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Research Paper

A study of the correlation between food deserts and heart disease

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ABSTRACT

This study aims to investigate the relationship between residence within a food desert and rate of heart disease. Previous study have focused on specific case studies of diseases within a location; by using data from national databases to compare the percentage of individuals living in food deserts for each U.S. county with their corresponding per capita heart disease rates, this study was able to explore the issue through a broader national lens. The data were stratified by three factors — median household income, population density, and average healthcare cost — to eliminate factors that were potentially obstructing patterns within the larger national data set. The stratifications showed a moderate positive correlation between heart disease and food desert population. Providing a large scale understanding of public health in food deserts will allow for the development of better policies with an awareness of the issue.

Key words: Undernutrition, heart disease, food-deserts.

INTRODUCTION

Millions of Americans currently live in food deserts, which are areas that do not have access to easily obtainable, nutrient-rich food (USDA). According to the USDA, in 2009, million people lived in low-income areas more than one mile from a supermarket, thus qualifying as residents of a food desert (USDA). Without a steady source of healthy food, millions of individuals are forced to rely on cheap and easily accessible fast foods (USDA). The heavy consumption of fast food in recent years has been shown to contribute towards an imbalanced diet, which in turn has been linked to an increase in micronutrient deficiencies (El-Seweidy). To understand the relationship between food deserts and the effects of malnutrition, one must examine the correlation, or lack thereof, between the two variables. This study examines the relationship between food deserts and heart disease to better understand the direct effect that food deserts have on the health of the people living in them. Previous studies have found evidence supporting the existence of relationships between malnutrition and certain diseases. Nutrition has been found to affect the severity of symptoms of hypertension in smaller sample sizes and severe malnutrition during childhood increases the risk for high blood pressure in adulthood, which can lead to heart disease (AHA). Additionally, data from the National Health and Nutrition Examination Survey showed that over 45% of deaths from heart disease, stroke, and type two diabetes in 2012 were linked to malnutrition (NHLBI). However, while it is widely accepted that residents of food deserts often suffer from malnutrition, the connection between food deserts and the heart has yet to be directly identified. Our study attempts to determine a correlation between these two factors.

To study the correlation between food deserts and heart disease, the data will first be stratified by factors in order to localize trends and eliminate factors that may have obstructed trends in the larger data set. For each factor, the data will be sorted by the factor from least to greatest. Then, each quartile will be graphed and the correlation will be calculated.

MATERIALS AND METHODS

Study design and setting

Data on the prevalence of heart disease were compared with data on the existence of food deserts within each U.S. county. Data for food deserts were sourced from the United States Department of Agriculture (USDA) while data for heart disease were sourced from the Center of Disease Control (CDC), a government organization dedicated to study US health and safety issues. The most recent available survey data for each variable were that of 2010.

Population

The United States Census Bureau is an organization that produces data of the US population and economy. The Census Bureau conducts a census every ten years and determines annual estimates of the United States population. They take the base population from the most recent census and then factor in births, deaths, and domestic/international migration to produce annual population estimates for individual counties. These data were used as the population of each county in the United States.

Variables

Heart disease data obtained from national voluntary CDC hospital surveys measured cases of hospitalization or death per 100,000 individuals.

The USDA's Economic Research Service provided data for food desert populations in each U.S. county. Their Food Access Research Atlas classifies a census tract as a food desert based on their level of income and access to stores. The Atlas classifies census tracts as *low -income* if either the poverty rate is greater than 20%, the median family income is less than or equal to 80% of the state median family income, or if the census tract is in a metropolitan area, the median family income is less than or equal to 80% of the metropolitan area's median family income. The Atlas classifies census tracts as *low access* if a significant number (at least 500 people or at least 33%) of the population live farther than certain distances to the closest supermarkets or grocery stores. Census tracts were classified as food deserts if they were both low-income and low-access (more than 1 mile (urban) or 10 miles (rural) from the nearest supermarket). For the purpose of this study, the category of "Low-income and low-access measured at 1 and 10 miles, respectively.

Measurement

The graphs comparing number of residents within a food desert to heart disease rate were stratified according to four socioeconomic factors to account for interfering variables. For each factor, the data were sorted by the factor from least to greatest. Then, each quartile was graphed and the correlation was obtained. The factors used to stratify the data are listed below:

1. Population density
2. Median household income
3. Healthcare cost

United States Census Bureau criteria were used for all three factors (DADS).

Statistical analysis

The graphs produced from this data graphed the correlation between food deserts and the prevalence of heart disease within the U.S.

The "CORREL" function, which calculates the Pearson product-moment correlation coefficient of a dataset, in Microsoft Excel was used for data analysis. Continuous data with symmetric distribution were presented as mean and standard deviation (SD) and median and interquartile range (IQR) for non-symmetric distributions. Symmetry was determined using Microsoft Excel's "SKEW" function. Interpretation of correlations was based on accepted references published by U.S. National Library of Medicine National Institutes of Health (Mukaka).

To represent food desert prevalence of each US county, the following calculation was performed: (population living in food desert in the county) / (total population of county * 100%). The calculation used to determine the prevalence of heart disease within a county was 100,000 * (population living in county with heart disease)/(total population of county).

