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The Consequences of Living in a Small-town Food Desert: Mixed Methods Evidence from a Quasi-Experiment

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Abstract

Past research finds that living in a food desert is associated with an unhealthy diet and poor health; however, more recent studies of urban food deserts suggest that these findings may be spurious. In this article, we leverage the flooding and subsequent closing of the only grocery store in a small town to examine the effects of living in a small-town food desert. Using difference-in-difference methods, we find that opening a grocery store in a small-town food desert is not associated with changes in diet, but we find that opening a grocery store in a food desert is associated with improved food access. Findings from in-depth interviews shed further light on how residents of a small-town food desert decide where to shop and how routine activities provide access to a range of nonlocal grocery stores. Moreover, we find that the absence of a grocery store negatively affects social relationships. While the findings add to growing skepticism about food desert effects on diet, the findings reveal important food desert effects on food access and also the social consequences of living in a food desert.

Keywords

food desert, mixed methods, community, social infrastructure, food

Introduction

Past studies find that living in a food desert—broadly defined as an area in which it is difficult to purchase affordable and nutritious foods—is associated with a range of poor outcomes. Most notably, compared with those who do not live in a food desert, residents of food deserts have worse diets and worse health (Chen, Jaenicke, and Volpe 2016; Dubowitz et al. 2012; Larson, Story, and Nelson 2009; Mayer et al. 2014; Morland and Evenson 2009; Powell et al. 2007; Rose and Richards 2004; Schafft, Jensen, and Hinrichs 2009). However, establishing a causal relationship between living in a food desert and these outcomes is challenging. Where people live and residential preferences are not random, the location of grocery stores is influenced by local economic and social conditions, and it may be the case that individual characteristics like economic disadvantage shape both the risk of living in a food desert and outcomes like diet and health (Bruch and Mare 2006; Clark and Ledwith 2007; Deener 2017; Hipp 2010; Roscigno, Karafin, and Tester 2009; Rosenbaum 1996;

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Ver Ploeg et al. 2009).[1] As a result, observed food deserts effects may be attributable to unobserved characteristics. In fact, more recent studies that are better able to test causal associations between living in a food desert and diet and health have found minimal or no food desert effects (Cummins, Flint, and Matthews 2014; Dubowitz et al. 2015; Elbel et al. 2015).

However, while recent studies have offered more robust tests of food desert effects, there are notable gaps in understandings of the consequences of living in a food desert. First, studies that attempt to identify the causal impacts of living in a food desert focus on urban areas. Rural, suburban, small-town, and urban food deserts are dissimilar in a number of ways, and the barriers to food access vary across these settings. For example, while the food retail environment is limited in all settings, a wider variety of options are available relatively nearby in urban food deserts. Moreover, public transportation is more likely to be available in urban areas. Living in a food desert may be of more consequence in rural areas and small-towns where even outside of the food desert there is often a scarcity of nearby food retailers and long distances between food retailers.

Second, while past studies of food deserts have explored robust and comprehensive measures of diet and health and thoroughly documented barriers to food access, past studies have overlooked the possible social functions of grocery stores. In small-towns and rural areas with a limited number of establishments and public spaces, grocery stores can serve as more than a place to buy groceries. Spatial contexts, the physical environment where social interactions occur (Small and Adler 2019), are important for shaping social relationships (Fine 2010; Oldenburg 1989; Small 2006). Public spaces and local establishments provide a place where informal interactions can occur and, in turn, sustain relationships, build community, and foster exchanges of information (Klinenberg 2018; Lofland 1973; Oldenburg 1989; Williams and Hipp 2019). In small towns, grocery stores can take on a prominent role in shaping spatial contexts, and in small-town food deserts, a grocery store, a key community institution, is absent.

In this study, we examined a small-town food desert. While "food desert" is a popular concept, there is not a universally accepted definition of what constitutes a food desert. Fundamentally, food deserts are areas where access to nutritious and affordable food is limited (Ver Ploeg et al. 2009). However, there are debates about whether access should be measured spatially or temporally, debates about how to distinguish between rural and urban food deserts, and debates about whether the definition should incorporate economic, sociological, and psychological barriers to accessing nutritious foods. Despite lacking a precise definition, the metaphor of "food deserts" is compelling and useful as an analytic tool. In this study, we focus on a small-town food desert, which we define broadly as a small town that lacks a supermarket.[2]

We used a quasi-experimental research design to explore the effects of living in a small-town food desert. Specifically, in October 2016, a hurricane flooded the only grocery store in Grifton, a small town in eastern North Carolina with a population of about 2,700. After the grocery store flooded and closed, the only place to buy groceries was a dollar store. Overnight, Grifton became a food desert and remained a food desert until a new grocery store opened in December 2017. For over a year, residents of Grifton had to either shop at a dollar store or travel to grocery stores in nearby towns.

Drawing on two waves of survey panel data, as well as data from 18 in-depth interviews with residents of Grifton, we examine the effects of living in a small-town food desert. We consider whether living in a food desert is associated with worse food access and decreased diet quality. Additionally, we explore barriers to food access; how costs, preferences, and biases shape shopping behavior; how the potential impacts of living in a food desert are moderated by routine daily activities; and the social functions and nonfood impacts of grocery stores. These findings add to understandings of the effects of living in a food desert and contribute to the literature on how local establishments and spaces shape social relationships.

In this article, we first review the food desert hypothesis and the potential mechanisms that link living in a food desert with decreases in diet quality and food access. We then describe evidence that suggests food desert effects may be spurious and consider whether results from studies of urban food deserts are generalizable to other settings. After this, we discuss how narrowly focusing on food-related outcomes misses the potential social functions of grocery stores. We then describe the research setting, our research design, present quantitative and qualitative results, and conclude by discussing the implications of our findings for research on food deserts.

