect of living in a food desert on the probability of skipping prescriptions is not statistically significant in any model. Prescription drug coverage may explain the lack of relationship. Much of our sample benefited from the introduction of Medicare Part D in 2006 and approximately one quarter of our sample receives Medicaid, which provides prescription drug coverage. Moreover, food desert residents are slightly more likely to receive Medicaid than those that do not live in a food desert.

In table 4b, we investigate receipt of food assistance programs and food spending. While the estimate in the 2006 cross-section (column 1) suggests a 17.0 percentage point increase in the likelihood of receiving SNAP for residents of a food desert that do not own a vehicle compared to other residents of food deserts, the fixed effects estimate is small, opposite in sign, and insignificant (column 3). Because the fixed effects model better controls for unobservable characteristics associated with SNAP receipt, we conclude that the likelihood of SNAP receipt is not differentially affected by vehicle ownership for residents of food deserts. The total effect of living in a food desert in the fixed effects model also suggests no significant relationship for SNAP receipt (p-value=0.53).

The middle panel of table 4b examines subsidized meal receipt. We find no significant effect of living in a food desert without a vehicle. In all specifications, however, those without a vehicle (regardless of whether they live in a food desert or not) are more likely to receive subsidized meals. The fixed effects estimate, our preferred estimate, suggests that not owning a vehicle is associated with a 7 percentage point increase in the likely to receive subsidized meals (column 3

of the middle panel or 4b). The total effect of living in a food desert is not statistically significant in any specification. Thus, subsidized meal receipt appears more related to transportation difficulties than to limited geographic access to food retailers.

The final panel of table 4b presents the food spending outcome. These estimates provide little evidence that living in a food desert, with or without a vehicle, significantly affects food spending. In the 2006 cross-section (column 1), compared to other residents of food deserts, living in a food desert without a vehicle is related to a 20 percent increase in food spending. The total effect of living in a food desert suggests higher weekly food spending and just misses conventional significance levels (p-value=0.12). However, the estimates for the 2010 cross-section and the fixed effects model are statistically insignificant and opposite in sign. In sum, we conclude there is little evidence that food desert residents spend more on food, regardless if they own a vehicle.

The effects of food deserts and SNAP participation

SNAP recipients are likely to be those with the lowest incomes and greatest food needs and thus, may be the most vulnerable to food access barriers. In tables 5a and 5b, we explore the extent to which SNAP recipients in food deserts experience unique difficulties by interacting the food desert status indicator with an indicator for receiving SNAP. Overall, these estimates tend to be sensitive to the choice of year and the empirical specification. For example, estimates for 2006 show that SNAP participants in food deserts are more likely to skip meals due to lack of resources than those who do not receive SNAP and live outside of food deserts, but this result

does not hold in 2010 or in fixed effects estimates. In fact, the estimate switches sign between 2006 and 2010.

Due to the endogeneity of SNAP receipt, we focus on fixed effects results (column 3) because these specifications control for time invariant unobservable characteristics. In table 5a, fixed effects estimates with interactions between living in a food desert and SNAP receipt suggest that SNAP participants in food deserts are less likely to report food insufficiency and less likely to skip meals due to financial resources than non-participants in food deserts, but neither estimate is statistically significant. There is no economically meaningful or statistically significant effect on skipping prescriptions due to financial resources for SNAP participants, compared to non-participants. The total effect of living in a food desert is related to a decline in skipping prescription drugs due to financial resources ($p=0.10$), although again the effect is likely related to food desert residents more likely to be receiving Medicaid.

In table 5b, we present estimates for subsidized meal receipt and food spending. For food desert residents, food stamp receipt is related to a significant 10.9 percentage point increase in subsidized meal receipt. Thus, for SNAP recipients in food deserts, subsidized meal receipt complements their SNAP receipt while food desert residents who do not receive SNAP are less likely to receive subsidized meals. We find no effect on food spending for SNAP recipients relative to non-recipients. Overall, we find little firm evidence that food deserts significantly harm households receiving SNAP.

Conclusions

Our results show that transportation burdens among the elderly may be more important in determining food and material hardship, as well as participation in food assistance programs than whether a senior lives in a food desert. While we do find that elderly with transportation limitations who live in food deserts are 12 percentage points more likely to be classified as food insufficient than those with vehicles in food deserts, this is the only outcome in our fixed effects estimates for which food desert status mattered.

