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Food Deserts and Their Association with Obesity and Diabetes in Ohio

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6/23/2012

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Abstract

Objective- The purpose of this study was to explore the association of food access, and availability, on prevalence of diabetes and obesity in Ohio census tracts designated as food deserts.

Methods- County and census tract-level data were combined from the USDA Food Environment Atlas and USDA Food Desert Locator respectively. Statistical analysis was conducted using IBM Statistical Package for Social Sciences (SPSS). Non-normally distributed variables were assessed using the Mann-Whitney nonparametric U-test and Spearman's correlation coefficient. Significance was considered at the $p < 0.05$ level.

Results- The mean rate of obesity and diabetes in Ohio in food deserts are 29.5% and 10.7%, when compared to Ohio (29.2%, 10.7%) rates, and US rates (35.7%, 8.3%), respectively. No significant difference was found in the mean percentages of the population with diabetes in rural versus urban communities. Rural communities were found to have a significantly higher rate of obesity. Supercenters and convenience stores without gas were found to be directly related to the incidence of diabetes in the overall observed population. Convenience stores with no gas, fast food restaurants and recreational facilities were found to be negatively correlated to the percentage of the population comprised of African Americans. Poverty had a strong influence in the African American population. Low poverty communities were found to have nearly twice as many farmers' markets as communities with a high poverty level.

Conclusion- This study concludes that the accessibility of supermarkets and club stores were correlated to the number of cases of obesity, as was the number of convenience stores with gas, and farmers; markets. Future research should highlight the association of food deserts and diabetes. Futures studies should also feature analysis of data collected on an individual level.

Food deserts and their health effects in Ohio

Many Americans are aware of the recommended food intake guidelines in order to lead a healthy life. However, not all are meeting the daily-recommended intake of fruits and vegetables, and are far exceeding the recommended intake of fat, added sugars and sodium. This contributes to several adverse health outcomes including obesity and numerous chronic diseases.

The American Dietetic Association, the National Institutes of Health, and many other national organizations recommend a balanced diet based on the US Department of Agriculture's Food Guide Pyramid (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). Recently, the USDA's food guide pyramid has been replaced with the concept of "My plate" to provide Americans with a simpler, easier guide. All foods are placed in one of five categories: grains, vegetables, fruits, dairy, and protein foods (with the exception of beans and peas, which are considered both protein foods and vegetables) (USDA, 2011).

Chronic diseases are responsible for 7 out of 10 deaths in United States each year. In the year 2005 alone the prevalence of chronic disease among Americans totaled 133 million (CDC, 2012). The most prevalent chronic diseases are cardiovascular disease, diabetes, and cancer. Poor diet, lack of physical activity, tobacco use and excessive consumption of alcohol are all modifiable behaviors that are known to contribute to the onset of these chronic illnesses (CDC, 2012). Poor eating habits contribute to the increased epidemics of obesity and chronic diseases, more than individual factors like knowledge, skills or motivation (Story et al., 2008).

The concept of "food deserts" was first introduced in Scotland in the early 1990s to explain disparities in food pricing. It is a term applied to areas with limited access to chain grocery stores. A food desert is any area where it is difficult to obtain healthy food. Food deserts are environments that are not conducive to health, presenting barriers that restrict access to

healthy food. Barriers to be considered are lack of access to food retailers, availability of nutritious foods, or affordability of foods. Currently, there are some sections of the population that lack access to healthy food. For instance, people living in low-income and/or predominantly black neighborhoods generally have less access to grocery stores and supermarkets (Zenk et al., 2011). Food deserts are most prevalent in areas of low socio-economic minority communities (Beaulac, Kristjansson, & Cummins, 2009).

Statement of Purpose

The purpose of this study is to explore the effect of food deserts on prevalence of diabetes and obesity and population characteristics in Ohio.

Literature Review

Healthy People 2010 aimed to reduce obesity in children and adolescents in the US by 5%. (Department of Health and Human Services, 1990). However, between the years 2000 to 2008, obesity increased 3% among 2-19 year olds (Ogden & Carroll, 2008). As response to this increase in obesity, several initiatives were undertaken, including a \$400 million healthy food initiative (Department of Health and Human Services, 2000), the founding of White House Childhood Obesity Task Force, (White House Task Force on Childhood Obesity, 2010, 2010) and an updated strategic plan giving obesity prevention a priority in the Department of Health and Human Services (Department of Health and Human Services, 2009).

