Are the food insecure more likely to be obese?

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Abstract:

This paper investigates the connections between food insecurity and obesity levels throughout the United States over three years (2011-2013). The causes of obesity are often not entirely a result of poor diet and exercise, but of the presence of food deserts in impoverished areas. Changes in income trends in recent years also the poor remain poor rather than experiencing upward mobility. This study builds on previous studies conducted both within the U.S. and internationally that found that food insecurity is a determinant of obesity rates. This study uses poverty as a proxy measurement for food insecurity at the state level, and finds that there is a positive, though not statistically significant, relationship with obesity.

JEL Classification: P46, I38
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1.0 INTRODUCTION

In a country as wealthy as the United States of America, the existence of widespread food insecurity is astounding. Every day, over 40 million people in the U.S. face food insecurity. This means that these people are unsure of when or where they will find their next meal due to low funds or resources (USDA ERS, 2018b). Oftentimes the cheapest food options available are those that are mass-produced and lacking nutritional value. This includes food sources such as fast food restaurants, pre-packaged snack foods, and sugary beverages. When diets consist mainly of these "cheap" foods, peoples' caloric, sugar, sodium, and fat intakes are far higher than they should be, thus causing high rates of obesity.

Obesity has become a chronic issue in American society. Caused by individual factors including genetics, food choices, activity levels, medications, etc., obesity is costing Americans millions of dollars and millions of lives per year. In 2008, obesity cost the U.S. almost $150 billion in medical care costs and about $6.4 billion in lost productivity ("Adult Obesity…", 2017). Among the top causes of death in the U.S. in 2016 were heart disease, diabetes, and kidney disease, accounting for a total of about 28% of all deaths (Heron, 2016). All three of these sources have links to obesity and overweight status ("Health Risks…", n.d.).

This study aims to enhance understanding of the effects of food insecurity on obesity rates within the United States. From a policy perspective, this analysis is important because food insecurity generally stems from low income and poverty. Thus, these issues and their effects on the health of citizens could be mitigated from insights provided by this study and by targeted health education campaigns. The relevance of this study is that obesity levels and poverty levels in the United States have both been trending upwards, making this issue important in recent decades.

This paper was guided by three research objectives that differ from other studies: First, it incorporates the ideas of minimum wage and average food costs into the model in order to determine the degree to which income levels and purchasing capability actually effect obesity rates. Second, it investigates the differences between males and females, rather than focusing on one group. Third, it aims to determine which factors, if any, including age, race/ethnicity, gender, etc. have a greater impact on obesity than others.

The rest of the paper is organized as follows: Section 2 is a brief literature review to establish where the current research and economic models originated. Section 3 outlines the empirical model with this paper's modifications. Data and estimation methodology are discussed

in Section 4. Section 5 presents and discusses the empirical results, explaining them in detail and establishing what the results show for the accuracy of the model. Finally, this paper concludes with Section 6 to summarize the findings and propose improvements for future studies.

2.0 FOOD INSECURITY AND OBESITY IN THE U.S.

2.1 Recent Income Trends

Since 2000, the United States economy has experienced an overall increase in real household incomes. However, during this period of 19 years, the U.S. has also experienced two recessions. The later recession—the 2007-09 Great Recession—dealt a major blow to household incomes, as shown below in Figure 1. Despite this setback, the boom in the economic cycle that followed this recession brought incomes rebounding with force to higher than their pre-recession peaks.

2Figure 1: Real Median Household Income in the U.S.