In fact, transportation difficulties may even play a larger role in food related hardship than measures of access to food retailers. While small sample size may limit strong conclusions and our findings are not causal, they have several policy implications for reducing food-related hardship among the elderly. First, it suggests that for the elderly, targeting those with transportation limitations in food deserts could make it easier for these elderly to achieve adequate amounts of nutritious foods. Such targeted policies could involve either providing the elderly transportation to food stores or policies that deliver food to elderly households that would otherwise not be able to access food retailers.

Second, our findings also suggest that subsidized meals participation is more likely among those who have transportation difficulties than those who do not, but that otherwise, subsidized meal participation is not affected by food desert status. This result could indicate that subsidized meal programs are closing the gap in food needs among elderly that lack an independent means of transportation. This relatively overlooked program in the food safety net may require additional attention and, with the growth in the elderly population, better support. Finally, we do not find strong evidence that SNAP participation is affected by food desert status. Our lack of

relationship could reflect the offsetting influences of higher prices and less SNAP purchasing power. More work may be needed to measure an effect.

More work is also needed to understand the causal links between food deserts, transportation, and food distress-related outcomes. This study only begins the examination of these relationships. Still, given the federal, state, and local resources to improve food access in some low-income communities that are currently in place, as well as those in the planning stages, it is important to know more about who is affected by food deserts and how they are affected, especially given the recently passed HFFI. In future work, we will explore whether food deserts affect the measured health of this population. The determinants of health and disease may be more complex and may have more to do with other factors such as genetics and longer-term behaviors, medical care, as well as environmental factors. There is a clear need to further investigate these relationships.

