DOES PARTICIPATION IN A SCHOOL LUNCH PROGRAM INCREASE THE INCIDENCE OF OBESITY IN LOW INCOME CHILDREN?

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ABSTRACT

America is under the influence of an epidemic - obesity. It is becoming one of the greatest health problems facing the nation. Healthy practices begin at an early age and most obese children grow up to be overweight adults. Therefore, it is important that students eat healthy meals at school at a young age. However, school meals have been criticized as unhealthy and some students have no choice whether to eat the lunch or not. Low-income children receive free or reduced price lunches and do not have the ability to brown bag or bring alternatives that are more nutritious. Because the school lunch program contains foods that are high in fat and calories, low-income students are more likely than other students to become obese because they are more likely to be eating the lunches. To examine this problem, data from the National Health and Nutrition Examination Survey data on the eating and exercise habits of these children are investigated. This study fills a gap in the literature by specifically examining low-income students and their diet, exercise, and income levels rather than looking at all students who eat school lunches. This study did not support the hypothesis that school lunch programs contribute to childhood obesity but it did have significant results that were supported by the literature. Variables like age, race, income, hours a child participates in sedentary activities, and gender all contribute to childhood obesity according to this model. Overall, the models have strong predictive power and still provide insight into the causes of childhood obesity even without proving the hypothesis. Recommendations include utilizing the pervasive nature of the National School Lunch Program to promote healthy eating in schools. This not only includes providing healthier food in the lunches, but also providing education programs on healthy eating, nutrition, and lifestyle as part of the core curriculum.
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Introduction

The purpose of this paper is to examine the prevalence of obesity among low-income children participating in school lunch programs. The problem of childhood obesity in the United States has grown considerably in recent years. Between 16 and 33 percent of children and adolescents are obese.

Chart 1:

Obesity is among the easiest medical conditions to recognize but one of the most difficult to treat. Unhealthy weight gain due to poor diet and lack of exercise is responsible for over 300,000 deaths each year, and the annual cost to society in medical and productivity costs for obesity is estimated at over $100 billion. Overweight children are much more likely to become overweight adults unless they adopt and maintain healthier patterns of eating and exercise (American Academy of Child & Adolescent Psychiatry [AACAP], 2001).
Causes of obesity include genetic, biological, behavioral and cultural factors. For instance, if one parent is obese, there is a 50 percent chance that the children will also be obese. However, when both parents are obese, the children have an 80 percent chance of being obese. Although certain medical disorders can cause obesity, less than one percent of all obesity is caused by physical problems. Another simple cause of obesity is eating more calories than the body is burning. Many factors relate to obesity in childhood and adolescence including: poor eating habits, overeating or binge eating, lack of exercise, family history of obesity, medical illnesses, medications, and various emotional problems. There are also many risks and complications from obesity including: increased risk of heart disease, high blood pressure, diabetes, breathing problems, and trouble sleeping (American Academy of Child & Adolescent Psychiatry [AACAP], 2001).

The school lunch program ties into the obesity epidemic because of the typically high fat and calorie content of the lunches. While the school lunch program has greatly improved recently, the nutritional content is still failing to meet Federal nutrition guidelines in many schools. Children that are not receiving free or reduced prices lunches are likely to have more healthy options by brown bagging their lunches or being able to partake in more expensive alternatives like salad bars at school, while the low-income children are limited to what is on their tray. Because of these limitations, these low-income children are more likely to be obese.
History of the School Lunch Program

The National School Lunch Program was established in 1946 when President Truman signed the National School Lunch Act into law. Prior to this Federal law, lunch programs like those initiated by the Children’s Aid Society of New York City in 1853 provided meals for some students in vocational schools. Feeding the low-income students lunch was one way these small advocacy groups protested the fact that the nation imposed compulsory school enrollment while many students came to school hungry and unable to learn. In the late 1930’s, some state legislatures began to pass laws to give school boards control over school lunches. Most of these laws provided the lunches at cost, but only a few made concessions for poor students. It became clear that state and local governments could no longer handle the burden of the lunch programs and the Federal Government stepped in with the National School Lunch Act. However, the goal of these programs from their inception was to promote the health and care of low-income students (Gunderson, 1971).

The National School Lunch Program\(^1\) is a Federally assisted meal program that operates in almost 100,000 public and non-profit, private school and childcare facilities in the United States. The program provides lunches to more that 28 million school children each school day.

