Comparing the Impact of Food Insecurity, Access to Exercise Opportunities, and County Classification on Obesity Rates in Ohio

Ankur Parekh  
*Wright State University - Main Campus*, parekh.14@wright.edu

Deborah Lee  
*Wright State University - Main Campus*, lee.509@wright.edu

Follow this and additional works at: https://corescholarlibrarieswrightedu/scholarship_medicine_all

Part of the Community Health and Preventive Medicine Commons, and the Endocrinology, Diabetes, and Metabolism Commons

Repository Citation

This Article is brought to you for free and open access by the Scholarship in Medicine at CORE Scholar. It has been accepted for inclusion in Scholarship in Medicine - All Papers by an authorized administrator of CORE Scholar. For more information, please contact library-corescholar@wright.edu.
Comparing the Impact of Food Insecurity, Access to Exercise Opportunities, and County Classification on Obesity Rates in Ohio

Ankur Parekh and Deborah Lee
Core Scholar

Abstract

Objective: We completed a study to determine how food insecurity, access to exercise opportunities, and county classification (rural or urban) impacted obesity rates in Ohio. We hypothesized that the county classification impacted obesity the most followed by food insecurity and access to exercise opportunities.

Methods: We obtained data on food insecurity, access to exercise opportunities, and obesity from County Health Rankings and county classification data from the United States Department of Agriculture Census. We analyzed correlations between obesity and food insecurity and obesity and access to exercise opportunities in both county types. We also analyzed changes in obesity rates in both county types during 2016 and 2022. Furthermore, we developed a regression model to measure how each factor contributes to obesity.

Results: Correlations between food insecurity and obesity were significant in both county types in 2022. However, the correlation between access to exercise opportunities and obesity was only significant in urban communities in 2022. In 2016, the correlation between food insecurity and obesity was not statistically significant in both county types. Similarly to 2022, the correlation between access to exercise opportunities and obesity was statistically
significant. Overall, obesity significantly increased from 2016 and 2022 in both county types. This increase is despite significant decreases in food insecurity. However, this increase matches the fact that access to exercise opportunities decreased significantly from 2016 and 2022. Our linear regression model showed that in 2022, food insecurity and access to exercise opportunities were significant predictors of obesity. In 2016, however, only food insecurity was a significant predictor of obesity.

Conclusion: The results of our study highlight how county classification, food insecurity, and access to exercise opportunities contribute to obesity in Ohio. Interestingly, these factors only contribute to 27% of current obesity rates, indicating that there are various contributing factors. Regardless, targeting these factors through healthcare intervention and policy can still alleviate a large contributor to obesity rates.

Key Words: Physical activity, food desert, Midwest, rural, urban, policy

Introduction

Lack of access to healthy foods and exercise opportunities, in addition to community type (i.e. urban, rural), results in differential rates of obesity. However, our team is interested in understanding how each of these factors contributes to obesity, which is defined as a BMI greater than 30. In this study, we determine which factors contribute most to obesity in rural and urban communities in Ohio, as examining and analyzing these relationships provides policymakers and healthcare professionals with specific data to target strategies for decreasing obesity prevalence.
Food insecurity results in increased rates of obesity. Food insecurity is a population statistic that accounts for the portion of the population that lacks access to adequate food. The statistic encompasses access to well-balanced meals, fruits, and vegetables. In the National Health and Nutrition Examination Survey high food security is defined as no indications of food access problems or limitations; marginal food security is 1 to 2 indications of food access problems or limitations, typically of anxiety over food insufficiency or shortage of food in the household; low food security is 3-5 indications of food reduced quality, variety, or desirability of diet. In the survey given to 12-18 year olds, individuals in marginally food secure and low food secure were more likely to be overweight than individuals from high-food secure areas. Kaiser and Cafer (2018) surveyed 2,365 individuals who accessed food pantries in 32 counties in a midwestern state in 2005, 2010, and 2013 and found that more than 14% of the individuals surveyed were obese and that individuals who used food pantries long term were 1.732 times more likely to be obese.

