Does Living In A Food Desert Affect Obesity Rates?

Marisa Boyette
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Professor Arias
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Abstract: The USDA conducted extensive research on US food access and found that 23.5 million US citizens currently live in food deserts, which are defined as low-income areas with low access to affordable, healthy food. Utilizing county-level obesity rates from the CDC and the USDA's definition of food deserts, I estimate the effect living in a food desert has on obesity rates. Previous work has found effects of race and income on obesity rates and on living in food deserts, but the causal link remains unclear. I find no causal effects, suggesting the policies surrounding food deserts may be ineffective in reducing obesity.

I. Introduction

The USDA defines a food desert as a low income area lacking access to places that provide food items to make up a healthy diet. Food deserts can be deficient of grocery stores, have high densities of fast food restaurants relative to other food retail outlets, and they are not typically conducive to farmer's markets. The USDA has done extensive research within the past decade with the goal of identifying food deserts across the nation and study the problems they present to American people. From this research, the USDA plans to enact programs that expand the availability of healthy foods to all areas of the country in order to encourage Americans to obtain a healthier diet and reduce negative health outcomes like diabetes and obesity. However, the idea that increasing access to healthy food leads to healthier outcomes is unfounded.

The Farm Bill passed in 2014 allocated $125 million in each of the next 5 years to the Healthy Food Financing Initiative (HFFI) for startup grants and affordable loan financing to incentivize healthy food providers to invest in food desert areas. To qualify as a food desert, the USDA must determine that at least a third of an urban area's population lives at least a mile (or ten, for rural areas) away from a supermarket or large grocery store (ANA 2010). The initiative was part of a major restructuring of the Supplemental Nutritional Assistance Program (SNAP) that will see an estimated 2.8 million people losing their benefits, according to the Congressional Budget Office. The goal of HFFI is to increase food access to the 23.5 million Americans currently living in food deserts and ultimately reducing health disparities by easing barriers to entry for food retailers in the underserved parts of the country. The effects of HFFI on food retailers and those communities being served by them will have to be studied in the future. I am interested in the effect of living in a food desert on obesity rates because at the root of the food

desert problem is that one third of the US population is considered obese, and the government is trying to implement solutions, like the HFFI, to combat this issue.

II. Lit Review

Research on food deserts is still in its developing stages, with the majority of research being done throughout the past decade and food deserts only recently becoming important in legislation. The main issue with the literature on this subject is the inconsistency in defining food deserts and the heterogeneity among findings linking the food environment to health disparities across race, and different levels of income and education. Cross sectional data and the studies of small geographic locations makes developing consistent theories difficult and interpretation of findings complicated because results deal with associations rather than causation. (Gordon-Larson 2014).

Hendrickson (2006) studied Minnesota communities, and defined food deserts as urban areas with 10 or fewer stores, none of which have more than 20 employees, and found that low income residents suffered from diminished healthy lifestyles due to absence of affordable, quality food. A more general definition was used by Cummins and Macintyre (2002**)** which stated food deserts were "poor urban areas, where residents cannot buy affordable, healthy food" focusing more on the quality of food available rather than quantities. The Mari Gallagher study (2006) developed a food balance score—a ratio that interacts the availability to healthy and unhealthy food retailers—to define food deserts.

Research by the USDA's Economic Research Service (ERS) is now collecting and analyzing data on food access at the national level using its own definition of food access which uses geocoding to measure distances to grocery stores. Because this definition of a food desert

could be used to enact federal legislation, it is important to look at research that has used this USDA definition to determine the effectiveness of potential policies.

In recent reports to Congress, the USDA ERS present their overall findings about food access in the United States. The HFFI advertises that 23.5 million people—8.4 percent of total US population—are living in food deserts across the nation, but this figure represents the people living in areas of low income and low access but are not necessarily low income households. In fact, the USDA ERS states there are only 11.4 million people (4.1%) who are low income residents living in a low access area, and only 2.3 million (2.2%) of those do not have access to reliable transportation. Thus, the access problem in the United States may be overstated. They also find that easy access to all food—called a food oasis—rather than lack of access to healthy food may explain increases in obesity rates (USDA ERS 2009).