Food Desert Hypothesis

Past research has investigated the various impacts of living in a food desert on individual diet and health. A number of studies find that living in an area with limited access to food retailers is associated with a less healthy diet, and in turn, worse health (Chen et al. 2016; Dubowitz et al. 2012; Larson et al. 2009; Morland and Evenson 2009; Powell et al. 2007; Rose and Richards 2004; Schafft, Jensen, and Hinrichs 2009). The food desert hypothesis posits that this relationship is causal.

Such findings are consistent with social ecological theory, which argues that individual-level behaviors and attitudes are shaped by community-level characteristics—the foods that are available at home are influenced, in part, by the foods that are available in the community. In food deserts, food retailers are generally limited to small food stores like corner and convenience stores. These stores typically have a limited selection of fresh and nutritious foods and instead carry energy-dense ("empty calorie") foods (Andreyeva et al. 2008; J. P. Block, Scribner, and DeSalvo 2004; Connell et al. 2007; Farley et al. 2009; Glanz et al. 2007; Liese et al. 2007). According to the food desert hypothesis, residents of food deserts have a lower quality diet as a result.

Additionally, foods available at corner and convenience stores are typically more expensive than the same groceries available at supermarkets (Block and Kouba 2006; Cannuscio et al. 2014; Chung and Myers 1999; Donkin et al. 1999; Latham and Moffat 2007). This leaves residents of food deserts with weaker purchasing power. For households that struggle to afford groceries, already strained food budgets must be stretched further, which encourages buying cheaper, less nutritious foods.

In response to the limited selection and high prices of nutritious foods, residents of food deserts can "outshop" by traveling to grocery stores outside of their community (Ledoux and Vojnovic 2013; Shannon 2014). While outshopping yields a better selection of foods at better prices, getting to the supermarket can be challenging and time intensive (Whelan et al. 2002). In fact, research shows that individuals living in areas with low levels of food access spend more time traveling to the grocery store than the national average (Ver Ploeg et al. 2009). As a result, those living in food desert have less available time for preparing foods at home, a common obstacle to healthy eating (Bowen, Brenton, and Elliott 2019; Bowen, Elliott, and Brenton 2014; Hemrick and Hopkins 2012; Jabs and Devine 2006). Moreover, these barriers can encourage residents of food deserts to buy groceries less frequently (Ver Ploeg et al. 2009), which can discourage purchasing fresh foods.

Food Deserts Effects as Spurious Associations

While living in a food desert is associated with a less nutritious diet and worse health, whether these associations represent a causal relationship is unclear. In evaluating whether such a causal relationship exists, it is useful to consider the assumptions made by the food desert hypothesis. First, the food desert hypothesis holds that physical access is the key barrier to eating nutritiously—if a nearby grocery store opened, the area would no longer be a food desert and issues related to food access would be resolved. While residents of food deserts are located further away from a supermarket, there are also other important barriers to food access. Most notably, food deserts are typically located in economically disadvantaged areas (Blanchard and Lyson 2002; Chung and Myers

1999; Powell et al. 2007; Zenk et al. 2005). This is important because household income is a strong predictor of food choices and diet (Daniel 2016; Darmon and Drewnowski 2008; Dean and Sharkey 2011a; Fielding-Singh 2017; Wang et al. 2014), and fresh and nutritious foods are typically more expensive than less nutritious, processed foods (Monsivais and Drewnowski 2007). The fact that residents of food deserts have a lower quality diet may simply reflect financial constraints and differences in household resources. For example, compelling research shows that economic constraints and child preferences interact to shape food choices. Namely, parents with limited financial resources prioritize minimizing financial losses from food waste, leading low-income parents to purchase foods they know their children will eat, which are often energy-dense and nutrient-poor foods, while high-income parents are able to afford potential food waste and experiment with different foods for their children (Daniel 2016). In contrast to the food desert hypothesis, the spurious model contends that if residents of food deserts had better access to a supermarket, the high costs of healthy and nutritious food may mean diets and consumption would remain the same.

A second assumption of the food desert hypothesis is that if the food desert had a supermarket, residents of the food desert would shop at the supermarket. Past studies suggest this may not be the case. A number of studies show that people do not shop at the grocery store closest to their home (Cannuscio et al. 2014; Ledoux and Vojnovic 2013; Shannon 2014). Instead, people travel to more distance grocery stores in search of better prices, particular foods, or a specific retail environment.

Finally, the food desert hypothesis does not incorporate personal preferences and biases and how these factors shape diet and consumption. What foods people eat and buy is fundamentally social (Bowen et al. 2019). Beyond proximity to food retailers, diet and consumption are shaped by social and cultural practices and beliefs, as well as structural forces such as available time to spend cooking and available financial resources to dedicate to food budgets (Bowen et al. 2019; Brenton 2017; Daniel 2016; DeSoucey 2016; Fielding-Singh 2017, 2019)

Recent studies that are better able to explore causal links between living in a food desert and diet and health have found minimal or no food desert effects. These studies evaluate food deserts before and after a new supermarket has opened. For example, a study that examined changes in diet before and after the introduction of a grocery store in a food desert in Glasgow found no change in fruit and vegetable consumption or self-rated health (Cummins et al. 2005). Similar studies of food deserts in Philadelphia (Cummins et al. 2014) and Pittsburgh (Dubowitz et al. 2015) found no food desert effects related to fruit or vegetable intake or body mass index, and a study in New York City also found no appreciable differences in diet or foods available at home (Elbel et al. 2015). However, some studies have found that opening a grocery store in a food desert is associated with improvements in perceived food accessibility (Cummins et al. 2014; Dubowitz et al. 2015). While food deserts are a pervasive concept, the empirical support for food desert effects is limited.

Overall, research on food deserts has emphasized urban areas (e.g. Ledoux and Vojnovic 2013; Mayer et al. 2014; Whelan et al. 2002), and to a lesser extent rural areas (e.g. Dean and Sharkey 2011b; Garasky, Morton, and Greder 2006; Smith et al. 2010). The recent studies that have attempted to estimate the causal impacts of living in a food desert have focused on urban areas exclusively (e.g. Cummins et al. 2014; Dubowitz et al. 2015; Elbel et al. 2015). Small-town food deserts are profoundly different from urban food deserts. While recent studies cast doubt on the food desert hypothesis for urban areas, the extent to which these findings can be generalized to small-town food deserts is unknown.