The effect of weight loss on reduced prevalence of obesity and associated comorbidities can be achieved through exercise, diet and behavioral change. Current guidelines state that adults should exercise at least 150 minutes per week with at least two muscle strengthening activities. From a physiological standpoint, exercise can lower body fat percentage, inflammatory markers, LDL cholesterol, and fasting insulin, resulting in a decreased likelihood of obesity. Access to exercise opportunity is defined as the percentage of the population that has adequate access to locations for physical activity. This encompasses proximity to parks, gyms, and sidewalks. While exercise can decrease obesity rates,
communities with a lack of access to exercise opportunities may not be able to experience these benefits.

The effect of differences in environment, economics, and lifestyle in rural and urban communities may lead to variations in obesity rates. The National Health and Nutrition survey conducted from 2005-2008 showed that the obesity prevalence in rural communities was over 6% higher. Additionally, the survey shows that among working age adults, obesity prevalence is higher in rural and nonmetropolitan counties. In Ohio specifically, obesity rates in rural counties are nearly 4% higher. In 2020, the Center for Disease Prevention and Control (CDC) reported data that indicated that the gap between the rural and urban obesity rates has shrunk, the prevalence of obesity is still over 5% higher in rural communities.

In a systematic review investigating differences in childhood obesity between rural and urban locations in the United States (US), rural children (ages 2-19 years) had a 26% higher chance of obesity than urban children. Furthermore, in a study that examined BMI, diet, exercise, and screen time among low-income preschool children in rural and urban areas in the midwestern US found children from rural areas had higher BMIz scores compared to urban children. While there are limitations in using BMI as a marker, this further demonstrates weight-related differences across all age groups between rural and urban communities. Considering the abundance of data indicating that obesity rates are higher in rural communities, we expect to see similar trends in Ohio in 2022. However, each community is different and some studies have shown higher obesity rates in specific urban communities.
Research Questions

RQ1: What is the correlation between food insecurity and obesity and access to exercise opportunities and obesity in rural and urban counties in 2016 and 2022?

RQ2: How has food insecurity, access to exercise opportunities, and obesity changed in rural and urban counties in 2016 and 2022?

RQ3: How does food insecurity, access to exercise opportunities, and county classification impact obesity rates in Ohio counties in 2016 and 2022?

Methods

Data Collection

We collected data from County Health Rankings, which obtains the data from multiple national and state resources.\(^1\) We included every county in the state of Ohio. The data that was collected represented projections for the 2016 and 2022 years. Our factors include food insecurity, access to exercise opportunities, and county classification, and we studied how these factors relate to adult obesity. Specifically, we analyzed correlations between obesity and food insecurity in rural and urban counties. We classified Ohio counties as rural or urban utilizing the United States Department of Agriculture Census. Counties that contained or were in proximity to major cities or counties with larger populations and close ties to other counties were considered metropolitan counties.\(^16\) All Ohio counties were included. Non-Ohio counties were not included.

Data Analysis
We determined the relationship between food insecurity and adults with obesity using correlations to determine how strong the linear relationship is between these food insecurity and obesity. Pearson correlations were used for normally distributed data, while Spearman correlations were used for non-normally distributed data. The distribution was determined by creating a histogram and analyzing its shape. We determined these same correlations for access to exercise opportunities and adults with obesity. We determined correlations for both 2016 and 2022 for both rural and urban counties to examine how the strength of the linear relationship changed in a six-year time span. We performed multiple paired T-tests to analyze differences between access to exercise opportunities, food insecurity, and adult obesity in 2016 and 2022. Furthermore, we analyzed differences in these factors between 2016 and 2022 in rural and urban Ohio counties. Finally, we developed an enter method linear regression model to determine which factor, county classification, food insecurity, or access to exercise opportunities best predicted a county's adult obesity rate. All significance levels were analyzed at $\alpha = 0.05$. All statistical analysis was completed using IBM SPSS v29.