One of the major current public health concerns is the increase prevalence in obesity and preventable diet-related diseases (Ver Ploeg et al., 2009). As a result of this increase, \$800 billion is spent annually in the US on health care costs (Schumacher, Nischan, & Simon, 2011). The annual cost to US taxpayers in 2005 for obesity and diabetes alone was \$115 billion and \$130 billion, respectively. In 2005, nearly 1 of every 2 adults suffered from at least one chronic

illness (Wu & Green, 2000). According to the CDC, 1 in every 3 adults is obese and almost 1 in 5 youth between the ages of 6 and 19 is obese (CDC, 2012). Moreover obesity is a major concern for youth and adolescents, as they grow into obese adults (An & Sturm, 2012).

Food Deserts

While there is no universal definition for a food desert, in the United States, “food deserts” are areas that have limited access to healthy, affordable food, are generally found in urban and rural low-income neighborhoods. Congress wanted to find a way to measure how many people have limited access to healthy food and who lived in those areas due to the Let’s Move initiative; the initiative proposed the HFFI will increase the availability of food. The Healthy Food Financing Initiative Working Group defines a food desert as a low-income census tract where a substantial number or percentage of residents has low access to a supermarket or large grocery store (Breneman & Ver Ploeg, 2009). Low access to a healthy food retail outlet in urban areas is living more than 1 mile from a grocery store or large supermarket, or more than 10 miles away from a retail location if living in rural areas. The distance between the place of residence and the nearest supermarket is measured as the distance between the center of a one-kilometer square area and the nearest grocery store or supermarket. Once this distance has been calculated for each separate area, the estimated number of people more than a mile away from a grocery store or supermarket is collected to determine the census tract level. At least 33 percent of the population, or a minimum of 500 people in the tract, must have low access to a supermarket or grocery store to be identified as living in a food desert. It is estimates that a total of 13.6 million people in these census tracts have low access to a supermarket or large grocery store (Breneman & Ver Ploeg, 2009). These areas are less likely to include grocery stores, or outlets from which people can obtain healthy, nutritious foods at affordable prices. The New

Markets Tax Credit program defines low-income census tract as any tract where the rate of poverty is at least 20 percent and the median family income for the tract does not exceed 80 percent of the statewide median family income for tracts located inside a metropolitan area, or 80 percent of the greater between statewide median family income and metropolitan median family income if the tract is not located in a metropolitan area (Breneman & Ver Ploeg, 2009).

Food insecurity has been connected to obesity (Dinour, Bergen, & Yeh, 2007). This relationship suggests that people living in food deserts are more likely to select foods that are higher in caloric content but lower in nutritional value (Murphy, 2011). These unhealthy food selections put this population at a higher risk of suffering from chronic illnesses like diabetes, cardiovascular disease, and obesity (Murphy, 2011).

The Food and Trust Policy recently reported that 23 million Americans or more living in food deserts and are at greater risk for obesity and obesity-related diseases (Steyn et al., 2007). In urban environments, a growing understanding of the relationship between diet and health in the recent years has led to increased analysis of the accessibility of competitively priced healthful foods (Sparks, Bania, & Leete, 2011). In the United States 2.3 million households live more than a mile from a supermarket and have no vehicle to access food. Households of an additional 3.4 million do not have access to a car and or live ½ mile to a mile away from the supermarket (Ver Ploeg, 2009).

Lack of Access to Food Retailers

People living in areas with limited access generally rely on small grocery or convenience stores that may not carry all the foods recommended for a healthy diet, or may offer them at substantially higher prices (Ver Ploeg et al., 2009).

Food access describes one's ability to reach local food retail outlets by use of convenient forms of transportation. Because full service markets may be further away, residents in these areas are more likely to buy food from convenience stores that stock mainly cheap, processed foods, usually high in fats and sugars (Bauer, 2004). Food retailers are discouraged from opening chains in urban and low-income rural communities because of crime rates, transportation costs and low return on investment (Bitler, 2009). Residents of food deserts have no choice but to utilize private cars, travel several miles on foot, or use public modes of transportation to obtain healthful foods (Bauer, 2004).