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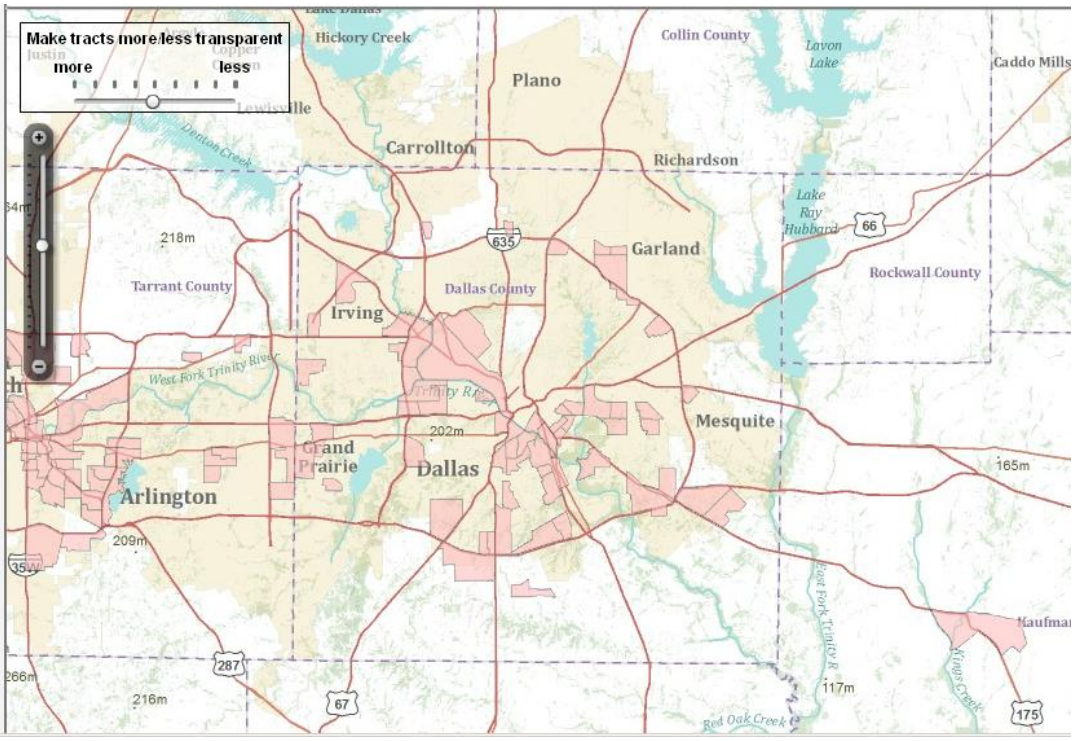
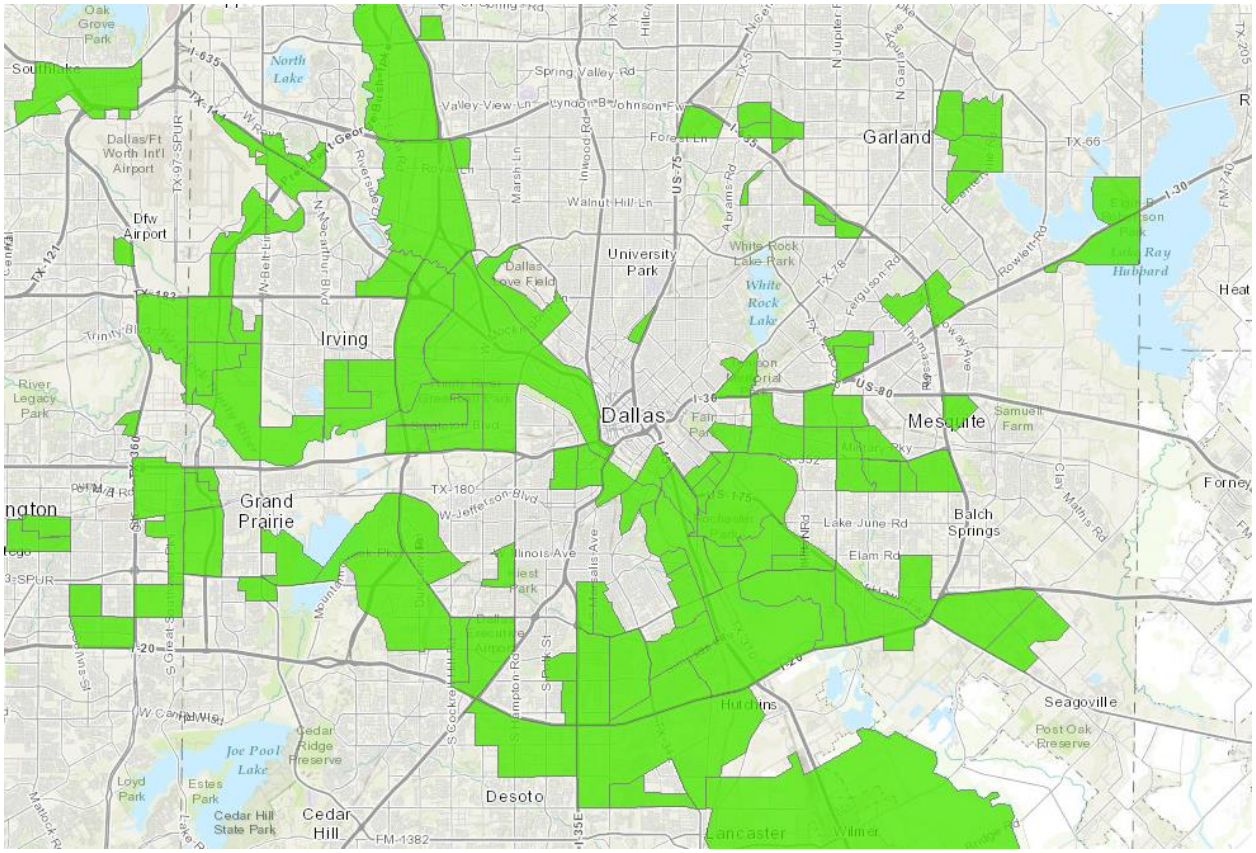
Figure 1. Food Deserts in the Dallas County, Texas, 2006



Note: Food desert Census tracts are shaded in pink. Food desert Census tracts based on ERS data that merges 2006 food retailer data and 2000 Census income data to 2000 Census tract definitions (ERS, 2013).

Figure 2. Food Deserts in Dallas County, Texas, 2010



Note: Food desert Census tracts are shown in green.Food desert Census tracts based on ERS data that merges 2010 food retailer data and 2006-2010 ACS income data to 2000 Census tract definitions (ERS, 2013).