Small-town Food Deserts and Nonfood Impacts

Existing research on urban food deserts has typically focused on diet and health, but grocery stores can have other impacts, especially in small towns. Local establishments shape spatial

contexts, and in turn, social relationships and community well-being (Klinenberg 2018; Small and Adler 2019). Small towns often have few establishments where informal interactions can take place, but supermarkets can serve this function. Supermarkets are particularly democratic spaces—unlike churches where attendance is based on religious affiliation or coffee shops or bars where the customers share common tastes, a small town grocery store is open to all. Small-town food deserts lack an important social institution that has the potential to shape spatial contexts and relationships.

There is a long history of social science research that explores how public spaces and local establishments facilitate social interactions and strengthen social relationships (Lund 2003; Whyte 1980). For example, Oldenburg (1989) argued that establishments like barbershops and cafes serve as "third spaces," which are physical places that facilitate social interactions and forming social relationships. Other studies have similarly found that bars, restaurants, and child care centers influence the development and maintenance of social relationships (Anderson 1978; Dunnier 1992; Small 2006).

More recently, Klinenberg (2018) has argued that commercial establishments are important for strengthening a community's "social infrastructure," which is defined as the physical space and organizations that influence when, where, and how people interact. Like research on third spaces, Klinenberg argues that a community's social infrastructure has implications for social interactions among community members and the formation of social relationships. As a result, Klinenberg argues that the social infrastructure of a community can have far-reaching consequences, affecting civic and community engagement, individual health and well-being, and political polarization.

Overall, this vein of research highlights the need for studies of food deserts that consider how the absence of a grocery store can influence outcomes beyond diet and health, especially in small towns where the number of establishments is minimal. A small-town grocery store has the potential to improve the social infrastructure and, consequently, increase social interactions among residents and foster greater community wellbeing.

Data and Method

Research Setting

Grifton is a small town in eastern North Carolina. At the 2010 census, the population was 2,617.[3] The main street in Grifton is only a few blocks. There is a public library, city hall, a pharmacy, a gas station, a hair salon, an auto supply store, and a number of vacant storefronts.

Like many small towns in eastern North Carolina, Grifton lags behind state averages in measures of economic wellbeing. In particular, compared with state averages, poverty rates in Grifton are 45 percent higher, the median household income is roughly 35 percent lower, and the unemployment rate is nearly double.[4] However, car ownership in Grifton is relatively common—over 90 percent of households have access to a vehicle.

In Grifton, approximately one third of households have children under the age of 18 in the household and a little over one fourth of households are adults living alone. Approximately, 45 percent of residents are non-Hispanic white, 48 percent of residents are non-Hispanic black, and 6 percent of residents are Hispanic of any race.

Grifton sits near the southern edge of Pitt County and is part of the Greenville, North Carolina Metropolitan Statistical Area. Greenville has a population of more than 80,000 and has a wide selection of grocery stores, supercenters, and other retail. By car, Grifton is approximately 30 minutes south of Greenville. Between Grifton and Greenville, sits Ayden. Ayden is a little less than 10 miles north of Grifton and has a population of over 5,000. In Ayden, there are a handful of supermarkets, as well as fast food chains and other restaurants.

On October 8 and 9, 2016, Hurricane Matthew passed over eastern North Carolina. The storm brought wind gusts of nearly 60 miles per hour and 10 inches of rain. In the following days, the creeks and rivers began to swell, causing extensive flooding throughout eastern North Carolina. In Grifton, the

Contentnea Creek spilled over its banks and flooded the Piggly Wiggly, the town's only grocery store. Piggly Wiggly closed and did not reopen. Grifton became a food desert overnight and would remain a food desert until December 2017 when a new grocery store opened. From October 2016 until December 2017, the only places to buy groceries in Grifton were a dollar store or a gas station convenience store. There were also a handful of restaurants where residents could purchase prepared food. The closest supermarkets were in Ayden.

Fourteen months after the Piggly Wiggly closed, a Tropicana supermarket opened in the same building that Piggly Wiggly had left. At nearly 17,000 square feet, both stores were smaller than the average grocery store, but still had substantial floor space with large produce and meat sections. While Tropicana describes its supermarkets as offering common grocery items along with a range of international foods from the Caribbean, Latin America, Asia, and Africa (Abramowitz 2017), the store places a greater emphasis on Hispanic grocery items, which is different from Piggly Wiggly.

We treat the unexpected closing of the only grocery store as a quasi-experiment. Quasi-experiments attempt to mimic a traditional experimental research design with a control and treatment group, with the notable exception that the researcher is unable to randomly assign respondents to either group. In this study, residents of Grifton serve as the "treatment" group: Grifton residents did not live in a food desert, but then unexpectedly lived in a food desert when a natural disaster forced the only grocery store in town to close suddenly. We identified two small towns that were similar to Grifton, except that both had a grocery store. The first town, Murfreesboro, is also located in eastern North Carolina, but 80 miles north of Grifton. The second, Franklinton, is located in central North Carolina and is 90 miles northwest of Grifton. Residents of these towns serve as the "control" group.

We collected two waves of survey data and also data from in-depth interviews. The first wave of data collection occurred before the new supermarket in Grifton opened while the town was a food desert. The second wave of data collection occurred a few months after the new Tropicana supermarket in Grifton had opened. We collected survey data for both the treatment and control groups. Additionally, after collecting the second wave of survey data, we conducted in-depth interviews with residents of Grifton.

A total of 219 households completed the baseline survey. Of those households, 159 (62 percent) completed the follow-up survey. We restricted the sample to be complete on all outcome variables, resulting in the loss of 14 percent of observations. After excluding those observations, there was minimal item missingness on independent variables. For example, our measure of income had the most missing observations with 6 percent missing. Nonetheless, we used multiple imputation to maintain all cases with missing data on independent variables.[5] Our analytic sample consists of a balanced panel of 131 respondents with two observations per respondent.