In exchange for subsidies and commodities from the Department of Agriculture, schools must serve lunches that meet Federal requirements and offer free or reduced price

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\(^1\) Administered by the Food and Nutrition Service at the Federal level and by state education agencies at the state level
lunches to those who qualify. The lunches must meet the recommendations of the Dietary Guidelines for Americans,\(^2\) which includes that no more than 30 percent of a person’s calories come from fat, and less than 10 percent from saturated fat. Other requirements are that the lunches must include at least one-third of the recommended levels of vitamin A, vitamin C, iron, calcium, and calories. These guidelines apply over the course of one week of school lunch menus (USDA, 2005). Local school authorities are the ones making decisions about what foods to cook and serve in order to meet these requirements.

Anyone can purchase a lunch through the NSLP, but children from low-income families are eligible for reduced price or free lunches. In order to qualify for a low income or free lunch, families must meet income requirements. To receive a free lunch, children must come from a family with an income that is at or below 130 percent of the poverty level. To receive a reduced price lunch, students’ families must be between 130 and 185 percent of the poverty level\(^3\) (USDA, 2005). For the period July 1, 2005 to June 30, 2006, 130 percent of the poverty level is $25,155 for a family of four; 185 percent is $35,798.

The irony behind the National School Lunch Program is that it began as a program with a goal of making sure that low-income children received a balanced meal at school and is now being criticized for doing exactly the opposite. School lunch evaluations now show that the lunches are high in fat and calories in some areas, which

\(^{2}\) Updated every five years by the Department of Health and Human Services and Department of Agriculture

\(^{3}\) Students may not be charged more than 40 cents
runs counter to the purpose of the program. Perhaps this is an unintended effect of government intervention into a social problem.

**Literature Review**

Americans are fat and getting fatter. The United States Surgeon General has publicized that the obesity epidemic is one of the “greatest health problems facing the nation today” (Wechsler et al., 2004). Today, it is estimated that up to 30 percent of adults are obese and the problem is even greater for children and adolescents (Whitmore, 2004). The percentage of children that are overweight is increasing exponentially, more than doubling since 1980 (and increasing threefold for adolescents). In 2002, 16 percent of 6-19 year olds were overweight⁴ (Wechsler et al., 2004). Furthermore, a significant change can be seen in children today compared to those about forty years ago by looking to the following chart.

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⁴ Overweight is defined as being greater than or equal to the 95th percentile for Body Mass Index (BMI) by age and sex.
A result of the obesity epidemic is a severe increase in health care costs and declining school performance for those children who are obese. Obesity leads to various chronic diseases such as type II diabetes, cardiovascular disease, high blood pressure, osteoporosis, and some cancers (Center for Health and Health Care in Schools, 2005). One estimate of the cost of obesity in 2000 (using medical costs and wages lost due to missed work from illness, disability, or premature death from just one of the aforementioned conditions) is $117 billion (Wechsler et al., 2004). The USDA’s
Economic Research Service estimates that improving American diets could save $43 billion in health care costs and lost productivity, as well as prevent almost 120,000 premature deaths among people 55-74 years of age (Variyam et al, 1998). School budgets are also being affected as they are determined in part by attendance, which is lower for overweight or obese children (National Parent Teacher Association [PTA], 2005). The growing numbers of children that are overweight means that these health care costs are being incurred at earlier ages and over longer periods. In one study, 61 percent of overweight 5-10 year olds already had at least one risk factor for heart disease, and 26 percent had two or more risk factors (National Conference of State Legislatures [NCSL], 2005). The U.S. Government is concerned that these children will have early health problems that will reach into their time as a working adult, having a greater effect on the U.S. economy.

This impending crisis has resulted in a variety of literature on the topic of childhood obesity and discussion about the factors that influence whether a person is overweight. Food consumption is the first obvious factor that contributes to obesity and the USDA notes four factors that contribute to a person’s decision on what to eat. These categories are consumer incomes, prices of food and other goods, consumer knowledge of health and nutrition, and tastes and preferences (Variyam et al., 1998). The USDA recognizes that in order to alter consumption, one of these factors must change and that is where government advertising and education come into play. However, tastes and preferences as well as health education levels vary depending on socioeconomic factors – bringing another variable into the equation. The USDA hypothesizes that families with
higher incomes will be more receptive to nutrition information and have better diets. They also note that gender, race, ethnicity, and employment status affect nutrition quality; and that diet tends to improve with age (Variyam et al., 1998). Other influences on whether a person is overweight include physical activity levels, and family history of being overweight.