Nutrition

Nutrition is the provision of the materials in the form of food to support life. Fruit and vegetable intake are important components of a healthy diet but are under-consumed especially among low-income groups that already have high obesity prevalence rates (Jilcott, Keyserling, Crawford, McGuirt, & Ammerman, 2011). According to the United States Department of Agriculture's 2011 MyPlate healthy eating initiative, there are 5 components of a healthful meal: Grains, vegetables, fruits, dairy and protein foods. The initiative highlights a pie chart-like diagram of the proportions of each group a balanced meal should be composed of. At least half of the plate should be fruits and vegetables. The other half of a dinner plate should be made up of grains and protein, with more emphasis on the grains. Dairy should be incorporated into the meal, but it should not be a main course.

An and Sturm (2012) proposed two hypotheses to improve the diet quality and prevent weight gain (1) improve access to grocery stores and supermarkets or (2) reducing exposure to small food stores, fast food and convenience store. Convenience foods, including products such as candy, sugary beverages, processed meats and cheeses, canned products, pre-cooked frozen

meals and fast foods require little or no preparation before eating, and normally contain higher amounts of sodium (Jeffrey, Baxter, McGuire, & Linde, 2006).

Health-threatening conditions like obesity and chronic illnesses like diabetes, cardiovascular disease and cancer are attributed to an excess food intake or lack of exercise. Cardiovascular disease has been linked to an omega 3 fats deficiency in diets. Omega-3 fatty acids are most commonly found in marine and plant oils. These acids, also called n-3 fatty acids, have many health benefits, and are considered essential fatty acids, because they cannot be synthesized by the human body alone, but are vital for normal metabolism. Omega-3s are essential for normal growth and development, and may play an important role in the prevention and treatment of coronary artery disease, hypertension, diabetes, arthritis other inflammatory and autoimmune disorders, and cancer (Simopoulos, 2011).

Availability of Nutritious Foods

Food availability describes access to healthy foods and beverages sold or served at retail food outlets. The prevalence of food deserts in poorer neighborhoods is driven by lack of consumer demand since the poor have less money to spend on healthy nutritious foods, which tend to cost more than convenience foods (Bitler, 2009). Consequently, this disallows urban residents the benefits of healthy foods at affordable prices (Yeh & Katz, 2006). The Healthy People 2010 initiative emphasizes the importance of increasing consumption of healthy foods because most Americans do not meet the dietary recommendations, however healthier foods are not equally available to everyone (Department of Health and Human Services, 2005). Researcher Mari Gallagher and associates pioneered a study that, instead of looking at areas that had been designated food deserts, calculated the food balance, a ratio of fringe stores to mainstream food venues. A community is said to be food balanced when large grocery stores are roughly the same

distance as a fringe food venue, making both venues equally easy to get to. Gallagher's study found that fringe food in Chicago was far easier to access for areas with a high concentration of single mothers and children (Mari Gallagher Research & Consulting Group, 2010).

Affordability of Food

Food affordability impacts low-income people. Instead of shopping for the healthiest food they can get have to purchase affordable Purchasing food may compete with paying for other necessities like housing, clothing and transportation (Ver Ploeg et al., 2009). Supermarkets frequently have a wider variety of foods, at better prices than smaller stores, sometimes saving consumers up to 75% of the cost, and providing better quality (Wilson, 1994).

Racial and Socioeconomic Disparity and Food Availability

There is strong evidence showing associations between socioeconomic status and racial/ethnic disparities and diet (Kant, Graubraud, & Kumanyika, 2007). These disparities can lead to disproportionate prevalence of obesity and diet-related disease (Department of Health and Human Services, 2009). For example, African Americans have a higher risk of dying than Caucasians in the US, which is 146% higher for stroke, 131% higher for heart disease, and 208% higher for diabetes (National Center for Health Statistics, 2009). Research has shown that low-income African American neighborhoods have fewer supermarkets and more liquor stores and convenience stores than higher income Caucasian neighborhoods, respectively (Zenk et al., 2011). Food security, defined as access by all people, at all times to enough food for an active, healthy life (Nord, Coleman-Jensen, Andrews, & Carlson, 2010). An estimated 11.1% of Americans have "low food security" and 4.1% have "very low food security" with African Americans and Latinos estimated to have doubled the national rates (Nord, Andrews, & Carlson, 2007).

Research Questions

In this study, we desire to answer the following questions:

1. Are the diabetes and obesity rates higher in census tracts or counties designated as food deserts?
2. Are African Americans more susceptible to living in a food desert?
3. Is the number of grocery stores per capita directly related to the number of obese and diabetics in a community?
4. Do areas with high poverty rates have less access to supermarkets or recreational facilities?