RESULTS

Data are shown in Figures 1 to 12. The graphs in the Figures 12 are divided into three for each of the stratifications used:

1. Stratification used: population density (Figures 1 to 4).
2. Stratification used: median household income (Figures 5 to 8).
3. Stratification used: healthcare cost (Figures 9 to 12).

The statistical analysis for each criterion is summarized in Tables 1 and 2.

DISCUSSION

Main findings

These stratified values show that across all stratified factors tested, there exists a moderate correlation between

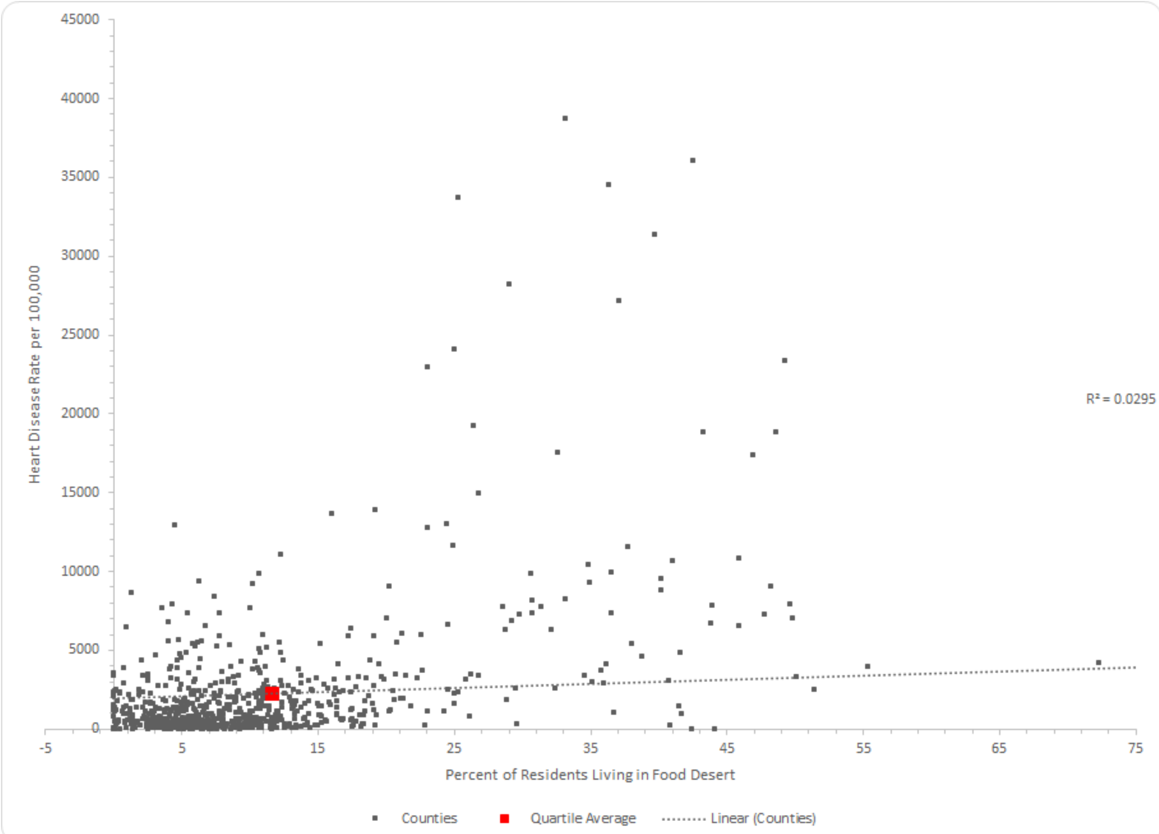

Figure 1: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by population density, quartile 1.

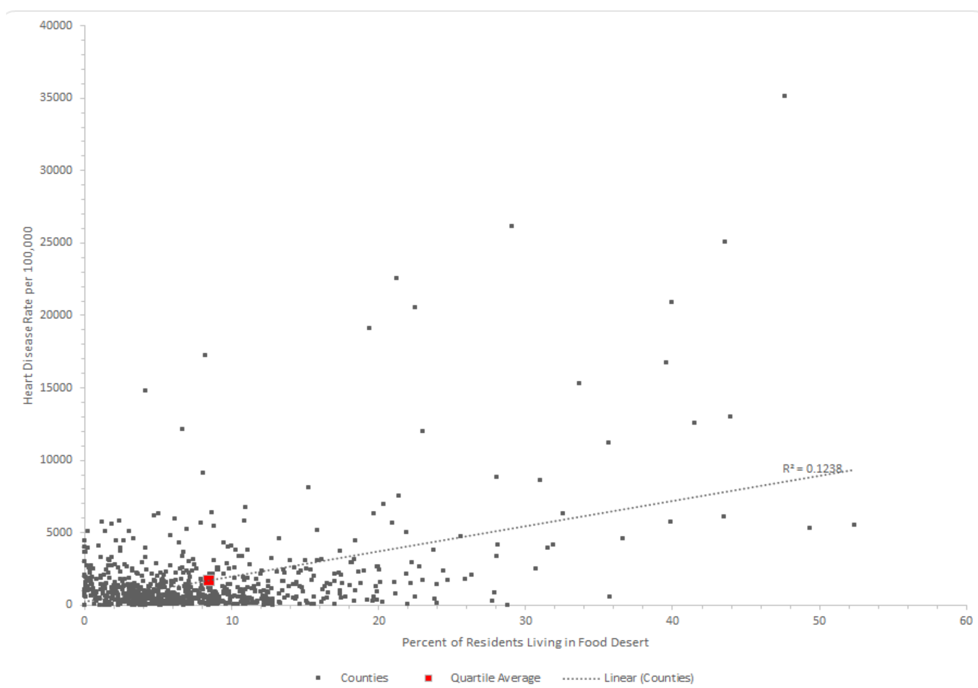

Figure 2: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by population density, quartile 2