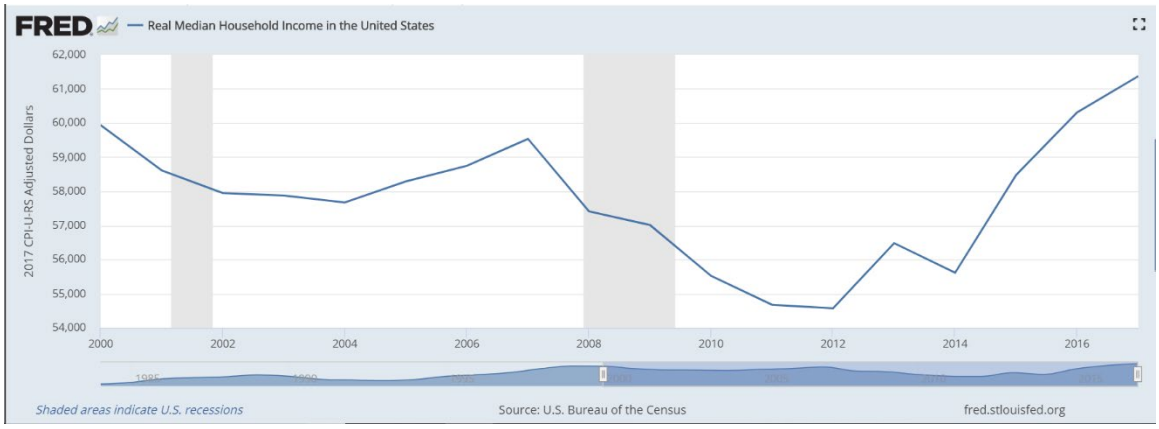
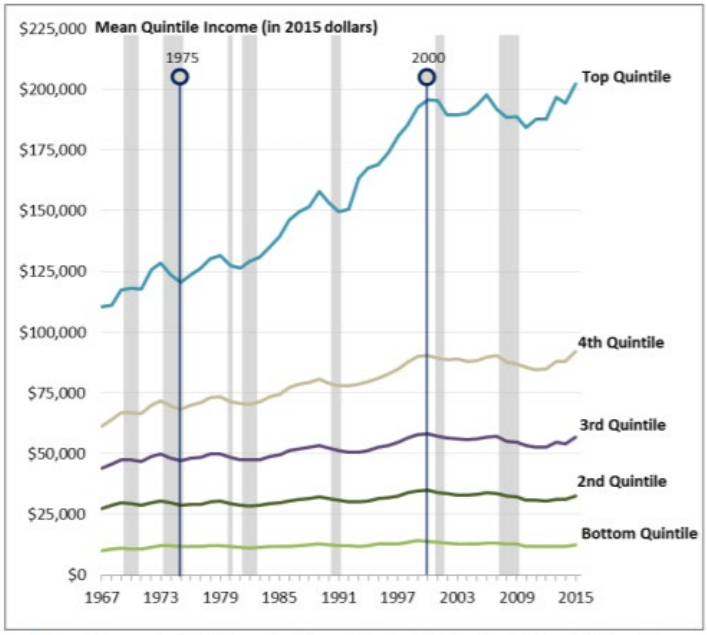


Chart Source: FRED

Since 2000 in the U.S., income trends seem to be that the rich get richer while the poor get poorer. More specifically, the incomes of the top 40% of Americans rose by about 0.1-0.2% while the incomes for the bottom 60% fell by up to 0.8% (Donovan, Labonte, & Dalaker, 2016). This is shown below in Figure 2.

Figure 2: Mean Quintile Household Income, 1967-2015



Source: Figure created by the Congressional Research Service (CRS) based on data from U.S. Census Bureau, Current Population Survey (CPS), Annual Social and Economic Supplements, available at http://www.census.gov/hhes/www/income/data/index.html. Recession data (in gray) are from the National Bureau of Economic Research, at http://www.nber.org/cycles.html.

Chart Source: Donovan et al. (2016)

The income gap becomes even more important when considering the difference between households of different races/ethnicities. For example, in 2015, 45% of all American households had annual incomes below $50,000, but 61% of those households are headed by black householders. Hispanic households are also over-represented for low-income earnings, accounting for about 54% of households bringing in under $50,000 per year (Donovan et al., 2016). Further, as shown in Figure 3, in 2016 the average African American household earned only about 60% of the incomes that their white counterparts earned (Wilson, 2018). On the other end of the spectrum, households that earned more than $200,000 per year were about 6% of all Americans but only 2% identified as black households. Further, only 3% of Hispanic households fall in this high-earning bracket (Donovan et al., 2016).

Figure 3: Earning Percentage of Black Households as a Percentage of White Households

