Obesity and Poverty in America

An honors thesis for the Department of Economics

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Tufts University, 2012

While the great majority of countries in the world struggle with the malnourishment of the population under the poverty line, several developed countries, especially the United States, face a very different situation. Historically, the waistline signified social status; a well fed, larger person displayed his riches around his midsection. In our current age of organic foods and expensive nutritionists, to be rich is often to afford to be impossibly skinny. Is the opposite also true?

This thesis looks at the relationship between poverty and obesity in the United States over a fifteen-year period at the macro state level. The data, spanning all fifty states from 1995 to 2009, is collected from several sources and databases and includes various indicators of poverty such as the percent of a state's population below the poverty line, food stamp prevalence, and crime. These variables also relate to income inequality in the state. The obesity variable is designated as the percent of the population with a Body Mass Index (BMI) over 30, which uses height and weight in calculating the generally accepted measurement of obesity.

By using poverty indicators, obesity levels, and other explanatory variables, this thesis aims to prove that poverty has been a significant contributor to the obesity epidemic in America. Unhealthier foods are perceived to be less expensive due to marketing and availability. Whether this is a correct assumption or not, the poor among others are over-feeding themselves with low-cost, fatty calories and becoming obese. According to a lecture given by Robert Lustig, MD in 2009, foods filled with sugar, especially high fructose corn syrup, have been created and modified to be less expensive; this has contributed to a significant increase in obesity over the past thirty years. Figure 1 shows the kilocalories per capita per day of sugar and sweeteners

consumed by Americans each day from 1995 to 2007.[1] Compared to a USDA recommended total food consumption of 2400 to 3000 kilocalories per day, one can see that the average American is consistently allotting about a fourth of his or her kilocalorie consumption to sugar and sweeteners.[2]

This paper will also look at the level of physical activity to determine if sedentary lifestyles contribute to obesity. Education is another factor to incorporate; those without the general knowledge gained from higher education of how food intake can affect their bodies may not know how to change their behavior to reduce their chances of becoming obese, or they may be more passive about it. Lastly, year variables are included to pick up remaining factors resulting from differences in the states from year to year.

II. LITERATURE REVIEW

A detailed review of existing literature is essential in studying the relationship between obesity and poverty.

Shenkin and Jacobson (2010) use the policies of the Food Stamp Program to observe the effect of poverty on obesity and other weight-related diseases. Shenkin and Jacobson (2010) conclude that impoverished people are more likely to consume overly sugary foods and drinks, which is why these groups are more likely to suffer from health issues related to obesity and diabetes. Sugar and sugar substitutes which do not add nutritional value cause tooth decay and obesity in children, and Shenkin and Jacobson (2010) find that those who use food stamps purchase 40% more sugar-sweetened beverages than the average consumer.

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[1] http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor
[2] http://www.nhlbi.nih.gov/health/public/heart/obesity/wecan/downloads/calreqtips.pdf

Even though the Supplemental Nutrition Assistance Program (SNAP), which runs the Food Stamp Program in the US, has been trying to promote healthy and low-cost diets, the outcome does not necessarily reflect the goals. Food stamps can be used for all grocery store items except dietary supplements, alcoholic beverages, tobacco products, hot prepared foods, and nonfood items, though this includes junk foods that contribute to expanding waistlines (Shenkin and Jacobson, 2010). They argue that products that can be purchased with food stamps should be reconsidered, yet the food industry might show resistance. For example, removing sugary beverages such as Coca Cola from food stamp purchases might create a great amount of opposition by the giant beverage companies. These companies might use their lobbying power to sway the politics behind the program, suggesting that this type of change cannot be easily accomplished. Additionally, some poverty organizations say that limiting food choices by removing these high-calorie high-sugar beverages is nothing more than discrimination against poor people.

Shenkin and Jacobson (2010) also suggest that food stamp users could be incentivized with monetary reimbursement for each time they buy a healthy item. The government is already taking steps towards providing healthier options within the reach of poorer populations, but more must be done. The government spends $400 million on constructing supermarkets in poor communities and promoting healthy food options in small grocery stores while encouraging more and more farmers markets to accept food stamps. According to one calculation, the implementation of a 12 cent tax per 12-ounce serving of sugar-sweetened beverages could amass $15 billion a year, as well as decrease the consumption of these beverages by 10%; however, many strongly oppose a tax that would interfere with the right people have to choose for themselves what they consume. Nevertheless, the United States can take small steps that have the

potential to impact the obesity crisis greatly, such as clearer labeling of healthy and unhealthy foods.

Pickett et al (2005) consider income inequality among developed countries and its relation to obesity, deaths caused by diabetes, and the amount of calories consumed each day. The study found that for developed countries, income inequality is positively related to obesity prevalence among men and women as well as diabetes, mortality rates, and calories per capita per day. Though this study is at the individual level of observation, it is still significant in understanding the link between obesity and poverty in America.

In developed countries, a quarter of the adult population is obese with a BMI of over 30. In the United States, this rate can exceed 30% in some states. This can be attributed to both environmental and genetic causes; according to Picket et al (2005), environments have the largest impact. Public health leaders try to curb obesity by creating policies to better label foods and promote exercise, but there is only so much governments can do if populations are unwilling to change their habits. Stress may also be an important factor, and in some countries more people are stressed than others based on the labor environment, for example. Anxiety and tension can be aggravated in conditions of low social status, as people feel that they have less of an ability to manage and control their daily actions. Being near the bottom of a socioeconomic hierarchy may be a cause of stress.

Another relevant point this article presents concerns the differences between poorer and richer countries. According to Pickett et al (2005), "during the epidemiological transition, in which chronic diseases replaced infectious diseases as the leading causes of mortality, obesity changed its social distribution—where once the rich were fat and the poor were thin, in developed countries these patterns are now reversed." The article uses the Gini coefficient to

measure inequality and uses the United Sates specifically as a case study. Findings show that in the United States there have been noticed relationships between income inequality and abdominal weight gain for men and for women, a higher BMI. As this BMI rises to over 30, obesity develops and becomes a threat to health. Pickett et al conclude that, when considering public health, it is necessary to consider policies that promote economic growth as well as equality.