In Online Appendix A, we discuss the survey and data collection in more detail.

Outcome Measures

In our quantitative analyses, we examined outcomes related to food access and diet.[6] Descriptive statistics for all outcome and control variables at the baseline survey are presented in Table 1. We examined four measures related to food access. First, respondents were asked, "What is the biggest problem you have getting groceries in your area?" Respondents could answer affording groceries, getting to the grocery store, local stores have inadequate selection, other, or "I don't have any problem getting groceries." Many respondents, particularly in the treatment group, reported "other." We, therefore, created a dichotomous variable where 1 = experienced a problem getting groceries and 0 = had no problems getting groceries. Second, respondents reported whether they shopped for groceries at a dollar store (1 = shopped at dollar store; 0 = did not shop at dollar store). Third, respondents reported their

Table 1. Descriptive Statistics at Baseline Survey.

	All	Treatment	Control	
	N = 131	*N* = 75	*N* = 56	
	Mean	Mean	Mean	Sig.
Food access				
Any problem getting groceries	0.6	0.64	0.54	
Ease of getting groceries	2.98	2.68	3.37	***
Shopped at dollar store	0.39	0.48	0.28	*
Quality of selection of fruits	3.1	3.12	3.09	
Diet				
Fresh meats	1.2	1.16	1.33	
Fresh vegetables	1.07	1	1.16	
Fresh fruits	1.2	1.13	1.28	
Grains	1.6	1.52	1.75	
Sweets	0.99	0.85	1.18	*
Control variables				
Income	4.7	4.8	4.6	
Married	0.54	0.47	0.59	
Associate's degree +	0.7	0.77	0.65	
Female	0.74	75	0.76	
White	0.76	0.79	0.73	
Age	57	59	58	
SNAP	0.15	0.12	0.17	

Note. Sig. reports tests of significant differences between control and treatment groups.
Descriptive statistics are based on non-imputed data and estimates are from the baseline survey. Age is measured in one-year intervals; white is measured as 1 if white and 0 if nonwhite; associate's degree is measured as 1 if the respondent has at least an associate's degree and 0 otherwise; married is measured as 1 if married and 0 if otherwise; Supplemental Nutrition Assistance Program (SNAP) receipt is measured as 1 if anyone in the household received assistance from the SNAP and 0 if otherwise; income is measured in categories: 0 = $0–$9,999; 1 = $10,000–$14,999; 2 = $15,000–$24,999; 3 = $25,000–$34,999; 4 = $35,000–$44,999; 5 = $45,000–$54,999; 6 = $55,000–$64,999; 7 = $65,000–$75,000; 8 = more than $75,000.
*$p < .05$. **$p < .01$. ***$p < .001$.

level of difficulty getting to the grocery store by responding to the statement "It is easy for me to get to the grocery store" (0 = strongly disagree; 4 = strongly agree). Last, respondents reported whether the food retailer where they usually shop has a large selection of fruits and vegetables (0 = strongly disagree; 4 = strongly agree).

We measured diet by asking respondents to report the number of servings of different types of food they ate on a usual day. Specifically, for five types of food (fresh fruits, fresh vegetables, fresh meats, grains, and sweets), respondents reported how many servings of each food they ate in a typical day (0 servings, 1–2, 3–4, 5–7, or more than 7).[7]

Quantitative Data Analysis

To analyze the panel survey data, we used difference-in-difference (DID) regression methods. Following Angrist and Pischke (2008), the basic model can be expressed as follows:

$$Y_{it} = \alpha + \beta \text{Time}_i + \gamma \text{Treatment}_{it} + \delta\left(\text{Time}_i * \text{Treatment}_{it}\right) + \lambda X_{it} + \epsilon_{it}$$

where Y represents an outcome variable such as food access for individual *i* at time *t*; Time is a dummy variable where Time = 0 for the baseline period and 1 for the posttreatment period (i.e. before and after the grocery store opened); Treatment is a dummy variable for whether the respondent was in the control or

treatment group; X is a vector of control variables, and ϵ_{it} represents random disturbances.

In this specification, β accounts for the time trend that is shared between control and treatment group, γ is the average permanent differences between treatment and control group, and δ, the DID estimate, represents the treatment effect of opening a grocery store in a food desert. We estimate probit models for dichotomous outcomes and linear models for ordered and continuous outcomes.

DID methods assume that there is no treatment group–specific time effect. That is, absent the intervention, unobserved differences between treatment and control groups would be the same across the two time periods.

In-depth Interviews

In addition to the survey data, we also conducted in-depth interviews with residents of Grifton. The interviews took place in May and June of 2018, after we had collected the second wave of survey data.

We initially recruited participants by posting a flyer at the Grifton Public Library and through social media pages for local organizations (e.g. local churches). This strategy only yielded five participants, all of whom Grifton librarians helped identify. We then sent letters out to the Grifton residents who had completed both Wave 1 and Wave 2 surveys, inviting them to participate in an interview. For those who agreed to participate, we also asked that they refer their eligible family and friends. In total, we conducted 18 interviews. Five participants were identified by posting a flyer at the library and with the help of the librarians. Eleven participants were part of the survey sample. Two respondents were referred to us by other participants from the survey sample.[8]

Of the 18 participants, 13 were women, half had children in the home, and two thirds lived in low-income households. Additionally, eight participants were non-Hispanic white, nine were non-Hispanic black, and one was Hispanic. The average age of the participants was 53. All of the participants were the person who was either primarily or jointly responsible for grocery shopping in their household.