Many studies have been done showing the effects of race, income, and education on health outcomes. Minority neighborhoods are disproportionately affected by adverse health outcomes (Cubbins 2001, Deaton and Lubotsky 2003). Alviola thoroughly studied the determinants of food deserts in Arkansas based on the USDA's measure of food deserts and found no meaningful evidence that urban areas with higher minority populations or low income communities have less access to grocery stores (Alviola 2013). However, they did find that minority urban areas may face higher densities of fast food and convenience stores. Morland conducted research in 2002 for four states and geocoded addresses for all food places to census tracts, using median house values to estimate neighborhood wealth and the proportion of black residents was used to measure racial segregation. They concluded that poor and minority communities do not have equal access to the variety of healthy food choices available for wealthier, nonminority neighborhoods (Morland 2002).

Mari Gallagher Research & Consulting Group studied the effect of food deserts at a local level using Chicago census tracts and the prevalence of health problems related to food access issues. They use a novel measure of food access that takes a more in depth approach than the traditional proximity measures. Food balance scores are calculated based on densities of healthy food stores relative to unhealthy ones within a certain distance of Chicago neighborhoods. They find a possible relationship between unfavorable food balance scores and diet-related deaths. Their data shows that census tracts with a majority black population face higher incidences of diet related deaths compared to majority white tracts. Even the majority black tracts with favorable food balance score face higher rates of diet related deaths than do majority white neighborhoods with unfavorable food balance scores. Their findings suggest that income levels—which were lower in majority black tracts—play a role in diet related deaths. Demand preferences toward less nutritious foods, which could be endogenous with income levels could also explain this variation. The food balance score is a different way of measuring food deserts that interact the availability of healthy and non-healthy food retailers, which gives a better insight to the choices people face in their food environment and does not assume that distance to a grocery store is the sole factor in food access (Mari Gallagher 2006).

Most recently, Handbury in 2015 takes a look at consumers with different socioeconomic backgrounds and studies household's food purchases and the kind of retail environment that influences that decision process and the role that access plays. They suggest that income and education play a more important role in food purchase decisions. They find that low income neighborhoods and less educated households are more likely to purchase less healthy food. But they find that spatial differences in access only explain a fraction of the variation in nutritional content of household purchases because systemic socioeconomic disparities still exist after

controlling for access—i.e. households with more education purchase healthier food. An important finding in this research is that even when food retail environments change, households only slightly respond to the changes, implying that household food purchases are made based mainly on demand rather than supply (Handbury 2015). Thus policies aimed at improving access such as the HFFI may not be the solution to improving healthful food purchases among low access households.

As for other economic explanations of the obesity epidemic, Finkelstein found evidence that suggests technology may be primarily responsible as it allows people to expend less calories while being more productive. Reduced food prices, especially energy dense food, television, and the built environment all contribute to rising obesity rates and should be considered when talking about the obesity epidemic. This study gives a thorough understanding of the economic causes behind obesity and why the recent discussion of the eradication of food deserts may not solve the epidemic (Finkelstein 2005).

Overall, the literature finds links between adverse health outcomes and racial minority neighborhoods as well as low income neighborhoods. And food deserts are low income neighborhoods, oftentimes populated with racial minorities. However, the literature has not been able to consistently find a causal link between food deserts and obesity rates or other adverse health outcomes. This paper attempts to test the causal link between obesity rates and food deserts that would help determine the usefulness of public policy regarding food deserts.

III. Data

The USDA's Economic Research Service (ERS) put together the *Food Environment Atlas* with the objective of encouraging research to be done on the determinants of food choices and diet quality. The *Atlas* is a database documenting food environment factors for every county in

the US such as health, access, assistance, restaurants, other food stores, prices, and socioeconomic characteristics. I used 2010 cross sectional data to conduct my research and observed 2,709 US counties after eliminating 434 counties for missing data. Panel data could not be utilized as many food environment variables have not yet been observed over time, and many other variables could only be collected at the state level and were excluded from the model as to avoid measurement error. Food deserts are a relatively recent concern in the US, and there will surely be more data collected in the future allowing researchers to observe food environment variation over time.