Drewnowski and Specter (2004) study the relationship between obesity and three dietary factors: diet quality, dietary energy density, and energy costs. The authors begin by stating that the least educated and most impoverished are the most obese. The most energy-dense foods (foods with the most calories) have the least cost per unit of energy, or are the least expensive for the consumer; the most energy-dense foods and enjoyable sugary foods are associated with higher consumption of energy in general. Additionally, poverty and food insecurity on the whole contribute to spending less money on higher quality food, especially fruits and vegetables; in turn, this leads to poorer diets. American people are eating more sugary and fatty foods and becoming obese while allocating a lower share of their disposable income to food expenditures.

Fast food, soft drinks, poor school lunches, larger portions, and other money-saving techniques for acquiring calories are all factors that contribute to obesity. To mitigate this, the government has begun to tax some sweets and fatty foods, hoping to dissuade consumers from purchasing unhealthy foods while encouraging the consumption of the alternative choices available. However, this may not be making enough of an impact. By 1999-2000, 30% of adults in the United States aged 20 years and older were obese with a BMI over 30. When looking at individual populations, obesity is mainly observed in poor minority populations (excluding Asian-Americans due to incomplete data sets) and for women: obesity is primarily in minorities

and in the low income and low education demographics. The data for men and socioeconomic status with obesity is not as clear. The highest increases in obesity, though occurring in all races, levels of education, and both sexes, is seen amongst the most underprivileged.

Food insecurity is examined as a cause for obesity as well. The 1995 US Department of Agriculture Current Population Survey defines food insecurity as the "limited or uncertain availability of nutritionally acceptable or safe foods." In 1995, 11.9% of US households fit this description, but food insecurity does not necessarily mean hunger. A positive relationship exists between participation in the food stamp program and food security; food insecurity that occurs among women without hunger is, in fact, associated with being overweight.

Picking foods that are energy-dense (therefore less expensive) is strategic in cost-savings. These energy-dense foods are connected to "passive overconsumption" of sweets and fatty foods with a diminishing satiation effect as well as greater overall energy consumption. Sugar and fat give great neurobiological reward, according to tests with laboratory animals. These tests have concluded that one might use these types of foods to improve his or her mood. Sugary and fattening foods are addictive when consumed in bingeing proportions, according to Avena, Rada, and Hoebel (2009). This can make people who consume a great deal of these types of foods more susceptible to further over-eating and displaying withdrawal symptoms when these people attempt to curb their consumption. Children like sweet and fatty foods because of the familiarity; preferences for food are from familiarity or positive experiences with certain foods. It is also possible that children are influenced by their mothers' food choices and preferences or by advertising.

Energy-dense foods are available at low cost because of food-processing technology and advances in agriculture. Dry items on a shelf are usually less expensive than perishable items like

meat, fruit, and vegetables; these foods also usually have preservatives and additives in them. It is noted that income disparities have a greater impact on the quality of diets than on total energy consumption. Higher household incomes are associated with higher quality diets according to studies in Canada, France, the United Kingdom, and some countries in the European Union. Higher-income households buy higher quality foods, while lower-income households spend relatively more of their disposable income on food products in general, especially canned or preserved food. Studies show that people do not think it is more expensive to eat a healthier diet, yet they continue to make choices to buy inexpensive, unhealthy foods; many studies show that food purchases are influenced by cost. Lower income families spend around 25% of their income on food while higher income families spend around 7%.

Other environmental factors can contribute to obesity as well. Television and marketing for unhealthy foods are major contributors to higher fat and energy consumption. When we look at how obesity occurs, we can see that it has reached beyond individual medical concerns and has become a societal problem. We must make societal and public sector changes and improvements to control this issue.

Chang and Lauderdale (2005) hypothesize that the poor may not face disproportional increases in obesity levels and that there may be a changing relationship between obesity and income over time. The authors examine the relationship between obesity and income disparities by using the National Health and Nutrition Examination Surveys for data on BMI within different income groups and how BMI changes over time within these groups. Chang and Lauderdale (2005) find that in all income groups they use, obesity increases over time (in this case, three decades); however, it is not necessarily the poorest that have become more obese over time. This increase over time could be contributed to several different factors, including food

consumption, the decline of smoking as an appetite suppressor, and the decrease in the participation in physical activities. The main finding of the paper is that poverty is only a partial contributor to obesity; policy makers and academics alike must consider many other contributors, especially among different racial groups.

Chang and Lauderdale (2005) look at the breakdown of race and sex while examining different levels of income distribution and the obesity prevalence in each over time. Over the past decade, obesity prevalence increased from 23% to 30%. 65% of adults are considered overweight or obese. Regarding women, the study finds that there is a strong inverse relationship between obesity and socioeconomic status. This is, however, not true for men. Some studies even show the opposite may be true or that there is no clear correlation. The NHANES survey was used due to its cross-sectional national data of in-person and physical health examinations. The subjects of the survey were adults aged 18-64, non-Hispanic whites and blacks, Mexican-Americans, and non-pregnant women. Income status is measured by the poverty-income ratio, which is a measurement of a family's income to a certain poverty threshold and is represented with continuous data. Education was not considered; there was not enough data, and over time, the meaning and value of educational distinctions have changed.

Findings include that non-whites have a higher percentage of obesity than whites, especially for women, and that obesity had increased within each race-sex group over time significantly. For black women, the largest increase in obesity over time is in the middle income level, but for black men it is in the highest income level. Generally for white and black women there is an inverse relationship between BMI and income, but Mexican-American women do not show a strong consistent relationship. For black and Mexican-American men, there is a positive

relationship between BMI and income, but for white men there is not a strong consistent relationship (though it is inversed).

The differences in male and female obesity trends can be due to differences in occupational demands (for example, men are more likely to work in physically demanding jobs like construction) as well as differences in food tastes. Concerning other differences, socioeconomic status can be a determinant of resources and access to health information and care. A reason for poorer men to have lower BMIs is that they may do more manual labor and may be more physically active. Additionally, other factors may contribute to the shape and size of a person's body. Perhaps there is a difference among racial and socioeconomic groups considering standards of aestheticism and expectations of weight norms.