One study by Datar and Sturm (2004) examined whether an increase in physical activity resulted in a lower BMI for students at risk for being overweight. They looked at the change in BMI for students between kindergarten and first grade and found that for girls, the increased hour of physical education lowered their BMI, but there was no significant change for boys. Jago and others (2004) examined 8-10 year old African-American girls over three days while they wore activity monitors. The girls were also asked what foods they consumed in order to collect information on any relationship between physical activity and diet. The results clearly showed that the girls with higher activity levels had lower levels of calories from fat. Another interesting result was that there was an inverse relationship between income and calories from fat. Finally, the Crooks study (2000) looked at young children in a poor area of the country and their food consumption, activity levels, and whether they were overweight. The results here showed that the diets were high in fat and sugar and that heavier children spent more time in sedentary activities like television watching or being on the computer. The boys in the study had a higher incidence of overweight than the girls (Crooks, 2000). Therefore, from these examples, physical activity is likely to lower a child’s BMI or prevalence to
be overweight, income is likely to be inversely related to BMI, and it is unclear whether girls or boys are more likely to be overweight.

Government and non-profit organizations have recognized that one of the best ways to promote nutrition education and influence what children eat is through the public school system. Over 95 percent of young people are enrolled in schools, creating an easy captive audience in a learning environment (Wechsler et al., 2004). In addition, a number of students eat a lunch or breakfast provided at the school by the USDA’s National School Lunch Program (NSLP). Lunch is provided to more than 28 million schoolchildren per day, and breakfast to about 8 million (United States Department of Agriculture [USDA], 2005).

The NSLP has nutritional guidelines for the meals they provide, but the problem with the guidelines is that many schools are not meeting the requirements. The USDA periodically completes School Nutrition Dietary Assessments and as of the April 2001 publication, the report noted that many school districts were not meeting the basic requirements (Physicians Committee for Responsible Medicine [PCRM], 2004). Moreover, even if the requirements are not met, the school will not be audited again for another five years meaning that low nutrition quality can continue for quite some time. This problem is contrary to the purpose of the school lunch program, which is to ensure that children, especially those from poor and low-income families, have nutritious food at school (Haskins, 2005). As word spread about the low quality of school lunches, a strong lobby has emerged to give school lunches an overhaul, and make them more nutritious. However, most people do not realize that the NSLP is the most expensive food program
outside of food stamps and is backed by powerful special interest groups in Washington that want to continue the program without alteration. Based on the political influence of the special interest groups and the food industry, the program itself is here to stay so the main option to make those lunches more nutritious is to change the content. If school lunches are a factor in childhood obesity, government must take action. So far, during the 2005 legislative session, state legislatures in 38 states have considered or enacted legislation related to the nutritional quality of school foods and beverages, so this issue is clearly on the policy radar screen (NCSL, 2005).

However, some studies suggest that the school lunches are not the problem in schools, but that it is the lack of physical education programs and the prevalence of vending machines in the schools where students can purchase unhealthy items. According to the Center for Disease Control [CDC], less than 10 percent of the nation’s elementary, junior, and senior high schools offer daily physical education (Haskins, 2005). Further, the national PTA found that 75 percent of the drinks and 85 percent of the snacks in school vending machines are junk foods like sweetened soda, candy, and chips (PTA, 2005). Gleason’s study found that by the time children are 14 years old, 32 percent of girls and 52 percent of boys are consuming three or more servings of soda per day (Gleason, 2001). Others note the level of obesity is higher in students that consume fast food outside of school or if the school has an open campus for the lunch period (Center for Health and Health Care in Schools, 2005). Other factors that cause children to use school vending machines are inadequate time to eat and cafeteria overcrowding – students want to get something quick and do not want to wait in line (Boyle, 2001).
problems of outside foods and a la carte menu items in school cafeterias make it hard to single out the impact of school lunches on obesity. In summary, the evidence suggests that obesity in children can be caused by more factors than just subsidized school lunches, but the impact of lunches warrant further investigation.