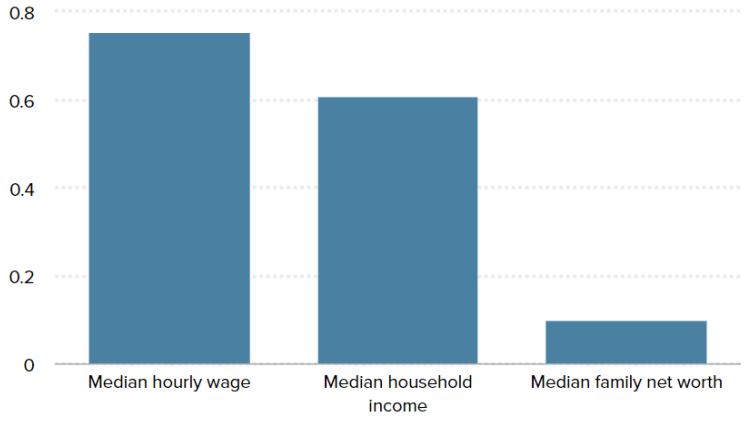


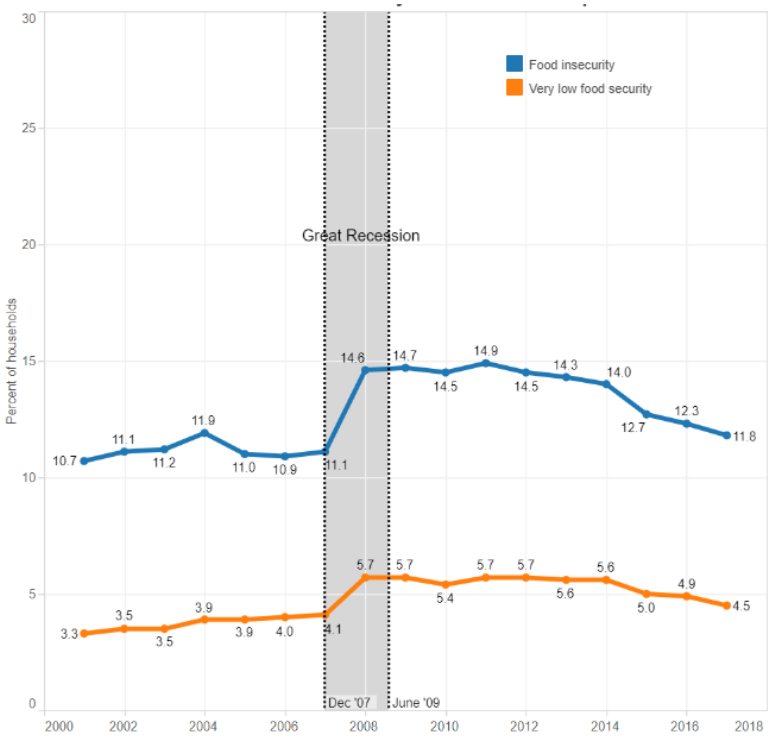
Chart Source: Wilson (2018)

2.2 Food Insecurity Trends

When finding trends for food insecurity, it is important to understand the levels of food security/insecurity. There are two sub-categories of food insecurity: low food security and very low food security. The difference between these levels is the disruption of regular eating patterns. People experiencing low food security can use government aid or planning strategies to avoid significant changes to their eating patterns. Conversely, people experiencing very low food security experience significant changes to their eating patterns because they are unable to afford or obtain food (USDA ERS, 2018b).

As shown below in Figure 4, food security has been relatively stable since 2000 from year to year—increasing only about 1.1-1.2% overall from 2000 to 2017—but the Great Recession severely impacted these numbers. As of 2017, there were about 9.3 million households (or about 7%) experiencing low food security and about 5.8 million households (or about 4.5%) experiencing very low food security in the U.S. (USDA ERS, 2018b).

Figure 4: Food Insecurity in the U.S., 2000-2017



Source: Calculated by USDA, Economic Research Service using Current Population Survey Food Security Supplement data.
https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/

Chart Source: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/interactive-charts-and-highlights/

When food insecurity is examined by race/ethnicity, it is clear that households that identify as black and as Hispanic have the highest rates of food insecurity (Figure 5). Additionally, the Great Recession appears to have caused a larger spike in food insecurity in these households than it did in White and non-Hispanic households. However, it is interesting to note that Hispanic households had the most volatile reactions to food security: these households spiked the highest during the Great Recession but also significantly reduced their numbers of food insecurity by 2017 to below their 2000 levels (USDA ERS, 2018a).

Figure 5: Trends in Food Insecurity by Race/Ethnicity, 2001-17

Source: Calculated by USDA, Economic Research Service, using Current Population Survey Food Security Supplement data.
https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/

Chart from: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/interactive-charts-and-highlights/#trends

2.3 Obesity Trends

Over the past two decades, obesity in the U.S. has risen and become a widespread issue. The average rate of obesity in the U.S. was about 11% in 1990. As shown in Figure 6, the highest rate of obesity in the U.S. in 1995 was about 20%. However, as of 2017, the average rate of obesity was 30.6% and the highest rate of obesity was over 35% in several states ("US Obesity…", 2017).

Figure 6: Obesity Rates in the U.S. Over Time

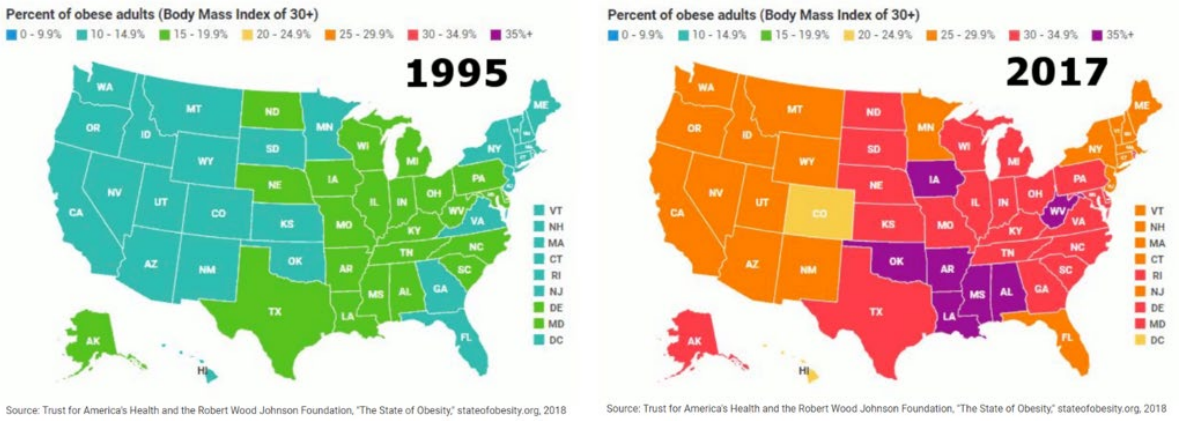


Chart Source: https://obesity.procon.org/view.resource.php?resourceID=006026

When examined by income level, the poor are much more likely to be obese than the wealthy. According to a New York Times article from 2008, the average American spends about $7 per day on food (Parker-Pope, 2008). When examined at a state level, the obesity rates across the U.S. by income level reflect this. In 2017, households that earned less than $15,000 annually had a much higher rate of obesity than the households that earned over $75,000 annually (Figure 7).

