The Growing Concern of Poverty in the United States: an exploration of food prices and poverty on obesity rates for low-income citizens

Catherine Gillespie
University of Notre Dame, cgillesp@nd.edu

Kathy Gray
University of Notre Dame, kgray@nd.edu

Ethan Bailey
University of Notre Dame, ebailey@alumni.nd.edu

John Zivalich
University of Notre Dame, jzivalic@nd.edu
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Abstract

Studies demonstrate the link between income and obesity, determining factors to explain the strong correlation between high body mass index and low socioeconomic status. Many focus on uncovering predictors but few use a systems approach: identifying the interaction among predictors and their relative magnitude concerning obesity. This study asks: do poverty or food price indicators have a statistically stronger relationship with obesity?

By collecting data, evaluating trends, and analyzing statistics, this study extends research by revealing a stronger relationship between obesity and food prices as opposed to obesity and poverty.

Keywords

Introduction

Obesity has become an epidemic in the United States. According to the Center for Disease Control, national health care expenditures have increased from $1,353.6 billion in 2000 to $2,105.5 billion in 2006 with direct health care costs of obesity estimated to be over $100 billion (Natarajan & Kabir 97; Martin 78). These costs greatly affect all aspects of life in the United States; high health care costs can impact government policies and regulations, businesses' operations and tax levels, and even consumer purchasing patterns and expenditures.

Approximately one-third of American children and adolescents are at risk of becoming obese or are already obese, and research suggests that obesity rates tend to transition from parent to child (Goldberg 162). This implies that the future holds even higher obesity rates as an increasing number of obese children may become obese adults. Lower obesity rates in the U.S. could potentially save $254 billion overall, avoiding $60 billion in treatment costs (DeVol 1-2). The money saved on reduced health care expenditures could be put to better use, such as in programs to fund research, create jobs, or reform poverty programs. In this way, obesity not only affects society through lifestyle choices and lifespan, but also has great cost implications in the health and business sectors.

Since obesity is notably influenced by food consumption, the disease is prevalent in society today and affects stakeholders at various levels of industry. Farmers, producers, manufacturers, retailers, consumers, and even the government all have a relationship to obesity rates. It is important to note that the relationship is two-sided; as producers can affect obesity rates, so can obesity rates affect producers. An example lies in marketing and purchase patterns of buyers. Producers of food can choose to provide healthy options and to market these health foods in a way that attracts consumers, whereby contributing to reduction of obesity. On the other hand, high obesity rates in consumers associated with patterns of purchasing lower-quality foods offers an incentive for producers to provide unhealthy foods. This drive for producers to stay competitive and satisfy consumer desires can contribute to the cycle of rising obesity rates.

Government is another very influential stakeholder that has the potential to reduce obesity rates in the United States. However, since specific drivers of obesity are difficult to

determine, the government cannot always spend its money effectively. If the right programs are put into place to successfully reduce obesity, then the government will likely save money on health care costs over time. Therefore, changing obesity rates strongly impact government, just as the government can impact obesity rates.

Another issue is that of poverty. An association between U.S. poverty and obesity is clear, in that low-income consumers in society are some of the most affected by obesity (Martin 78). This association adds significant complexities to the issue of combating obesity, as those in poverty have much less control over their purchases, income, health, and overall environment. It is possible that breaking the poverty cycle for certain consumers could also have the effect of eliminating obesity rates over time. Alleviating consumers from poverty gives them more stability in their mentality and in their lifestyle, which could lead them to more conscious and healthy decisions. In all, the vast array of stakeholders not only mirrors the importance of the topic at hand, but it also echoes the range and complexity of factors that directly influence the nation's health.

While it is clear that obesity is becoming more prevalent in the United States, neither the direct sources behind the rise of obesity nor the magnitude of these variables have been wholly ascertained. Studies have found a myriad of indicators for obesity, especially with relation to those of low socioeconomic status (SES). The question remains not necessarily which factor or factors influence obesity, but rather which factor or combination of factors have the *greatest* effect on obesity, specifically with regards to low-income consumers.

Overall, the obesity epidemic is a growing concern in the United States. Many stakeholders are involved, and a successful change could have tremendous future implications for American lifestyles. Although consumers have the final choice on their eating patterns and health expenditures, it is the responsibility of businesses and the government to give them information. Providing consumers with various options and informing them on all of the possible implications of their decisions may potentially change their thoughts and lifestyles. As obesity becomes more of a problem in the United States, especially for low-income consumers, all stakeholders need to reevaluate their decisions and effects on society as a whole.

Literature Review

As obesity has steadily increased in the United States, the amount of scholarly research on the subject has simultaneously expanded. Studies show that diet quality is affected by occupation, education, and income levels—the conventional indexes of socioeconomic status (Darmon & Drewnowski 1107). Additionally, the association between poverty and obesity in the United States has been shown as a clearly positive relationship (Martin 78). Researchers widely agree that diet quality—and almost all major indicators of health status—are, often dramatically, inversely associated with socioeconomic status (Darmon & Drewnowski 1107; Schnkittker & McLeod 77). Insights such as these shed light on the reality that primary stakeholders in the topic of obesity are low-income consumers.

The causes behind obesity are twofold in that diet and exercise play a large role in influencing obesity rates. Simply considering the angle of food consumption as a sub segment of dynamics affecting obesity, studies have found a multitude of influences claimed to noticeably affect eating habits, especially as it relates to those of low SES. Such factors include food price (Martin; Darmon & Drewnowski), marketing for healthy and unhealthy foods (Petty & Seiders), distance to healthy food (Natarajan & Kabir; Cassady; Burke et al), and other sociological factors (Just, Mancino & Wansink).

The connection between high obesity among the poor has commonly been cited with high food prices of nutritious foods. Data suggest that relative to sweets and fats, the price of fruits and vegetables has been increasing disproportionately over the past twenty years (Darmon & Drewnowski 1113). With energy relating to the amount of calories, researchers found the energy-costs of cookies or potato chips averages 20 cents/MJ while fresh carrots cost about 95 cents/MJ, implying that energy-dense (or calorie-rich) foods are the lowest cost option to consumers (Martin 79). Similarly, in a California study, Cassidy and Jetter found that a healthier food plan is equivalent to 35 to 40% of the food-at-home budget of families in the lowest two income quintiles (Cassidy & Jetter 43). The fact that an inverse relationship exists between food energy-density (calories) and its price per energy unit is troubling yet provides a possible explanation for the evident relationship between poverty and obesity rates (Drewnowski 155-156).

Additionally, the fact that energy-dense foods generally create less satiation may heighten the effects of obesity among citizens that consume these foods (Drewnowski 156). In one study, it was found that Food Stamp Program participants are more likely to purchase energy-dense meat, sugars, and fats over fruits and vegetables (Drewnoski 155). As low-income consumers have less money to spend on food, high calorie foods at low costs are the more attractive option. Yet, as consumption of energy-dense foods is correlated with increased obesity risk, many believe this to be a large factor behind high obesity rates throughout the American poor (Beydoun 2218-2219). In this way, nutritious foods have been found as generally unaffordable and unfulfilling to those of lower SES in the United States.

Research suggests that expanding food stamp usage to more high quality foods will be beneficial. Lower-income shoppers are more responsive to price and tend to make larger purchases at one time, mostly in lower-priced foods (Jones 86-112). In fact, it has been found that price elasticity of foods vary greatly. For example, fast food has a 2.09% elasticity for low-income consumers while consumers as a whole measure only 0.51% (Andreyeva 216-222). This suggests that falling incomes lead consumers to purchase those foods lowest in cost, regardless of quality (Andreyeva 206-222). As expected, one study showed that the price index of fast food (FFVI) and body mass index (BMI) are inversely related and that a lower fruits and vegetables price index (FVPI) led to a lower body mass index; however, increases in FVPI did not yield increases in BMI (Beydoun et al). In general, food prices have been shown to be a significant factor influencing obesity, even if the relationship has yet to be fully ascertained.

Though the relationship between prices and health has been researched extensively, the causes behind the high prices of healthier food options are largely debated, as many factors are involved. One basic reason could be that sugars and fats can be easier to produce and store than foods that are perishable, such as meat, vegetables, and fruits (Drewnowski 156). Another important influence on expenses is increased farm product prices. Influencing factors behind rising farm product prices include a rising global demand due to rising incomes, the U.S. dollar's low value resulting in international farming demand from the U.S., and the fluctuations of fuel prices (Lambert 221). Some assert that rising food prices are more directly affected by fuel prices, as fuel is used in many steps of the food production process including machinery operating, pesticide production, and transportation (Neff 1587). However, others refute the

notion that fuel costs are a large influence on food price, and instead assert that farm product prices and labor costs are the prime determinants of rising farm product prices (Lambert 221). Perhaps it can merely be agreed the multitude of factors which heighten the price of food on the whole deepens the necessity of the poor to choose less healthy food options.

With the price of food being an indicator in the spotlight in regards to obesity, taxes have been a popular proposed solution. Currently, no state or local taxes exist to promote healthier diets or combat the obesity epidemic (Food 250). A common view is that a small tax will not result in a large difference in food consumption, but that a modest tax will have significant effects, especially among the low-SES consumers (Food 229; Martin 82). One study asserted that even a large tax would not result in a large difference in consumer diet, but this study only considered chip snacks (Kuchler 18). Nevertheless, one proponent for taxation compared the energy-dense food industry to the tobacco industry. As both public and private resources must be used to combat the negative effects of tobacco, the government has been able to intervene and bluntly tax these products; similar intervention could be implemented with energy-dense foods if similar logic is used (Food 233).