The key independent variable—the food desert measure—is the percentage of each county's population living in a low income area and having low access to grocery stores or supermarkets (more than 1 mile in urban areas and more than 10 miles in rural areas). The USDA used 2010 Census population data, 2006-2010 American Community Survey data on income and vehicle access, along with 2010 directories of supermarkets to map food access across the United States. Population data are reported at the block level and the center point of each half kilometer square block was used as the point to measure distance to the nearest grocery stores. If the block was more than 1 mile from a grocery store or supermarket in an urban area or more than 10 miles in a rural area, the block would be considered low access. Urban and rural areas defined by the Census Bureau, coded 0 if rural and coded 1 if urban. Then the number of these low access blocks were divided by the total blocks in the county to develop a proxy for percentage of the county living in an area with low access to healthy food retail stores. Food deserts, however, should not simply be defined as areas with low access to healthy food. Rather, they should be more precisely defined as areas of low access and low income. If more than 40 percent of a

county's population lives at or below 200 percent of the Federal poverty thresholds, it is considered a low income area. I used the low access, low income percentage variable.

Health variables were collected from the County Health Rankings and Roadmaps database for 2010. Mortality rate measures the deaths recorded in the county divided by the total population. Percentage of fair/poor health was collected by the Center for Disease Control (CDC) via telephone interviews asking participants whether they ranked themselves as having "fair" or "poor" health reflecting the percentage of each county's population. I collected education data from the 2010 Census using the American FactFinder to extract aggregate percentages of adults aged 25 or over at the county level for all different levels of educational attainment. Table 1 provides summary statistics of the data collected.

Table 1: Summary Statistics for 2709 US Counties

	Mean	Std. Dev.	Min	Max
Dependent Variable				
%OBESE	30.60	4.37	13.1	47.9
Independent Variables				
%FOOD_DESERT	7.98	7.41	0	62.93
REC_FACILITIES	11.48	32.39	0	705
%FAIR/POORHEALTH	16.88	5.89	2.26	46.37
FASTFOOD	76.88	244.62	0	7175
FULLSERVICE	79.70	246.27	0	7008
%SNAP_PART	15.33	7.68	.86	59.33
%BLACK	8.89	14.38	0	85.43
%HISP	7.08	11.01	.09	95.74
%OTHERRACE	3.30	8.46	0	95.17
MEDIAN_HHINC	43827.28	10978.86	20577	119075
PERPETULPOV*	.11	.31	0	1
METRO*	.41	.49	0	1
GROCERY	23.18	82.32	0	2084
SUPERMARKET	1.19	2.81	0	60
CONVENIENCE	89.91	273.79	0	7575
MORTALITYRATE	.45	.14	0	1.01
%HSGRAD	56.45	6.72	18.60	74.50
%ASSOCIATES	7.61	2.29	1	18.80
%BACHELORS	12.92	5.41	1.90	42.20
%GRADUATE/PROF	6.72	3.91	.50	36.80

*Zero-one dummy variable

IV. Model

In order to find the effect of living in a food desert on obesity rates, I estimated the following model using Ordinary Least Squares.

$$\%OBESE_i = \beta_0 + \beta_1 \%FOODDESERT_i + \delta X_i + \varepsilon_i$$

Controls (X)

Race- %BLACK, %HISP, %OTHERRACE

Education- %HSGRAD, %ASSOCIATES, %BACHELORS, %GRADUATEPROF

Income- MEDIAN_HHINC, %SNAP_PART, PERPETUALPOV

Health- MORTALITYRATE, %FAIRPOORHEALTH, REC_FACILITIES

Other- METRO, FASTFOOD, FULLSERVICE, GROCERY, SUPERMARKET, CONVENIENCE

Full definitions and data sources of variables found in the Food Environment Atlas can be found in the Food Environment Atlas Documentation released in July 2015.

The dependent variable %OBESE is the county level obesity rate for the year 2010 which is the year from which I pull the rest of my cross sectional data. %FOODDESERT is the variable representing the percentage of the county that lives in a food desert as defined by the USDA. The findings of the food desert effect on obesity rates will have policy implications for the future of federal spending on this issue.

The vector of control variables include health, income, education, race, and other food environment variables that were controlled for in previous literature as they have been found to be related to variations in obesity rates. To measure health characteristics of counties, I used %FAIRPOORHEALTH measuring the percentage of the county which feels that they are in fair or poor health to control for the physical health that may affect higher likelihoods of obesity. Other health variables include RECFACILITIES which counts the number of recreational

facilities in each county and MORTALITYRATE which is the number of deaths in a county divided by its population.