Methods

Data Sources

The two sources used for this analysis were:

- 1) The Food Desert Locator Documentation
(www.ers.usda.gov/data/fooddesert/documentation.html)
- 2) The Food Environment Atlas
(www.ers.usda.gov/foodatlas/documentation.htm)

The Food Desert Locator

The Food Desert Locator is an online database that includes characteristics only for census tracts that qualify as food deserts. It provides a spatial summary of food-desert census tracts located throughout the U.S. It also provides population characteristics and offers data for community planning or research purposes. The food desert locator initiative began in 2009, in an effort to provide access to affordable and nutritious food.

Food Desert definition: To qualify as a food desert tract, at least 33 percent of the tract's population or a minimum of 500 people in the tract must have low access to a supermarket or large grocery store.

- A **food desert** is defined by HFFI Working Group as a low-income census tract where a number of residents have share low access to a large grocery store or supermarket. The Treasury Department's census tract must meet criteria to qualify low-income.

Low-income census tract is any tract:

- where at least 20 percent and the population has income below the USDA poverty rate and,
 - in a metropolitan area the median family income does not exceed or 80 percent of the statewide median family income for metropolitan census tracts.
 - in a non-metropolitan area 80 percent of the greater amount between statewide median family income and metropolitan median family income.
- Low access to a healthy food retail outlet is as living more than 1 mile from a grocery store or large supermarket in urban areas, or more than 10 miles away from a retail location if living in rural areas.
 - A census tract is considered rural when an area contains a population of less than 2,500 people, and all other tracts are considered urban.

The use of this criteria is based on the definition above there are in 6,529 food-desert census tracts in the continental U.S. Approximately 75 percent of these food desert tracts are urban, with the remaining 25 percent designated as rural. The Food Desert Locator includes characteristics for the census tract that qualify as food deserts.

The Food Environment Atlas

The Food Environment Atlas is an online database, which provides information regarding diet quality and food choices at county level throughout the U.S. It provides an overview of socio-demographic characteristics of a community and how it accesses healthy foods. The Atlas includes factors such as store/restaurant proximity, food prices and nutrition assistance programs. Also included are a few health status indicators, access to physical activity centers. In total this database had 168 indicators related to food availability.

Data Variables

The descriptions of the variables use in his analysis are as follows:

Table 1.a. *Food access indicators (census tract) in Ohio in 2008*

<i>Variable</i>	<i>Description</i>	<i>Source</i>
<i>Grocery store/100,000 pop, 2008</i>	The number of supermarkets and grocery stores in the county. Grocery stores include establishments generally known as supermarkets and smaller grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry.	U.S. Census Bureau, County Business Patterns
<i>Supercenters and club stores/100,000 pop, 2008</i>	Engaged in retailing a general line of groceries in combination with general lines of new merchandise, such as apparel, furniture, and appliances.	U.S. Census Bureau, County Business Patterns. Population data are from the U.S. Census Bureau, Population Estimates.
<i>Convenience stores no gas, 2008</i>	Convenience stores or food marts (except those with fuel pumps) are primarily engaged in retailing a limited line of goods that generally includes milk, bread, soda, and snacks	U.S. Census Bureau, County Business Patterns
<i>Convenience stores with gas, 2008</i>	Establishments known as gasoline-convenience stores are engaged in retailing automotive fuels (for example, diesel fuel, gasohol, and gasoline) in combination with convenience store or food mart items.	U.S. Census Bureau, County Business Patterns.
<i>Fast-food restaurants/100,000 pop, 2008</i>	The number of limited-service restaurants in the county per 1,000 county residents	U.S. Census Bureau, County Business Patterns. Population data are from the U.S. Census Bureau, Population Estimates.
<i>Farmers' Market/100,000 pop, 2009</i>	Number of farmers' markets in the county. A farmers' market is a retail outlet in which two or more vendors sell agricultural products directly to customers through a common marketing channel.	Marketing Services Division, Agricultural Marketing Service, USDA.
<i>Recreation & fitness facilities/100,000 pop, 2008</i>	Primarily engaged in operating fitness and recreational sports facilities featuring exercise and other active physical fitness conditioning or recreational sports activities, such as swimming, skating, or racquet sports	U.S. Census Bureau, County Business Patterns
<i>% Black, 2008</i>	Percent of county resident population that is non-Hispanic Black or African American.	U.S. Census Bureau, 2008 County Population Estimates.