Figure 7: Obesity Rates by State and Income Level, 2017

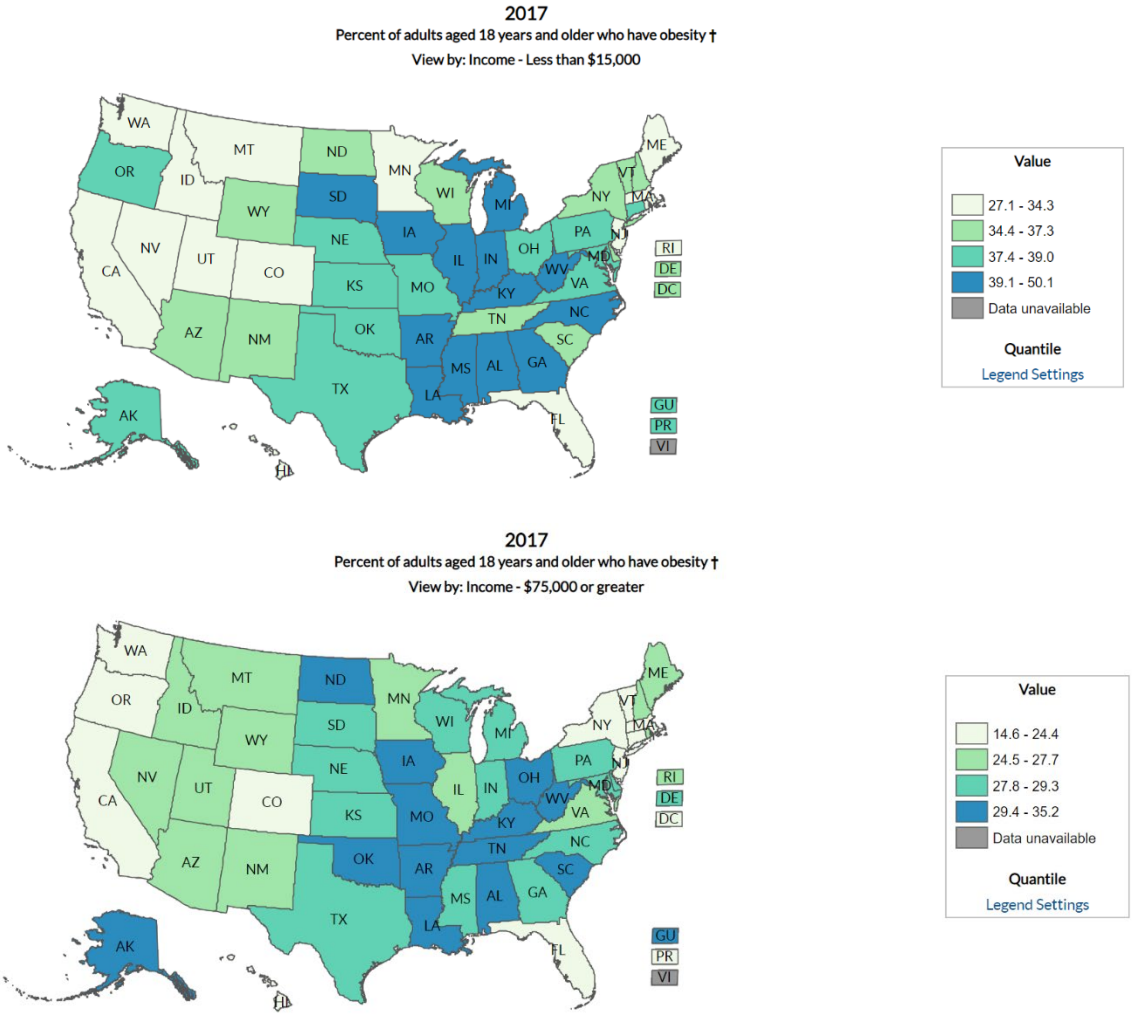


Chart Source: https://nccd.cdc.gov/dnpao_dtm/rdPage.aspx?rdReport=DNPAO_DTM.ExploreByTopic&islClass=OWS&islTopic=OWS1&go=GO

3.0 LITERATURE REVIEW

3.1 Obesity

In order to have a benchmark for measuring obesity, obesity itself must first be defined and understood. Obesity is excess body fat by definition. Obesity has typically been measured by the use of the Body Mass Index, or BMI. This index is a function of a person's height and weight. Traditionally, any BMI over the ratio of 30 is considered obese. However, this measure is problematic for two reasons. First, it does not consider that height and weight are highly subject to variance. Therefore, one height among people with different body structures and builds can have many healthy weights that could potentially be categorized as obese. The second problem builds on the first in that the BMI cannot differentiate between weight caused by fat and weight caused by muscle. For this reason, again, a perfectly fit person could be categorized as obese because of the test's inability to distinguish the weight source (Friedman, 2009).