All interviews were conducted by either the first or third author. The interviews took place in a private room at the Grifton Public Library. Interviews typically lasted a little under one hour. We audio recorded interviews and later had the interviews transcribed. The interviews were semi-structured. The interview guide began with general questions about living in the town, and then transitioned to questions about grocery shopping behaviors and preferences; diet, consumption, and food preferences; food insecurity; and cool-down questions that focused on the residents' wants for food retail in Grifton and ideas for improving food access in Grifton. When developing the interview guide, we drew on interview protocols made available by the Cornell Food Choice Research Group (Bisogni et al. 2002) and a USDA project on food insecurity among SNAP (Supplemental Nutrition Assistance Program) recipients (Edin et al. 2013).

To code the transcribed interviews, we adapted the flexible-coding method outlined by Deterding and Waters (2018). The first author initially indexed the verbatim transcripts using index codes that came from the interview guide or emerged from interview notes. Using those index codes, the first author then applied more narrow analytic codes. During this process, four major themes emerged: issues related to accessing groceries in a food desert, motivations for leaving town to shop for groceries, routine activities enabling outshopping, and grocery stores as a community institution.

Quantitative Findings

Table 2 presents estimates from DID regression models predicting access to foods. In the first column, the outcome is a dichotomous measure of whether the respondent experienced any problems getting groceries. The DID estimate shows that opening a grocery store in a food desert was associated with a decreased likelihood of experiencing problems getting groceries ($\delta = -0.93$; $p < .05$). Similarly, opening a grocery store in a food

Table 2. Difference-in-Difference Estimates of the Effects of Living in a Food Desert on Access to Groceries.

	Any problem getting groceries	Ease of getting groceries	Shopped at dollar store	Quality of selection of fruits
	Coef.	Coef.	Coef.	Coef.
	(Standard error)	(Standard error)	(Standard error)	(Standard error)
Treatment	0.549	−0.750***	1.023*	−0.029
	(0.45)	(0.18)	(0.51)	(0.16)
Time	0.293	−0.134	−0.576	−0.283*
	(0.34)	(0.13)	(0.40)	(0.12)
Treatment × Time	−0.930*	0.582***	−0.133	0.562***
	(0.47)	(0.17)	(0.51)	(0.17)
Income	−0.125	0.105**	−0.193†	0.063†
	(0.10)	(0.04)	(0.10)	(0.03)
Married	−0.767†	0.267	0.314	0.192
	(0.44)	(0.17)	(0.46)	(0.16)
Associate's degree +	1.330**	−0.219	−0.705	−0.255†
	(0.47)	(0.17)	(0.45)	(0.15)
Female	0.274	−0.060	0.180	−0.220
	(0.37)	(0.15)	(0.43)	(0.14)
White	−0.559	0.050	−1.431*	0.241
	(0.54)	(0.21)	(0.60)	(0.19)
Age	−0.017	−0.005	0.011	0.004
	(0.01)	(0.01)	(0.01)	(0.00)
SNAP	−0.274	−0.407†	0.343	0.181
	(0.58)	(0.23)	(0.58)	(0.21)
Constant	1.458	3.244***	0.420	2.575***
	(1.04)	(0.41)	(1.09)	(0.38)

Note. $N = 262$ observations. Probit model for dichotomous outcomes and linear model for ordered outcomes. SNAP = Supplemental Nutrition Assistance Program.
†$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$.

desert was associated with increased ease of getting groceries ($\delta = 0.582$; $p < .001$) and improved access to fruits ($\delta = 0.562$; $p < .001$); however, opening a grocery store in a food desert was not associated with the likelihood of shopping for groceries at a dollar store.

Table 3 reports estimates from DID regression models predicting typical daily consumption of different food groups. Opening a supermarket in a food desert was not associated with an increased consumption of fresh fruits, fresh vegetables, or fresh meats, or with a decreased consumption of grains. However, there is some evidence that opening a supermarket in a food desert was associated with an increased consumption of sweets ($p < .1$). This is consistent with recent research that suggests nearby supermarkets may increase consumption of less healthy foods due to greater accessibility of a wide variety of innutritious foods (Epstein et al. 2012).

Qualitative Findings

Access to Groceries in a Food Desert

According to the food desert hypothesis, the closing of the only grocery store in Grifton should have led to decreased access to fresh and nutritious foods and a corresponding decrease in the consumption of such foods. However, our quantitative findings did not support this argument; and in interviews, few

Table 3. Difference-in-Difference Estimates of the Effects of Living in a Food Desert on Diet.

	Fresh fruits	Fresh vegetables	Fresh meats	Grains	Sweets
	Coef.	Coef.	Coef.	Coef.	Coef.
	(Standard error)	(Standard error)	(Standard error)	(Standard error)	(Standard error)
Treatment	−0.103	−0.099	−0.177	−0.213	−0.361*
	(0.15)	(0.15)	(0.16)	(0.17)	(0.16)
Time	−0.065	0.025	−0.155	−0.185	−0.099
	(0.13)	(0.12)	(0.15)	(0.16)	(0.13)
Treatment × Time	0.035	−0.075	0.099	0.193	0.289†
	(0.18)	(0.16)	(0.20)	(0.21)	(0.17)
Income	0.028	0.056†	0.009	−0.036	−0.008
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Married	−0.175	−0.201	0.015	−0.116	−0.042
	(0.14)	(0.15)	(0.15)	(0.16)	(0.15)
Associate's degree +	0.180	0.128	0.080	0.200	0.116
	(0.14)	(0.15)	(0.15)	(0.16)	(0.15)
Female	0.197	0.076	−0.062	−0.093	0.128
	(0.13)	(0.13)	(0.13)	(0.14)	(0.13)
White	−0.299†	−0.519**	−0.421*	−0.146	−0.329†
	(0.17)	(0.18)	(0.17)	(0.19)	(0.18)
Age	0.001	−0.004	0.002	−0.004	0.007
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SNAP	−0.199	0.128	0.361†	−0.079	−0.085
	(0.20)	(0.20)	(0.21)	(0.23)	(0.20)
Constant	1.193***	1.470***	1.431***	2.238***	0.950**
	(0.34)	(0.35)	(0.34)	(0.37)	(0.35)

Note. $N = 262$ observations. Linear model. SNAP = Supplemental Nutrition Assistance Program.
†$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$.

residents thought living in a food desert changed their diet or the types of food they bought. Many respondents shopped at grocery stores in nearby towns, particularly a Walmart about 30 minutes outside of town. When Grifton was without a grocery store, there were limited fresh and nutritious foods available in town, but many residents responded by either starting to shop or continuing to shop in other communities.