Table 1. Summary Statistics, by Food Desert Status in 2006 and 2010

	2006		2010		Change Between 2006 and 2010	
	Food Desert	Not a Food Desert	Food Desert	Not a Food Desert	Food Desert 2006 Not a Food Desert 2010	Not a Food Desert 2006 Food Desert 2010
	(1)	(2)	(3)	(4)	(5)	(6)
White	0.644	0.789	0.683	0.746	0.634	0.798
	(0.480)	(0.408)	(0.466)	(0.435)	(0.485)	(0.403)
Number of Kids Ever Born	3.872	3.389	3.718	3.378	3.995	3.378
	(2.842)	(2.293)	(2.690)	(2.207)	(3.168)	(2.821)
Female Respondent	0.682	0.680	0.611	0.662	0.729	0.632
	(0.467)	(0.467)	(0.488)	(0.473)	(0.447)	(0.484)
Married	0.317	0.370	0.400	0.384	0.424	0.402
	(0.466)	(0.483)	(0.491)	(0.487)	(0.497)	(0.492)
Age	72.854	73.665	71.464	73.731	73.317	75.877
	(9.004)	(9.472)	(9.153)	(9.474)	(8.129)	(9.115)
Number of persons in Household	2.355	2.371	2.414	2.405	2.496	2.396
	(1.530)	(1.505)	(1.621)	(1.619)	(1.606)	(1.814)
Household Respondent: Some College	0.188	0.241	0.199	0.312	0.239	0.159
	(0.391)	(0.428)	(0.400)	(0.463)	(0.429)	(0.367)
Annual Income, in 2010 Dollars (in thousands)	18.767	22.480	21.083	27.269	20.283	19.384
	(15.631)	(21.113)	(19.091)	(33.647)	(17.650)	(13.541)
Household Respondent Works	0.145	0.133	0.148	0.146	0.215	0.090
	(0.353)	(0.340)	(0.355)	(0.353)	(0.414)	(0.287)
Household Respondent IADLs	0.595	0.576	0.641	0.657	0.216	0.831
	(1.164)	(1.164)	(1.230)	(1.268)	(0.709)	(1.503)
Household Respondent ADLs	0.790	0.643	0.673	0.643	0.380	0.844
	(1.274)	(1.193)	(1.235)	(1.236)	(0.814)	(1.406)
Household Respondent does Physical Work	0.089	0.083	0.123	0.103	0.102	0.064
	(0.286)	(0.276)	(0.329)	(0.305)	(0.304)	(0.246)
Vehicle Ownership	0.360	0.367	0.363	0.348	0.352	0.410
	(0.481)	(0.482)	(0.482)	(0.477)	(0.480)	(0.494)
Child lives within 10 miles	0.564	0.533	0.603	0.537	0.517	0.619
	(0.497)	(0.499)	(0.490)	(0.499)	(0.503)	(0.488)
Unemployment rate	5.299	5.107	10.752	10.450	5.110	10.496
	(1.335)	(1.316)	(2.261)	(2.538)	(1.168)	(2.245)
% Minority in Census	0.648	0.374	0.376	0.330	0.554	0.284

Tract	(0.323)	(0.353)	(0.317)	(0.288)	(0.338)	(0.282)
% Senior Poverty in	0.195	0.116	0.174	0.114	0.155	0.150
Census Tract	(0.107)	(0.107)	(0.124)	(0.113)	(0.106)	(0.112)
Housing Price Index	203.188	219.229	165.823	181.918	220.426	168.911
	(61.929)	(63.087)	(23.202)	(33.580)	(69.094)	(24.887)
Observations	247	1,460	326	1,553	82	129

Notes: Authors' calculations using 2006 and 2010 Health and Retirement Survey (HRS) data for households living in an urban area and at or below 200% of the federal poverty line in 2004. Standard deviations provided in parentheses. Columns 1 through 4 include a cross-sectional sample of households in the relevant year. Columns 5 and 6 include a sample of households from 2006 that were also in the HRS in 2010. See text for further description of the samples.