These relevant articles help focus this study; the models consider all of these articles and take a macro approach, as the data reflects obesity and poverty indicators at the state level. The basic conclusions of the articles above cover many topics included in this paper including the links between the following: poverty and the over-eating of sugary foods, income inequality and obesity, calories consumed and cost per unit of energy, and consumption of sugary foods and susceptibility to binge eating. From here, I will determine the variables to incorporate and create hypotheses based upon the data collected.

III. DATA

The data collected for this thesis is composed of variables that span all fifty states from 1995 to 2009. This includes several poverty indicators, an obesity level indicator, education attainment, and indicator of physical activity. Year variables are also included in the regressions.

Obesity is the main variable in this thesis. It is the variation in the variable that is explained. Using BMI to determine obesity is most commonly used because gathering height and weight data is fairly easy. The BMI data used in this thesis (the percent of the population with a BMI over 30 by state from 1995 to 2009) is collected from the Centers for Disease Control and Prevention (CDC) website under the Office of Surveillance, Epidemiology, and Laboratory Services.[3] The category of BMI levels of 30 and above is used, as 30 is the generally accepted threshold of obesity. Figure 2 shows obesity's relationship with time, which is a clear constant upward trend. A separate yet possibly relevant contributor to the increase of obesity over time could be the national decline of smoking; smoking depresses the appetite, and with the government's actions in the past couple of decades to encourage quitting, there is a possibility of correlation. United States government sources indicate that quitting smoking could cause four to ten pounds of weight gain.[4]

The primary indicator of poverty comes from ProQuest Statistical Datasets.[5] The database gives raw numbers of the amount of people considered impoverished in each state for each year from 1995 to 2009; for purposes of this paper, those numbers were divided by the total number of people living in each state in order to calculate the percentage of the number of people in poverty. The population by state data was also collected from ProQuest Statistical Datasets. With this general measurement of poverty, one can begin to see trends of which states have higher and lower levels and which have slow and rapid growth rates of poverty. Figure 3 shows the relationship between poverty and time. It is interesting to note the shape of the graph:

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[3] http://apps.nccd.cdc.gov/brfss/list.asp?cat=OB&yr=1995&qkey=4409&state=All
[4] http://www.smokefree.gov/pubs/ff3.pdf. This has a more significant impact on shorter people, as BMI takes height and weight into account. For example, a 5'4" woman who is 140 pounds would increase her BMI by 1.7 if she gained 10 pounds, making her "overweight." A 6' man who is 180 pounds would increase his BMI by 1.4 if he gained 10 pounds, though this would still be considered "overweight."
[5] http://www.lnstatistical.com/Main.jsp

poverty declines during the Clinton administration in the 1990s because of the relative economic

prosperity during that time, then in the years between and after the recessions of 2001 and 2008,

there is a sharp increase in poverty.[6] In Figure 4, the relationship between the mean of the

obesity data and the mean of the poverty data is displayed with a trend line showing its basic

correlation. The "problem" is that obesity shows a continuous upward trend where poverty first

declined and then increased; consequently there must be other factors that explain the rise in

obesity. Of course, this masks variation across states.

Another indicator of poverty is the percent of the population that uses food stamps. This

data, also gathered from ProQuest Statistical Datasets, is already in percentage form and spans

from 1997 to 2008. The Food Stamp Program, also referred to as the Supplemental Nutrition

Assistance Program (SNAP), gives low-income households money to spend on food each month.

To partake in the program, recipients must apply, undergo an interview process, and meet certain

criteria of eligibility, such as a gross income below 130 percent of the poverty line.[7] Specific

products such as tobacco and alcohol are banned from being purchased through this program;

however there has been much focus on the inclusion of "junk foods" in the purchasing power of

the stamps. According to the United States Department of Agriculture Food and Nutrition

Service website,

> Soft drinks, candy, cookies, snack crackers, and ice cream are food items and are
> therefore eligible items…Since the current definition of food is a specific part of
> the Act, any change to this definition would require action by a member of
> Congress. Several times in the history of SNAP, Congress had considered placing
> limits on the types of food that could be purchased with program benefits.
> However, they concluded that designating foods as luxury or non-nutritious
> would be administratively costly and burdensome.[8]

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[6] It is important to note that the means of the values used to generate Figures 2-6 take the mean of the percentages of
the population that fall under each category across the states and do not weigh each state separately in terms of
population size.
[7] http://frac.org/federal-foodnutrition-programs/snapfood-stamps/eligibility/
[8] http://www.fns.usda.gov/snap/retailers/eligible.htm

This poverty indicator is interesting for two main reasons. First, there is a significant process necessary to acquire these stamps; many people who do not want the government to know their personal information or fail to complete the application process are not included in the program. This makes both the variable a self-selection statistic and the outcome when regressed with obesity a measurement of the BMI of those who may be particularly needy and motivated. This is also fascinating when considering obesity because the government funds this program yet is not able to pass legislation to restrict its use to healthy foods. Reasons the government has had difficulties with implementing restrictions include the costs, definitions of "healthy" and "junk," monetary politics involving food companies, and complaints of discrimination against people in poverty. It may be meaningful to explore the government's role in obesity in another paper. Figure 5 describes the relationship between food stamps and time. This graph closely mimics that in Figure 3, as in times of greater poverty, more people will apply to receive food stamp benefits.

Crime is the third indicator of poverty used in this paper. According to several studies including Hsieh and Pugh (1993)'s *Poverty, Income Inequality, and Violent Crime: A Meta-Analysis of Recent Aggregate Data Studies*, "it is concluded that poverty and income inequality are each associated with violent crime."[9] Crime is used in place of the poverty variable to eliminate any reverse causality issues that may arise from poverty being caused by obesity, which is possible due to workplace discrimination, limitability of movement needed for certain jobs, and healthcare costs, to name a few. The data comes from the Uniform Crime Reporting Statistics - UCR Data Online.[10] It is given as the total estimated violent crime by state from 1995

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[9] http://cjr.sagepub.com/content/18/2/182.full.pdf+html
[10] http://www.ucrdatatool.gov/

to 2009, so this will be divided by the state population to give the percentage of the population engaged in crime. If the results from this model are greatly different than those from the percent impoverished and percent using food stamps models, then it can be deduced that crime may be an acceptable proxy for poverty because it may minimize the noise picked up by reverse causality. Crime has been on the decline over the studied period, as can be seen in Figure 6. This differs from the patterns shown in the poverty and food stamp graphs (Figures 3 and 5), as it is a more consistent trend downwards. The decline of crime in the 1990s is linked to the legalization of abortions in the 1970s, according to the Donohue-Levitt hypothesis (2001), though this has been partially contested by further research. From these graphs we can see a strong negative correlation between obesity and crime, which is the opposite of what one may expect if crime is to be used as an indicator of poverty.