Table 1.b. *Obesity and diabetes prevalence (county level) in Ohio in 2008*

<i>Variable</i>	<i>Description</i>	<i>Source</i>
<i>Adult diabetes rate, 2008</i>	Estimates of age-adjusted percentages of persons age ≥ 20 with diabetes (gestational diabetes excluded)	Centers for Disease Control and Prevention (CDC). CDC used data from the Behavioral Risk Factor Surveillance System (BRFSS) for 2007, 2008, and 2009 and from the U.S. Census in 3,141 counties in the United States, <i>Estimated County-Level Prevalence of Diabetes and Obesity, United States, 2007, Morbidity and Mortality Weekly Report, November 20, 2009 / 58(45); 1259-1263.</i>
<i>Adult obesity rate, 2008</i>	Estimates of age-adjusted percentages of persons age ≥ 20 with obesity, where obesity is BMI is equal to a BMI ≤ 30 kg / m ² .	Same as above

Data Analysis

Statistical analysis was conducted using IBM Statistical Package for Social Sciences (SPSS) for Windows, version 19. Ohio census tract data from those tracts that had been designated as food desert (Food Desert Locator) was merged with Ohio county data (Food Environment Atlas). The normality distribution of all variables was checked. Variables were analyzed to determine overall distribution of food access, socio-demographic, obesity and diabetes variables in Ohio census tracts designated as food deserts. Significance was considered at $p < 0.05$, and highly significant at $p < 0.01$.

Mann Whitney U test was utilized to compare the average distribution of non-normally distributed variables between urban rural status, high versus low poverty areas, and low versus high African American population.

Spearman correlation analysis was conducted to determine association between food access variables and health outcome (diabetes, obesity). The strength of association was determined by effect size; Effect sizes were as follows:

- <0.29 = low effect size
- $0.3 - 0.49$ = moderate effect size
- >0.5 = strong effect size.

Results

There were a total of 287 Ohio census tracts designated as food deserts in this study, 14 rural, and 273 urban. Since most of the variables were non-normally distributed, values are presented as medians and interquartile ranges (IQR). The percentage of obesity in these tracts ranged from 27% to a high of 36%, with a median value of 30%. The prevalence of diabetes ranged from 9% to 14%, with a median value of 11%. The median poverty rate was 15%, ranging from 7% to as high as 30%. The median was used as cutpoint of 15% was used as a separation point between low and high poverty rate levels. The percentage of the population comprising of African Americans varied between census tracts, ranging from 0.4% to 29%, with a median value of 14%.

The descriptive characteristics of the study variables are presented in Table 1. At the $p < 0.05$ level of significance, several variables displayed statistical differences in the median values. There was a significant difference between the number of recreational facilities in rural versus urban tracts. Significantly more fast food venues were found in urban tracts. There was no significant difference in the number of grocery stores and number of super centers and/or club stores, or farmers' markets in the rural communities when compared to that of the urban

communities. No significant difference was found in the diabetes rates, but obesity rates were higher in rural tracts.

Table 2. *Descriptive characteristic of study variables by community type*

Characteristic	Overall N: 287		Rural N:14		Urban N:273		P- value**
	Median	IQR*	Median	IQR	Median	IQR	
Farmers' market/100,000 pop	0.8	1.2	1.3	2.7	0.8	1.1	< .700
Recreational facility/100,000 pop	10.7	2.8	6.4	5.6	11.1	2.9	< .001
Grocery Stores /100,000 pop	18.3	5.8	18.7	3	18.3	6.2	0.901
Super Center + Club stores/100,000 pop	1.6	1.4	1.7	3.3	1.6	1.4	0.542
Convenience Stores- No Gas/100,000 pop	12.5	6	6.8	8.1	12.5	5.7	< .042
Convenience Stores w/ Gas/100,000 pop	28.4	3.8	39.9	10.7	28.4	3.7	< .001
Fast Food Restaurants /100,000 pop	63.8	16	44.6	24	63.8	13	< .001
Percent African American pop	13.9	13.5	2.5	3.3	15.6	12.6	< .001
Percentage of Diabetes	10.7	0.8	10.9	1.3	10.7	0.8	0.477
Percentage of Obesity	29.5	2.8	31.0	2.2	29.4	2.7	< .001
Poverty Rate	15	2.7	19.9	3.8	15	3.4	0.001

*IQR: Inter-quartile range

**Mann-Whitney U-Test

The availability of food stores and their correlation to obesity and diabetes, overall and by urban, rural status are displayed in Table 3.a and Table 3.b.