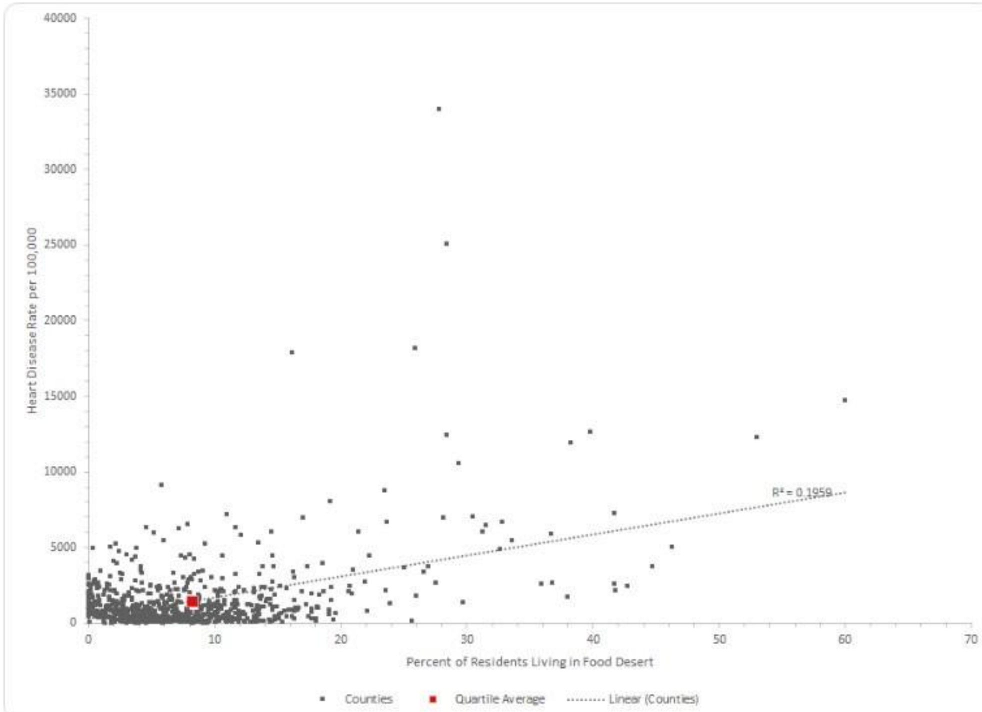

Figure 3: Hypertension rate per 100,000 vs. Percent of residents living in food Desert; sorted by population density, quartile 3.