Obesity is commonly thought of as an individual choice. For years, a rational obesity model was used by economists to investigate why obesity rates have been growing so quickly. The rational obesity model is based on an individual's preferences for the types of diets and amount of exercise in which they engage. Thus, if an individual's diet preferences have a higher caloric intake than the calories burned during their activity preferences, their weight will rise above their equilibrium weight (Tomer, 2011). One problem, however, with generalizing obesity as an economic issue is that many times it is not up to the individual's control. A person's weight is often effected by their genetics, hormones, and stress levels. That is why people's weights can fluctuate so often during their lives (Friedman, 2009; Tomer, 2011).

There is another fallacy that people still believe when it comes to obesity: that healthy food costs more than "junk" food. Research studies into the costs of typical "healthy" and "unhealthy" meals show that it is in fact more affordable for both individuals and families to eat healthy. One study by Bittman (2011) found that an unhealthy McDonalds meal for four can cost about $23 while a healthy roasted chicken and vegetables meal made at home can cost about $9-14. Another study by McDermott and Stephens (2010) finds that the annual cost of a healthy diet is just over $5,000 per person, while the annual cost of an unhealthy diet is just over $10,000.

Therefore, the major factor that can cause higher obesity rates is not necessarily the cost of healthy foods, but access to them and the existence of food deserts. A "food desert" is any place "lacking in adequate supply of fresh fruit, vegetables, and other healthy whole foods, usually

impoverished areas" ("Food Deserts…", 2019). Many studies have found that low-income areas, and particularly people of minority backgrounds that live in those areas, have higher rates of obesity that higher income areas. There are typically not quality grocery stores or healthy food options in low-income areas. Since residents in these areas also cannot typically afford a car to travel for food, they do not have access to healthy foods, which will cause weight gain and higher obesity rates (Ghosh-Dastidar et al., 2014).

3.2 International Studies of Income and Obesity Relationships

In a series of studies by Monteiro, Conde, and Popkin that took place in Brazil from 1975 to 2003, it was found that in both women and men, the lower quintile income levels had the greatest increases in obesity risk. However, from 1975 to 2003 the rate of obesity risk increase has slowed. They attributed these increases to the disproportionate intake of energy-dense foods, meaning those that are extremely high in calories, to energy-exerting activity. They found that people with low-income levels do not exercise in their free time as much as their high-income counterparts. This study also suggested that education levels could play a role in obesity rates because higher education could lead to better knowledge of healthy decision making (Monteiro et al., 2007).

In another study that took place in Pakistan, Iram and Butt (2004) utilize per capita calorie intake as a proxy for food insecurity and relating that to the recommended daily allowances. In addition to finding that household income affects the obesity rates of the people residing there, they also found that the mother's age, and assumedly her maturity and experience levels, are a key determinant of obesity rates. This is because experienced mothers will know how to feed their families the best at the cost they can afford (Iram & Butt, 2004).

3.3 Domestic Studies of Income and Obesity Relationships

Much of the research existing on the topic of food insecurity and obesity relates to how the income and food security of a household affects the dependent children. One study conducted in Pennsylvania by Papas, Trabulsi, Dahl, and Dominick (2015) surveyed Hispanic mothers. The study found that 58% of the mothers were living in poverty conditions and 74% of those women were experiencing some level of food insecurity. Of those 58%, 37% were obese themselves and 30% of their children were obese. Overall, this study concluded that "[l]ow food security increased

the odds of child overweight/obesity 10-fold …whereas very low food security increased the odds 30-fold" (Papas et al., 2015).

In a study conducted across regions in the United States found that food insecurity has a positive relationship with obesity in adult women but not in men. Food insecurity was also significantly related to the variables: income, education, occupation, region, urbanization, ethnicity, age, household size, welfare status, food stamps, total energy intake, and television viewing. To elaborate, the lowest income level with less than an eleventh grade education and high fat diets/low activity lifestyles were the most at risk for obesity. However, food insecurity was not found to be significantly related to any variables related to fat consumption (Townsend, Peerson, Love, Achterberg, & Murphy, 2001).

A few years later, Adams, Grummer-Strawn, and Chavez (2003) also found that, in California specifically, adult women were most at risk of obesity if they were food insecure. Similar to Townsend et al. (2001), this study found that food insecurity and variables related to education levels and race/ethnicity are all factors that increase the obesity risk in women. Specifically, Adams et al. (2003) found that those who struggled with food insecurity and with hunger were 2.8 times as likely to be affected by obesity. This study used the USDA food sufficiency indicator as a measure of food security (Adams et al., 2003).