Table 3.a shows that the number of supercenters and club stores and the number of convenience stores without gas are positively correlated with diabetes. The number of recreational facilities, grocery stores and fast food venues per 100,000 people were all found to be negatively correlated with the prevalence of diabetes. Both the number of supercenters and fast food restaurants were more closely related to the diabetes rate in urban communities versus rural ones.

Table 3.a. *Spearman Correlation for Diabetes Rates by Access and Availability of Food Measures*

Characteristic	Overall	Urban	Rural
Farmers' market/100,000 pop	10.0	8.0	54.0 *
Recreational facility/100,000 pop	-16.0 **	-17.0	12.0
Grocery Stores /1000 pop	-12.0 *	-11.0	-13.0
Super Center + Club stores/100,000 pop	25.0 **	24.0 **	17.0
Convenience Stores- No Gas	17.0 **	15.0 *	46.0
Convenience Stores w/ Gas	15.0 *	15.0 *	-40.0
Fast Food Restaurants /100,000 pop	-33.0 **	-36.0 **	11.0
Percent African American pop	-11.0	-1.0	-8.0
Poverty Rate	15.0 *	15.0 *	-20.0

*p<.05, **p<.01

Table 3.b shows significant positive correlations between obesity and farmers' markets, supercenters and club stores, convenience stores carrying gas, and the tract's poverty rate. Negative correlations were made between obesity and recreational facilities, grocery stores, convenience stores not offering gas, fast food restaurants, and the percentage of the population comprised of African Americans. Statistically significant correlations were made between all of our food access variables and obesity, except for the poverty rate. Among those correlations, recreational facilities, grocery stores, convenience stores without gas, fast food restaurants, and African American population were all negatively correlated with the rate of obesity. Concerning urban census tracts, a relationship was cited between all food outcome variables and obesity except the poverty rate. Farmers' markets and supercenters were the only variables among them that exhibited positive correlations.

Table 3.b. *Spearman Correlation for Obesity Rates by Access and Availability of Food Measures*

Characteristic	Overall	Urban	Rural
Farmers' market/100,000 pop	29.0 **	29.0 **	40.0
Recreational facility/100,000 pop	-46.0 **	-43.0 **	10.0
Grocery Stores /100,000 pop	-15.0 *	-17.0 **	19.0
Super Center + Club stores/100,000 pop	52.0 **	56.0 **	0.00
Convenience Stores- No Gas	-18.0 **	-16.0 **	13.0
Convenience Stores w/ Gas	38.0 *	34.0 **	-56.0 *
Fast Food Restaurants /100,000 pop	-51.0 **	-51.0 **	15.0
Percent African American pop	-40.0 **	-37.0 **	30.0
Poverty Rate	17.0 **	11.0	-52.0

*p<.05, **p<.01

Table 4 displays the distribution of food access variables by % of African American population. Variables were compared to describe the prevalence of the food accessibility, and obesity, and diabetes in the communities designated as having high African American percentage versus low percentage. The majority of the variables displayed statistical significance at the p<0.001 level. The number of farmers' markets and prevalence of diabetes in African American population were the only two variables that showed no difference of statistical value.

The African American population had generally lower access to supermarkets or large grocery stores. The number of grocery stores per 100,000 populations was higher in communities with higher concentrations of African Americans. Fast food access was significantly higher in communities with a larger African American population than in other populations.

Table 4. *Food access in census tracts with African American population*

Characteristic	Low Afr Am N=146		High Afr Am N=141		P- value**
	Median	IQR	Median	IQR	
Farmer market/100,000 pop	0.8	1.6	0.8	0.5	0.02
Recreational facility/100,000 pop	10.3	3.0	12.7	2.3	< .001
Grocery stores per 100,000 pop	16.5	2.5	21.0	6	< .001
Super center/club per 100,000 pop	1.5	0.9	2.0	1.9	< .001
Convenience store- no gas per 100,000 pop	8.3	4.7	12.9	1.7	< .001
Convenience stores with gas per 100,000 pop	29.3	9.2	28.4	3.0	< .001
Fast food restaurants per 100,000 pop	54.3	14.0	68.1	6.0	< .001
Percentage of Obesity	30.2	2.0	28.2	2.4	< .001
Percentage of Diabetes	10.8	0.7	10.7	0.8	0.016

**Mann-Whitney U-Test

Table 5 describes the effects of poverty on the population's access to food. There were more grocery stores and supercenters in the area of high poverty than in the low poverty communities. The population of African Americans is nearly two times larger in high poverty communities when compared to areas of low poverty. High-poverty areas possessed nearly double the number of recreational facilities of low-poverty areas. Low poverty communities had nearly twice as many farmers/ markets, but the number of fast food restaurants appears to be the same for both poverty levels.