Another proponent of the food tax is Kelly D. Brownell, a psychology professor at Yale University and Director of the Yale Center for Eating and Weight Disorders. Brownell is credited with the invention of the "fat tax": tax energy-dense foods and use the tax revenue to subsidize the cost of non-energy-dense foods (Martin 83). Key goals of the "fat tax" are focused on bringing the prices of healthy foods and unhealthy foods in balance and on promoting healthy food choices (Martin 83). One major component of the plan would use the tax revenue to provide low-cost fruits and vegetables in places where they are lacking (Martin 83). However, many critique food taxes because an increase in the price of certain foods imposes a cost on the lower SES population who continue to purchase the goods (Just, Mancino & Wansink 178).

Although two of the most commonly cited variables correlated with high obesity rates among low SES are poverty factors (that influence a person's income and ability to obtain food) and the price of food in the market, there are a number of researchers that argue otherwise. Other factors that have been used in studies as determinant factors in the epidemic have been the

presence of food deserts (areas that do not have access to supermarkets or stores), education and nutritional labeling, and sociological factors such as marketing and heuristics.

One study at the University of Sheffield indicated that price and availability of healthy foods are not related to their purchase by low SES individuals, suggesting social attitudes have a greater effect in determining dietary composition (Pearson et al). Notably, the issue of food deserts as a determinant of unhealthy consumption behaviors has become closely examined over recent years. Researchers have been seeing trends in differences in healthy food availability in higher income areas in comparison to lower-income neighborhoods. The issue of food deserts is related to the notion that supermarkets are not as prevalent in low socioeconomic neighborhoods compared to other neighborhoods (Wang 491). Instead, there are more small grocery stores and convenience stores in poorer areas, with these stores carrying less variety of fresh and healthy foods than the variety of supermarkets (Wang 497).

Studies have revealed individuals in low SES neighborhoods have a statistically fewer grocery options and more fast food options than higher SES counterparts (Smoyer-Tomic et al). A popular example of such a lack of access to supermarkets is apparent in Philadelphia, PA, where the highest income neighborhoods had 156% more supermarkets than the lowest income neighborhoods (Burke, Keane, & Walker 878). Building upon this, lower-income families often face trouble with transportation costs and a lack of available time when considering access to supermarkets located outside of the immediate vicinity (Burke, Keane, & Walker 878). The monetary and time costs of traveling to different locations for healthier food options may be prohibitive for a low-income worker who may work multiple jobs. These costs may provide a possible explanation for why lower-income consumers are more likely to purchase from smaller grocery and convenience stores close to home (Petty & Seiders 157). Yet, small independent grocery stores often do not have items such as higher-fiber breads, or other nutritious substitutes available some or any of the time (Cassady & Jetter 42). This lack of nutritious foods combined with the lack of availability of supermarkets in low-SES neighborhoods creates a need for increased availability of high quality foods. However, probable explanations for absence of supermarkets and higher costs of food in lower-income areas include increased theft and crime; this makes it difficult to attract supermarkets to less affluent areas (Burke, Keane, & Walker 878).

Another variable that has been argued to have a great impact on food consumption is education and nutrition labeling. Looking to the source, health perception and health habits are often transmitted from parents to their children; children of obese parents are "five times more likely to become obese as adults" than those with normal-weight parents (Highland 13). While limiting food access or instructing how to eat delivers limited results to children, research has found parents' fruit and vegetable consumption is the best predictor of young children's fruit and vegetable consumption (Goldberg 163).

Moving to a different angle of education, some critics claim that since no nutritional labeling is mandated for foods in vending machines and restaurants, consumers are unaware of the great amount of calories they are consuming (Petty & Seiders 155). In this way, some academics argue that the lack of awareness of food contents is what plays a large role in food consumption among consumers. A New York study surveyed the consumer awareness of menu calorie information at fast food chains after the health code regulation which mandated nutritional labeling of caloric content on menu boards. The study found that the percentage of customers who reported seeing calorie information rose from a pre-enforcement 25% to 64% while the percentage of customers making calorie-informed choices doubled (Dumanovsky, Huang, Basset, & Silver 2520). Although the study has yet to determine the effects of calorie displays on actual consumption and health, this new enforcement shows the new trend of considering more than food prices on consumption patterns.

Another variable that has been more widely considered in recent years is the psychosocial determinants that affect consumption behavior relating to obesity. As with any product, marketing—advertising, promotion, and supply chain—all influence food choice (Beydoun 2219). In addition to marketing on the packages of the food items themselves, there are other psychological and sociological influences that may affect purchase behavior. For example, food decisions are oftentimes based on simple heuristics or emotions rather than rational behavior: factors such as stress or the presentation of food can result in impulsive behavior leading consumers to choose unhealthy foods (Just, Mancino & Wansink 177). Research has presented that people have issues of self-control and are likely to choose the "default option" when purchasing food (Just, Mancino, & Wansink 176). Due to this, allowing persons to preselect more healthful choices may be effective. Online grocery shopping or pre-ordering groceries

could help people make better choices in the long-term by making purchasing decisions without being tempted in-store with unhealthy food options or trying to manage stresses that may occur while in-store shopping (Mancino 13). Food psychology research demonstrates that common marketing practices to increase consumption such as product placement, package size, and fixed-cost pricing should be just as effective at reducing consumption as well (Just, Mancino & Wansink 178).

Even as food prices and poverty are regularly utilized as qualitative descriptive factors for obesity, there are a multitude of other variables argued to have an equivalent impact on obesity rates in the United States. However, as the research in many of these more qualitative topic areas is relatively new, hard numbers are not yet readily available for substantial analysis. From an analysis of the available literature on obesity and the poor, it seems that there is not just one factor that should be given attention. Instead, it appears that many if not all of the factors mentioned are likely to have some influence on obesity rates; the real question is how large of an impact do such indicators have on obesity? For this reason, in conjunction with a lack of data availability and the clear evidence of correlations, the research conducted focuses on whether the price of foods or poverty factors have a larger influence on obesity among low-income citizens in the United States.

Methods

Analytical Strategy

The literature review indicated that the obesity epidemic is affected by a large variety of interrelated factors. Such factors include poverty level, the state of the economy, food availability, food prices, psychological buying influences, and societal values. However, food prices and poverty level appeared to be significantly and consistently linked with obesity levels. Therefore, the analytical strategy was to discern which of these two indicators—food prices or poverty—are more strongly correlated to obesity.

By determining which indicator is more significantly linked with obesity, the research team hoped to discover the most impactful ways to combat rising obesity rates. Influencing indicators that have a high correlation with obesity may also influence obesity if causation

between obesity and the indicators is present. Therefore, while the obesity epidemic has many influences, the team looked to discover what indicators may be most important. Through the results, the idea was to find the most impactful strategy to combat obesity.

Data method

The design of this project mandated that many variables were discerned to find those that most impact obesity. The two indicators that the team aimed to compare—food prices and poverty—were split up into multiple indicators for each. Thus, these two indicators became indicator groups (see Appendix A).

The first step was then to gather data, and this began with finding data on the dependent variable, obesity. The most widely recognized national obesity statistics from the Center for Disease Control were used. Next, the team searched for indicators of the food price indicator group. During this phase, the team collected data on indicators that are believed to affect food prices. Such indicators included agricultural subsidies, sugar and sweetener consumption, fruit/vegetable price index (FVPI), oil and gas prices, corn syrup prices, and sugar prices. The sugar and sweetener consumption indicator was selected to reflect prices of unhealthy foods, which is critical in obesity studies. Gas and oil prices were relevant because they reflect both a cost of traveling when purchasing food and a resource used in food manufacturing.

Finally, data was gathered concerning the poverty indicator group. Based on the literature review, the data chosen to represent poverty were the percentage of U.S. citizens living in poverty, the percentage of those who are on food stamps, and the percentage of those who are unemployed. These statistics came from the Bureau of Labor Statistics.

One significant issue discovered during the data collection process was the lack of uniformity of indicators; while food price indicators were only available nationally, poverty data was available at the state level. Therefore, national data was used for the food price indicators since this was all that was available, and state data was used for the poverty indicators since such data provided more data points and resulted in more accurate statistical analyses.

Additionally, only sixteen years of obesity data—both state and national—was available. Therefore, food price indicators at the national level had approximately sixteen data points to run against national obesity data, while poverty data at the state level had 500-800 data points to run against state obesity data.

Analytical Method

The analytical method was a three-phase analysis. First, the team looked at the dependent variable and independent variables individually to discern any apparent trends across time. If applicable, trend lines were calculated. Second, a correlation analysis was performed between each indicator group—food prices and poverty—and obesity. Through the findings, it was possible to determine which indicator group was more significantly correlated with obesity.

Third and lastly, the team conducted a time-series multiple regression analysis. The benefit of this model was that it allowed the effects of choice variables to be observed with relation to obesity over time. Given the way the data was structured, the optimal way to analyze the data was to construct two models, one for the food price indicator group and one for poverty indicator group. Then, the data was regressed with the variables on obesity over time to observe which model provided the best fit and which variables within each model had the largest statistically significant coefficients.

By comparing the correlation analysis and multiple regression analysis, the indicator group more closely linked with the obesity epidemic could be established.

Analysis

Trend Analysis of Indicators - Obesity

The research team began its statistical analysis by graphing the obesity and indicator data across time to observe evident trends. For variables with relevant historical patterns, trend lines were calculated. A summary table follows the subsequent trend analysis.