However, while respondents reported modest impacts of living in a food desert on diet and consumption, many respondents believed that living in a food desert did affect access to food and disrupted typical shopping habits. In particular, interview participants frequently focused on the troubles created by not having a grocery store when they only needed a few items. For example, Tiffany, who is white and a mother to young children, emphasized that not having a grocery store in town meant she would have to go without items until the next time she needed to go to Greenville:

> It was different because you had—if there was no ice cream, you had to go to Ayden [a town approximately 8 miles from Grifton] at least. Even for those few little things, it was kind of like when we want ice cream, you know, I don't want to drive 20 miles for ice cream. Or we're out of apples? Well, we're just going to wait until I need to go to Greenville again.

Even after the grocery store opened, many participants highlighted the effects of the new supermarket as particularly useful when a shopping trip to a grocery store in a different

town was not feasible. For example, Nicole, who is white and a parent to two school-age children, lamented not being able to quickly get whatever she happened to need:

> I don't think I've gotten real food there [at the Tropicana]. I think I've only gone because my kids needed stuff for school right now because they couldn't tell me three days ago when I was in [Greenville]. So we'll go to Tropicana because it's handy and I can get there faster than going all the way to Ayden and back.

Others discussed how the Tropicana was useful for picking up a single item to a complete a meal (e.g. one participant last went to Tropicana to buy garlic bread to complete a planned Italian dinner) or to buy enough food to get by until they were able to make a shopping trip to a grocery store in a nearby town. For example, Amber, who is African American and a mother to adolescents, discussed how the prices at Tropicana prevented her from regularly shopping there, but she would buy groceries at Tropicana to hold her over until she was able to get to an out-of-town grocery store:

> And then [Tropicana's] prices, like, this little stuff that is in there that I would eat, it's higher than the Piggly Wiggly or Walmart or Food Lion. When I first get my food stamps, my kids want to go in there, and I tell them just get something frozen until we can go to Ayden or wherever.

While living in a food desert, many participants maintained access to the foods they typically ate by outshopping. Still, participants expressed frustration with living in a food desert when they needed only a few items to complete a meal or to hold them over until they could go grocery shopping in a nearby town. Even after the new grocery store opened, participants emphasized that the store was particularly useful for filling in gaps in between trips to buy groceries in other nearby towns.

Reasons for Outshopping: Affordability, Selection, and Biases

Why did many participants emphasize grocery trips for only a few items when discussing how the new grocery store had changed shopping behavior? An important reason is that many participants seldom shop at the Tropicana. In the Wave 2 survey, we asked residents of Grifton what were the main reasons they outshopped. The non-mutually exclusive response options were related to prices, food quality, available selection of groceries, general feelings about the grocery store, or that it was more convenient to shop somewhere else. Nearly 40 percent of Grifton respondents cited prices as a reason for shopping somewhere other than the Tropicana. The issue of price came up repeatedly in interviews. Participants were cognizant of prices and thought prices at the Tropicana were too high compared with other stores in different towns.

Andrew, who is white and retired, expressed a strong desire to shop at Tropicana because he wanted to support the local grocery store, but lower prices at out-of-town grocery stores prevented him from regularly shopping there:

> I took one look at the price tags [at Tropicana], and I mean, easily they were 20 percent higher overall, and probably 25 percent in a lot of cases. I mean, just a can of—we love baked beans, love Bush's baked beans, and just a can [at Tropicana] was—if I remember right, 70 cents more, and that's on a $1.69 item at Food Lion. That's a pretty healthy percentage.

This issue was not unique to Tropicana. In interviews, respondents thought that before the Piggly Wiggly closed, it also had high prices (albeit lower than the Tropicana). While many respondents reported frequently shopping at the Piggly Wiggly when it was open, they did not exclusively shop there. Respondents thought the prices were much better at other grocery stores, particularly Walmart and Food Lion, and that led them to outshop despite positive feelings about the Piggly Wiggly.

Beyond issues related to cost, participants also expressed frustration with the selection of foods available at the Tropicana. In fact, in the Wave 2 survey, nearly 60 percent of respondents listed the available selection of groceries at Tropicana as a motivation for outshopping. This issue was not a simple concern about the availability of preferred brands, the availability

of particular cuts of meat, or the freshness of produce. For many, the unhappiness with the available selection was rooted in tastes and biases. Specifically, several participants believed the Tropicana targeted Hispanic shoppers and ignored Grifton's African American population. When asked about the difference between the Tropicana and Piggly Wiggly, Andrea, who is African American and a longtime resident of the town, conveyed a belief that Tropicana was focused exclusively on Hispanic shoppers:

Andrea: Piggly Wiggly tried to cater to everybody. Tropicana to me is just catering to them.

Interviewer: Who would you say them is?

Andrea: I don't know if you want to call them Mexican or Hispanic. The Hispanics. You know, to me, that's all they're catering to, but you need to cater to everybody . . . to me, they don't cater to everybody.

Derrick, who is African American and also a longtime resident, echoed a similar sentiment:

> To be honest, [Tropicana is] for Mexican people . . . They got a lot of Mexican food and stuff all up in there, and a whole lot of spicy stuff, and I like spicy stuff, but I don't like a whole lot of crazy spicy stuff, and I don't think a lot of people like that either.