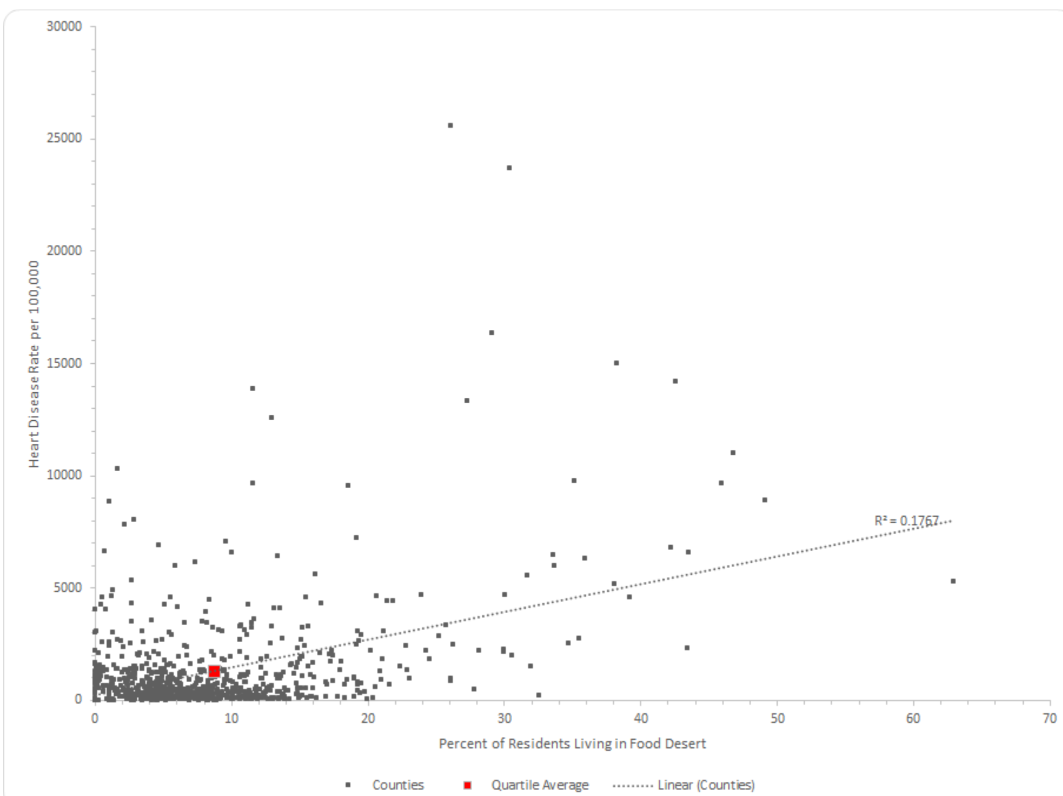

Figure 4: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by population density, quartile 4.

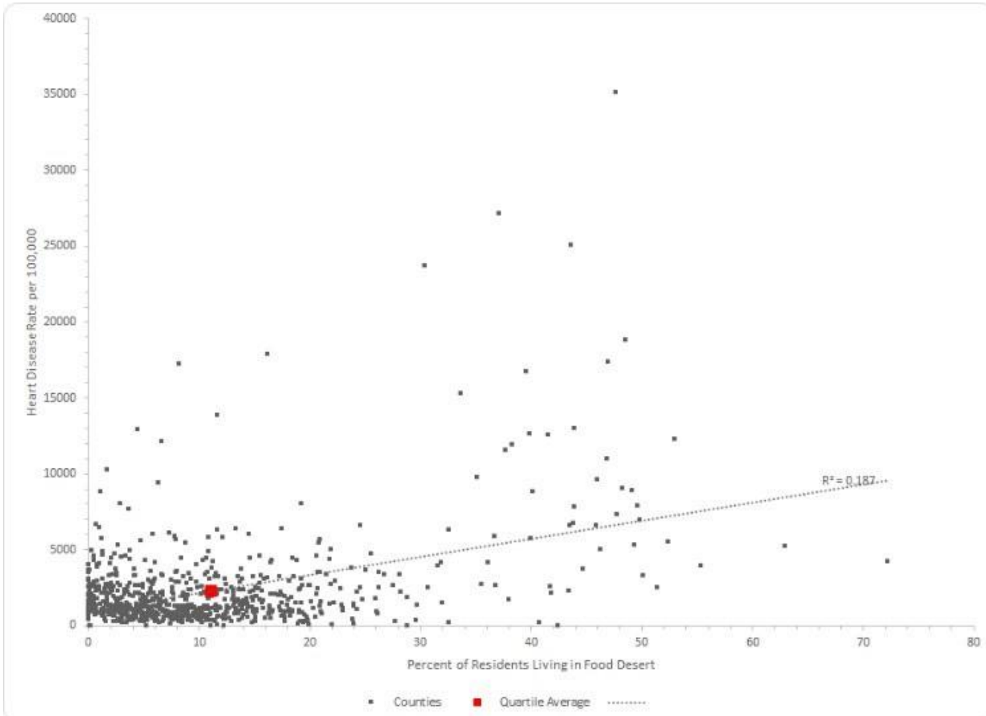

Figure 5: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by median household income, quartile 1.