Table 5. *Poverty and Access to Food*

	Low Poverty Rate		High Poverty Rate		P-value*
	Median	<i>IQR</i>	Median	<i>IQR</i>	
Farmer's market/100,000 pop	0.6	0.9	1.0	1.6	0.032 *
Recreational facility/100,000 pop	10.3	3.7	11.1	2.8	0.011 *
Grocery Stores /100,000 population	16.5	1.7	21.0	0.1	< .001 **
Super Center + Club stores/100,000 pop	1.8	0.6	1.6	1.4	0.597
Convenience Stores- No Gas/100,000 pop	8.6	4.6	14.3	4.2	< .001 **
Convenience Stores w/ Gas/100,000 pop	28.4	3.7	28.5	3.6	0.009 **
Fast Food Restaurants /100,000 pop	62.2	23.0	63.8	0.1	0.091 **
Percent African American pop	9.5	7.5	18.5	12.3	< .001 **
Percentage of Diabetes	10.7	1.1	10.7	0.8	0.259
Percentage of Obesity	29.0	2.5	30.1	2.7	0.208

*Mann-Whitney U-test

Discussion/Conclusion

The purpose of this study was to analyze the association between food access and prevalence of chronic disease outcomes such as obesity and diabetes in Ohio. The correlation and distribution of food accessibility, chronic disease by urban rural status, poverty, and by ethnicity was evaluated. The overall prevalence of obesity observed in this sample (29.5%) is nearly congruent with the rates found in the CDC's 2011 statistics Fact Sheet for Ohio (29.2), but lower than the national average of 35.7% (Ogden, Carroll, Kit, & Flegal, 2012). The diabetes outcome revealed in this study (10.7%) was nearly congruent with the CDC's statistics for Ohio (10.1%), but higher than the U.S. rate (8.3%).

According to the study conducted by Jilcott, Keyserling, Crawford, McGuirt, and Ammerman (2011), access to healthier foods was inversely associated with obesity. There are several hypotheses that attempt to explain obesity due to variations in retail food environments. Some blame the rise in obesity rates on geographical differences in the access and availability of

foods, which results in disparities in the environment surrounding the retail food venues. This observation is supported by the current study which showed that the accessibility of super centers and club stores was correlated to prevalence of obesity, as was the number of convenience stores with gas and farmers markets.

Studies conducted in the U.S. and Canada have shown that there exists neighborhood differences in the price and availability of food, with healthier foods being generally more expensive and less readily available in communities of lower SES (Morland, Wing, Diez-Roux, & Poole, 2002). A study conducted by Horowitz, Colson, Herbert, and Lancaster (2004) reported that only 18 percent of grocery stores in low SES neighborhoods stocked foods associated with the recommended diet, as compared to 58 percent of grocery stores in high SES neighborhoods. Neff, Palmer, Mckenzie, and Lawrence (2009) found price of food is a key factor for purchasing decisions of consumers. Cost is significantly more important in low-income areas of non-white households versus high income areas of white households (Basil, Maibach, Goldberg, & Snyder, 1998; Macintyre, 2007). Evidence proves that the higher the price of healthier foods the more it contributes to poor diets in the low-income populations (Neff, Palmer, Mckenzie, & Lawrence, 2009). It was also found that in this study, access to grocery stores and recreational facilities was not dependent on poverty level.

In the current study a significantly higher percentage of low-income population and a higher percentage of African American population in Ohio had low access to a supermarket or large grocery store. Counter-intuitively, it was noted that there were more grocery stores and supercenters per 100,000 population in documented communities with high African American populations. In their study in 2008, Ford and Dzewaltowski hypothesized that neighborhoods of low SES with high concentrations of minorities have limited access to healthy foods, suggesting

that they live in poor-quality retail food environments. Zenk et al. (2005) reported that socially disadvantaged neighborhoods comprised primarily of African Americans were, on average, 1.1 miles further from nearest supermarket compared to predominately white neighborhoods within the same socioeconomic classification. African Americans were more likely to live in a food desert. A study by Moore and Diez Roux (2006) found that minority and racially mixed neighborhoods, after controlling for population ratio, had more small grocery stores and fewer supermarkets than white neighborhoods. Matthew Salois (2011) concluded in his study that a one-percent increase in the percentage of black in a population increases the diabetes rate by 0.06%, and the obesity rate by 0.09%. Another study by Morland, Diez-Roux, and Wing (2006) found that the greatest prevalence of overweight and obesity was found in communities with combination of no supermarkets and one or more grocery stores and/or convenience stores. This finding coincided with the findings of the current study, that the presence of convenience stores was directly related to the number of diabetes cases.