The first data analyzed was the research obesity data. In order to verify and visualize the increasing trend in obesity rates that were evident in the literature review, the median percent obese nationwide was graphed from 1995 to 2010 as shown in Exhibit 1.
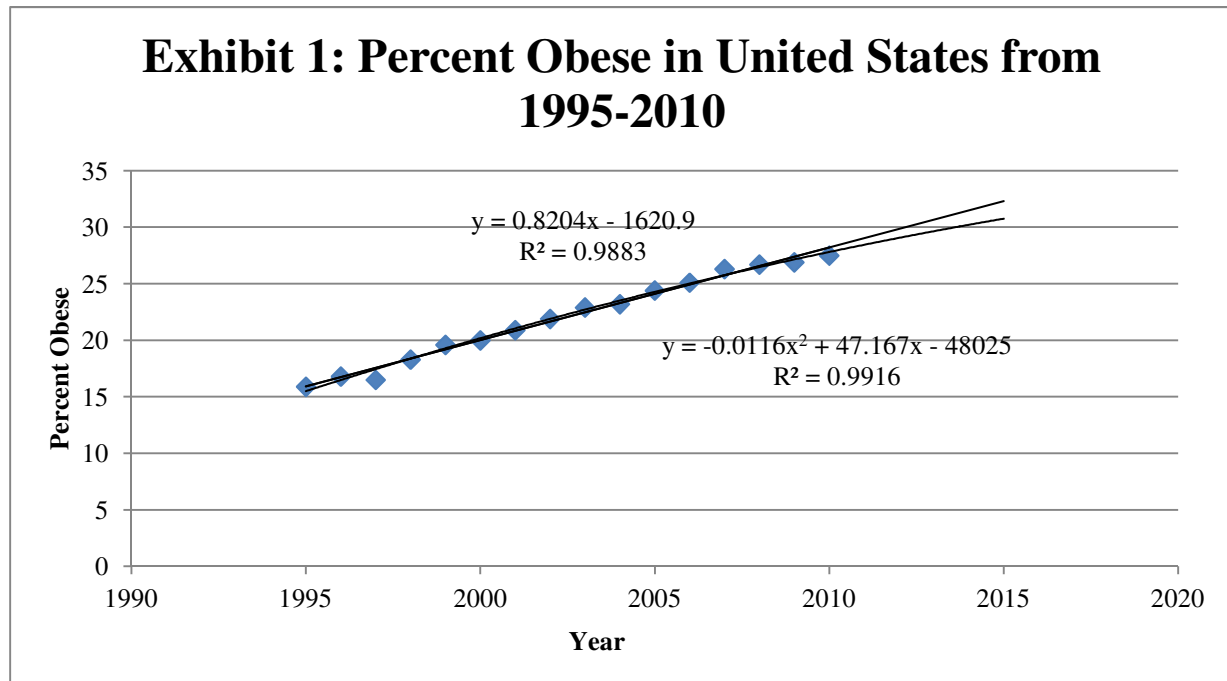
## Exhibit 1: Percent Obese in United States from 1995-2010

$y = 0.8204x - 1620.9$
$R^2 = 0.9883$

$y = -0.0116x^2 + 47.167x - 48025$
$R^2 = 0.9916$

Source: Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance Survey

As obesity data was not available before 1995, analysis was limited. However, a clear positive trend was apparent. The R^2 value, which indicates the "fit" of the trend line, was higher for the polynomial trend line than for the linear trend line, suggested a better future trend analysis. By following the polynomial trend line, one can observe a slightly decreasing rate of obesity growth. Nevertheless, the regression suggests much future growth in obesity rates for at least the next 5 years, with rates surpassing 30% by 2015.
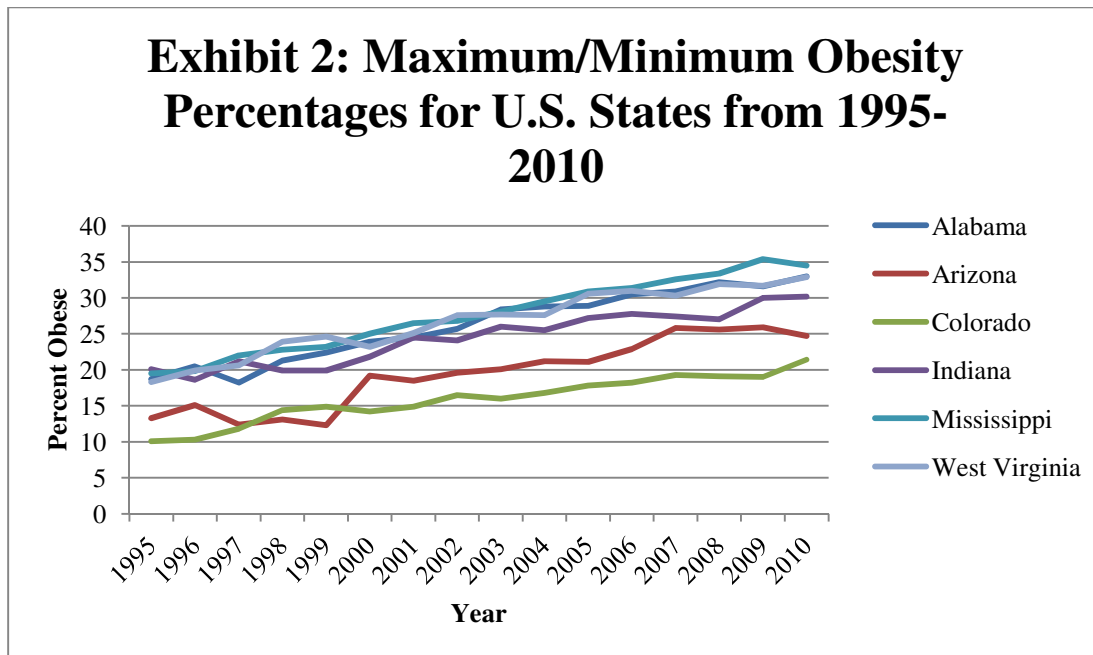
Exhibit 2: Maximum/Minimum Obesity Percentages for U.S. States from 1995-2010
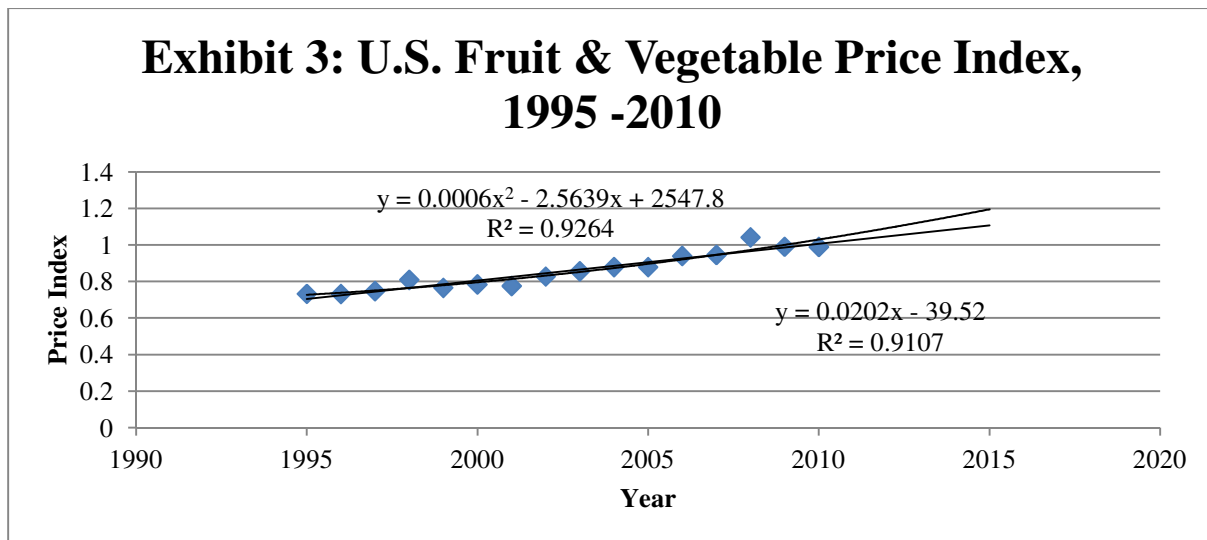
Source: Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance Survey