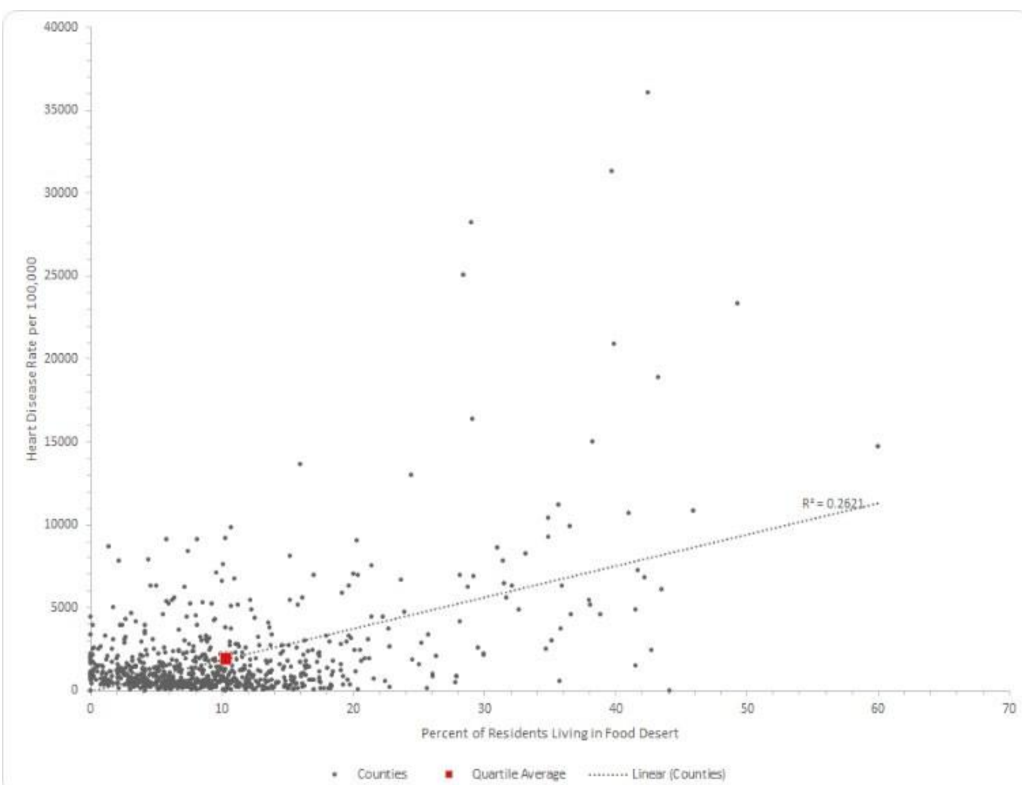

Figure 6: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by median household income, quartile 2.

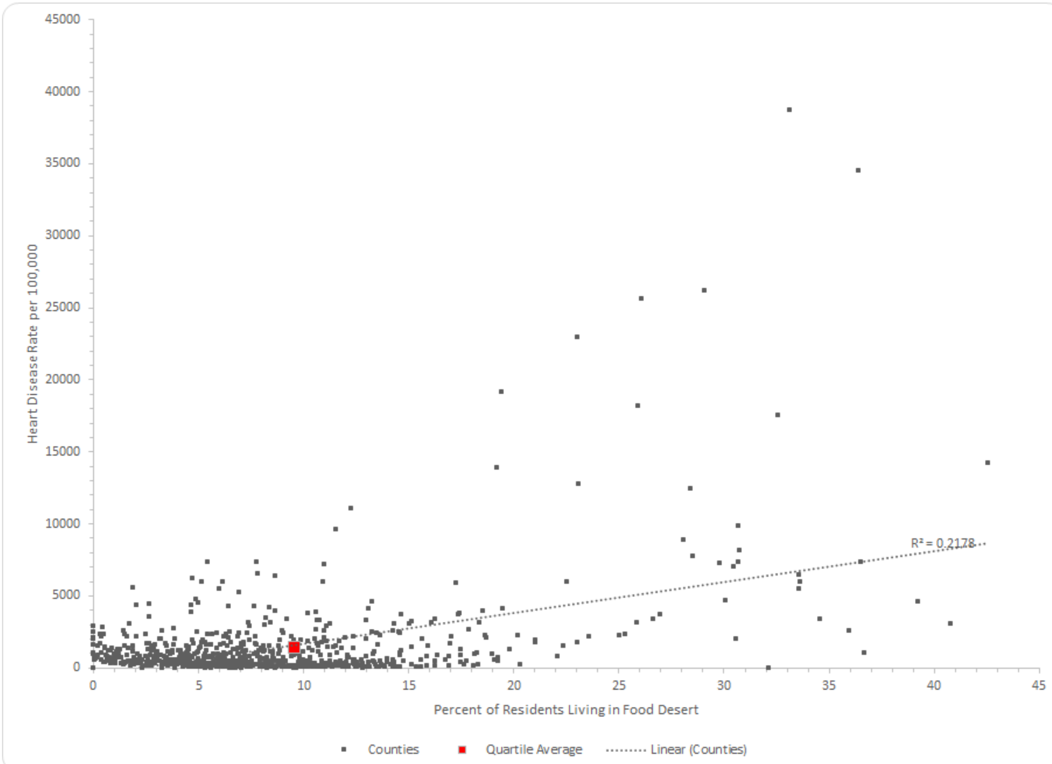

Figure 7: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by median household income, quartile 3.