The education variable, from ProQuest Statistical Datasets, gives raw statistics on the number of people in each state to complete a Bachelor's Degree from 1995 to 2009, with the years 1999 and 2000 omitted. These numbers must be divided by the population of the state in the given year to give a percentage of the residents holding each degree. This paper hypothesizes that with an increase in educational attainment there is less of a chance that a person will be obese. This is based on the idea that with more education, one should theoretically be more aware of the impact certain lifestyle choices have upon health. This thinking may only be significant to a certain extent, as the difference in intelligence between a Master's and Doctorate holder may not be as substantial as that between a Bachelor's and Master's holder.

To measure physical activity, a constant to control for differences in obesity levels, another CDC data set is used that gives the percent of the population that

exercised in the past month. This data is collected from 1996 to 2009 with data missing

from 1997 and 1999 because before 2000, the data was only observed every other year.[11]

In a majority of circumstances, these percentages do not increase or decrease specifically

with time; most of the numbers fluctuate on a yearly basis. Physical activity is an

important variable because exercise, such as running or walking, is a free way to prevent

obesity. This is a choice people can make to take control of their weight gain. This choice

is relatively independent of income level aside from the time-cost of executing the work

out.

Finally, the year variables are included to pick any changes that may be observed

due to natural developments over time. This could include changes in policy, changes in

methods of food production, trends in time spent doing sedentary activities such as

watching television, surfing the internet, and playing video games, and the level of

female participation in the workforce which would perhaps lead to the greater

consumption of fast-food meals. The year variables capture what we see in Figure 2

where there is a constant rise in obesity over time.

Summary statistics are included in the Appendix.

IV. MODELS

This paper collects observations from six different models to form a stronger

understanding of the relationship between obesity and poverty. These models come in sets of

two; I will first regress obesity on each of the three indicators of poverty—percent impoverished,

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[11] Since these full years are missing for this variable, in order to include a full data set I must perform a standard fix
for missing data. I set these missing values equal to zero and include indicators of missing values in the regression.

percent using food stamps, and percent of the population engaging in crime—then I will use a

fixed effects model for each of the three poverty indicators. I estimate in three separate models to

look at the separate effects they have on obesity; if they were all together, there may be

collinearity issues with poverty and food stamps since it can be determined from Figures 3 and 5

that they move generally in the same direction. Additionally, separating the poverty indicators

provides a simpler way to determine the impact of individual explanatory variables, case by case.

Three regressions will estimate the relationship using a linear regression model, which

implies that the change in obesity is related to a certain one-unit change in each of the other

variables used. For the three fixed effects runs, inherent differences between the states such as

policies, the economy, and significant events that have taken place within the time period will be

considered only from year to year within a state rather than across all of the states. This makes it

a better model when looking across a set of data such as states, as it prevents the comparison of

states that have distinct characteristic differences (for example, a state that borders an ocean can

have different economic and societal features than one that is landlocked). In other words, the

Ordinary Least Squares regression allows for variation across states, while in the fixed effects

model, the individual state characteristics are held constant.

(1) Obesity=β_0 + β_1Poverty + β_2Exercise + β_3Education + β_4Years(1995-2009) + ε
(2) Obesity=β_0 + β_1Food Stamps + β_2Exercise + β_3Education + β_4Years(1997-2008) + ε
(3) Obesity=β_0 + β_1Crime + β_2Exercise + β_3Education + β_4Years(1995-2009) + ε

Using all the same explanatory variables will make it simple to compare the results across

regression types and poverty indicators. However, since the food stamp data spans from 1997 to

2008, this regression deals only with twelve years of data as opposed to fifteen in the other two

poverty indicator regressions.

The findings of the percentage of the population in poverty regressions will describe the effect of a one percentage-point increase in poverty in a state in terms of a certain percentage point change of obesity, keeping the level of exercise, degree reached of education, and year constant. This shows the direct relationship between poverty and obesity. Only for this set of regressions, I will include the year variables but on a different table (Table 4). This is because the time trend is similar for all regressions.

Using the percentage of the population participating in the food stamp program as a proxy for poverty, the results give the effect on the percentage of the population with a BMI level greater than 30 with a one percentage-point increase in the usage of food stamps, still holding exercise, education, and year constant.

The final set of regressions uses the percentage of the population engaged in violent crime as an indicator of poverty. Again, it is expected that this regression will overcome reverse causality issues brought about by comparing poverty levels to obesity levels. This aims to determine the effect of a one percentage point change in crime levels on the percentage of the population of people with a BMI over 30 with all explanatory variables held constant.

V. RESULTS

I will describe the findings from the six regressions in this section and compare the resultant effects on obesity in the following section.

Percentage of the Population in Poverty

The first regression looks at obesity and its relationship to the percentage of the population in poverty, holding physical activity, educational attainment, and the year variables constant. Column I of Table 2 presents the results. The data suggests that with a one percentage point increase in the amount of people in poverty, the chance of the population having a BMI

over 30 is correlated with an increase by 0.28 percentage points. This is significant at the one percent level and has an elasticity of 0.16. Exercise is also significant here at the one percent level; with each additional percentage point of the population that exercises at least once a month, obesity corresponds with a decline of 0.21 percentage points. Education is not a major factor in this model and is not significant. The adjusted R-squared is 0.77, meaning that over three quarters of the contributors to poverty are described by the model.

When considering this regression with fixed effects, the results are much less convincing. Column I in Table 3 describes the findings. A one percentage point increase in poverty corresponds with only a 0.05 percentage point increase in obesity, yet this is not a significant figure. Exercise is no longer significant either, but education is significant at the five percent level. With an additional percentage point of the population that has attained a Bachelor's Degree, obesity correlates with a decrease by 1.69 percentage points. The adjusted R-squared is rather high at 0.92. This regression not particularly useful is describing obesity and poverty patterns because most of the explanatory power is picked up by the year variables.

