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Abstract

This study looked at state public land acreage, average median income, poverty rates, and unemployment rates to analyze the significance of their impact on obesity in the United States. Percentage of public land for each state was gathered from a data overview of 2018, data for the economic factors of influence were from 2017-2019, and obesity rate information was collected from 2019. The hypothesis was that there would be a negative relationship to obesity with public land and average median income; and a positive relationship to obesity with poverty and unemployment rates. This study found there to be a negative relationship with obesity and the variables public land, median household income, and poverty. With unemployment, there was a positive relationship. The results also identified statistical and economic significance with public land and median household income.

Keywords: Obesity, Public Land, Median Income, United States

JEL Classification: Q51, Q56, I12

Section 1: Introduction

Obesity is an increasing epidemic within the U.S. and around the world. Even though awareness is growing, rates continue to rise. According to the Centers for Disease Control and Prevention, obesity rates rose from 30.5% in 1999-2000 to 42.4% in 2017-2018, while severe obesity increased from 4.7% to 9.2% (CDC, 2020). The National Institutes of Health state that obesity is the second leading cause of preventable death in the U.S. (West Virginia, 2002). Obesity-related conditions also rank in the leading causes of preventable death such as heart disease, stroke, type 2 diabetes, and types of cancer (CDC, 2020). This epidemic is not only a medical and health concern, but also has economic consequences because of resources forgone as a result of a health condition and it is expensive. CDC reported in 2008 USD that the medical cost of obesity was \$147 billion annually (CDC, 2020). It is estimated that people with obesity have an average of \$1,429 more in medical costs per year.

Previous studies have been performed on how access to public parks influence obesity; results from a particular study in Southern California showed that this access reduced risk of overweight and obesity in children (Wolch, 2011). This study focuses on examining potential causes of obesity to answer the question, “does the economic health of a state lead to lower rates of obesity in the United States?” It observes and identifies whether there is significant causation between obesity and poverty, unemployment, median income, and public land. Data is collected for the fifty states and Washington D.C. The data is taken from the most current numbers that range from 2016 to 2020. There is extensive variation across states in the independent variables that offer insight into potential influencing factors on obesity to help understand and confront this growing epidemic; possibly through economic health. We found median income and public land to be significant in their impactful role towards obesity within the United States.

Section 2: Data Overview

Obesity is the dependent variable in this study. The data we are using represents the prevalence, by percentage, of obesity in adults in each individual state. We pulled our obesity numbers from the CDC for 2019. The data comes from the Behavioral Risk Factor Surveillance System, and is an on-going state-based, telephone interview survey system. This being said, our numbers are self-reported, which may open up some space for error or truth in the study. This method of data collection, while is often the easiest, makes us consider the short falls of the data in terms of accuracy and reliability, however, the CDC is a reliable source for data that represents the majority.

Our first X variable is the amount of public land available to citizens in each state. To measure this, we have combined the total acreage of BLM, FS, NPS land in each individual state. Our data is pulled from a data overview of federal land ownership done by the Congressional Research Service in 2018. In each of these categories, there is a portion that may not be accessible to public use, but we are unable to separate this data from the total. To make this data more meaningful, we will be turning each acreage amount into a percentage of total acreage in a state, to allow for a more accurate representation of accessibility relative to state size. The data we pulled is very credible, which is why we're using this source, as the Congressional Research Service is a government institution, and all the data is simply checking in on boundary lines to find how many acres fall into each organization's jurisdiction. The summary statistics of this data set can be found in Table 2 in the appendix.

The second X variable included in this study is the median household income reported for each individual state. This data set is pulled from Census.gov, for the year 2018. Data is

collected through several trusted sources headed by the U.S. Census Bureau. Incomes are collected annually, with over 3.5 million households surveyed, and median income for each state is calculated from the values reported. This data is subject to sampling error, as it is a portion that represents the greater majority, but is presented by a credible government source.

The independent variable unemployment is the percentage unemployed in the state in 2019 collected from the U.S. Bureau of Labor Statistics (2019). A misleading factor of unemployment rate is that it doesn't account for all joblessness, because it isn't tallying everyone who doesn't have a job. It measures those who are open and actively seeking work within the recent four weeks. In observing our last variable of poverty within states and its relationship with obesity, we are using data whose sources are from the U.S. Census Bureau, Current Population Survey, 1960 to 2020 Annual Social and Economic Supplements (CPS ASEC). This data represents the percentage of people in poverty by state using 3-year averages from 2017-2019. There are some limitations where poverty cannot be measured. Some of these include: institutional group quarters, college dorms, military barracks, and unconventional housing situations. Also, income data isn't collected for anyone under the age of 15. Therefore, poverty status can't be determined for anyone under 15 who is not living with someone over that age.