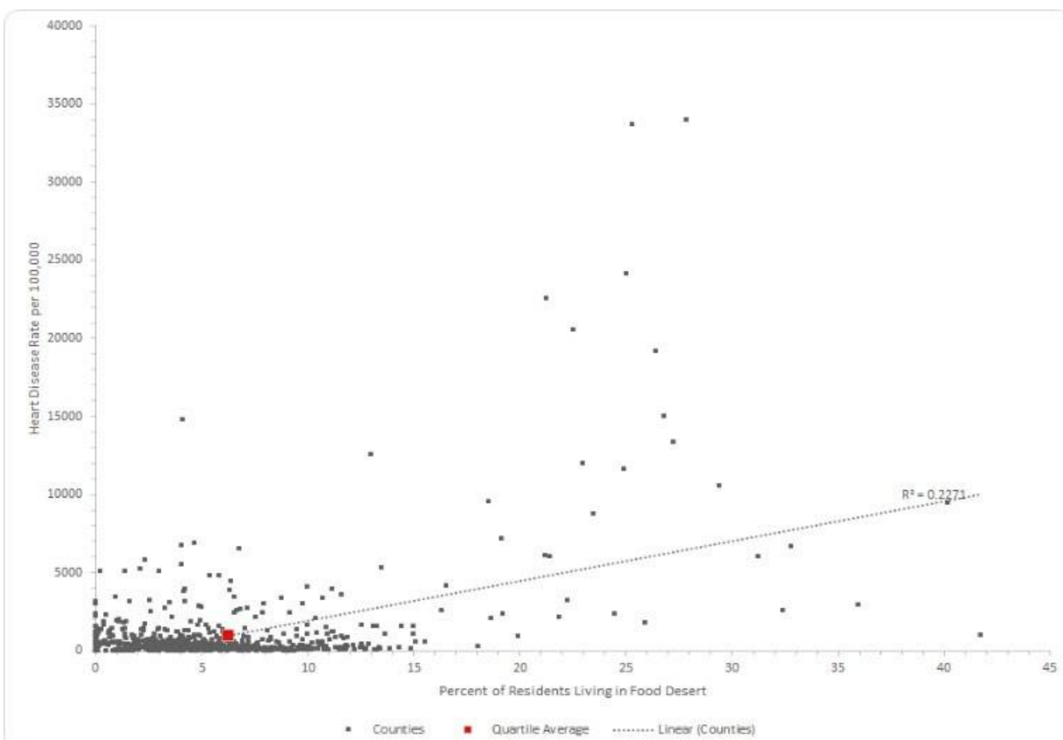

Figure 8: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by median household income, quartile 4

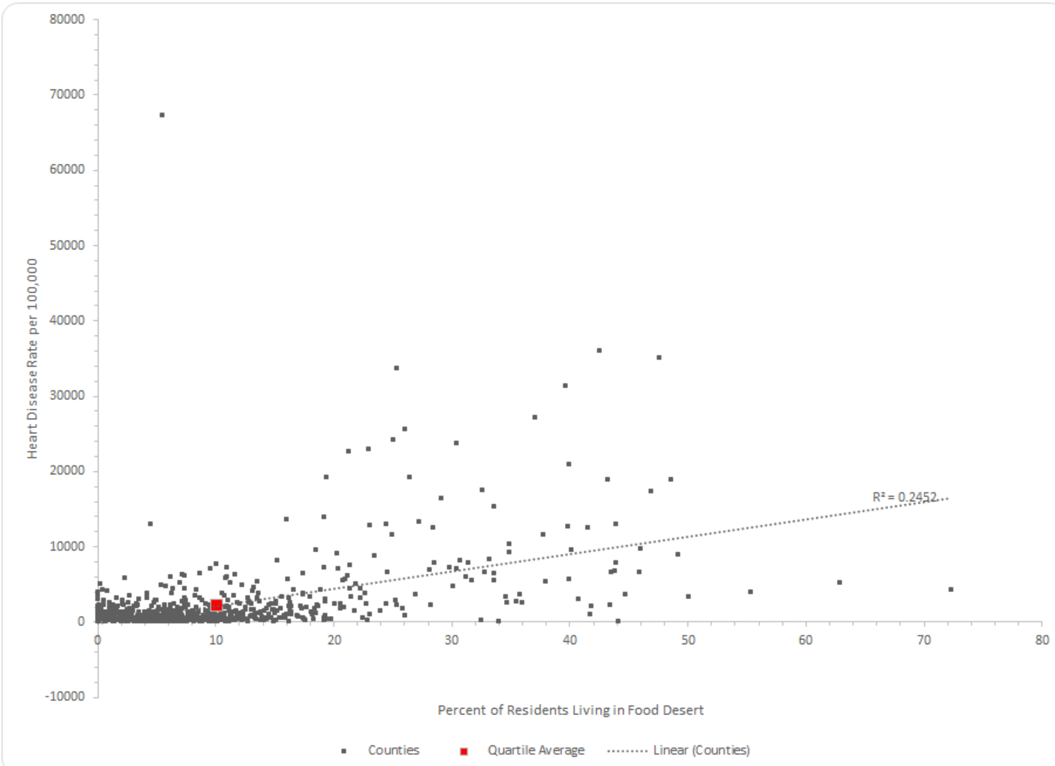

Figure 9: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by healthcare cost, quartile 1.