As for demographic factors, in the U.S., Asian adults were found to be the least likely to be obese, while black and Hispanic adults are the most likely to be obese. This correlates with the income level disparity that is prevalent in the U.S. in which Asian-Americans tend to be higher earners on average and African-Americans and Hispanic-Americans tend to be disproportionately low earners (Public Health Staff, 2019).

4.0 DATA AND EMPIRICAL METHODOLOGY

4.1 Data

This study uses panel data from 2011 to 2013. The data is state-level data for the U.S. 50 states and Washington D.C. All data except for Income, Age, and MinWage are all percentages of the state population that have the variable characteristic. Income, Age, and MinWage are all median values. Data were obtained from the U.S. Census, Bureau of Labor Statistics (BLS), and

the Henry J Kaiser Family Foundation (KFF). Summary statistics for the data are provided below in Table 1.

Table 1: Summary Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Obesity	153	0.2956521	0.0382777	0.2068	0.3635
Poverty	153	0. 142607	0.0362786	0.055	0.258
Income	153	52336.41	8484.005	32338	72472
Male	153	0.4901961	0.0085433	0.47	0.52
Female	153	0.5110458	0.0082847	0.48	0.53
AgeTotal	153	37.7634	2.385972	29.6	44
AgeM	153	36.51046	2.385972	29.1	42.8
AgeF	153	39.00784	2.52343	30	45.1
Unmployed	153	0.0743181	0.0181985	0.0291667	0.1301667
White	153	0.701634	0.1619513	0.22	0.95
Black	153	0.1080392	0.1082338	0	0.5
Hispanic	153	0.1098693	0.0999999	0.01	0.47
MinWage	153	7.172222	1.120057	2	9.19
HSAttn	153	0.8728431	0.0328173	0.803	0.924
BSAttn	153	0.2825294	0.057697	0.176	0.524

4.2 Empirical Model

Based on the model proposed by Adams et al. (2003), this study adapted and modified the variables and regression model to explore links between food insecurity and obesity on a state level across the U.S. Adams et al. (2003) focused on women in California specifically, on an individual level. That study used variables for age, race/ethnicity, household income as a percent of poverty, general health status, food security, BMI, and education.

Building on that model, this study uses variables for income/poverty levels, race/ethnicity percentages, median age, and education. Additionally, this model incorporates unemployment and minimum wage as labor market controls and gender controls to account for differences between males and females.

This study uses two general models, both with slightly variant sub-models for robustness. The two general models account for differences between race/ethnicities and between genders.

TOTAL POPULATION ACCOUNTING FOR RACE/EHTNICITY

$$Obesity = \beta_0 + \beta_1 Pov + \beta_2 Unemp + \beta_3 MinWage + \beta_4 White + \beta_5 Black + \beta_6 Hispanic + \beta_7 AgeT + \beta_8 BSAttn + \beta_9 2012 + \beta_{10} 2013 + \varepsilon \quad \textbf{(I)}$$

$$Obesity = \beta_0 + \beta_1 Income + \beta_2 Unemp + \beta_3 MinWage + \beta_4 White + \beta_5 Black + \beta_6 Hispanic + \beta_7 AgeT + \beta_8 BSAttn + \beta_9 2012 + \beta_{10} 2013 + \varepsilon \quad \textbf{(I.1)}$$

$$Obesity = \beta_0 + \beta_1 Pov + \beta_2 Unemp + \beta_3 MinWage + \beta_4 White + \beta_5 Black + \beta_6 Hispanic + \beta_7 AgeT + \beta_8 HSAttn + \beta_9 2012 + \beta_{10} 2013 + \varepsilon \quad \textbf{(I.2)}$$

TOTAL POPULATION ACCOUNTING FOR GENDER

$$Obesity = \beta_0 + \beta_1 Pov + \beta_2 Unemp + \beta_3 MinWage + \beta_4 PopM + \beta_5 AgeM + \beta_6 BSAttn + \beta_7 2012 + \beta_8 2013 + \varepsilon \quad \textbf{(II)}$$

$$Obesity = \beta_0 + \beta_1 Pov + \beta_2 Unemp + \beta_3 MinWage + \beta_4 PopF + \beta_5 AgeF + \beta_6 BSAttn + \beta_7 2012 + \beta_8 2013 + \varepsilon \quad \textbf{(II.1)}$$

The regression method employed in this study is a fixed effects model, with the states being fixed over time. There are many differences between states that cannot be effectively accounted for with variables: their geography, cultures, history, etc. Utilizing a fixed effects panel regression allows each state to be compared to itself in each year rather than muddling the effects together for all of the states.

The dependent variable in each model is the Obesity variable. Obesity, as discussed in the literature review, is defined as a BMI over 30. The percent of adults in each state with a BMI over 30 is accounted for in the data in order to make predictions about the relationship with food insecurity.

The independent variable of interest in this model is Pov (or in the case of model I.1: Income). The Pov variable is the percentage of people living in poverty in each state. The original goal of this study is to determine the effects of food insecurity on obesity. However, since food insecurity is not a variable that has publically available data by state over time, the poverty prevalence by state is used as a proxy. Since food insecurity is partially caused by inadequate income to be able to afford three meals per day, the poverty income should be an effective proxy. Additionally, in the case of food deserts, there tend to be fewer food sources in cities and towns that are mainly impoverished. Income is used in one model because poverty is often classified as earning below a benchmark income. Thus, income level is used for robustness in model I.2.