Table 2. Outcomes, by Food Desert Status

	2006		2010		Change Between 2006 and 2010	
	Food Desert	Not a Food Desert	Food Desert	Not a Food Desert	Food Desert 2006 Not a Food Desert 2010	Not a Food Desert 2006 Food Desert 2010
	(1)	(2)	(3)	(4)	(5)	(6)
Food and Material Hardship						
Food Insufficient	0.129	0.092	0.126	0.136	0.102	0.068
	(0.335)	(0.290)	(0.332)	(0.343)	(0.305)	(0.252)
Skipped Meals	0.051	0.046	0.080	0.084	0.059	0.036
	(0.220)	(0.209)	(0.272)	(0.278)	(0.237)	(0.186)
Skipped Prescriptions	0.127	0.128	0.126	0.127	0.110	0.112
	(0.333)	(0.335)	(0.333)	(0.333)	(0.315)	(0.317)
Receipt of Food Assistance Programs						
Household Receives	0.166	0.113	0.214	0.144	0.121	0.206
SNAP	(0.373)	(0.317)	(0.411)	(0.351)	(0.328)	(0.406)
Household Receives	0.055	0.048	0.061	0.048	0.059	0.030
Subsidized Meals	(0.228)	(0.214)	(0.239)	(0.215)	(0.238)	(0.172)
Food Spending						
Ln(weekly food	4.047	4.134	4.233	4.243	4.066	4.224
spending)	(0.607)	(0.714)	(0.693)	(0.689)	(0.497)	(0.615)
Observations	247	1,460	282	1,280	82	129

Notes: Authors' calculations using 2006 and 2010 Health and Retirement Survey (HRS) data for households living in an urban area and at or below 200% of the federal poverty line in 2004. Standard deviations provided in parentheses. Columns 1 through 4 include a cross-sectional sample of households in the relevant year. Columns 5 and 6 include a sample of households from 2006 that were also in the HRS in 2010. See text for further description of the samples.

Table 3.Cross-Sectional and Fixed Effects Regression Estimates for the Relationship of Food Desert Status on Food and Material Hardship, Receipt of Food Assistance, and Food Acquisition

	2006	2010	Fixed Effects
	(1)	(2)	(3)
Food and Material Hardship			
Food Insufficient	-0.013	-0.033	-0.037
	(0.030)	(0.026)	(0.031)
Observations	1,705	1,871	2,393
Skipped Meals due to Financial Resources	-0.012	-0.023	-0.023
	(0.018)	(0.024)	(0.024)
Observations	1,706	1,870	2,393
Skipped Prescriptions due to Financial Resources	-0.040	-0.026	-0.024
	(0.029)	(0.028)	(0.030)
Observations	1,703	1,875	2,393
Receipt of Food Assistance Programs			
Receives SNAP	-0.003	0.017	0.037
	(0.033)	(0.030)	(0.029)
Observations	1,707	1,879	2,393
Receives Subsidized Meals	0.011	0.022	-0.041*
	(0.018)	(0.016)	(0.024)
Observations	1,705	1,875	2,393
Food Spending			
Ln(Weekly Food Spending)	-0.001	0.066	-0.021
	(0.059)	(0.051)	(0.051)
Observations	1,359	1,562	1,900

Note: Author's calculations based on Health and Retirement Study data. See text for details on the sample selection and covariates. Standard errors provided in parentheses. Asterisks indicate that the coefficient is statistically different from zero at the 10% (*), 5%, (**), and 1% (***) level.

Table 4a. Estimates for the Interaction of Lack of Vehicle Ownership and Food Desert Status on Food and Material Hardship, Cross-Sectional and Fixed Effects Models