For this set of regressions only, I have included the year variables in Table 4.These are for the individual years that I am observing except for the first year, 1995, as this is used as a reference year for the others. Year variables pick up trends in obesity over time that are not suggested in the model but still may contribute to obesity. This variable demonstrates the rise of obesity over time seen in Figure 2. With the inclusion of the years in Table 4, we can see that almost every year for both the OLS regression and the fixed effects regression has significance at the one percent level.

These two regressions show that perhaps the variable "poverty" could be a valuable measurement of the amount of impoverished people in the population, yet using fixed effects

takes away from some of its importance. For fixed effects, we can see that educational attainment and time are driving obesity levels, and that the percent of the population that is impoverished is not important. This can be due to a lack of differences in the changes in poverty levels across states such that the differences among the states are picked up more in other factors like the education than in percentage of people impoverished.

Percentage of the Population using Food Stamps

This regression replaces "poverty" with a measurement of the amount of people in the population using food stamps to hopefully decrease any reverse causality issues; however, the results are fairly similar. Column II of Table 2 describes the results. With an adjusted R-squared of 0.75, food stamp usage as a correlate of obesity is significant at the one percent level. A one percentage point increase in food stamp usage corresponds with an increase obesity by 0.45 percentage points with an elasticity of 0.16. Again, exercise is significant at the one percent level: a one percentage point increase in the number of people who exercise each month correlates with a decrease in obesity by 0.18 percentage points. Education is now significant at the ten percent level with a coefficient of -1.21, meaning obesity will decrease by this many percentage points with a one percentage point increase in a population's attainment of Bachelor's Degrees.

Column II of Table 3 shows the results of this regression using fixed effects. With a one percentage point increase in the usage of food stamps, obesity correlates with an increase by 0.18 percentage points which is significant at the one percent level. This is the only main poverty indicator that is significant using fixed effects, and it has an elasticity of 0.06. The adjusted R-squared is 0.90, much of which is picked up in the year variables; however, education is also

significant here at the five percent level. A one percentage point increase in the percentage of people within a state to gain a Bachelor's Degree corresponds with a decrease of obesity by 1.59 percentage points. Similar to the fixed effects regression using the poverty variable, exercise is not significant.

This method of determining the connection between poverty and obesity is very similar to using the poverty variable, yet food stamp usage is shown to be a small driver of obesity in the fixed effects model whereas poverty levels are not. This may be due to some reverse causality issues picked up with the poverty variable that are overcome by using food stamp usage as a proxy.

Percentage of the Population Engaged in Violent Crime

The final set of regressions uses a totally different method of evaluating poverty to describe its relationship with obesity: crime. Earlier, it was hypothesized that crime would have the least amount of reverse causality with obesity as it is correlated with poverty but does not have an endogeneity problem when considering it with obesity.

The results are all significant, as can be seen in Column III of Table 2. With a one percentage point increase in the population engaged in crime, the likelihood of obesity correlates with an increase by 0.92 percentage points at a significance level of ten percent. The elasticity is 0.02. One explanation of this correlation may be due to the fact that the fear of crime in an area could increase stress levels and food consumption due to stress. Exercise is significant at the one percent level with the results suggesting that it corresponds with a decrease in obesity by 0.30 percentage points. Education is also significant here; this is the only run in which this is so.

Education corresponds to a decrease obesity levels by 1.62 percentage points. The adjusted R-squared is 0.74 which is similar to the regression using food stamps as an indicator of poverty.

For the fixed effects regression using crime, the overall R-squared is 0.92. Column III of Table 3 shows the outcomes by variable. Neither crime nor exercise is significant, but at the five percent level, education is. With a one percentage point increase in the amount of the population that has a Bachelor's Degree, obesity correlates with a decrease by 1.72 percentage points.

From this we learn that crime is the least indicative of obesity levels among the three poverty indicators used. This contradicts the earlier hypothesis that crime would be the best proxy for poverty. Reasons for this lack of significance may be due to crime picking up other noise not associated with the model or the fact that crime is not as good of an indicator of low income as Hsieh and Pugh (1993) suggest.

VI. CONCLUSIONS

In closing, we can see that the Ordinary Least Square models have proven to be generally very significant in their results across all variables except for education, which has mixed significance at a lower level. Though the fixed effects models are significant for education and year, they may not be as significant for the primary poverty levels because there may not be a great deal of differences across the states. Food stamp usage, nevertheless, proves to be substantial in explaining obesity with state variances held constant.

These findings show that the obesity levels in America can be partly explained by different indicators of poverty and that this paper's main hypothesis is fairly accurate. The years studied in this experiment did not capture the exact effects and correlations that were assumed in the hypothesis, but some significance was still discovered using the data. More work must be

done to incorporate other variables that were picked up in the year variables in this experiment to better explain what drives obesity levels; however, based upon the findings of this paper, some policy suggestions can still be made to attempt to curb the obesity epidemic.

First, when considering public health legislation, income levels and available foods in poor neighborhoods must be addressed. Promoting more farmers markets and discouraging the opening of inexpensive fast food options could be an important way to steer a population's spending habits in a more healthy direction. Nevertheless, there has been research on this solution and its effectiveness. One study shows that obesity has little to do with the amount of fast food restaurants in an area because areas of high fast-food density are more likely to have a greater amount of produce-selling grocery stores as well.[12] This would mean that with more unhealthy options, populations also have a relatively proportional amount of healthy options to choose from. The solution here would be to make the existing healthy choices at the grocery stores more visible and appealing through individualized neighborhood campaigns.

Second is the issue of what can be purchased using food stamps. As this was the most significant variable found to explain obesity in this experiment, more work should be done to further prove its importance. Though the arguments of what constitutes "junk" foods and the idea that government should not discriminate against the food choices of the poor should not be ignored, it is clear that some changes should be made to enlighten people of alternative, better choices of groceries. The food stamp program is called the Supplemental Nutrition Assistance Program because the stamps are supposed to *supplement* what can be bought by the users with their own money. A way around the discrimination argument is to remove selected "junk foods" (to be defined by the Surgeon General, perhaps) from the list of what food stamps can buy, while

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[12] http://www.nytimes.com/2012/04/18/health/research/pairing-of-food-deserts-and-obesity-challenged-in-studies.html?_r=1&ref=health

making it clear that the consumer himself can still make the choice to buy these items from his personal earnings. The food stamp program is a benefit of living in the United States, not a basic right, therefore the government should be stricter on its usage especially with the adoption of semi-nationalized healthcare.