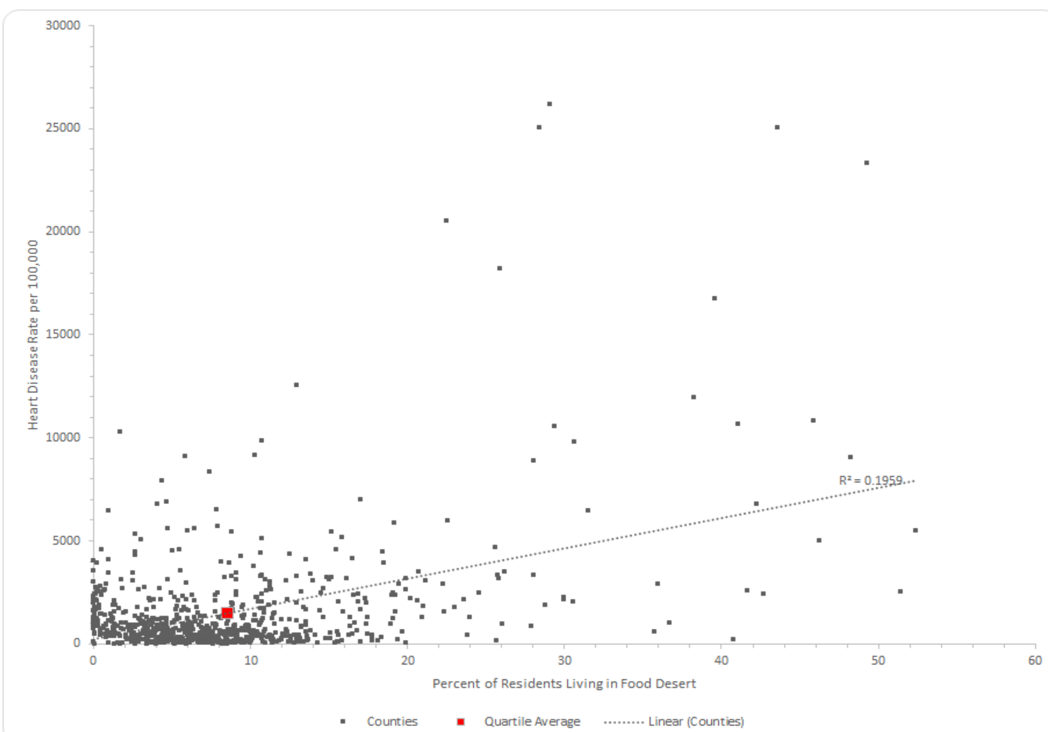

Figure 10: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by healthcare cost, quartile 2.

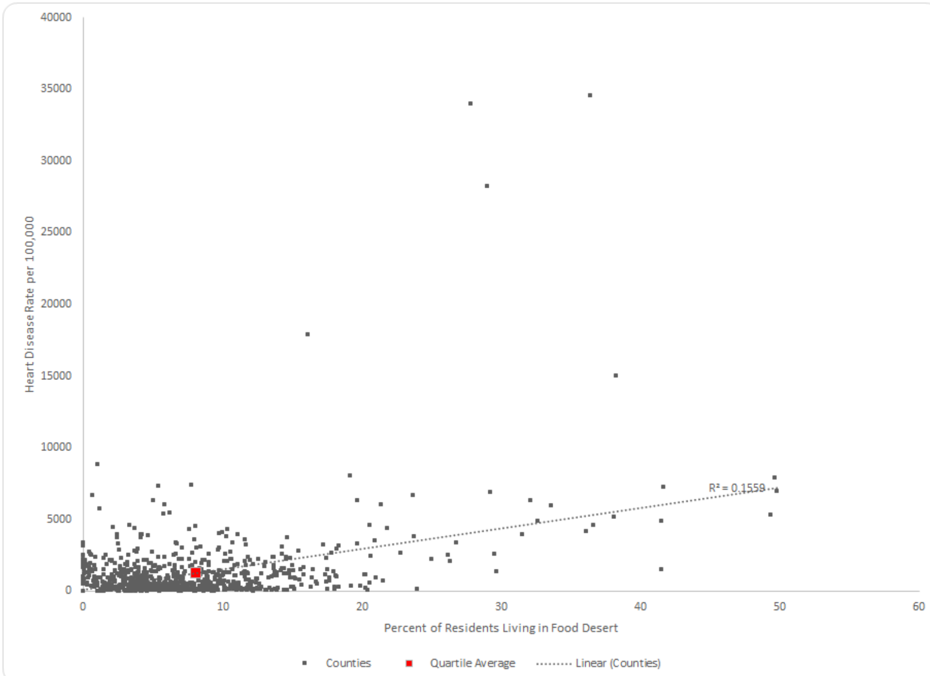

Figure 11: Hypertension rate per 100,000 vs. Percent of Residents living in food desert; sorted by healthcare cost, quartile 3.