**Results**

The correlation between food insecurity and adults with obesity and the correlation between access to exercise opportunities and adults with obesity in 2022 for both rural ($n = 47$) and urban ($n = 41$) areas are shown in Table 1 below (RQ1-4). The correlation between food insecurity and obesity was statistically significant in both rural and urban counties; however, in each case, these correlations were weak ($<0.5$). The correlation between access to exercise opportunities and obesity was statistically significant in urban counties only but was also weak.
**Table 1:** Correlation between relevant variables in 2022

<table>
<thead>
<tr>
<th></th>
<th>2022 Adults with obesity</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food insecurity</td>
<td>r = 0.315(^a)</td>
<td>r = 0.455(^b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = 0.031</td>
<td>p = 0.003</td>
<td></td>
</tr>
<tr>
<td>Access to exercise opportunities</td>
<td>r = -0.167(^b)</td>
<td>r = -0.350(^b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = 0.180</td>
<td>p = 0.025</td>
<td></td>
</tr>
</tbody>
</table>

a. Pearson correlation

b. Spearman correlation

The same correlations for 2016 are shown in Table 2 below (RQ5-8). In 2016, the correlation between food insecurity and obesity was statistically insignificant in both rural and urban counties, indicating that the correlation between food insecurity and obesity strengthened in 2022. Similarly to 2022, the correlation between access to exercise opportunities and obesity was statistically significant in urban counties; however, the correlation is weak. In both rural and urban counties, the correlation between access to exercise opportunities and obesity decreased from 2016 to 2022, while the correlation between obesity and food insecurity increased and became significant in 2022 compared to 2016.

**Table 2:** Correlation between relevant variables in 2016
When we compared the prevalence of obesity in rural Ohio counties in 2016 vs 2022 (RQ9), the results illustrated a significant increase in prevalence from 32.85% in 2016 to 38.15% in 2022 ($t = -12.525, p < .001$) (Table 3).

Table 3: Prevalence of Obesity in Rural Ohio Counties

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>47</td>
<td>32.85%</td>
<td>2.49%</td>
</tr>
<tr>
<td>2022</td>
<td>47</td>
<td>38.15%</td>
<td>2.28%</td>
</tr>
</tbody>
</table>

When we compared the prevalence of obesity in urban Ohio counties in 2016 vs 2022 (RQ10), the results illustrated a significant increase in prevalence from 31.18% in 2016 to 36.91% in 2022 ($t = -14.939, p < .001$) (Table 4).
Table 4: Prevalence of Obesity in Urban Ohio Counties

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>41</td>
<td>31.18%</td>
<td>2.83%</td>
</tr>
<tr>
<td>2022</td>
<td>41</td>
<td>36.91%S</td>
<td>2.41%</td>
</tr>
</tbody>
</table>

Abbreviation: SD, Standard Deviation  
SStatistically significant difference from 2016 (p<0.001)

When we compared the prevalence of food insecurity in rural Ohio counties in 2016 vs 2022 (RQ11), the results illustrated a significant decrease in prevalence from 15.76% in 2016 to 14.53% in 2022 (t = 8.250, p < .001) (Table 5).

Table 5: Prevalence of Food Insecurity in Rural Ohio Counties

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>47</td>
<td>15.76%</td>
<td>2.08%</td>
</tr>
<tr>
<td>2022</td>
<td>47</td>
<td>14.53%S</td>
<td>2.77%</td>
</tr>
</tbody>
</table>

Abbreviation: SD, Standard Deviation  
SStatistically significant difference from 2016 (p<0.001)

When we compared the prevalence of food insecurity in urban Ohio counties in 2016 vs 2022 (RQ12), the results illustrated a significant decrease in prevalence from 14.98% in 2016 to 12.52% in 2022 (t = 11.266, p < .001) (Table 6).

Table 6: Prevalence of Food Insecurity in Urban Ohio Counties

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
</table>
When we compared the prevalence of exercise opportunities in rural Ohio counties in 2016 vs 2022 (RQ13), the results illustrated a significant decrease in prevalence from 60.49% in 2016 to 51.07% in 2022 ($t = 5.397, p < .001$) (Table 7).