The research team also graphed obesity rates by state. Each line on the above graph represents a different state. Each state depicted had a maximum or minimum percent obesity in the United States for at least one year. Therefore, the graph depicts the spread of U.S. state obesity levels. Like the national data, only 15 years of state data was available; thus, analysis was limited. However, the state trends led to some new analysis. One notable aspect was that states with a below-average percentage of obesity remained below-average throughout this 16 year period. A similar trend is visible for states with an above-average percentage of obesity. State obesity percentages ranged from 10.1-20.1% in 1995. However, in 2010, state obesity percentages ranged from 21.4-34.5%, increasing the gap from 10% to 13.1%. Therefore, despite the fact that all 50 states experienced increasing obesity rates, the variance between the states increased at different rates. If this trend continues, the U.S. will have an increasingly wider variance of obesity rates between different states in the future.
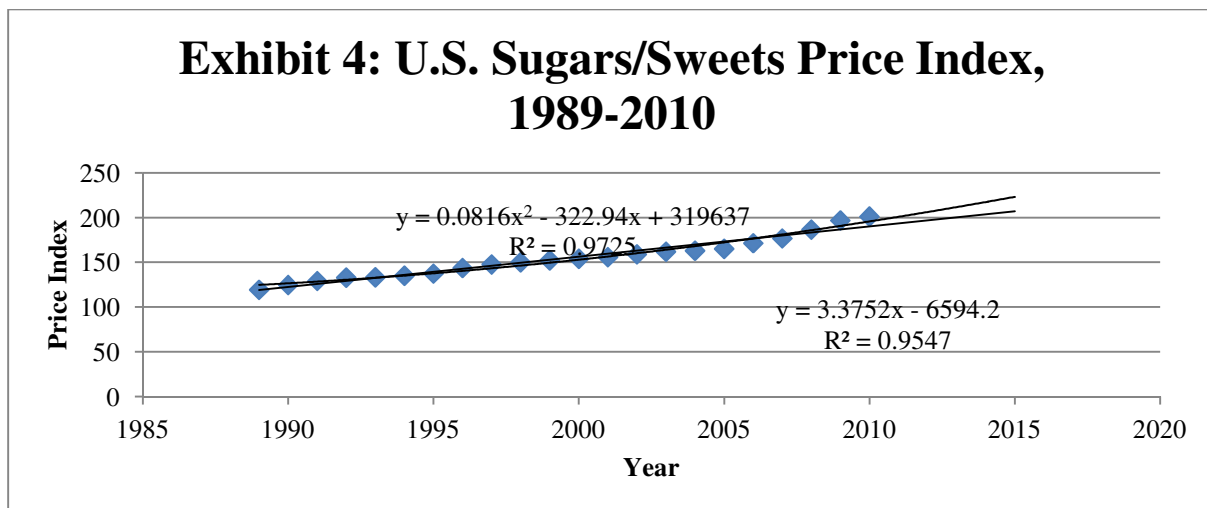
Overall, the trend analysis of obesity data confirmed the research presented to us in the literature review. Obesity rates have been rising steadily for the last decade and a half and do not appear to be slowing significantly in the near future.

Trend Analysis of Indicators – Food Price

Once this data supporting the notion of increasing obesity rates in the United States was gathered, the research group then focused on the trends of other indicators. The first indicators examined were those affecting food price, the first of which being the price indices of fruits/vegetables (FV) and sugars/sweets (SS). Both indicators lacked data spanning many years, so analysis was limited. Additionally, the SS price index was scaled to a 100 multiple of the FV index, e.g. 1 for the FV price index was 100 on the SS price index.

Exhibit 3: U.S. Fruit & Vegetable Price Index, 1995 -2010

$y = 0.0006x^2 - 2.5639x + 2547.8$
$R^2 = 0.9264$

$y = 0.0202x - 39.52$
$R^2 = 0.9107$

Source: Bureau of Labor Statistics

Exhibit 4: U.S. Sugars/Sweets Price Index, 1989-2010
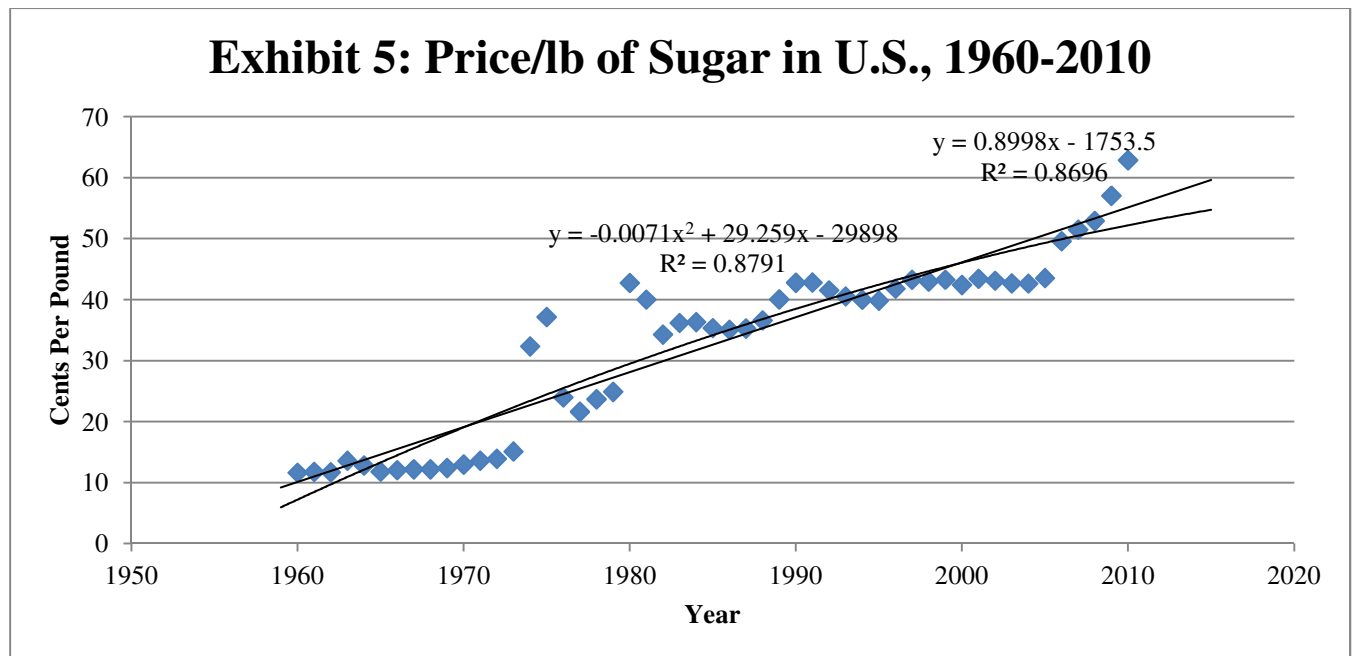
$y = 0.0816x^2 - 322.94x + 319637$
$R^2 = 0.9725$

$y = 3.3752x - 6594.2$
$R^2 = 0.9547$

Source: Bureau of Labor Statistics

With both sets of data, the polynomial trend line is more accurate than the linear trend line as evident by the R^2 values. By observing the polynomial trend lines, the graphs suggest that prices for both sets of foods, fruits & vegetables and sugars & sweets, are increasing at a slightly increasing rate. However, due to the limited data points, it was more conservative to state that the graphs suggest at least linear growth in both sets of data.

Similar to the price indices, the research group then graphed the trends in price per pound of sugar and high fructose corn syrup in the United States.

Exhibit 5: Price/lb of Sugar in U.S., 1960-2010

$y = 0.8998x - 1753.5$
$R^2 = 0.8696$

$y = -0.0071x^2 + 29.259x - 29898$
$R^2 = 0.8791$

Source: Bureau of Labor Statistics

Exhibit 6: Price/lb of High Frucose Corn Syrup in U.S., 1994-2010

$y = 0.1521x^2 - 608.23x + 608250$
$R^2 = 0.8467$

(Chart: X-axis "Year" ranging 1990 to 2020; Y-axis "Cents Per Pound" ranging 0 to 50)
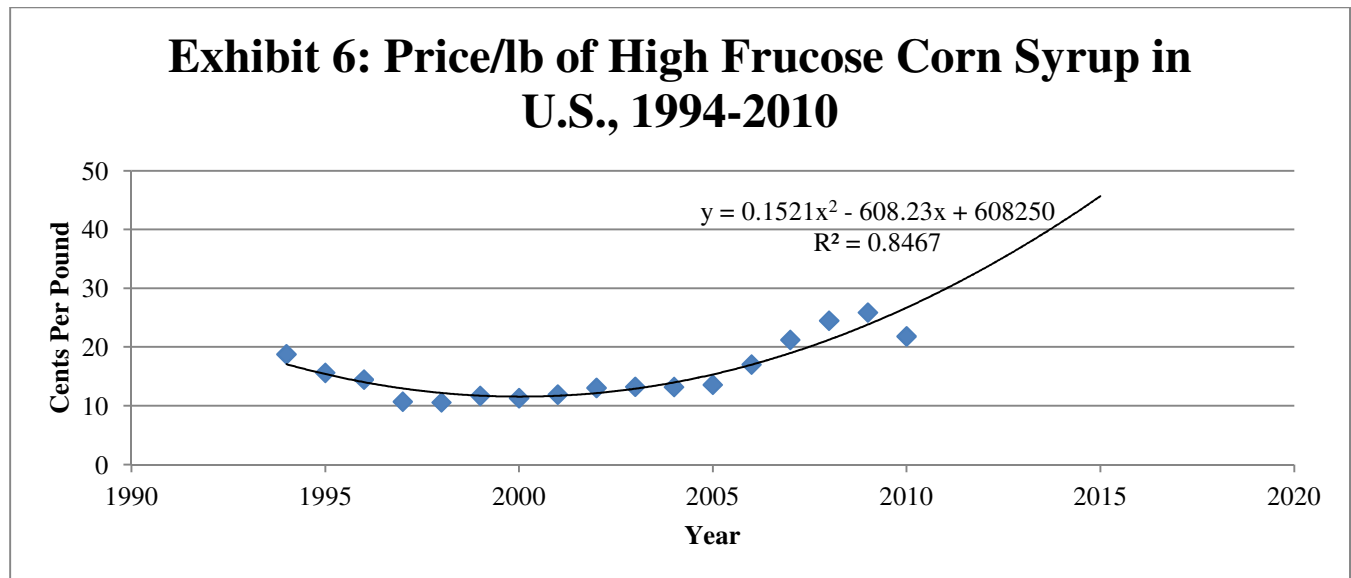
Source: Bureau of Labor Statistics

The data for the price of sugar per pound had many data points and appeared to show a generally increasing trend. The polynomial trend line for this data suggested that prices may eventually stabilize as they increased at a decreasing rate. However, the trend line for the price of high fructose corn syrup showed that prices could potentially increase dramatically in the coming years. Nevertheless, quantity of data for the price of high fructose corn syrup per pound was limited and had to be viewed with scrutiny.