Third, the importance of education and exercise must continue to be emphasized and taught at a very early age. The government can accomplish this in several ways. Keeping children in school—and enjoying school—must be a main priority for states. If children learn at an early age the fundamental importance of education, it is more likely that they may elect to pursue higher education in the future. Parents should also be educated through community center or church programs to learn what types of foods they should be buying for their households. Additionally, increasing the accessibility of education loans to poorer populations would enable more people to overcome monetary issues when deciding to obtain a Bachelor's Degree. Finally, requiring physical activity through high school will keep children active and more likely to continue to enjoy healthy lifestyles in the future. Recent research has shown that educating children has had a positive impact upon obesity rates.[13]

Further work can be done using data at the individual level or by ZIP code as opposed to the state level to get a more detailed overview of the data and results. State-wide data proved to be limiting in the amount of data available. It may also be interesting to look at what causes obesity at income levels over the poverty line to compare results. Including other variables that may have significantly changed over time such as participation of women in the work force and average hours of television watched per day could help further explain the obesity epidemic in America as well, as these were largely picked up in the year variables used.

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[13] http://www.boston.com/lifestyle/health/articles/2012/04/23/obesity_rates_drop_in_states_youngest_children_study_shows/?s_campaign=8315

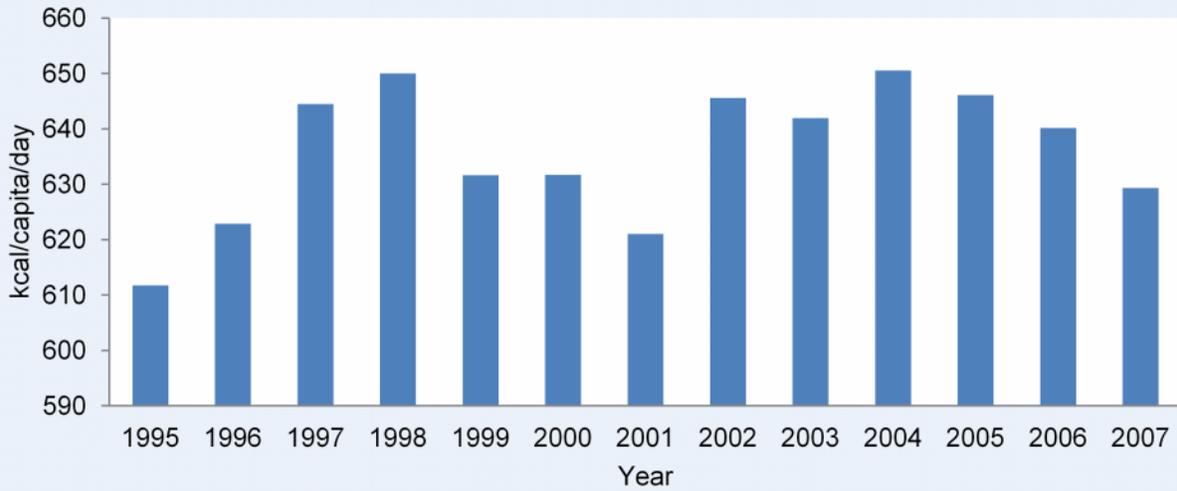Figure 1: Sugar and Sweeteners, kcal/capita/day