Various studies have tried to pinpoint the impact of the school lunch on childhood obesity. Whitmore estimates that children who eat a school lunch are about two percentile points more likely to be obese than those who brown bag their lunches (Whitmore, 2005). Whitmore used National Health and Nutrition Examination Survey (NHANES) food diary data to estimate that children who ate a school lunch consumed about 40-120 more calories per day than those who brown bagged their lunch. The study cites among other aforementioned variables, the fact that a mother’s employment status might affect the dietary behavior of children because working mothers might not have enough time to prepare healthy foods for their children. Other factors include family size, number of books in the home, and even the prevalence of day care before starting kindergarten. She also noted that physical activity outside of school was important because most children in school are required to complete the same level of activity. Overall, her conclusion is that for a program as large, fund rich, and pervasive as the NSLP; the impact of healthier foods can be realized in lower obesity rates for children (Whitmore, 2005).

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5 There are no nutritional guidelines for a la carte menu items in public schools.
A broader, policy-oriented study by Forman discussed evaluations of healthy school lunch initiatives. Recognizing that school lunches are failing the Federal guidelines (some exceed fat guidelines by as much as 10 percent) she found that school based intervention is a plausible solution to the obesity problem (Forman, 2000). Programs like The Child and Adolescent Trial for Cardiovascular Health (CATCH), Pathways, and Gimmee 5 were all successful in lowering the fat content of the school lunch. The programs all consist of nutritional training of school food program employees, nutritional instruction on how to make healthy diet choices for the children in school, more aggressive physical education programs, and supplying a healthy variety of food options at the schools (replacing whole milk with one percent and two percent for example) (Forman, 2000).

It seems there is a consensus that the children’s obesity problem is caused by poor food choice and can be contributed to by school lunch programs. Legislators and public interest groups have been trying to compromise in promoting healthy choices for kids, improving the nutrition of the lunches, and bringing nutrition into the school curriculum. The USDA recently developed “Prescription for Change: Ten Keys to Promote Healthy Eating in Schools” to address the obesity problem. The program includes monitoring the content of the school lunches, meeting USDA standards, providing adequate serving areas, and making sure vending machine foods and other options not on the regular menu are in one of the five major food groups (American Obesity Association [AOA], 2005). Other creative initiatives include new electronic credit cards so that parents can monitor their children’s food choices; the child must scan the card with every food purchase and
the parent will be able to see if the child is buying junk food or nutritious foods (Feld, 2005).

The study here is similar to the Whitmore study in that it also uses NHANES data, but will study a narrower, at risk population of low-income students. Moreover, unlike Whitmore who was more interested in the family structure and social aspects of food choice, this study will focus on food choice, physical activity, and income.

In summary, there are many contributors to childhood obesity including the NSLP. There is much room for improvement in the nutritional value of the lunches but the lunch program alone is not likely to solve the problem, but warrants further investigation. Realistic policy options will be discussed later in the paper after a thorough analysis of the relationship between school lunches and obesity.

**Hypothesis, Data Sources, and Research Design**

This study will test the hypothesis that the likelihood that low-income children are obese is positively correlated with their participation in a school lunch program.

The data used for the study are from the National Health and Nutrition Examination Survey, which is conducted by a division of the CDC’s Center for Health Statistics. It is cross sectional survey data that are collected and published in two-year increments. The following are characteristics of the dataset:

- Demographics, Laboratory and Examination files which include detailed health information including blood test results
- Information on the number of times per week that a child eats a school lunch or breakfast and whether it is free or reduced in price
Detailed information about each person’s nutritional intake, and activity levels
Income levels and weight histories for the participants as well as their body mass index (BMI) as a measure of obesity

The NHANES data have some limitations. Variables do not exist to test the extent that the vending machines and open campuses during lunch times allow students to eat other unhealthy foods. Other factors such as the price of foods in geographic areas are not included in the dataset. It might be interesting to see how much an alternative healthy lunch might cost and any substitution effects that might exist. The dataset is also lacking information on how much information on healthy eating the students are receiving. Any educational programs in schools might help students make healthier choices outside of school, lowering their obesity rate. Overall, the dataset is a very comprehensive and includes a very wide range of information on each participant relevant to the obesity issue.

In order to test the school lunch participation hypothesis, the study will control for other factors that might have an influence on the obesity rate. These factors will include activity rate for the children, their weight history, age, race, and household income. Other factors that might determine obesity rates include the amount of time children watch television and any use of dietary supplements.