Next, sugar and sweet consumption per capita per year was examined, as shown in Exhibit 7.

Exhibit 7: Sugar and Sweetener Consumption in the U.S., 1966-2010
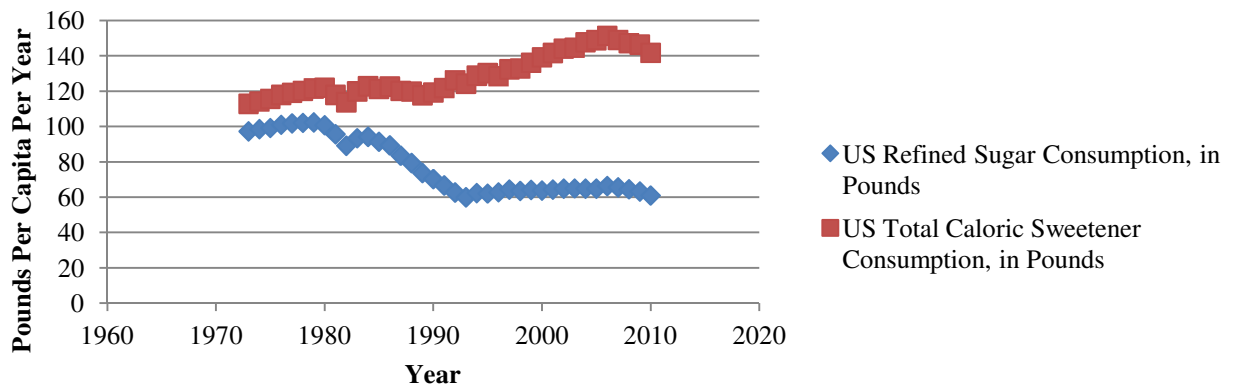
Source: Bureau of Labor Statistics

This data appeared to show a steady increase in consumption of sweetener and a steady decrease in the consumption of refined sugar. Such opposing trends may suggest that these two products act in such a way due to their substitutability. Nevertheless, both data sets seemed to be somewhat positively correlated at times; both trends dipped in 1983 and began to decrease in 2007.

The next indicators examined were oil and gas prices, as shown in Exhibits 8 and 9.

Exhibit 8: World Average Crude Price of Oil/Barrel, 1990-2011

Source: Energy Information Administration

Exhibit 9: Average Price of Gas/Gallon, 1993-2011
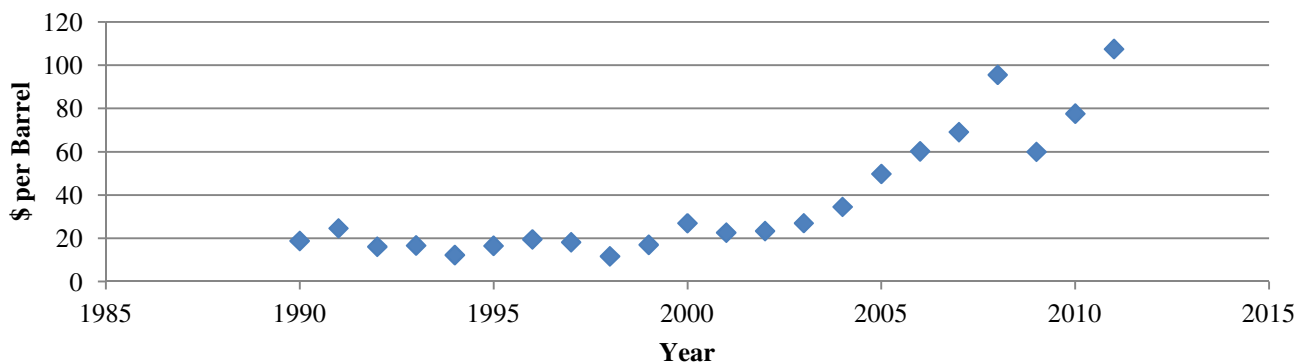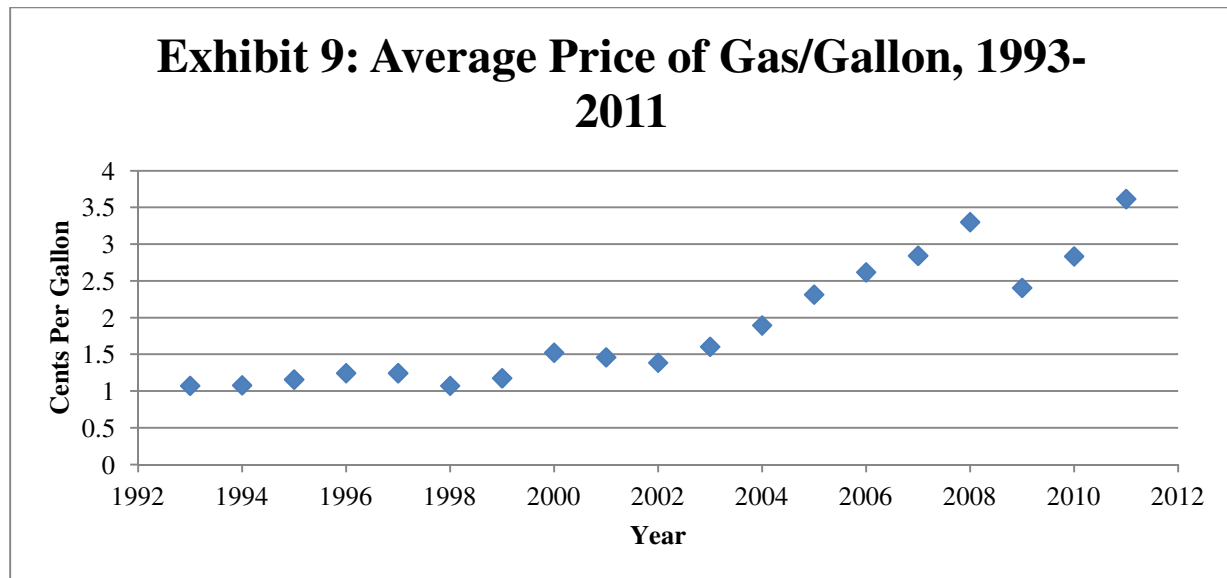
Source: Energy Information Administration

While cyclical in the 1990's, oil and gas prices have since increased. However, cyclical patterns were still evident, such as the decrease in price in 2009. This analysis was limited due to the restricted amount of data available.

The last two indicators for which the research group calculated trend lines were the percentage of U.S. government spending on agricultural subsidies and the percentage of the U.S. population on the Food Stamp Program. Although the percent of the U.S. population on the Food Stamp Program belonged in the "Poverty" section of the trend analysis, it was placed here to highlight its apparent relationship with agricultural subsidies spending.

Exhibit 10: Percentage of U.S. Government Agricultural Subsidy Spending, 1962-2010
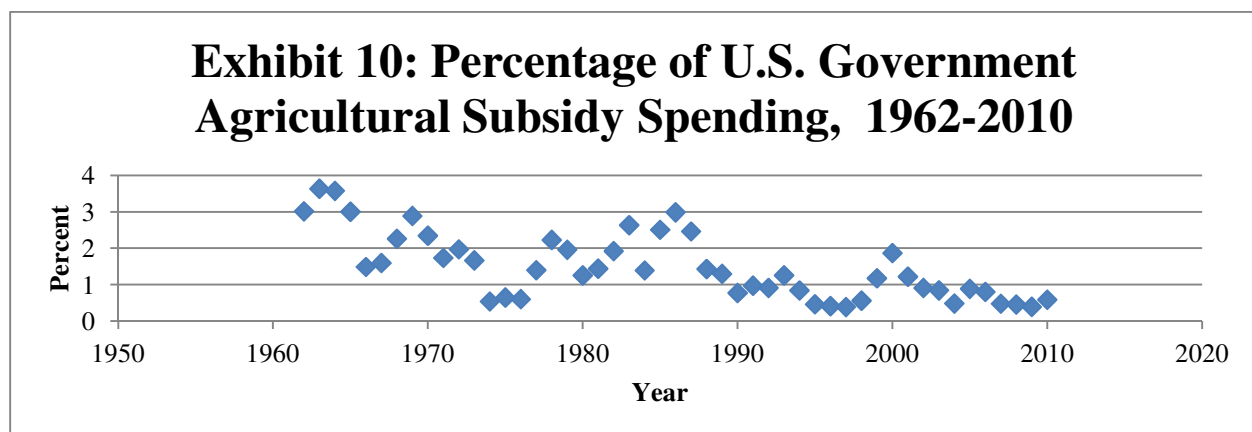
Source: United States Government Printing Office

Exhibit 11: Percentage of U.S. Population on Food Stamp Program, 1969-2009
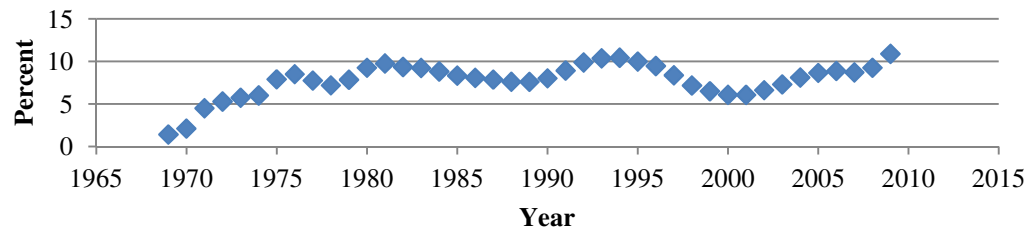
Source: United States Department of Agriculture, Food and Nutrition Service

Given the cyclical nature of the two variables, trend calculations were not suitable. Nevertheless, the percentage of farm subsidies appeared to have decreased gradually over time, and the percentage of the population on food stamps seemed to have increased over time, albeit in volatile movements. What was most interesting is the negative relationship between the two variables that was visible through the trend graphs. This suggested a possible causation of one variable on the other.