While Michelle, who is white and has adult children, did not express the same belief that the Tropicana focused only on Hispanic shoppers, she was still displeased with the selection at Tropicana:

> It's just something about [Tropicana] that doesn't—I guess it's not as appealing as Piggly Wiggly was. And it doesn't offer, I don't think, the same varieties as Piggly Wiggly did. Funny thing about Piggly Wiggly is if you needed something really weird that like your grandmother needed when she had a recipe, Piggly Wiggly seemed to have it. Piggly Wiggly had a lot of country, downhome items that you couldn't find in other places.

This unhappiness with the selection of foods and belief that the store's target market was Hispanic shoppers spilled over into a more general dislike of the grocery store that focused on employees speaking Spanish to each other. Jessica, who is white and retired, went to the Tropicana only once because she found the store unfriendly:

> I may have just had a really bad experience, but I haven't gone back. When I was there, everybody was speaking Spanish. They were yelling across the store at each other in Spanish . . . I didn't feel welcome . . . They were very nice when they talked English. And I know that sounds really, really bad. I'm not objecting to them speaking Spanish. I'm objecting to walking into a store and no one's paying attention to me and they're busy.

When asked why she thinks people do not like the Tropicana, in addition to prices and selection of stocked foods, Crystal, who is African American and retired, said,

> [Tropicana is] not welcoming. They're speaking Spanish, and you're standing there and everybody's speaking Spanish around you, and when they call to each other, they're speaking Spanish, another language, whatever. It's just not comfortable, some people have told me. I was only there [once]. So I can't judge.

The food desert hypothesis assumes that people will shop at the closest grocery store—a single grocery store remedies food deserts by giving residents a place to buy fresh and nutritious foods. However, Grifton residents outshopped to find better prices, to find a better selection of groceries, and because of an unfavorable view of the Tropicana. Simply opening a grocery store in a food desert is not enough to ensure that people will shop at it.

Outshopping and Routine Activities

While Grifton residents outshopped because of issues related to prices, selection, tastes, and biases, the structure of daily routine activities made outshopping feasible. Grifton residents described regularly leaving Grifton for work, to visit nearby family and friends, and to go to doctor's appointments and run other errands. During interviews, we asked Grifton residents

to describe a typical trip to buy groceries. Few participants described leaving home, going to the grocery store, and returning home. For most participants, a typical grocery store trip was at the tail end of a routine activity that took them away from Grifton.

Tiffany is a full-time student and also has a young child. While attending school in Greenville, she paired shopping trips with days she had class. When she transitioned to online classes, Tiffany paired shopping with other errands:

> For me, [shopping in Greenville] is such a habit because I was going to [school in Greenville], so I was going to Greenville anyway. [Shopping in Greenville] was just a part of my routine. Now I'm doing online [classes], but I have to go to Greenville for things like doctor's appointments, so I just sort of fit it in. It's not really an inconvenience.

Maya, who is white and a mother, offered a similar view of outshopping:

> I try to make [grocery shopping] work with my schedule. I don't go out of my way, like, go all the way to Greenville just for grocery store purposes. I try to have an errand or bill to pay or something like that. Plan it around accordingly.

Many participants expressed a strong want for a Food Lion or Walmart in town, and a preference for shopping at an in-town grocery store with low prices, a good selection of foods, and a welcoming environment. Relative to shopping at an in-town grocery store, outshopping is burdensome. However, the costs associated with outshopping were reduced for many residents because daily routine activities—work, errands, visiting family—took them past grocery stores that they preferred over the Tropicana.

A Grocery Store as a Community Institution

When participants discussed living in a food desert, they lamented not just losing a place to buy groceries, but also losing a community institution. In Grifton, there are few places where people can expect to run into one another and few places that serve as a community bulletin board. Crystal described how Piggly Wiggly served such a role:

> Well, it was quieter [after the Piggly Wiggly closed]. You didn't see the people that you would see normally when you go in [to Piggly Wiggly]. Just running in the store, you'd see this one and that one and your friend, and "hi, how are you doing?" and have conversations, see people from church somewhere other than at church . . . It was more social, you know. [Piggly Wiggly] would have bulletins up of activities in the town and when this church is going to have this and this date and everything.

Michelle also viewed Piggly Wiggly as an important space in town for social activities and also connected trips to Piggly Wiggly to going to church:

> I think people used [Piggly Wiggly] more as a meeting place [than Tropicana]. I'm going to go to Piggly Wiggly, run into people I know, talk. There are days you could go to the Piggly Wiggly and you think you're going to run in for something quick and you're there for 45 minutes to an hour, which was nice. Almost like church.

Later in the interview, Michelle added,

> [Piggly Wiggly] was more than just a grocery store I guess. It was a place to see people. And it was involved in the community.

When the Piggly Wiggly closed, participants felt the absence of the community institution and thought the town felt different as a result:

> [The town] was just different, but I can't put my finger on exactly how. It was just like something was missing, other than just a grocery store. (Tiffany)

> It seemed like people just—people didn't see each other as much. People just drifted apart. (Sarah)

> It was just weird not having a store. I'm like, "how can you have a town without a grocery store?" (Nicole)

Later, Nicole added,

> I think if there's a grocery store [the town] kind of feels more complete. It's like having a post office. You know what I mean? It's something that you kind of need.

In Grifton, the Piggly Wiggly served a purpose beyond a place to buy groceries. The Piggly Wiggly was part of the social infrastructure, functioning as a place for people to see friends and acquaintances and a place to advertise events and learn about community activities. For good reason, food desert research typically focuses on access to food. However, in rural and small-town food deserts, the absence of a grocery store can also mean the absence of an important social institution and have nonfood impacts.

Discussion

The food desert hypothesis holds that living in a food desert negatively affects diet and health. This hypothesis is pervasive and generally accepted by the public and policymakers alike. However, recent research suggests that observed food deserts effects are spurious and attributable to characteristics other than access to a grocery store (Cummins et al. 2014; Dubowitz et al. 2015; Elbel et al. 2015). While these recent studies challenge conventionally held views of food deserts, important questions remain unaddressed. In particular, the studies that are best able to identify the effects of living in a food desert focus exclusively on urban areas and have not fully explored the potential social consequences of living in a food desert.