Two regressions will be run – one using all the children in the NHANES dataset and the other regression testing just those children who receive school lunches. Both of the regressions will use the children’s basal metabolic rate (known as the Body Mass Index or BMI) as the dependent variable with independent variables such as age, race,
household income, activity levels, and lunch participation rates. The following exhibit shows variables that might be used in the regression along with sources and predictions.

<table>
<thead>
<tr>
<th>Variable and Description</th>
<th>Prediction (correlation)</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMX BMI Body Mass Index (BMI)</td>
<td>Dependent variable / Measure of Obesity</td>
<td></td>
</tr>
<tr>
<td>RIAGENDR - Gender</td>
<td>uncertain</td>
<td></td>
</tr>
<tr>
<td>RIDRETH1 - Race</td>
<td>uncertain</td>
<td></td>
</tr>
<tr>
<td>INDHHINC - Annual Household income</td>
<td>negative</td>
<td>Jago et al.</td>
</tr>
<tr>
<td>DBD381 - # of times/wk get school lunch</td>
<td>positive</td>
<td>Whitmore</td>
</tr>
<tr>
<td>DBQ390 - school lunch free, reduced, or full px</td>
<td>positive if free or reduced</td>
<td>Whitmore</td>
</tr>
<tr>
<td>DBD411 - # times/wk get school breakfast</td>
<td>positive</td>
<td>Whitmore</td>
</tr>
<tr>
<td>DBD421 - school breakfast free, reduced, full px</td>
<td>positive if free or reduced</td>
<td>Whitmore</td>
</tr>
<tr>
<td>PAQ180 - Avg level of physical activity each day</td>
<td>negative</td>
<td>Jago et al., Datar, Crooks</td>
</tr>
<tr>
<td>PAD480 - Daily hours of TV, video, or computer use</td>
<td>positive</td>
<td>Crooks</td>
</tr>
<tr>
<td>PAD590 - # of hours watch TV, video, or computer use</td>
<td>positive</td>
<td>Crooks</td>
</tr>
<tr>
<td>PAD600 - # of hours use computer past 30 days</td>
<td>positive</td>
<td>Crooks</td>
</tr>
<tr>
<td>WHD020 - Current self reported weight</td>
<td>positive</td>
<td>BMI formula</td>
</tr>
<tr>
<td>WHD050 - self reported weight one year ago</td>
<td>positive</td>
<td>AACAP</td>
</tr>
<tr>
<td>WHQ060 - was the weight change intentional?</td>
<td>negative if on purpose</td>
<td>AACAP</td>
</tr>
</tbody>
</table>

** Source for all variables is the 2001-2002 National Health and Nutrition Examination Survey (conducted by a division of the CDC’s Center for Health Statistics)

Ninety-five percent of the sample attends schools that serve school lunches and the following charts show breakdowns of how many students eat school lunches and at what frequency, as well as what type of lunch they eat.
About 2/3 of the students participating in the school lunch program get those lunches free or at a reduced price. Similarly, 2/3 of the students that eat school-provided lunches free or at a reduced price.
lunches do so four or five days per week. These results demonstrate the popularity and pervasive nature of the school lunch program.

Policy Relevance

The topic is important because of its possible relationship to obesity, which is becoming an American epidemic. People believe that unhealthy habits are started at an early age. There is growing apprehension that obesity will create an increasing strain on our health care system. The aforementioned costs associated with lost work productivity and health care costs that have been predicted by USDA economists are staggering; this will have a significant effect on the nation’s economy. Obesity has been linked to conditions such as high blood pressure, heart disease, and diabetes among others – all of which have impacts on health care spending and workplace performance.

In addition, because the program is the most expensive Federal food program outside of food stamps, it has considerable influence in Washington. The food and agriculture industries that contribute to the school lunches are very concerned with the program’s well being and make up powerful interest groups.

School lunches for low-income students, and in general, have been in the media spotlight being portrayed as very unhealthy and having low nutritional content. In many cases, low-income students have no other option but to eat the school lunch that is provided due to their income limitations. These limited options also bring up social justice questions about the fairness to give those students who have no other option only
unhealthy choices. The irony remains that a program that was born out of concern to aid the nutrition of low-income students is now faltering.