Section 3: Methodology

This study uses Ordinary Least Squares (OLS) regressions using Gretl. Table one reports general summary statistics on each variable, and table two shows the results for the regressions that were run.

Column One in Table two sets obesity as the dependent variable, and regresses public land, poverty, median income, and unemployment. Public land and median household income

were the only variables that reported statistical significance, and to the 99% confidence. The R^2 and adjusted R^2 report promising values above .5, and the reported F-statistic is 13.4. The regression shows that for every unit change in public land, the percentage of adult obesity in a state decreases by .0765. Median incomes coefficient reports for every one unit increase in median income, the percent of adults with obesity in a state decreases by .0003. This was our baseline regression, however, it did support our original hypothesis that an increase in public land and/or median income would cause lower rates of obesity.

To account for any non-linearity, the regression in column two was run. This includes a square of our public land variable. Not only were median income and public land still significant to the 99%, but unemployment reported significance to the 90%. Regression one reported the highest R^2 values at .57 and .61 and an F-statistic of 16.79. The coefficient for public land changed to -0.221, meaning a greater decrease in obesity as public land increases, and the median income coefficient remained the same at -.0003. Unemployment, now significant, reported a coefficient of 1.012, meaning as unemployment increases one unit in a state, obesity increases by 1.012.

The third regression in *Table 2* (3 lnOb) included the dependent variable natural log for obesity to account for non-linearity and the independent variables of public land, unemployment, median income, and poverty. The results show that for every one-unit increase in percentage of public land, there is a 0.22% decrease in obesity. It is statistically significant at the 99% level showing us that there is a possible relationship between public land and obesity. A one-unit increase in unemployment correlates with a 0.0229% increase in obesity. This was not statistically significant. For median income, a one-unit increase responds with a -0.000009% decrease. It is significant at the 99% level, portraying that there is an important relationship

between median income and obesity. Poverty is significant at the 90% level and decreases 0.013% for every unit increase. Adjusted R^2 is 0.525 and shows us how much of the data is dispersed around the mean.

The final regression regresses on public land and median income; the two variables that were significant at the 99% level in all of the regressions that were run. Table 1 (Ob) shows that if public land has a one-unit increase in percentage of state public land, then obesity is predicted to decrease by 0.071. It indicates that percentage of public land impacts obesity rates because of its 99% significance. The column (Ob) also shows that if average median household income increases by one dollar then there is a predicted decrease in obesity rate by 0.0002. The high 99% significance suggests that median income affects obesity. Adjusted R^2 is 0.55, identifying that about 55% of the observed variation can be explained by the inputs in the model.

Section 4: Results and Limitations

This study found statistical significance in a couple variables across all regressions, and a few variables in a select one or two. We saw both median household income, and our public land variable significant to the highest level in every regression we ran. Unemployment also made an appearance of statistical significance in our most significant regression at the 10% confidence level. Our initial direction in this study was to research the economic and social benefits of public land so it was expected that it would have significance in its integral role to public health. It was surprising that unemployment wasn't statistically significant because we expected that physical habits and mental health associated with unemployment would influence obesity in a state. All in all, these results allow us to apply our findings to determine economic significance as well as societal impact.

Average median household income and percentage of public land revealed through statistical significance that they have a strong, causal relationship with obesity. In addition to their 99% significance level in all of our regressions, we believe them to also be economically significant. A 1% increase in median income decreases obesity rates by 0.0002%. While this coefficient is seemingly small, it has an impact worth highlighting. An average pay increase is 3-5%. Taking this into account, if an employee is in good standing with the company for 10 years, this could translate to a cumulative declining obesity rate of 0.0086%. Those with a better position in society and wealth have an advantage and are more likely to be in higher-paying jobs that offer better, consistent raises. For example, high income families make up 19% of the US population, which is 62,358,000 people. If 0.0086% of this subpopulation had a decrease in obesity rates, that would be 536,278.80 people out of obesity. This is a significant number because it shows us how a “small” coefficient can still have a powerful impact on hundreds of thousands of lives.

This opens up for policy emphasis towards communities of lower income who may be in cyclical poverty. Their lives are increasingly at risk because of their financial standing and opportunity. Lower income families seem to bring about a higher risk for obesity not only in affordability and exercise routine, but also under the surface in psychosocial stressors, including: higher insecurity, stress and mental disorders, social isolation, and decreased control over life (Kim, 2018). What is interesting about obesity is that while there appears to be a negative relationship between income and obesity across the state level, on an international level, high-income countries tend to have greater rates of obesity (Levine, 2011). In 2016, the US was at a peak in obesity rate, one decade after the introduction of high-fructose corn syrup in processed food. Cost and food selection gets noticeably worse as the household income

decreases (University, 2018). This opens up a serious conversation for a nutrition and manufacturing change within our nation so that people who are disadvantaged financially aren't allowed equal opportunity to have a healthy, affordable diet.