	(1)	(2)	(3)
	2006	2010	Fixed Effects
Food Insufficient			
Food Desert Status	-0.041	-0.051*	-0.085**
	(0.038)	(0.028)	(0.037)
No Vehicle	-0.011	0.056**	0.002
	(0.022)	(0.026)	(0.035)
Food Desert * No Vehicle	0.079	0.059	0.122*
	(0.056)	(0.052)	(0.070)
F-statistic on total effect of food desert status	0.73	0.00	0.41
P-value on F-statistic	0.39	0.99	0.52
Observations	1,705	1,871	2,383
Skipped Meals due to Financial Resources			
Food Desert Status	-0.042**	-0.042	-0.060*
	(0.019)	(0.025)	(0.032)
No Vehicle	0.0001	0.023	-0.035
	(0.018)	(0.022)	(0.027)
Food Desert * No Vehicle	0.082**	0.049	0.096
	(0.036)	(0.045)	(0.064)
F-statistic on total effect of food desert status	1.55	0.04	0.55
P-value on F-statistic	0.21	0.85	0.46
Observations	1,706	1,870	2,383
Skipped Prescriptions due to Financial Resources			
Food Desert Status	-0.045	-0.004	-0.011
	(0.037)	(0.036)	(0.038)
No Vehicle	-0.026	0.005	-0.034
	(0.025)	(0.024)	(0.046)
Food Desert * No Vehicle	0.013	-0.057	-0.034
	(0.051)	(0.053)	(0.056)
F-statistic on total effect of food desert status	0.70	2.28	1.04
P-value on F-statistic	0.40	0.13	0.31
Observations	1,706	1,870	2,433

Note: Author's calculations based on Health and Retirement Study (HRS) data. Coefficient estimates presented are the interaction between food desert status and lack of vehicle ownership. See text for details on the sample selection and covariates. Standard errors provided in parentheses. Asterisks indicate that the coefficient is statistically different from zero at the 10% (*), 5%, (**), and 1% (***) level.

Table 4b. Regression Estimates for the Interaction of Lack of Vehicle Ownership and Food Desert Status on Receipt of Food Assistance and Food Spending, Cross-Sectional and Fixed Effects Approach

	(1)	(2)	(3)
	2006	2010	Fixed Effects
Receives SNAP			
Food Desert Status	-0.063*	-0.007	0.043
	(0.035)	(0.034)	(0.036)
No Vehicle	0.030	0.059**	0.058
	(0.020)	(0.025)	(0.038)
Food Desert * No Vehicle	0.170***	0.064	-0.015
	(0.063)	(0.061)	(0.053)
F-statistic on total effect of food desert status	3.35	1.13	0.39
P-value on F-statistic	0.07	0.29	0.53
Observations	1,707	1,879	2,383
Receives Subsidized Meals			
Food Desert Status	0.007	0.016	-0.021
	(0.016)	(0.019)	(0.022)
No Vehicle	0.041**	0.047***	0.074***
	(0.019)	(0.017)	(0.028)
Food Desert * No Vehicle	0.010	0.014	-0.050
	(0.040)	(0.039)	(0.048)
F-statistic on total effect of food desert status	0.20	0.86	2.36
P-value on F-statistic	0.66	0.35	0.12
Observations	1,705	1,875	2,383
Ln(Weekly Food Spending)			
Food Desert Status	-0.059	0.082	-0.013
	(0.068)	(0.062)	(0.055)
No Vehicle	0.032	0.076	-0.099
	(0.049)	(0.049)	(0.084)
Food Desert * No Vehicle	0.200*	-0.046	-0.027
	(0.106)	(0.097)	(0.099)
F-statistic on total effect of food desert status	2.38	0.21	0.20
P-value on F-statistic	0.12	0.64	0.66
Observations	1,706	1,870	2,433

Note: Author's calculations based on Health and Retirement Study data. Coefficient estimates presented are the interaction between food desert status and lack of vehicle ownership. See text for details on the sample selection and covariates. Standard errors provided in parentheses. Asterisks indicate that the coefficient is statistically different from zero at the 10% (*), 5%, (**), and 1% (***) level.

Table 5a. Fixed Effects Regression Estimates for the Interaction of SNAP Receipt and Food Desert Status on Food and Material Hardship