Regression Design, Diagnostics, and Results

A table of the variables considered and used in this study is attached in Appendix One. All of the variables are from the NHANES dataset. Many of these variables were missing a significant number of observations. The missing observations required some variable substitution. The variables used to measure activity levels tended to have more missing observations. Because of missing observations for PAQ180 and PAD480, those variables were eliminated and replaced with PAD590 and PAD600. PAQ180 and PAD480 measure average activity level and daily television, computer, and video game use, respectively. The replacement variables measure hours per month of television watching and hours per month of computer use, respectively. These variables are adequate replacements to measure how activity levels of the children might affect their obesity, and the variables were not missing as large an amount of observations as the original variables. In addition, for all variables that included observations such as “refused” or “don’t know” – those observations were dropped. Other observations that were removed were those for activity variables that were coded as “unable to do activity” on the premise that those children might be handicapped.

The following are the two regressions with the variable choices from the NHANES dataset:
Regression 1 (dataset includes all children from the NHANES dataset)
BMXBMI = \beta_0 + \beta_1DBD381 + \beta_2DBQ390 + \beta_3INDHHINC + \beta_4PAD590 + \beta_5PAD600 + \beta_6RIAGENDR+ \beta_7RIDAGEYR+ \beta_8RIDRETH1 + u

Regression 2 (dataset includes those children who participate in the school lunch program) BMXBMI = \beta_0 + \beta_1DBD381 + \beta_2INDHHINC + \beta_3PAD590 + \beta_4PAD600 + \beta_5RIAGENDR+ \beta_6RIDAGEYR+ \beta_7RIDRETH1 + u

Diagnostic tests were run on both of the regression models and specific results can be found in Appendix Two. Both of the models had R-squared values that showed that 21.12% of the variation in obesity can be explained by the independent variables in the models. Also the F-values for both models were significant, proving that the variables in the model provide some explanatory value to obesity levels. An additional diagnostic test for the validity of the regression models is the Durbin-Watson test, which tests for first order autocorrelation, but is increasingly used as a quick indicator of model specification. As a general rule of thumb, the Durbin Watson test statistic should be close to two. The Durbin-Watson statistics for both of the models in this study are 1.982, indicating that both models are probably properly specified but further tests must be run. Also, a correlation matrix was constructed to determine if there was any correlation between the independent variables in the regressions. Scatterplots were also utilized to test for model specificity and heteroskedasticity. The correlation matrix and scatterplots can be found in Appendix Two. Overall, these tests indicated that the models were properly specified, and had no multicollinearity or heteroskedasticity problems.
Regression One Results (all children):

<table>
<thead>
<tr>
<th>Variable</th>
<th>Label</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>t Value</th>
<th>Pr &gt;</th>
<th>t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>Intercept</td>
<td>12.14297</td>
<td>0.82529</td>
<td>14.71</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>DBD381</td>
<td># times/week you get school lunch</td>
<td>-0.00361</td>
<td>0.10013</td>
<td>-0.04</td>
<td>0.9713</td>
<td></td>
</tr>
<tr>
<td>DBQ390</td>
<td>School lunch free, reduced, or full price</td>
<td>-0.0555</td>
<td>0.13994</td>
<td>-0.4</td>
<td>0.6917</td>
<td></td>
</tr>
<tr>
<td>INDHHINC</td>
<td>Annual Household Income</td>
<td>-0.50169</td>
<td>0.26476</td>
<td>-1.89</td>
<td>0.0583</td>
<td></td>
</tr>
<tr>
<td>PAD590</td>
<td># hours watch TV or videos past 30 days</td>
<td>0.24341</td>
<td>0.07708</td>
<td>3.16</td>
<td>0.0016</td>
<td></td>
</tr>
<tr>
<td>PAD600</td>
<td># of hours use computer past 30 days</td>
<td>0.02958</td>
<td>0.05016</td>
<td>0.59</td>
<td>0.5555</td>
<td></td>
</tr>
<tr>
<td>RIAGENDR</td>
<td>Gender</td>
<td>0.39498</td>
<td>0.22183</td>
<td>1.78</td>
<td>0.0752</td>
<td></td>
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<tr>
<td>RIDAGEYR</td>
<td>Age</td>
<td>0.75448</td>
<td>0.03618</td>
<td>20.85</td>
<td>&lt;.0001</td>
<td></td>
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<tr>
<td>RIDRETH1</td>
<td>Race/Ethnicity</td>
<td>-0.2256</td>
<td>0.0871</td>
<td>-2.59</td>
<td>0.0097</td>
<td></td>
</tr>
</tbody>
</table>