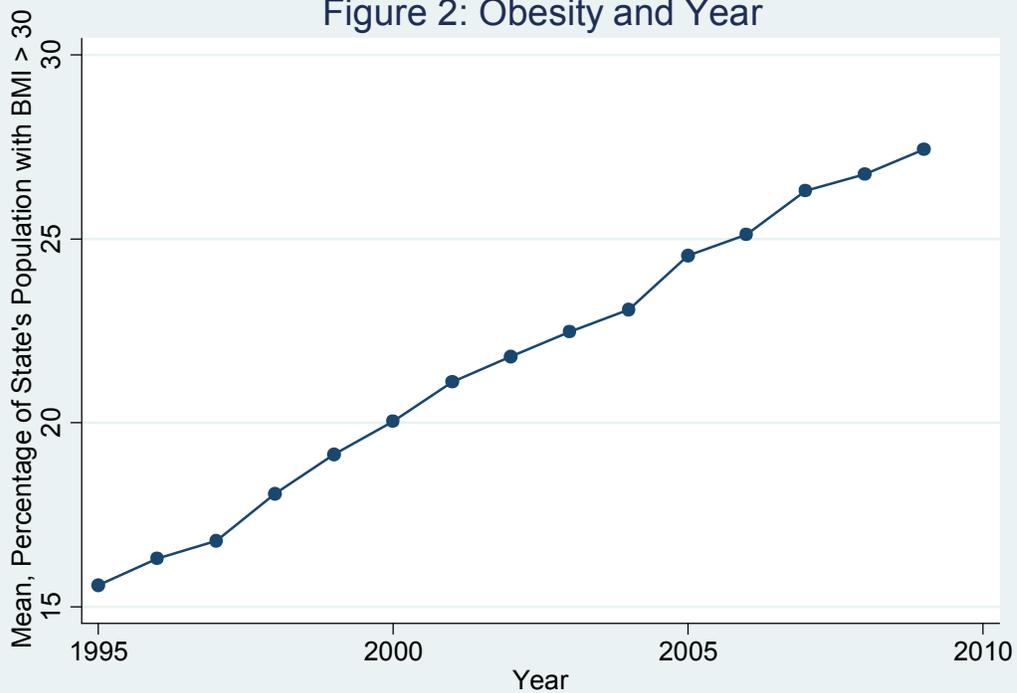Figure 2: Obesity and Year
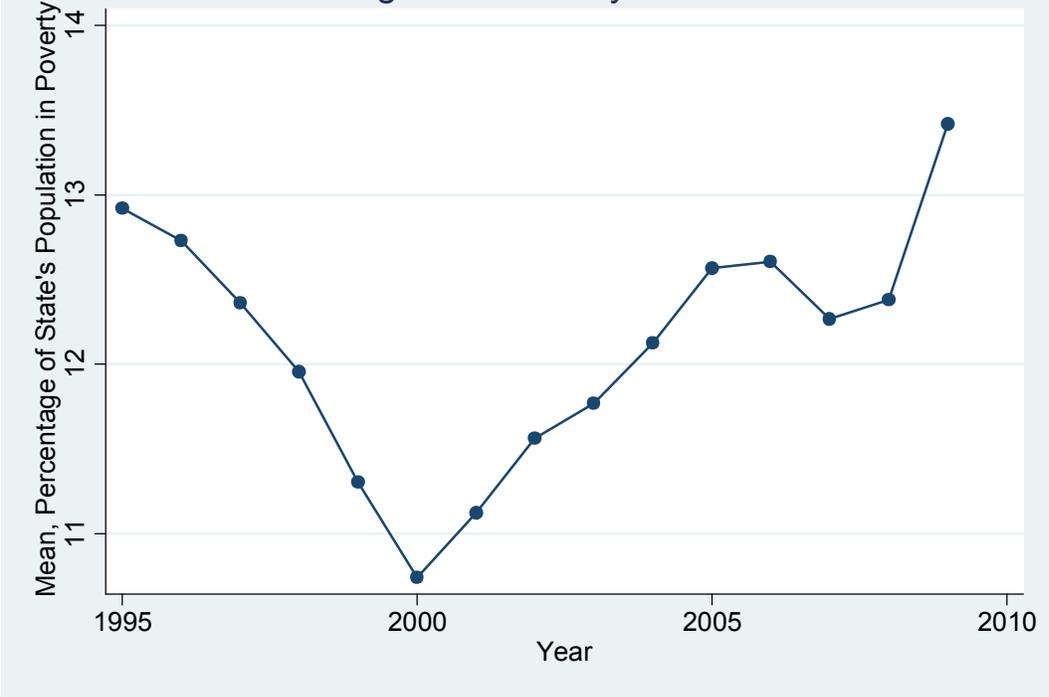
Figure 3: Poverty and Year
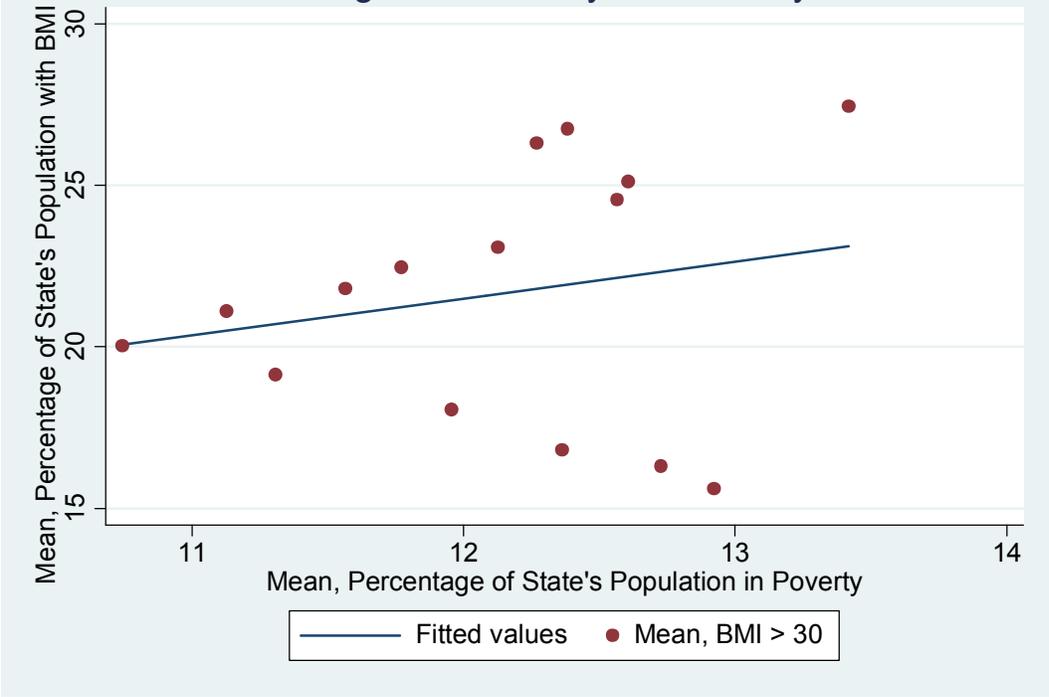