	(1)	(2)	(3)
	2006	2010	Fixed Effects
Food Insufficient			
Food Desert Status	-0.017	-0.023	-0.027
	(0.033)	(0.026)	(0.032)
SNAP Recipient	0.145***	0.121***	0.066
	(0.041)	(0.042)	(0.053)
Food Desert * SNAP Recipient	0.029	-0.053	-0.073
	(0.079)	(0.072)	(0.098)
F-statistic on total effect of food desert status	6.62	1.24	0.01
P-value on F-statistic	0.01	0.27	0.94
Observations	1,706	1,871	2,393
Skipped Meals due to Financial Resources			
Food Desert Status	0.004	-0.013	-0.014
	(0.017)	(0.022)	(0.026)
SNAP Receipt	0.081***	0.126***	0.042
	(0.028)	(0.039)	(0.050)
Food Desert * SNAP Recipient	0.085	-0.059	-0.059
	(0.063)	(0.068)	(0.079)
F-statistic on total effect of food desert status	8.60	1.39	0.05
P-value on F-statistic	0.01	0.24	0.83
Observations	1,706	1,870	2,393
Skipped Prescriptions due to Financial Resources			
Food Desert Status	-0.054*	0.004	-0.031
	(0.030)	(0.032)	(0.028)
SNAP Recipient	0.026	0.029	0.119**
	(0.035)	(0.036)	(0.047)
Food Desert * SNAP Recipient	0.081	-0.142**	0.012
	(0.075)	(0.057)	(0.085)
F-statistic on total effect of food desert status	2.43	5.65	2.65
P-value on F-statistic	0.12	0.02	0.10
Observations	1,703	1,875	2,393

Note: Author's calculations based on Health and Retirement Study data. Coefficient estimates presented are the interaction between SNAP participation status and food desert status. See text for details on the sample selection and covariates. Standard errors provided in parentheses. Asterisks indicate that the coefficient is statistically different from zero at the 10% (*), 5%, (**), and 1% (***) level.

Table 5b. Fixed Effects Regression Estimates for the Interaction of SNAP Receipt and Food Desert Status on Receipt of Food Assistance, and Food Acquisition

	(1)	(2)	(3)
Receives Subsidized Meals			
Food Desert Status	0.004	0.016	-0.058**
	(0.018)	(0.018)	(0.024)
SNAP Recipient	0.017	-0.017	-0.047*
	(0.021)	(0.019)	(0.026)
Food Desert * SNAP Recipient	0.037	0.027	0.109*
	(0.051)	(0.047)	(0.065)
F-statistic on total effect of food desert status	1.31	0.05	1.10
P-value on F-statistic	0.25	0.83	0.30
Observations	1,705	1,875	2,393
Ln(Weekly Food Spending)			
Food Desert Status	-0.059	0.108**	-0.011
	(0.065)	(0.053)	(0.054)
SNAP Receipt	-0.379***	-0.134**	-0.122*
	(0.067)	(0.067)	(0.071)
Food Desert * SNAP Recipient	0.359***	-0.217*	-0.042
	(0.137)	(0.125)	(0.128)
F-statistic on total effect of food desert status	0.03	10.58	1.72
P-value on F-statistic	0.86	0.01	0.19
Observations	1,359	1,562	1,900

Note: Author's calculations based on Health and Retirement Study data. Coefficient estimates presented are the interaction between SNAP participation status and food desert status. See text for details on the sample selection and covariates. Standard errors provided in parentheses. Asterisks indicate that the coefficient is statistically different from zero at the 10% (*), 5%, (**), and 1% (***) level.

[1] Households could choose to shop at a location other than near their home, such as near a workplace or other location. For example, Widener et al (2013) show differences in access measures when commuting patterns of people are considered and Hamrick and Hopkins (2012) provide evidence that shoppers combine work and other activities around grocery shopping. With less labor force attachment of the elderly, we think this is less of a concern than for other demographic groups.

[2] Local efforts to boost access to healthy foods are growing in number. Baltimore's Virtual Supermarket Project allows grocery delivery at local grocery stores. New York City boasts a variety of programs: the Food Retail Expansion to Support Health (FRESH) program, which through zoning policies and financial incentives aims to encourage the development of grocery stores in underserved areas; Green Carts, which a mobile fruit and vegetable carts that operate in underserved areas; Healthy Bodegas, which works with small corner stores to encourage them to carry healthier food options; and the Health Bucks program, which gives coupons that can be used at local farmers' markets. See the Healthy Food Access Portal for specific details about these and other examples: http://www.healthyfoodaccess.org/home?destination=home.

[3] The federal Healthy Food Financing Initiative is modeled after Pennsylvania's Fresh Food Financing Initiative, a public-private partnership to develop supermarkets in underserved areas.

[4] One exception to this is a recent analysis by Bonanno and Li (2013) that examines the relationship between adult food insecurity and type of food outlet (Walmart Supercenters, medium-to-large grocery stores, and small food stores) at the county-level.