**Table 7: Prevalence of Exercise Opportunities in Rural Ohio Counties**

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>47</td>
<td>60.49%</td>
<td>14.72%</td>
</tr>
<tr>
<td>2022</td>
<td>47</td>
<td>51.07%$^S$</td>
<td>17.11%</td>
</tr>
</tbody>
</table>

Abbreviation: SD, Standard Deviation

$^S$Statistically significant difference from 2016 ($p<0.001$)

When we compared the prevalence of exercise opportunities in urban Ohio counties in 2016 vs 2022 (RQ14), the results illustrated a significant decrease in prevalence from 77.04% in 2016 to 68.06% in 2022 ($t = 4.815, p < .001$) (Table 8).

**Table 8: Prevalence of Exercise Opportunities in Urban Ohio Counties**

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
</table>

Abbreviation: SD, Standard Deviation

$^S$Statistically significant difference from 2016 ($p<0.001$)
<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>% with Obesity</th>
<th>% SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>41</td>
<td>77.04%</td>
<td>16.17%</td>
</tr>
<tr>
<td>2022</td>
<td>41</td>
<td>68.06%</td>
<td>20.04%</td>
</tr>
</tbody>
</table>

Abbreviation: SD, Standard Deviation

Statistically significant difference from 2016 ($p<0.001$)

Our linear regression model predicted which factors, food insecurity, access to exercise opportunities, or county classification (i.e. rural or urban), contributed most to obesity in Ohio in both 2016 and 2022 (RQ15-16). The 2022 model was statistically significant ($F_{3,84} = 10.295, p < 0.001$). This model accounted for 26.9% of the variability in percent of adults with obesity; additionally, food insecurity ($B = 0.355, t = 3.909, p < 0.001$) and access to exercise opportunities ($B = -0.026, t = -2.081, p = 0.041$) were statistically significant factors. However, the county classification did not significantly contribute to the model. The 2016 model was also statistically significant ($F_{3,84} = 5.052, p = 0.003$), accounting for 15.3% of the variability in percent of adults with obesity but predicted that only food insecurity significantly contributes to obesity ($B = 0.268, t = 1.991, p = 0.05$), whereas county classification and access to exercise opportunities do not.

**Discussion**

The correlation between food insecurity and adults with obesity was statistically significant but weak in both rural and urban counties in 2022. In 2016, the correlation between food insecurity and adults with obesity was not statistically significant in both rural and urban communities, indicating that the linear relationship between food insecurity and obesity increased in 2022 compared to 2016. Given that those in food insecure households are more likely to experience obesity, this relationship is consistent with our correlation from 2022; however, it is not
consistent with the 2016 correlation. Interestingly, the overall rate of food insecurity was lower in 2022 compared to 2016 in both rural and urban communities, thus a decrease in obesity should be expected, especially considering the significant correlation. However, the obesity rate increased from 2016 to 2022. Additionally, this increase in obesity is inconsistent with our linear regression model as the unstandardized beta value was higher in our 2022 model compared to the 2016 model. The explanation lies in the fact that there are numerous interconnected factors that contribute to obesity prevalence. Some of these factors may have changed, increasing the obesity rate independent of food insecurity. Due to the interconnected nature of these factors, others may have confounded our correlation results.

The negative correlation between access to exercise opportunities and adults with obesity slightly decreased in 2022 compared to 2016 in urban counties; however, the correlation was statistically significant in both years. In rural areas, on the other hand, the correlation was not statistically significant in neither 2016 nor 2022. Interestingly, the correlation was positive in 2016 in rural areas, meaning that despite increasing exercise opportunities, the percentage of adults with obesity still increased. Although aerobic exercise is strongly associated with decreased obesity rates, our results show the opposite trend; however, completing exercise and accessing exercise opportunities are not the same. While individual exercise would likely decrease the likelihood that said individual would experience obesity, if individuals have trouble accessing available opportunities, then the obesity rates may not change. We hypothesize that the correlation results are due to factors in the social-ecological model of behavior. Compared to individuals in urban communities, rural residents are more likely to report lower social support, greater distance to
exercise facilities, and environmental barriers, such as fewer transportation options and inefficient use of land.\textsuperscript{17}

Compared to 2016, in 2022 the prevalence of obesity increased in both rural and urban counties. This increase in prevalence is despite a drop in food insecurity overall and in both rural and urban counties. However, access to exercise opportunities in both community types decreased. The results seem slightly counterintuitive considering that food insecurity has a stronger correlation with obesity compared to access to exercise opportunities. This counterintuition can be explained by the fact that obesity rates are determined by far more than just food insecurity and access to exercise opportunities.