Figure 4: Obesity and Poverty

Figure 5: Food Stamps and Year
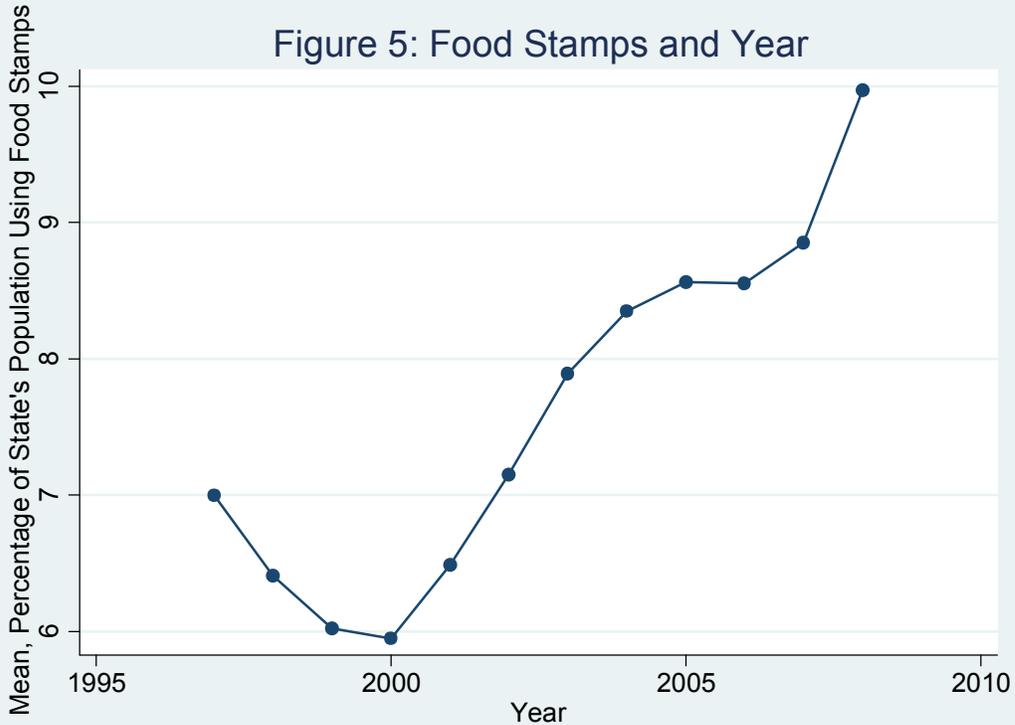
Figure 6: Crime and Year
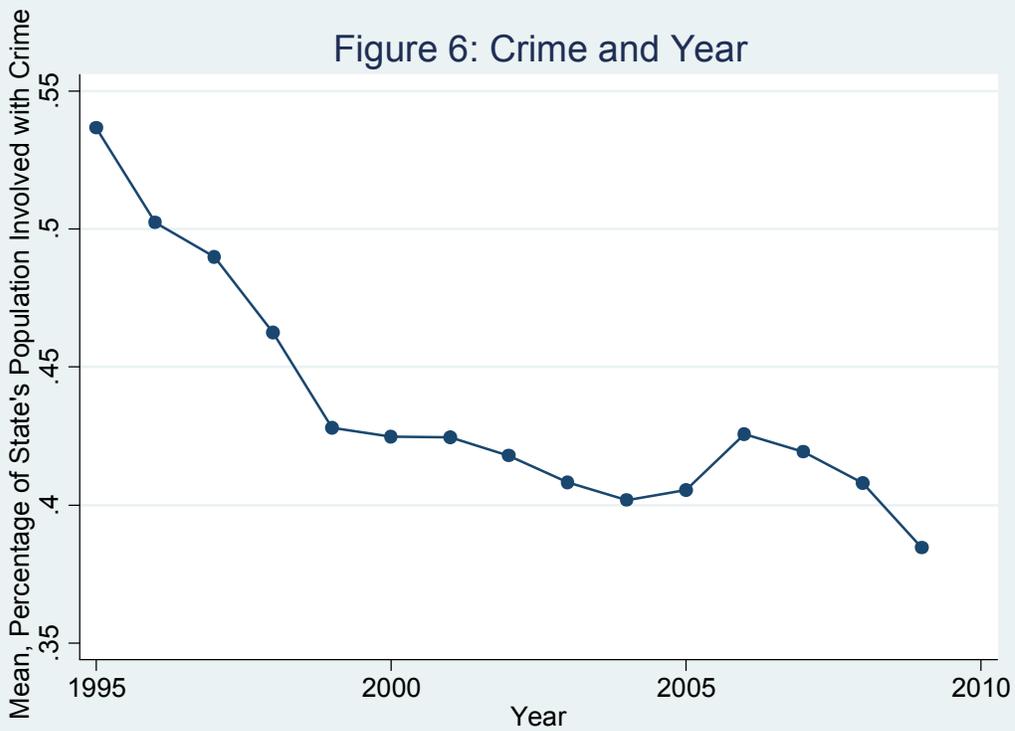
Table 1. Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max	Corr. with Year
Obesity	750	21.64	4.66	10.10	35.40	0.81
Poverty	750	12.12	3.04	5.63	21.17	0.05
Food Stamps	624	7.60	3.34	0.00	16.49	0.33
Crime	735	0.44	0.20	0.07	1.04	-0.17

Table 2. Obesity and Poverty Indicators

	I	II	III
Poverty	0.2842***		
	(0.033)		
Food Stamps		0.4481***	
		(0.036)	
Crime			0.9167*
			(0.501)
Exercise	-0.2063***	-0.1779***	-0.2956***
	(0.022)	(0.024)	(0.021)
Education	-0.7619	-1.2148*	-1.6192**
	(0.630)	(0.641)	(0.706)
adj R-squared	0.766	0.749	0.743
SER	2.253	2.055	2.369
Observations	750	600	735

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. Obesity and Poverty Indicators with Fixed Effects

	I	II	III
Poverty	-0.053		
	(0.060)		
Foodstamps		0.1838***	
		(0.051)	
Crime			0.7115
			(0.840)
Exercise	0.0031	-0.0137	0.0022
	(0.015)	(0.017)	(0.015)
Education	-1.6894**	-1.5874**	-1.7207**
	(0.746)	(0.716)	(0.751)
adj R-squared	0.918	0.901	0.918
SER	1.125	1.02	1.129
Observations	750	600	735

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Obesity and Poverty Indicators with Year for OLS and FE

	I	II
Poverty	0.2842***	-0.053
	(0.033)	(0.060)
Exercise	-0.2063***	0.0031
	(0.022)	(0.015)
Education	-0.7619	-1.6894**
	(0.630)	(0.746)
1996	-2.1708	0.8153
	-1.648	-0.858
1997	1.3624***	1.1649***
	(0.451)	(0.228)
1998	-0.042	2.5243***
	(1.680)	(0.878)
1999	3.6496***	2.6670***
	(0.550)	(0.424)
2000	2.2748	3.6365***
	(1.705)	(0.942)
2001	3.9524**	5.5565***
	(1.679)	(0.882)
2002	4.7874***	6.2912***
	(1.677)	(0.877)
2003	5.5340***	6.9975***
	(1.677)	(0.875)
2004	6.2129***	7.6541***
	(1.645)	(0.856)
2005	7.2021***	9.1716***
	(1.676)	(0.871)
2006	8.0192***	9.7531***
	(1.676)	(0.871)
2007	9.3155***	10.9367***
	(1.677)	(0.874)
2008	9.3688***	11.4007***
	(1.678)	(0.875)
2009	9.9241***	12.1580***
	(1.676)	(0.870)
adj R-squared	0.766	0.918
SER	2.253	1.125
Observations	750	750

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

VIII. BIBOLIOGRAPHY

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