[5] Activities of Daily Living (ADLs) refer to basic tasks of everyday life, including eating, bathing, dressing, getting out of bed, and transferring. This standard measure in healthcare is used to assess whether an individual can live independently.

[6] A vast literature exists on the effect of SNAP on food insecurity (for reviews, see Gundersen et al. 2011 and Caswell et al. 2013**).**

[7] Most studies focus only on average prices within neighborhood stores rather than prices paid by shoppers, regardless of if they shop in their neighborhood or outside of their neighborhood.

[8] A wide variety of food retailers accept SNAP benefits, from large supermarkets to convenience stores to farmers' markets. General requirements for eligibility include selling food for home preparation and consumption and either having at least three varieties of four staple food groups (meat, poultry, fish; bread or cereal; vegetables or fruits; dairy products) or having more than 50% of the store's sales as these eligible staple foods (see http://www.fns.usda.gov/snap/retailers/store-eligibility.htm).

[9] Zedlowski and Issa (2010) note that long wait lists exist for Meals on Wheels, suggesting unmet nutrition needs do exist. Like other groups, the elderly report "too many hassles" as a reason for not participating (Daponte et al. 1999, Gabor et al., 2002). Yet, the elderly likely have more leisure time as other groups and should face lower opportunity costs than working households or households with children.

[10] The HRS does not include the Food Security Survey Module so we are unable to measure food security status, only self-reports of insufficient food due to lack of resources. Gundersen and Ribar (2011) conclude that self-reports of food insufficiency are well-correlated with food security status.

[11]Measuring the food environment, particularly at the national level, is problematic because it is difficult to assess food availability and prices among retailers. Additionally, measuring access at the neighborhood level, rather than the individual level, may mask differences in resources across individuals that may be related to other characteristics, such as vehicle availability, transportation modes, social networks, and food preferences.

[12] Low-income was defined based on the New Markets Tax Credit (NMTC) program. The NMTC program is a U.S. Treasury program providing incentives for business and real estate development in low-income communities. The NMTC definition of low-income is: "Any population Census tract if: (a) the poverty rate for that tract is at least 20 percent, or (b) in the case of a tract not located within a metropolitan area, the median family income for the tract does not exceed 80 percent of statewide median family income, or in the case of a tract located within a metropolitan area, the median family income for the tract does not exceed 80 percent of the greater of statewide median family income or the metropolitan area median family income."

[13] Because Dallas County, Texas is a highly urbanized area, both figures show low-income Census tracts where a significant number or share of the population is more than 1 mile from a supermarket.

[14] Tract boundaries and shapes are not necessarily the same in these two figures--the 2006 food deserts are based on 2000 Census tract boundaries while the 2010 food deserts are based on 2010 tract boundaries.

[15] Two longitudinal studies in the U.K. suggest that when supermarkets open in underserved areas there is little to no change in consumption of fruits and vegetables (Wrigley et al., 2003; Cummins et al., 2005). Another study based on longitudinal data in the United States did not

find a relationship between supermarket proximity and dietary intake (Boone-Heinonen et al., 2011). Harding and Lovenheim (2014) find that census tract store density measures are not related to broad categories of foods purchased by consumers.

[16] The most striking of these differences was in 2009 in which Social Security cost of living adjustment was 5.8% while the measured inflation rate was only 2.7%. According to the Social Security Administration (http://www.ssa.gov/cola/automatic-cola.htm), Social Security provided cost-of-living adjustments of 3.3% in 2007, 2.3% in 2008, and 5.8% in 2009, while the measured inflation rate was lower during the same time period with changes of 4.1%, 0.1%, and 2.7% in 2007, 2008, and 2009 respectively. http://www.usinflationcalculator.com/inflation/current-inflation-rates/.

[17] Instrumental Activities of Daily Living (IADLs) refer to activities that are not fundamental to living but are necessary for independently living in the community. These include taking prescribed medications, managing money, and shopping and preparing for meals.

[18] The ERS food desert measure first divides the country into one kilometer square grids to measure where people live and how far they live from food retailers. Once this is completed, ERS examines Census tracts based on tract income levels and the number or share of residents that live more than one mile from a store. Thus, the food desert status of a tract could change because people in the Census tract moved closer to or further from an existing store. See ERS (2013) for more detail on the food desert measure.