Overall, the trend analysis revealed growing food prices, increasing gas and oil prices, and less spending on agricultural subsidies. With such data, the research group expected to see generally positive correlations between obesity and food prices during its correlation and regression analyses.

Trend Analysis of Indicators - Poverty

The research group next examined its poverty and unemployment data to look for historical trends in these indicators affecting U.S. poverty. The data examined was the percentage of the population below 50% of the poverty threshold, the percentage of the population below 125% of the poverty threshold, and the national unemployment rate.

Exhibit 12: U.S. Poverty Rates, 1959-2010
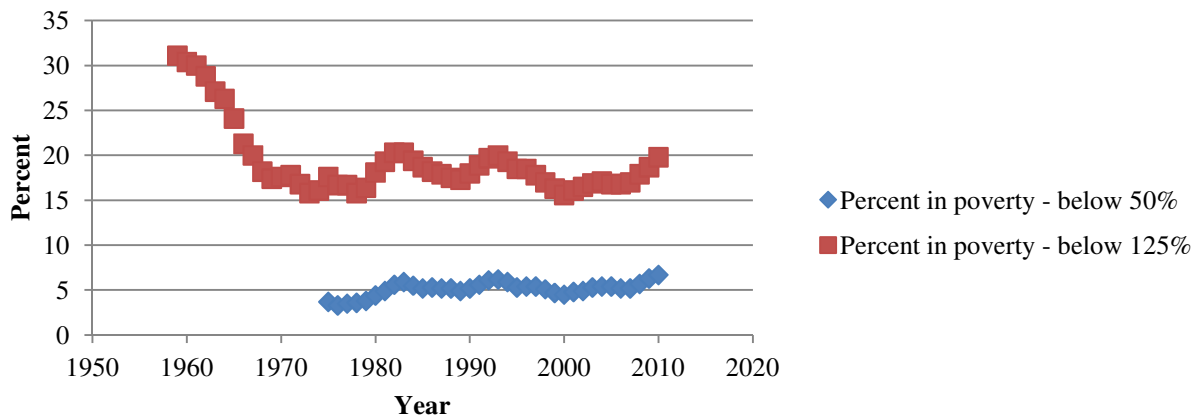
Source: United States Bureau of the Census

Exhibit 13: U.S. Unemployment Rate, 1959-2010
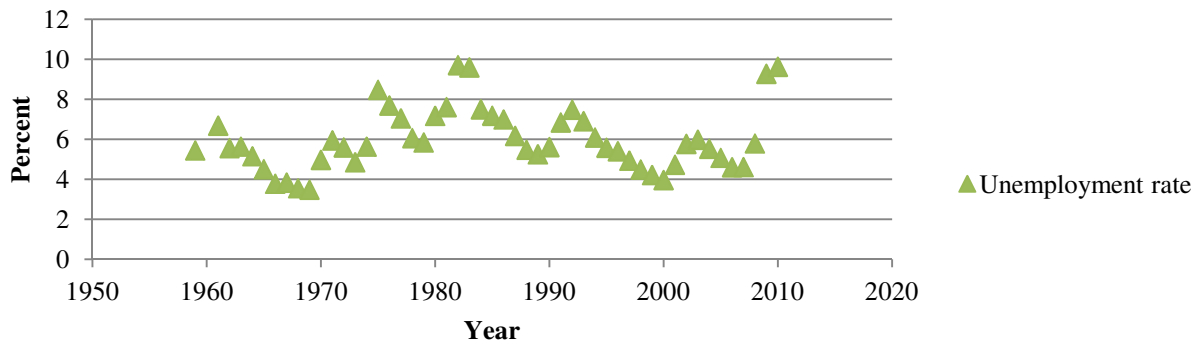
Source: Bureau of Labor Statistics

Although the percentage beneath the 125% poverty threshold decreased from 1960 to 1970, this data appeared to be cyclical in the following years. The 50% poverty data and unemployment rate also appeared to be cyclical and to be positively correlated with one another. The most recent years seemed to have reached the point where prior cyclical periods have peaked. This may suggest that unemployment and poverty rates will begin to decrease again in the next several years. However, given the length of the current recession, historical data may not repeat itself and unemployment and poverty rates may continue to climb.

In summation of the trend analysis, both food price data and poverty data increased over time. Therefore, the research group expected to see positive correlations between both indicator groups and obesity (see Appendix B). Given the cyclical nature of some indicators, historical indicator data may be able to be used to predict and combat rising obesity rates if such indicators are correlated with obesity. The analyses of the following sections discuss such potential correlations.

Correlation Analysis of Indicators

After analyzing the indicators for historical trends, the research team correlated both food price indicators and poverty indicators against obesity rates in the United States. Then, they compared the correlations of the two indicator groups to determine which was more closely linked to obesity levels. These calculations were performed in Stata, which generated both correlation coefficients and p-values for the coefficients so statistically significant variables could be determined.

The nine food price indicators could only be found at the national level, and thus the team correlated these indicators against national obesity data. However, as obesity data only spanned from 2010 to 1995, only 16 data points were correlated for these indicators. Thus, such correlations were limited in their interpretation.

The three poverty indicators could be found at the state level. Therefore, the research group correlated poverty data against state obesity data from the same national obesity source since using state data provided a greater number of data points and resulted in more accurate statistical output. Consequently, the two indicator groups—food price and poverty—faced a tradeoff. While there were more food price indicators to correlated, the poverty indicators were more accurate due to their greater number of data points.

The following table summarizes the significant correlations found in the correlation analysis between the two indicator groups and obesity.

Table 2: Indicator & Obesity Correlations

Indicator Category	Indicator	Correlation Against Obesity	Significance	N
Food Price Indicators				
	FV Price Index	0.947	0	16
	SS Price Index	0.934	0	16
	Gas/gallon Price	0.906	0	15
	Oil/barrel Price	0.879	0	16
	Annual Sweets Consumption Per Capital	-0.819	0	16
	Price of Sugar (lb)	0.794	0	16
	Price of Corn Syrup (lb)	0.74	0.001	16
Poverty Indicators				
	Percent on Food Stamps	0.597	0	549
	Percent Unemployed	0.437	0	547

*(For detailed table of full results, see **Appendix C**)*

As shown in Table 8 in the appendix, agricultural subsidies and sugar consumption were the only two food price variables that did not have a statistically significant correlation with obesity according to their higher p-values. Also, it should be noted that the FV and SS price indices had the highest correlations with obesity and that both were statistically significant.

Additionally, all the p-values are extremely low. This is more surprising for the food price indicators, as they lacked the quality of having many data points. For poverty, the low p-values may have been a result of having much more observations (from 398 to 797), which could have made the results far less noisy and subject to undue influence from random, exogenous shocks

Overall, food price indicators had much higher correlations with obesity rates that did poverty indicators. Especially with such few data points to correlate, such significance found in the food price indicators was surprisingly high. Nevertheless, the poverty indicators still showed positive correlations with obesity.

Regression Analysis of Food Price Indicator Group

The next step in analyzing the data was running regression analyses to further explore determinants of obesity. There were limitations to such analysis because the data set used only

had fifteen observations, which is short of the thirty observations necessary to approximate a standard normal distribution. As a result, this paper could not derive absolute conclusions with the data collected; however, this is a limitation with working with limited obesity data. However, the obesity dataset used was the standard obesity dataset used in literature, so the findings faced the same limitations that many other obesity studies were subject to.

The first regression run was a comprehensive regression, running all the variables against obesity. The results appear in Table 4.

Table 4: Regression of Food Price Variables against Obesity

Indicator	Coefficient	P-value
FVPI	-0.0229931	0.865
Agriculture Subsidies	0.6101703	0.524
Oil Price	-0.051484	0.742
Gas Price	3.616484	0.479
Sugar Sweets PI	0.2521404	0.043*
Sugar Consumption	-.5001754	0.219
Sweets Consumption	0.2248001	0.315
Sugar Price	-0.1391843	0.369
Corn Syrup Price	0.0566892	0.736
Constant	-17.06413	0.638
Observations	15	
Adj R-squared	0.9586	
SSM	188.32758	
SSR	2.82575376	
SST	191.153333	

statistically significant at α = .10

The interesting and surprising aspect with this model was that the overwhelming majority of variation occurred endogenously as opposed to from error, shown by the sums of squares from the model and residual. However, only one of the coefficients was statistically significant, which was the coefficient for the sugar and sweets price index. This proved to be quite frustrating, considering such a finding went against intuition as well as the results that had been established in the literature review. As such, the team decided that the result could have occurred because of noise in the data from variables that were uncorrelated with obesity. Hence, these two variables—agricultural subsidies and sugar consumption—were eliminated, and the regression was run again.