Food environment variables—FASTFOOD, FULLSERVICE, GROCERY, SUPERMARKET, and CONVENIENCE—are simple counts of each establishment in each county. If low access to food were to have an effect on obesity rates, counties with low numbers of food establishments should have higher incidences of obesity. In particular, it will be interesting to find the effect of certain food stores such as fast food on obesity rates.

Aggregate percentages of county demographics such as race and education are controlled for in the model. The racial makeups and educational attainments of counties have previously been found to have significant effects on obesity rates (Handbury 2015, Morland 2002, Cubbins 2001, Deaton and Lubotsky 2003).

Two zero-one dummy variables are in the model, PERPETUALPOV turns on when a county's poverty rate was at least 20 percent for the 30 years prior to 2010, and METRO turns on in cases when a county contains one or more urbanized areas containing 50,000 or more people and when outlying counties are economically tied to urban areas.

V. Results

Regression results appear in Table 2. Within my model, twelve of twenty explanatory variables were statistically significant. My findings reflected previous research which also finds that variation in obesity rates can be explained by race, income, poverty, and education variables. All but two of the twelve significant variables were statistically significant at the 99% level.

Table 2

Dependent Variable: %OBESE
Method: Least Squares

	Coef.	Std. Err.	T	P>|t|
%FOODDESERT	.012	(.010)	1.17	0.244
RECFACILITIES	-.006	(.006)	-0.87	0.383
%FAIRPOORHEALTH	.058***	(.015)	3.81	0.000
MORTALITYRATE	-.528	(.698)	-0.76	0.450
FASTFOOD	.006***	(.002)	3.01	0.003
FULLSERVICE	.001	(.006)	0.20	0.844
GROCERY	-.002	(.002)	-0.98	0.325
SUPERMARKET	.055	(.041)	1.32	0.188
CONVENIENCE	-.007	(.005)	-1.57	0.118
%SNAP_PART	.081***	(.016)	5.19	0.000
MEDIAN_HHINC	.0000168*	(9.79e-06)	1.71	0.087
PERPETUALPOV	.667***	(.236)	2.82	0.005
METRO	.532***	(.136)	3.91	0.000
%BLACK	.080***	(.005)	15.98	0.000
%HISP	-.078***	(.007)	-11.76	0.000
%OTHERRACE	.035***	(.011)	3.14	0.002
%HSGRAD	.036**	(.017)	2.16	0.031
%ASSOCIATES	-.043	(.029)	-1.43	0.152
%BACHELORS	-.193***	(.028)	-6.96	0.000
%GRADUATEPROF	-.256***	(.029)	-8.76	0.000

P values *=.1 **=.05 ***=.01
Number of obs = 2709
F(20, 2688) = 168.57
Prob > F = 0.0000
R-squared = 0.5869

All race variables were significant at the 99% level. All else constant, when the black population of a county increases by 1 percentage point relative to the white population, the obesity rate will increase by .08 percentage points. There have been several possible explanations as to why black populations suffer from higher rates of obesity compared to other races, income and education disparities among them. In a moderately surprising result, I found that increasing the Hispanic population by 1 percentage point relative to the white population, there would be a .07 percent decrease in the obesity rate. Statistics from the CDC show that Hispanic adults are obese at a rate of 42 percent compared to 32.6 percent of white adults (Ogden 2011). Other races (%OTHERRACE) is an aggregate percentage of the counties' populations of

Native Americans, Asians, and Pacific Islanders. I found that at the 99% level, increasing the population of these other races relative to the white population, obesity rates will increase by .035 percentage points. The results of the race variables are meaningful to the conversation about the link between race and obesity, and warrants questions about why certain races are more likely to have an obesity problem than others.