Public land we believe to have economic significance. In retrospect, a 1% point increase in per capita public land causes a 0.22% change in obesity. While this is already a large number, we can look to our summary statistics to gain some perspective where public land has a minimum value of 0.0005056% and the maximum is 76.11%. With a coefficient of 0.22%, it has a big impact on obesity when the percentage of public land varies so greatly. If public land increases we hold this to justifying the coefficient to have a large impact on obesity rates across states that strongly vary in acreage. We originally hypothesized that median income and public land would have a negative relationship with obesity. The results of this study have confirmed these hypotheses. In furthering the studies toward obesity, an important factor that shows the true impact of public land may be proximity of access. This may give us a more accurate presentation of public land use as opposed to just federal acreage. Overall, these conclusions of significance yield helpful information and opportunity for health professionals and policymakers in the conversation over the epidemic of obesity.

This study does run with limitations to be aware of. Our data is reported across more than one year, although that time frame is closed into two years, there is some discrepancy in the time frame for the data, which leads to limitations in the externality of our data. This means that these values are for a single point in time, and further analysis across years may be beneficial. Also, as discussed in the data overview, there are a few variables that have data collected from surveys. Although these surveys were run and come from reputable sources, there is room for error in self-reporting. Another limitation in our data is the immeasurable influence of emotional factors,

stress, overeating, and variables associated with mental health that may be missing from our data collection. Psychological factors are prominent in the serious conversation of obesity that we haven't measured in our regressions. Therefore, mental health could be an omitted variable that may need to be highlighted in the conversation of this obesity epidemic.

Section 5: Conclusion

This study utilized cross-sectional data and analysis. Data was pulled from a time span of three years for four different variables. We regressed public land, poverty, median income, and unemployment on obesity. Although unemployment had some statistical significance, we believe median income and public land to be the central focus. Median income and public land were consistently significant at the 99% level. On an economic level we determined the percentage of public land within a state, and the median income for a household to be economically significant. This is highlighted through the economic, causal relationship income has with obesity in affordability, exercise, and psychosocial stresses. With the coefficients reported, changes in these variables have a strong effect on obesity, and as the U.S. continues to see the rise of this issue, it's worthwhile to look further into these variables. As we look at the application of this study to the world around us, we can already see that further research into the association between public land or geography and obesity or health could be beneficial. We need to tease out what is the cause or reason that public land has so significant an impact on obesity, and what that means for our country's relationship with conserving public lands in the future.

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Table 1¹*Summary Statistics of Explanatory Variables*

	Mean	Median	Minimum	Maximum	<i>SD</i>
Obesity	32.03	32.1	23.8	40.8	3.996
Public Land (percentage)	12.98	4.009	0.0005056	76.11	19.06
Poverty Rates	10.84	10.3	4.9	19.4	2.931
Median Household Income	64411	62539	42781	86345	10363
Unemployment Rates	3.622	3.5	2.4	6.1	0.8218

¹ Public land is the percentage of federal land ownership out of total acreage in a state in 2018. Median Household Income and Unemployment Rate were measured for the year 2019. Poverty is the percentage of people in poverty using a 3-year-average from 2017-2019; measured by comparing a family's income to their threshold. Obesity rate is a cumulative number measuring adults with a BMI greater than or equal to 30 in 2019.

Table 2*Regression Results*

Dependent Variable: Obesity Rates

Regressor	(1)	(2)	(ln3)	(4)
Public Land (percentage)	-0.0765481 (0.0208782)***	-0.220713 (.063884)***	-0.00242385 (0.000698308)***	-0.0705625 (0.0183857)***
Public Land ² (percentage)		.00242964 (.000976912)**		
Unemployment Rates	1.01173 (.594481)*	0.659077 (0.545214)	0.0228918 (0.0180005)	
Median Household Income	-.0002767 (5.5354e-05)***	-0.000289515 (5.80714e-05)***	-9.82152e06 (1.97976e-06)***	-0.000241119 (4.36191e-05)** *
Poverty Rates	-0.299489 (.200206)	-0.309144 (.19878)	-0.0126729 (0.00663003)*	
Intercept	52.5105 (4.90748)***	51.1226 (4.73643)***	4.17676 (0.165841)***	48.4427 (2.75121)***
<i>F-stat</i>	13.35372	16.78891	12.51871	26.89658
<i>Adjusted R²</i>	0.531968	0.570846	0.525106	0.534742
<i>R²</i>	0.570175	0.614637	0.563873	0.553732