Table 5: Adjusted Regression of Food Price Variables against Obesity

Indicator	Coefficient	P-value
FVPI	0.0112932	0.913
Oil Price	-0.2225688	0.061
Gas Price	9.129523	0.027*
Sugar Sweets PI	0.2729972	0.005*
Sweets Consumption	0.1681209	0.256
Sugar Price	-0.2564981	0.094*
Corn Syrup Price	0.0896253	0.598
Constant	-45.54356	0.129
Observations	15	
Adj R-Squared	0.9558	
SSM	186.926524	
SSR	4.22680896	
SST	191.153333	

statistically significant at α = .10

These results were surprising as well. What the team intuitively thought would be significant was in fact not statistically significant, and gas price, which was thought would not be a main driver of obesity, had a statistically significant coefficient in addition to the sugar and sweet price index. Furthermore, the regression faced problems dealing with multicollinearity because some of the variables were highly correlated with each other. Therefore, the team thought it prudent to regress what it intuitively thought were principle drivers of obesity, the two price indices, as shown in Table 6.

Table 6: Regression of Price Indices against Obesity

Indicator	Coefficient	P-value
FVPI	0.2301216	0.028*
Sugar Sweets PI	0.0811668	0.133
Constant	-10.94367	2.867438
Observations	16	
Adj R-Squared	0.9004	
SSM	211.593364	
SSR	19.9860114	
SST	231.579375	

statistically significant at α = .10

This regression yielded a result that was consistent with both the literature review and intuition. However, there were a couple issues with this regression other than the aforementioned lack of observations. The first issue was an omitted variables bias when some of

the other variables that correlated with the FV price index were eliminated. To evaluate the direction and extent of the bias, we used the formula $\beta_{FV\_PI(est)}=\beta_{FV\_PI(true)}+\beta_2\delta_1+\beta_3\delta_2+\ldots\beta_n\delta_{n-1}$, which related the estimated coefficient for FVPI with the correlations and coefficients of the other variables. Using this formula, the team saw that the coefficient for the FV price index generated by Stata was most likely biased up. However, the team chose to not include some of the variables because the price data omitted was most likely affected by similar geopolitical factors that affected FV prices and were most likely not determinants of obesity.

Regression Analysis of Poverty Indicator Group

This paper took a similar approach in analyzing the poverty data by running a regression of percent food stamps, percent poverty, and percent unemployment on percent obese.

Table 7: Regression of Poverty Variables against Obesity

Indicator	Coefficient	P-value
% Food Stamp	0.8045101	0*
% Poverty	-0.0918434	0.153
% Unemployment	-0.0692683	0.592
Constant	18.00541	0
Observation	397	
Adj R-Squared	0.4246	
SSM	1958.19962	
SSR	2607.26244	
SST	4565.46207	

statistically significant at α = .10

The advantage of this regression was that there were enough observations to approximate it as normally distributed. However, the sum of squared errors was particularly high, indicating much exogenous variation, and the R^2 was low, indicating the regression line was not the greatest fit. On the positive side, the food stamps variable had a statistically significant coefficient. Overall, these results showed that food price is a better determinant of obesity than poverty, because the price model was a much better fit than the poverty model. Additionally, the variation in the price model was mostly endogenous, whereas the variation in the poverty model was mostly exogenous.

Results

The object of this research and analysis was to answer the central question: How can obesity be eliminated in the United States, and what is the relation to poverty? In addition, "What is a strong driver of obesity in low-SES consumers, and how can this be changed to reduce obesity rates?" These questions were answered by the research comparing poverty indicators and food price indicators and determining which had a stronger relationship with obesity rates. As was indicated in the analysis, obesity is trending upward with further growth anticipated in upcoming years. More alarmingly, the obesity rate in many states has more than doubled over the past fifteen years, and the variance among states is widening. This indicates that the obesity epidemic continues to grow and impact the United States population while especially becoming a problem to those in poverty.

As discussed, two sides of the issue were considered to potentially combat rising obesity rates in the United States: food price level and poverty level. Though these two factors are related, the goal was to determine which problem—high food prices or high poverty rates— would be a more effective predictor of body mass index and obesity. By and large, the correlation and regression analyses pointed toward price indicators as the better predictor of obesity. Nevertheless, poverty was also positively correlated with obesity.

Additionally, the trend data revealed some potential obesity implications. The data suggested that the government impacts the food prices that businesses can charge, which ultimately affects the goods that consumers purchase. As stated in the analysis, one of the most interesting findings is the relationship between government subsidy spending and the percentage of the United States population receiving food stamps. The apparent negative correlation between the two indicators suggested that as the amount of subsidies the government issued to farms increased, the percent of people on the food stamp program decreased. This finding is especially important due to its apparent relationship and possible implications. The data suggests that a trade-off exists between giving money to agricultural business sectors and giving money to the food stamp programs. It is possible that giving more money to agricultural sectors leads to lower food prices, meaning that more consumers can provide for themselves. This lower dependence on food stamp issuance could explain the negative relationship between subsidy

spending and percent of people using food stamps in a given year. If this causation is true, the government should make subsidy spending more of a priority, especially because the amount of subsidies in a given year relates to obesity rates; data has shown that as the amount of agricultural subsidies increases, the obesity rate decreases in the United States for a given year.

More specific analysis of the correlations concerning food price provided additional insights. Both sugar/sweets (SS) and fruits/vegetables (FV) price index indicators had exceptionally strong positive correlations with obesity, being 0.934 and 0.947, respectively. Regarding the SS and FV price indices, as both indices increased, gas prices and obesity rates also increased. This result could be contributed to many factors but one possibility may be the fact that food and fuel have much of the same input processing. Research shows that influencing factors behind rising farm product prices include the fluctuations of fuel prices (Lambert 221). It is possible that rising food prices are directly affected by fuel prices, not merely through rising farm product prices as fuel is used in many steps of the food production process, including machinery operating, pesticide production, and transportation (Neff 1587). In addition, commodities such as corn and ethanol are used in many food products as well as in the production of fuel. The finding that food and gas prices positively correlate with U.S. obesity rates suggests that inputs are consistently getting more expensive. Due to this, many consumers, especially those in poverty, may have to choose lower quality, cheaper food to sustain themselves. This is an especially important implication, as research shows that food prices are found to be higher and food quality lower in impoverished areas, most likely worsening the issue at hand to a greater extent (Burke, Keane, & Walker 880).

The correlations also illustrate the relationship between obesity, food prices, and fuel can be connected to agricultural subsidy issuances in a given year. As the amount of agricultural subsidies decreases, fuel and food prices increase, and obesity ultimately increases; this suggests a negative relationship between agricultural subsidies and fuel prices, food prices, and obesity. This reiterates the theory that food prices are rising, particularly for higher quality and healthier foods. In the opposite situation, agricultural subsidies would increase as fuel and food prices decrease, ultimately leading to a decrease in obesity rates. This suggests that lower food prices allow consumers to have more choice of quality and the ability to purchase healthier foods. However, one interesting result is seen in the correlation between sugar consumption and SS and

FV price indices. With a correlation of around -0.8, sugar consumption seems to decreases as food prices rise signifying that consumers are buying cheaper food, which is usually lower quality but not necessarily lower in sugar content than more expensive alternatives. As earlier findings suggest, with healthy options available at a lower cost, the assumption is that consumers would consume higher quality foods leading to a decrease in obesity. Yet, it is interesting to note that sugar consumption actually increases in this case.

Overall, one can conclude that price is a main factor in consumer purchasing behavior and, as the quality of cheap foods is usually low, obesity rates seem to rise when prices rise (Martin 79). Additionally, varying prices of food cause irregular eating pattern for low-income consumers. Research has shown that imbalanced eating behavior, defined by alternative periods of overconsumption and under-consumption, leads to unhealthy BMI and higher obesity rates (Chen 508-520).

While the issue of food price is certainly an important factor to consider in combating obesity, poverty may well be a strong driver, too. One surprising aspect of the data analysis was that the percentage of the United States population in obesity was not significantly correlated with the percentage in poverty, having a correlation of only 0.258. However, other factors implied a relationship between the two, such as the remaining poverty indicators: the percent of the population on food stamps and the percent unemployed. The data shows as both of these poverty indicators increased by state, obesity rates also increased by state. This result not only alludes to the relationship between poverty and obesity but it also suggests that food stamps are being used for lower quality food, as the relationship between obesity and food stamp usage is a strong, positive correlation.

There could be several reasons why consumers in poverty and on the food stamp program would continually purchase such low-quality food. One reason deals with food price, as discussed above, supporting the research that low-income consumers can only afford to buy cheaper food, thereby increasing their obesity rates. If this would prove to be true, there would be significant implications for food stamp programs in the United States. The amount issued and items qualifying to be purchased should be reevaluated, for the amount currently issued to consumers is not sufficient to purchase a standard, healthy meal. Another possibility for buying

low-quality food would be that lower income consumers habitually eat this type of food, thereby increasing obesity rates. Psychological factors must be analyzed in order to identify how these poor eating habits began, and research shows that "children of obese parents are five times more likely to become obese as adults than those with normal-weight children" (Highland 13). In this case, the solution to rising obesity would be to focus on eliminating poverty and habitual eating patterns associated with that lifestyle. Finally, as discussed with relation to food price, the positive correlation between percentage of people on food stamps and the percentage obese could be the result of the irregular eating patterns of those in poverty.