Out of the four education variables, three were statistically significant. The effect of having a high school diploma is significant at the 95% level and having a bachelor's or graduate or professional degree is significant at the 99% level. Only having an associate's degree did not have a significant effect. The omitted group was the percentage of the adult population that had earned less than a high school diploma or the equivalent. I found that, all else constant, when there is a 1 percentage point increase in the percentage of high school graduates relative to those with less than a high school diploma, there is a .036 percentage point increase in the obesity rate. At first, this seemed to be a surprising result as increases in education should lead to decreases in adverse health outcomes but there could be significant differences in outcomes for people that achieve a high school diploma relative to those who do not, such as substantial differences in income which also affects obesity rates. In a result that is consistent with the literature, I found that a 1 percentage point increase in the population earning bachelor's degrees decreases the obesity rate by .193 percentage points and a graduate or professional degree would decrease the obesity rate by .256 percentage points which are among the strongest effects on obesity rates in the model.

Income and poverty variables such as counties of perpetual poverty (PERPETUALPOV), participation in the Supplemental Nutritional Assistance Program (%SNAP_PART), and median household income (MEDIAN_HHINC) are all in the model to represent different measures of

income or poverty. Multicollinearity between these variables were tested and found not to be an issue. The percentage of the population participating in SNAP has an effect on obesity rates at the 99% significance level. When a county's population increases SNAP participation by 1 percentage point relative to those who do not, it results in a .081 increase in the obesity rate. Although the effect is not large in magnitude, it is still economically meaningful because the USDA's major goal is to improve the overall health in the United States but their major welfare program, SNAP, seems to play a role in diminishing it.

Counties in perpetual poverty were found to have a significant, positive effect on obesity rates at the 99% level. The obesity rate in perpetual poverty counties are .67 percentage points higher than counties not in perpetual poverty. This effect is massively important as it indicates that the areas where income has been a problem for a long period of time will have unhealthier people. To combat the worst instances of obesity, policymakers may focus on these areas of perpetual poverty. As for median household income, it is statistically significant at the 90% level and I find that with all other variables held constant, increasing the county median household income by $1,000 results in an increase of .016 percentage points in the obesity rate. The sign of the coefficient is inconsistent with the literature but not economically meaningful because the changes in income is often linked to higher education which I see has a bigger impact on obesity than a simple aggregate measure of income.

VI. Conclusion

From my model, I cannot say with any level of confidence that food deserts have an effect on obesity rates. Previous literature shows that minority neighborhoods have significantly less access to healthy foods than do nonminority neighborhoods. And I found that counties with minority populations have larger, positive effects on obesity rates. The model also indicates that

the highest levels of education such as bachelors and graduate degrees have a meaningful, negative effect on obesity relative to the lowest level of education which is consistent with the literature as well. In a particularly interesting finding, impoverished counties, particularly the ones who have been that way for an extended period of time, have significantly higher rates of obesity. As expected, the variables measuring education, income, race all had significant effects on obesity whereas the variable of interest had no effect at all. Concluding that food deserts may not be the explanation of the obesity issue, rather there may be a foundational problem surrounding the areas of high obesity such as poverty and race that plays a more prominent role for health outcomes in the US.

What is unclear is the causal pathway from food deserts to obesity rates. Minority and low income neighborhoods do live in food deserts and they typically have higher rates of obesity, but from my model I cannot say with any confidence that there is a clear link between these food deserts and obesity. Cross sectional data makes me unable to control for unobserved heterogeneity across counties. My model also does not control for demand factors such as preferences towards healthy and unhealthy diets and different levels of physical activity, which is difficult to measure at the individual level and especially difficult at the county level and could potentially bias my model.

Without being able to find a causal relationship between food deserts and obesity, the policies set forth by Congress such as the HFFI may be able to increase access to healthier food which may help food insecurity issues, but it may not necessarily solve anything relating to the obesity epidemic. What these government programs such as these fail to address is the demand for healthy foods relative to unhealthy foods. Fast food restaurants are not only successful because of their convenience and cheaper prices, but people do in fact enjoy the unhealthier

food. In fact, places considered “food oases” where healthy and unhealthy food stores are prevalent have high rates of obesity as well. The average obesity rate of the 200 counties with the most access to grocery stores is 30.8 percent, which is 0.2 percentage points higher than the mean obesity rate for all counties. What the model in this paper does is address the supply side of the food access issue, finding that lacking access to healthy food outlets has little to do with variation in obesity rates. Perhaps the pertinent issue is the demand for unhealthy foods relative to healthy foods and in order to solve the obesity epidemic in the US, there has to be an increase in demand for healthy foods with a corresponding supply.

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