Independent control variables consist of a total of 12 variables obtained from various sources. Appendices A and B provide data sources, acronyms, descriptions, expected signs, and

justifications for using the variables. Appendix C shows the correlations between the variables in the model. MinWage is the minimum wage in effect for the state during that year. This data comes from the US Department of Labor. Unemp, which is collected form the Bureau of Labor Statistics, is the average unemployment rate in the state for the year. In the race/ethnicity models, White, Black, and Hispanic are independent variables that measure the percentage of people in each state that have identified as white, black, or Hispanic respectively from KFF. PopM and PopF which are the percentages of male and female residents of the state respectively also comes from KFF. AgeM and AgeF are the median ages of male and female state residents, and this data is from the US Census data. BSAttn is the percent of state residents who hold a bachelor's degree or higher. HSAttn is the percent of state residents who hold a high school degree or higher. The data for these variables comes from the Census as well. Finally, there are dummy variables for the years. 2012 and 2013 are included in the model so that 2011 is the base year.

5.0 EMPIRICAL RESULTS

The empirical estimation results are presented in Table 2. The empirical estimation shows the positive relationship between obesity and poverty. This means that generally as poverty increases so do the obesity levels.

The only variable that the model shows is significant and robust is the Hispanic variable. This variable is significant at the 10% level each time it is included in the model. However, the sign of this variable contradicts the findings by Papas et al. (2015). The constant is also typically significant at the 1% level.

Although the other variables in the model are not significant, the models themselves are significant at the 1% level each time, as shown by the F-statistics. Interpreting these results in terms of relative change in the independent variable leads to two points. First, although the poverty variable and others are not significant, they are generally the expected sign. This is a positive result for the model. The second important note is that the nature of using fixed effects is that it controls for differences that exist within states already. Therefore, this could be the reason that the variables are not significant. The fixed effects specification may be absorbing all of the significant impacts of the independent variables on obesity.

Table 2: Regression Results

	OBESITY				
	I	I.1	I.2	II	II.1
CONSTANT	0.360***	0.336***	0.218	0.180	0.285**
	(0.1334)	(0.133)	(0.248)	(0.119)	(0.134)
POV	0.00444		0.000665	0.00957	0.00667
	(0.0255)		(0.0263)	(0.0253)	(0.0254)
INCOME		8.85 e-08			
		(1.46 e-07)			
MINWAGE	-0.00175		-0.00114	-0.00255	-0.00183
	(0.0046)		(0.00472)	(0.00471)	(0.00462)
UNEMP	0.0450	0.0621	0.0645	0.0413	0.00136
	(0.1091)	(0.107)	(0.108)	(0.107)	(0.111)
WHITE	-0.0594	-0.0652	-0.0394		
	(0.109)	(0.106)	(0.107)		
BLACK	-0.173	-0.157	-0.195		
	(0.169)	(0.170)	(0.168)		
HISPANIC	-0.212*	-0.216*	-0.205*		
	(0.121)	(0.120)	(0.123)		
POPM				0.0688	
				(0.132)	
POPF					-0.0503
					(0.152)
AGET	-0.00197	-0.00178	-0.00215		
	(0.00231)	(0.00233)	(0.00235)		
AGEM				-0.000454	
				(0.00184)	
AGEF					-0.00188
					(0.00184)
BSATTN	0.355	0.363		0.392	0.428
	(0.3084)	(0.305)		(0.301)	(0.297)
HSATTN			0.264		
			(0.268)		
2012	0.00193	0.00180	0.00229	0.00148	0.00114
	(0.00169)	(0.00167)	(0.00158)	(0.00147)	(0.00148)
2013	0.00390	0.00356	0.00493	0.00293	0.00226
	(0.00308)	(0.00307)	(0.00262)	(0.00268)	(0.00269)
R^2	0.2749	0.2963	0.0054	0.4948	0.4814
F-statistics	52.19***	53.31***	108.58***	106.43***	106.40***
Number of obs.	153	153	153	153	153

Note: ***, **, and * denotes significance at the 1%, 5%, and 10% levels respectively. Standard errors in parentheses.

6.0 CONCLUSION

In summary, food insecurity and poverty may have a positive relationship with obesity, although this study did not find significance in the impact.

6.1 Limitations

The main limitation of this study was the ability to find data to fill all of the variables that were planned to be employed here. The main independent variable of interest in this study—food insecurity—is not a variable that is available on a state or national level. Most studies that came before this one that utilized a food insecurity variable were ones that were done on an individual level in an experimental setting. The lack of data availability here led to having to substitute this variable for the poverty variable. Although poverty should be a close substitute—since in theory, those living in poverty will not have extra money to buy nutritious or enough food—it is not a perfect substitute.