Thus far correlations have been discussed; these correlations show trends and relationships but do not indicate magnitude. For this reason, the regression analysis provided deeper meaning on relative variables and assisted in determining which factors had the most significant impact on obesity rates. In the end, the most statistically significant result came from the regression between the FVPI and obesity. The standard coefficient was about .23 units, indicating that as fruit/vegetable price increases by one dollar, the obesity rate in the United States increases by about .23 percentage points. This is a very large factor, especially when compared to the sugar/sweetener correlation coefficient of only 0.08. This implies consumers are influenced by food price and probably buy less fruits and vegetables when those prices are higher, thereby increasing chances of obesity. Since lower income consumers are most price elastic, the obesity effects in this category of consumers should be even larger that than for consumers as a whole (Powell et al).

In conclusion, it may be possible to combat rising obesity levels in the United States by lowering food price or by alleviating poverty. The analysis suggests, however, that lowering food price would be a stronger driver for alleviating obesity. As shown by the higher correlations and the strong regression coefficient for fruits/vegetable pricing, food prices affect obesity rates more than poverty status. With this knowledge, the government should be conscious of the amount of subsidies that they issue to agricultural sectors, as this decision likely affects the supply chains and prices that businesses charge along with the demand of consumers for different products. The goal should be to keep fruit and vegetable prices as low as possible, keeping quality high and encouraging consumer buying, especially for those consumers on food

stamp programs. It is possible that more affordable food would even reduce irregular eating patterns for those in poverty, which could also reduce obesity rates.

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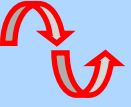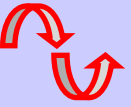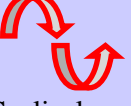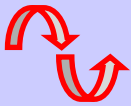
Appendix A

Table 1: Indicators Summary Table

Indicator (source)	Details of how measured	Years (time periods covered); total number of data points	Total number of data points	Type of variable
Percent obese, by state (CDC, BRFSS)	Monthly telephone interviews with U.S. adults for self-reported height and weight; obese if BMI > 29.9	1995-2010	797	Dependent variable
Percent obese, national (CDC, BRFSS)	Monthly telephone interviews with U.S. adults for self-reported height and weight; obese if BMI > 29.9	1995-2010	16	Dependent variable
Percent on food stamps (USDA)	Actual data gathered through U.S. Department of Agriculture	1969-2009	550	Independent variable – Poverty
Percent in poverty by state (U.S. Census)	Estimated percentage in poverty by state	1980-2010	800	Independent variable - Poverty
125% in poverty (U.S. Census)	Estimated percentage of national poverty living at or below 125% of the threshold that defines poverty in the United States	1959-2010	52	Independent variable - Poverty
50% in poverty (U.S. Census)	Estimated percentage of national poverty living at or below 50% of the threshold that defines poverty in the United States	1975-2010	36	Independent variable - Poverty
Unemployment rate by state (BLS)	Seasonally adjusted average annual unemployment rate	1959, 1961-2010	548	Independent variable - Poverty
Agricultural subsidies (U.S. Government Printing Office)	Divided "farm income stabilization" outlays by total government expenditures for all years	1962-2010	49	Independent variable – Food price
Refined sugar consumption (BLS)	Pounds, dry basis	1966-2010; 45	45	Independent variable – Food price
Caloric sweetener consumption	Pounds, dry basis	1966-2010	45	Independent variable – Food price

(BLS)				
Fruits & vegetables price index (FV PI) (BLS)	Average annual price index of fruits & vegetables	1995-2010	16	Independent variable – Food price
Oil prices (EIA)	Dollars per Barrel (All Countries)	1990-2011	22	Independent variable – Food price
Gas prices (EIA)	Cents per Gallon	1993-2011	19	Independent variable – Food price
Spot price – High fructose corn syrup (BLS)	Cents per Pound	1994-2010	17	Independent variable – Food price
Refined sugar price (BLS)	Cents per Pound	1960-2010	51	Independent variable – Food price
Sugar/sweets price index (BLS)	Seasonally adjusted consumer price index for all urban consumers for sugars and sweets, average annual price index	1989-2010	22	Independent variable – Food price

Appendix B

Table 2: Summary Table of Indicator Trends

Trend category	Indicator (source)	Details of how measured	Years	Measure of interest or central tendency	How trending
Society					
	Percent obese, by state	Monthly telephone interviews with U.S. adults for self-reported height and weight	1995-2010	Range	⬆ Upward
	Percent obese, national	Monthly telephone interviews with U.S. adults for self-reported height and weight	1995-2010	Range	⬆ Upward
Government					
	Percent on food stamps	Actual data gathered through U.S. Department of Agriculture	1969-2009	Mean	Cyclical and upward
	Agricultural subsidies	Divided "farm income stabilization" outlays by total government expenditures for all years	1962-2010	Mean, Range	⬇ Downward
Demography					
	Percent in poverty by state	Estimated percentage in poverty by state	1980-2010	Mean	Cyclical
	125% in poverty	Estimated percentage of national poverty living at or below 125% of the threshold that defines poverty in the United States	1959-2010	Mean	Cyclical
	50% in poverty	Estimated percentage of national poverty living at or below 50% of the threshold that defines poverty in the United States	1975-2010	Mean	Cyclical

	Unemployment rate	Seasonally adjusted average annual unemployment rate	1959, 1961-2010	Mean	Cyclical
	Refined sugar consumption	Pounds, dry basis	1966-2010	Range	Downward
	Caloric sweetener consumption	Pounds, dry basis	1966-2010	Range	Upward
Economics					
	Fruits & vegetables price index (FV PI)	Average annual price index of fruits & vegetables	1995-2010	Range	Upward
	Oil prices	Dollars per Barrel (All Countries)	1990-2011	Mean, Range	Cyclical and Upward
	Gas prices	Cents per Gallon	1993-2011	Mean, Range	Cyclical and Upward
	Spot price – High fructose corn syrup	Cents per Pound	1994-2010	Range	Upward
	Refined sugar price	Cents per Pound	1960-2010	Range	Upward
	Sugar/sweets price index	Seasonally adjusted consumer price index for all urban consumers for sugars and sweets, average annual price index	1989-2010	Range	Upward

Appendix C

Table 8: Food Price Indicator Group Correlations

		Percent Obese	FV Price Index	Percent Spending on Agr. Subsidies	Oil Price per Barrel	Gas Price per Gallon	Sugar/ Sweets Price Index	Annual Sugar Consum. per Capita (lb)	Annual Sweets Consum. per Capita (lb)	Price of Sugar (lb)	Price of Corn Syrup (lb)
Percent Obese	Corr.	1	.947	-.205	.879	.906	.934	-.388	-.819	.794	.740
	Signif.		.000	.463	.000	.000	.000	.138	.000	.000	.001
	N	16	16	15	16	15	16	16	16	16	16
FV Price Index	Corr.	.947	1	-.389	.937	.935	.939	-.299	-.871	.837	.836
	Signif.	.000		.152	.000	.000	.000	.261	.000	.000	.000
	N	16	16	15	16	15	16	16	16	16	16
Percent Spending on Agr. Subsid.	Corr.	-.205	-.389	1	-.334	-.320	-.327	.244	.530	-.372	-.472
	Signif.	.463	.152		.223	.246	.235	.380	.042	.172	.076
	N	15	15	15	15	15	15	15	15	15	15
Oil Price per Barrel	Corr.	.879	.937	-.334	1	.990	.882	-.152	-.856	.835	.864
	Signif.	.000	.000	.223		.000	.000	.575	.000	.000	.000
	N	16	16	15	16	15	16	16	16	16	16
Gas Price per Gallon	Corr.	.906	.935	-.320	.990	1	.861	-.233	-.864	.781	.854
	Signif.	.000	.000	.246	.000		.000	.403	.000	.001	.000
	N	15	15	15	15	15	15	15	15	15	15
Sugar/ Sweets Price Index	Corr.	.934	.939	-.327	.882	.861	1	-.151	-.882	.942	.837
	Signif.	.000	.000	.235	.000	.000		.576	.000	.000	.000
	N	16	16	15	16	15	16	16	16	16	16
Annual Sug. Consum. per Capita (lb)	Corr.	-.388	-.299	.244	-.152	-.233	-.151	1	.313	.054	-.089
	Signif.	.138	.261	.380	.575	.403	.576		.238	.842	.742
	N	16	16	15	16	15	16	16	16	16	16
Annual Swe. Consum. per Capita (lb)	Corr.	-.819	-.871	.530	-.856	-.864	-.882	.313	1	-.858	-.925
	Signif.	.000	.000	.042	.000	.000	.000	.238		.000	.000
	N	16	16	15	16	15	16	16	16	16	16
Price of Sugar (lb)	Corr.	.794	.837	-.372	.835	.781	.942	.054	-.858	1	.847
	Signif.	.000	.000	.172	.000	.001	.000	.842	.000		.000
	N	16	16	15	16	15	16	16	16	16	16
Price of Corn Syrup (lb)	Corr.	.740	.836	-.472	.864	.854	.837	-.089	-.925	.847	1
	Signif.	.001	.000	.076	.000	.000	.000	.742	.000	.000	
	N	16	16	15	16	15	16	16	16	16	16

Table 9: Poverty Indicator Group Correlations

		Percent Obese	Percent on Food Stamps	Percent in Poverty	Percent Unemployed
Percent Obese	Corr.	1	.597	.258	.437
	Signif.		.000	.000	.000
	N	797	549	797	547
Percent on Food Stamps	Corr.	.597	1	.685	.417
	Signif.	.000		.000	.000
	N	549	550	550	398
Percent in Poverty	Corr.	.258	.685	1	.449
	Signif.	.000	.000		.000
	N	797	550	800	548
Percent Unemployed	Corr.	.437	.417	.449	1
	Signif.	.000	.000	.000	
	N	547	398	548	548