In this study, we used a quasi-experiment to investigate the effects of living in a small-town food desert. Results from DID regression estimates show that living in a food desert is not associated with changes in diet. However, similar to studies of urban food deserts (Cummins et al. 2014; Dubowitz et al. 2015), we find that living in a food desert is associated with decreased access to food. Specifically, following the opening of a new supermarket in a small-town food desert, regression estimates show a decreased likelihood of experiencing problems getting groceries, an increase in reported ease of getting groceries, and an increase in reported access to fruits.

Findings from in-depth interviews shed additional light on the consequences of living in a small-town food desert. First, even after the new grocery store opened, preferences and biases led many participants to travel to nearby towns to shop at stores they felt had better prices, better selection, or a more welcoming environment. Second, routine activities made outshopping feasible. While many participants would prefer to shop at a grocery store in town, routine activities like work, visiting family, and errands meant participants routinely left town and used these activities as an opportunity to complete grocery trips. Third, the absence of a grocery store negatively affected social relationships and interactions. Local establishments shape spatial contexts and influence when and how community members see each other. In many small towns, establishments and spaces that are regularly frequented by residents and where residents can have unplanned interactions are rare. When living in a food desert, several interview participants expressed a belief that an important community institution was absent and that social relationships deteriorated as a result.

While these findings further understandings of food deserts, there are limitations and areas where additional research is needed. First, the estimates rely on a quasi-experiment from a single treatment town and two control towns, and as such, there is a tradeoff between robust estimates of food desert effects and generalizability. Small towns are not homogeneous and the extent to which these findings are applicable to other small towns with different economies and geographies is unclear. Second, while the flooding that occurred in the treatment town was localized to a small area and initial data collection did not occur until one year after the hurricane, the hurricane and flooding that closed the only store in the treatment town may have influenced shopping behaviors and diet through mechanisms unrelated to the grocery store closing. Third, while these findings build on past studies by focusing on nonurban

contexts, additional studies that identify the effects of living in rural and suburban food deserts are needed. In particular, suburban and rural areas often have overburdened social services, limited public transportation, and patterns of routine daily activities that may make outshopping particularly difficult. Fourth, the estimates assume homogeneous treatment effects. That is, for example, that living in a food desert has similar effects regardless of income, age, or education. This seems unlikely to be the case. Unfortunately, the sample does not have sufficient power to fully explore possible heterogeneous treatment effects. The findings offer robust estimates of the average treatment effect of living in a food desert, but additional research that considers how these effects vary across social groups is needed.

Finally, these findings have important broader implications for policymakers and understandings of economic and social life in small towns. In recent years, policymakers have embraced the idea that food deserts are social problems. A common response is for policymakers to subsidize new grocery stores in food deserts through subsidies and tax incentives, focusing on increasing local food availability. However, if the goal is to improve diets and, in turn, public health, then increasing local food availability may be insufficient. In particular, cost is a significant barrier to eating nutritious foods (Daniel 2016; Darmon and Drewnowski 2008; Wang et al. 2014), and financial supports that allow people to purchase nutritious foods may be a more effective way to improve diets. Moreover, when deciding where to shop, community residents consider more than proximity. If the grocery store is a poor fit for the community or cannot compete with the price and selection of nearby grocery stores, community use may be low despite the need for the grocery store. Nonetheless, while our research adds to recent studies that question the extent to which opening supermarkets in food deserts can improve diets, dismissing food deserts effects outright is a mistake. In addition to improving perceived food access, our findings show that grocery stores can have important community and social impacts.

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Supplemental Material

Supplemental material for this article is available online.

Notes

1. There are different types of food retailers (e.g. supermarkets, supercenters, discount stores, natural or organic stores, convenience stores, farmers' markets). Typically, research on food deserts focuses on access to the types of food available at either a supermarket or supercenter. Here, we use grocery store and supermarket interchangeably to represent large, self-service food retailers.
2. Despite disagreement about what constitutes a food desert, the United States Department of Agriculture's (USDA) definition of a food desert is widespread and commonly used. According to the USDA, food deserts are Census tracts where a substantial portion of the population has low access to a grocery store or supermarket, defined as at least 500 people and/or 33 percent of the tract population living more than one mile from a grocery store in urban areas and more than 10 miles in rural areas. In an alternative definition, the USDA limits food deserts to areas that have low access to a grocery store and are also

low-income tracts, defined as tracts where the poverty rates is at least 20 percent or greater or the median family income is 80 percent or less of the median income in the metropolitan area (Dutko, Ver Ploeg, and Farrigan 2012). By both of these definitions, the town we studied would be considered a food desert.

3. Small towns are common in the United States. The U.S. Census Bureau identifies approximately 19,500 incorporated places in the United States, defined as cities, towns, boroughs, or villages that have local governments with the power to collect taxes and provide services (Cohen 2015). Of the roughly 19,500 incorporated places in the United States, three in four have populations less than 5,000, and nearly 10 percent of the U.S. population lives in an incorporated place with a population size below 10,000 (Cohen 2015).
4. Estimates of Grifton and state population characteristics are derived from the 2012–2016 American Community Survey.
5. We generated 25 imputations. Each of the imputed data sets were then analyzed separately and the resulting set of estimates were averaged to produce estimates based on all 25 imputed datasets. We also ran all analyses using listwise deletion and found substantively similar results.
6. We also examined whether living in a food desert was associated with food insecurity. We did not find any statistically significant associations between living in a food desert and experiencing food insecurity. Results from these analyses are presented in Online Appendix B.
7. The survey included additional food types. Namely, we also asked respondents about consumption of frozen fruits, frozen vegetables, frozen meats, sugary drinks, and water. Analysis of these outcome yielded similar results and we elected to exclude these outcomes from our findings for parsimony.
8. Interview participants received a $20 gift card. We use pseudonyms for all participants. In presenting our findings, we include minimal description of the participants to protect the confidentiality of participants.

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