Another key to understanding why people who are effected by poverty are food insecure is not the prevalence of junk food, but the existence of food deserts in impoverished areas, as discussed earlier. However, this variable is also not available at a state level. In order to account for food deserts, this study would have had to go to the county or city level.

Control variables for average healthy and unhealthy food cost, hours spent watching television, and hours spent exercising on average were not possible to find at the state level over multiple years. Additionally, just obesity prevalence on its own (without including all overweight people) was not publically available more recently than 2013.

6.2 Moving Forward

Future studies should focus either on the individual level or the county level. This will allow more accurate data collection to study the effects of the variables that this study originally set out to examine on obesity. Additionally, future studies may be able to make more accurate predictions with these extra variables as well as with data that is more recent than 2013 to account for shifting health trends.

Appendix A: Variable Description and Data Source

Acronym	Description	Data source
Obesity	Percentage of people in the state who are categorized as obese	Center for Disease Control and Prevention (CDC)
Pov	Percent of the population living in poverty	Census
Unemp	State unemployment rate, seasonally adjusted	BLS
MinWage	Legal minimum wage of the state	United States Department of Labor
PopM	Percent of the state population who is male	Henry J. Kaiser Family Foundation (KFF)
PopF	Percent of the state population who is female	KFF
White	Percent of the state population whose race/ethnicity is white	KFF
Black	Percent of the state population whose race/ethnicity is black	KFF
Hispanic	Percent of the state population whose race/ethnicity is Hispanic	KFF
AgeT	Median age of the state, in years	Census
AgeM	Median age of the male residents of the state, in years	Census
AgeF	Median age of the female residents of the state, in years	Census
HSAttn	Percentage of the state population holding a high school degree or higher	Census
BSAttn	Percentage of the state population holding a bachelor's degree or higher	Census

Appendix B: Variables and Expected Signs

Acronym	Variable Description	What it captures	Expected sign
Income	Median state income	Earnings of the state population	-
Pov	Percent of the population living in poverty	Percentage of the state population who may not be able to afford food or transportation	+
Unemp	State unemployment rate, seasonally adjusted	Percentage of the state population who may be at risk of poverty	+
MinWage	Legal minimum wage of the state	Minimum earnings of an employed person	-
PopM	Percent of the state population who is male	Differences between males and females on obesity/overweight	+/-
PopF	Percent of the state population who is female		+/-
White	Percent of the state population whose race/ethnicity is white	Differences in race/ethnicity on obesity/overweight percentages	+/-
Black	Percent of the state population whose race/ethnicity is black		+/-
Hispanic	Percent of the state population whose race/ethnicity is Hispanic		+/-
AgeT	Median age of the state, in years	Whether age is a predictor of obesity/overweight rates	+
AgeM	Median age of the male residents of the state, in years	Differences in age of the sexes on obesity/overweight rates	+
AgeF	Median age of the female residents of the state, in years		+
HSAttn	Percentage of the state population holding a high school degree or higher	Differences in educational attainment on obesity/overweight rates	-
BSAttn	Percentage of the state population holding a bachelor's degree or higher	Differences in educational attainment on obesity/overweight rates	-

Appendix C: Correlation Matrix

	Obesity	Income	Pov	Pop	PopM	PopF	White	Black	AgeT	AgeM	AgeF	Unemp	MinWage	HSAttn	BSAttn
Obesity	1														
Income	-0.5601	1													
Pov	0.3364	-0.7206	1												
Pop	0.162	0.0808	-0.0389	1											
PopM	-0.142	0.2079	-0.4137	-0.1075	1										
PopF	0.106	-0.1356	0.3225	0.1256	-0.9231	1									
White	0.2796	-0.0486	-0.3766	0.0061	0.3783	-0.3538	1								
Black	0.3092	-0.1952	0.4525	0.1746	-0.7324	0.7096	-0.4609	1							
AgeT	0.0369	-0.0105	-0.2363	-0.0641	-0.1513	0.2316	0.3769	-0.1707	1						
AgeM	0.0075	0.0217	-0.2616	-0.0558	-0.1	0.1825	0.4084	-0.1952	0.9912	1					
AgeF	0.0721	-0.0486	-0.2069	-0.0699	-0.178	0.2561	0.3521	-0.1606	0.9933	0.9713	1				
Unemp	-0.0475	-0.2968	0.3875	-0.1279	-0.3816	0.3719	-0.3891	0.3919	0.0365	0.0172	0.0361	1			
MinWage	-0.2143	0.2109	-0.1006	0.0203	-0.1048	0.1193	-0.11	0.0414	0.0918	0.093	0.0759	0.2508	1		
HSAttn	-0.366	0.5899	-0.7271	-0.0416	0.5241	-0.4579	0.4524	-0.4942	0.1323	0.1851	0.0865	-0.5732	-0.0305	1	
BSAttn	-0.7083	0.7023	-0.3611	0.0078	-0.2034	0.2448	-0.2503	0.1507	-0.0383	-0.0143	-0.0765	-0.0352	0.2833	0.4041	1

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