In this study, a positive relationship was cited between the number of farmers' markets per capita and the diabetes rate in that area. Conversely, study by Salois (2011) concluded that the density of farmers' markets was found to be negatively related to the prevalence of diabetes, and those additional farmers' markets per 1,000 people was associated with 0.05% increase in diabetes rate. He also found that every additional no gas convenience store per 1,000 people increases the diabetes rate by 2.04%.

Limitations

Some limitations of this study should be noted. First, two different data sets were used in analysis. County-level and census tract-level data were merged, which could explain some of the ambiguity within the findings. Second, because the data used in this study was not collected on

an individual level, no generalizations concerning the population as a whole can be made. The influence of the African-American population on the food access variables was not clear, perhaps due to majority of African Americans residing in urban areas. There was uncertainty to conclude if the findings were so because the community in question was urban, or because there was a high African American population present. Another weakness in this study is that there are several definitions of food desert, and without there being one unified definition, it is difficult to make recommendations on how to remedy their prevalence. There were very few published research studies regarding association between food deserts and diabetes with which to compare the findings of this study.

Strengths

There were some strengths of this study. The data analyzed were the most recent which was only made available online for public use during 2010. The concept of food deserts is relatively new in public health field; we were able to explore its association with a number of socio-demographic variables and its relationship with obesity and diabetes. The analysis incorporated data from almost all counties in Ohio that were available in the Food Desert Atlas which allowed us to present a possible snapshot of the effects of food deserts on health outcomes.

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Appendix A – List of Public Health Competencies Met

Specific Competencies
Domain #1: Analytic Assessment Skills
Defines a problems
Determines appropriate uses and limitations of both quantitative and qualitative data
Selects and defines variables relevant to defined public health problems
Identifies relevant and appropriate data and information sources
Evaluates the integrity and comparability of data and identifies gaps in data sources
Applies ethical principles to the collection, maintenance, use, and dissemination of data and information
Makes relevant inferences from quantitative and qualitative data
Obtains and interprets information regarding risks and benefits to the community
Applies data collection processes, information technology applications, and computer systems storage/retrieval strategies
Recognizes how the data illuminates ethical, political, scientific, economic, and overall public health issues
Domain #2: Policy Development/Program Planning Skills
Collects, summarizes, and interprets information relevant to an issue
Identifies, interprets, and implements public health laws, regulations, and policies related to specific programs
Domain #3: Communication Skills
Communicates effectively both in writing and orally, or in other ways
Effectively presents accurate demographic, statistical, programmatic, and scientific information for professional and lay audiences
Domain #4: Cultural Competency Skills
Identifies the role of cultural, social, and behavioral factors in determining the delivery of public health services
Attitudes
Understands the dynamic forces contributing to cultural diversity
Domain #5: Community Dimensions of Practice Skills
Identifies how public and private organizations operate within a community
Identifies community assets and available resources
Describes the role of government in the delivery of community health services
Domain #6: Basic Public Health Sciences Skills
Identifies the individual's and organization's responsibilities within the context of the Essential Public Health Services and core functions
Defines, assesses, and understands the health status of populations, determinants of health and illness, factors contributing to health promotion and disease prevention, and factors influencing the use of health services
Identifies and applies basic research methods used in public health
Applies the basic public health sciences including behavioral and social sciences, biostatistics, epidemiology, environmental public health, and prevention of chronic and infectious diseases and injuries
Identifies and retrieves current relevant scientific evidence
Identifies the limitations of research and the importance of observations and interrelationships
Attitudes
Develops a lifelong commitment to rigorous critical thinking
Domain #7: Financial Planning and Management Skills – N/A
Domain #8: Leadership and Systems Thinking Skills
Identifies internal and external issues that may impact delivery of essential public health services (i.e. strategic planning)
Promotes team and organizational learning