Physical inactivity, access to healthy foods, sidewalks and green space, stress, genetic background, socioeconomic status, and comorbidities all contribute to obesity.\textsuperscript{18,19} Additionally, high fat and sugar consumption, processed food consumption, and changing farming policy and food prices have continually perpetuated the obesity epidemic in the United States.\textsuperscript{20} Furthermore, as the American lifestyle has become more sedentary, obesity has increased.\textsuperscript{21} Internet use is positively associated with obesity and a linear dose-response meta-analysis showed that an additional 1 hr/day of internet use was associated with 8\% increased odds of obesity.\textsuperscript{22} In addition to an overall more sedentary lifestyle, increased screen time has been shown to negatively affect sleep patterns, which further increases the risk for obesity.\textsuperscript{23} The COVID-19 pandemic might provide some additional insight into the increase in obesity despite decreases in food insecurity. Similarly to increased screen-time, the pandemic resulted in a more stoic lifestyle. In a study analyzing 14,000 participants, a significant weight gain was reported
during the COVID-19 lockdown. Participants reported increased consumption in hypercaloric and hyperglycemic foods, reduced exercise, and changes in sleep.\textsuperscript{24}

Our linear regression model predicted that in 2022 food insecurity and access to exercise opportunities significantly affect the obesity rate. The county classification was not significant, however. This model accounted for 26.9\% of the variability, indicating that various factors that were not included in the study may account for the discrepancy. The model coefficients demonstrate that food insecurity is a greater contributor, which is consistent with our previous correlation results. The 2016 model only accounted for 15.3\% of the variability and predicted that food insecurity significantly contributed to obesity, whereas access to exercise opportunities and county classification did not. This is inconsistent with the literature, as rural areas tend to have higher rates of obesity.\textsuperscript{8,9,10,11,12,13} This inconsistency could potentially be explained by the fact that the data source that we used did not control all other variables that impact obesity. Thus, this model does not directly compare the impact of county classification on obesity. Furthermore, the definition of rural and urban counties may also contribute to this inconsistency, as counties within the same metropolitan statistical area may differ in urban or rural characteristics.

**Conclusion**

We identified a few limitations in our study. The method in which we classified counties as urban or rural may limit the generalizability of our study. We used the USDA Census data to differentiate Ohio counties as rural or urban, but this definition could limit our results and conclusions uniquely to our study. The definition that we utilized could limit how other researchers interpret or use our findings. In the future, we can utilize percentage rural or another
source that other researchers have used to define county type to classify which counties are rural versus urban.

County Health Rankings is bulk, conglomerate data rather than data obtained through random or controlled sampling methods. The data that we used is from multiple sources, and thus, there may be certain biases not addressed and differing methodologies that may not match. In the future, we could obtain our data from other sources with clearer methodologies. Moreover, County Health Rankings provides aggregate data on the county level and the data cannot be applied to individuals. Additionally, County Health Rankings data is projected from 2 years prior, which means that the 2022 data was projected in 2020 and thus the data may not account for the impacts of major recent events, such as COVID-19.

Furthermore, we included only three variables in our analysis on obesity. There are numerous factors that can impact obesity prevalence, such as physical inactivity, that were not included, which could limit our conclusions. Lastly, we only included Ohio counties and thus, we may not be able to make conclusions about other states and countries. In the future, we can include other states to expand our conclusions.

The results of our study highlight how food insecurity, access to exercise opportunities, and county classification factors contribute to obesity and demonstrate how changes in these factors impact the obesity prevalence in rural and urban counties in Ohio. These findings can help healthcare providers better counsel patients on what factors they should address in reducing
obesity prevalence. Furthermore, these findings can also assist policy makers in creating interventions that target factors that contribute more to obesity.
References


https://www.cdc.gov/