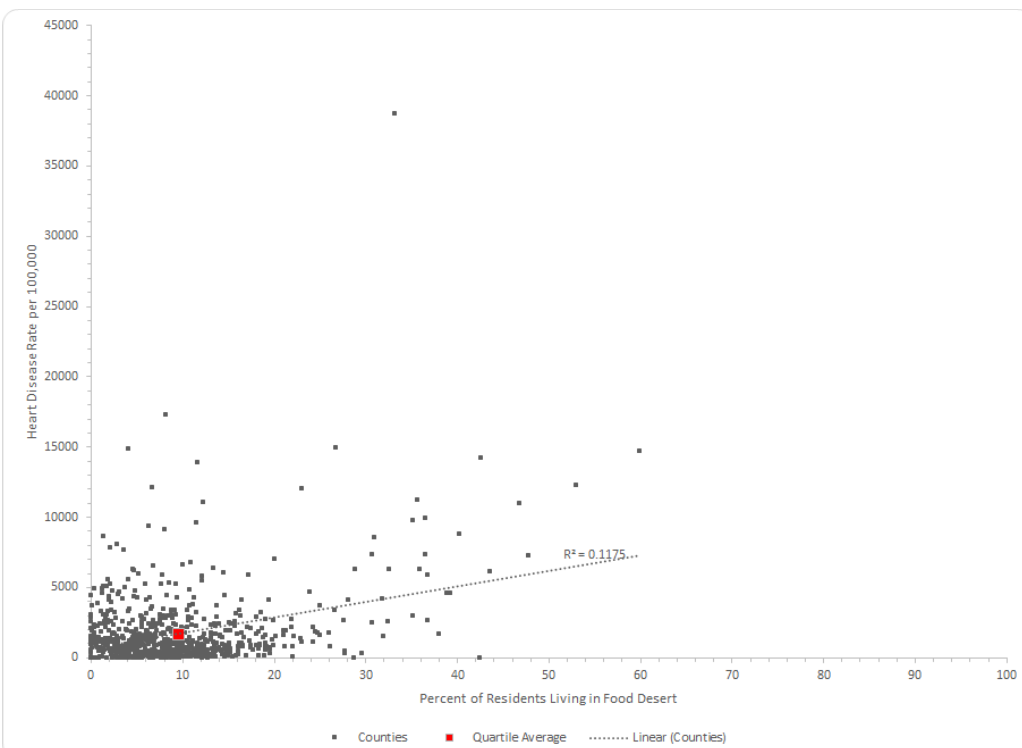

Figure 12: Hypertension rate per 100,000 vs. Percent of residents living in food desert; sorted by healthcare cost, quartile 4.

food desert populations and heart disease. Within each stratification, there was no significant difference in

Table 1: Correlation between food desert populations and heart disease stratified by socioeconomic indicators.

Analysis of stratified data		**Quartile 1**	**Quartile 2**	**Quartile 3**	**Quartile 4**
Population density	Coefficient of determination	0.227	0.124	0.196	0.176
	Correlation	0.476	0.352	0.443	0.420
	P-value for Correlation	<0.01	<0.01	<0.01	<0.01
Median household Income	Coefficient of determination	0.192	0.270	0.223	0.227
	Correlation	0.438	0.520	0.472	0.476
	P-value for Correlation	<0.01	<0.01	<0.01	<0.01
Healthcare Cost	Coefficient of Determination	0.254	0.196	0.156	0.123
	Correlation	0.504	0.443	0.395	0.351
	P-value for Correlation	<0.01	<0.01	<0.01	<0.01

Table 2: Analysis of correlations from Table 1.

Center and spread of correlations for each factor	**Center**	**Spread**
Population density (non-symmetric)	0.432	0.099
Median Household Income	0.477	0.032
Healthcare Cost	0.423	0.056

correlation between quartiles except for healthcare cost where we noted that a lower healthcare cost was associated with a higher correlation between food desert population and heart disease.

LIMITATIONS

This study is limited by the number of stratifications used; if there had been more categories that the heart disease-food desert correlation had been stratified against, there would be more confidence in the conclusion.

IMPLICATIONS FOR FUTURE POLICY AND RESEARCH

Many of the sources used were not specifically intended for studying the relationship between food deserts and heart disease, so the trends generated from these sources may have had an abnormally high margin for error. Ideally, an experiment would be conducted to generate the most accurate data. A control group of individuals who do not live in a food desert would be compared with an experimental group of individuals who live in a food desert in order to isolate the effects of living in a food desert on the probability of developing heart disease. Multiple steps would be taken to sufficiently eliminate the effects of chance variation and confounding variables among the subjects. First, the sample size would be very large. Additionally, subjects would be randomly selected. Although they are randomly selected, subjects would be informed about the specifics of the experiment and given the choice to opt out of participating. Furthermore, the sample populations would contain similar distributions of ethnicities, ages, income brackets, and genders. Finally, the disease rates within each group would be recorded over an extended period of time and eventually analyzed.

The association between lower healthcare cost and a higher level of correlation between food desert population and heart disease should be further evaluated by looking into the relationships between healthcare cost and disease prevalence. It should be taken into account, however, that our research showed no correlation between wealth and the correlation between food desert population and heart disease, as opposed to a negative correlation which one might assume complements the association between lower healthcare cost and a higher level of correlation between food desert population and heart disease. Further research should strive to identify the reasons behind this disjunction.

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SUPPLEMENTARY

Undernutrition and related terms

Undernutrition is a blanket term defined by the United Nations Children's Fund (UNICEF) as "the outcome of insufficient food intake and repeated infectious diseases". Micronutrient malnutrition, a type of malnutrition, is defined as the state of being "deficient in vitamins and minerals". For reference, the more commonly used term "malnutrition" can refer to both "undernutrition" and "overnutrition". This report focuses primarily on the effects of undernutrition, specifically micronutrient malnutrition.

Food desert

The term "food desert" is a broad term for a geographic area that has limited or no access to affordable and high-quality produce, such as fresh fruit and vegetables. There are various technical definitions that are accepted by the USDA. This study used the definition "low-income census tracts where a significant number or share of residents (more than 500 individuals or 33% of the population) is more than 1 mile (urban) or 10 miles (rural) from the nearest supermarket" (USDA). Food deserts are characterized by a shortage of grocery stores, farmers' markets, or other whole food providers. Thus, residents primarily rely on local corner stores that contain large amounts of processed foods and little fresh produce.

Heart disease

According to the Center for Disease Control (CDC), "heart disease" is an umbrella term referring to various heart conditions. Generally, it refers to conditions involving narrowed or blocked blood vessels, which can lead to strokes and heart attacks. This study data compiled by the CDC that classified an incidence of heart disease as hospitalizations and deaths caused by any of the following heart disease related conditions: coronary heart disease, acute myocardial infarction, cardiac dysrhythmia, heart failure, hypertension, ischemic stroke and hemorrhagic stroke.