Sample Size = 4132; R-squared = 0.2112; F-value = 59.81

Regression one examined all children in the NHANES dataset. The hypothesis that those children who participate in a school lunch program are more likely to be obese was not supported. The two variables related to the school lunch program (DBD381: “Times/wk student gets a school lunch” and DBQ390: “School lunch free, reduced, or full price”) were not statistically significant. There were three variables that were statistically significant and two others that were marginally significant. Variables that were significant included age, race, and the number of hours children watched television or played video games in the past thirty days. The marginally significant variables were annual household income and gender.

The age variable can be interpreted to explain that the older a child gets, the higher their level of obesity. This interpretation makes sense given that most children probably eat more as they get older and consume more calories. The variable measuring the amount of television watched and the amount of gaming that children participate in
shows that the more hours children participate in these sedentary activities, the more likely they are to be obese. While this result may also seem intuitive, it is also supported by the literature in studies such as Crooks, Whitmore, and Datar. Children today spend much more time indoors and engaged in dormant activities versus their peers in the past. Finally the race variable shows that non Hispanics are likely to have lower obesity rates than other races. While no literature is conclusive about the ability of race to predict obesity level this might be interpreted in conjunction with the income variable, which is marginally significant. The income variable explains that as the household income for the children’s family increases, their obesity level decreases. The literature, the Crooks study in particular, noted that children in low income areas of the country tend to consume a higher fat diet. This difference in diet might be due to eating habits, and lack of parental resources or instruction on healthy eating. The last variable that was marginally significant was gender which predicted that females were likely to have a higher obesity level than males. This result is consistent with the Datar study but an opposite conclusion from the Crooks study. While the literature is conflicted about the predictive power of gender on obesity, this model’s prediction might be explained by the fact that as females mature, they tend to store more body fat, or that young males probably participate in more sports activities.
**Regression Two Results (all children eating school lunches):**

| Variable     | Label                                | Parameter Estimate | Standard Error | t Value | Pr > |t| |
|--------------|--------------------------------------|--------------------|----------------|---------|------|---|
| Intercept    | Intercept                            | 12.02634           | 0.78407        | 15.34   | <.0001 |
| DBD381       | # times/week you get school lunch     | 0.0058             | 0.09799        | 0.06    | 0.9528 |
| INDHHINC     | Annual Household Income              | -0.54906           | 0.23227        | -2.36   | 0.0182 |
| PAD590       | # hours watch TV or videos past 30 days | 0.24711        | 0.07636        | 3.24    | 0.0012 |
| PAD600       | # of hours use computer past 30 days  | 0.03227             | 0.05011        | 0.64    | 0.5197 |
| RIAGENDR     | Gender                               | 0.40054            | 0.22195        | 1.8     | 0.0713 |
| RIDAGEYR     | Age                                  | 0.75424            | 0.03615        | 20.87   | <.0001 |
| RIDRETH1     | Race/Ethnicity                       | -0.23149           | 0.08654        | -2.67   | 0.0075 |

Sample Size = 2538; R-squared = 0.2112; F-value = 68.30

This regression using data on those children who are participating in school lunch yielded similar results. Again, the hypothesis of this study was not supported by the model. The variable determining the number of times a student receives a school lunch was not significant, and therefore has no predictive power on the obesity level of these children. It was expected that the more times that a child ate a school lunch that they would have a higher obesity level. The same three variables that were significant in regression one (age, race, and the amount of television and video watching) were also significant here, with similar predictive power and explanations. However, the income variable was much more significant in this model than in regression one. Here, the prediction is that the higher the child’s family income is, the lower their obesity level. The variable is probably more significant here because most students participating in a school lunch program are doing so because they have limited income or qualify for some
type of subsidy through the program. Gender was also marginally significant in this model with the same predictive explanation as regression one.

**Overall Results**

Generally, the regression models that were estimated in this study did not prove the hypothesis that those students who participate in school lunch programs are more likely to be obese. The models did however have strong predictive power and other significant results that provided insight into causes of childhood obesity. Variables including age, race, amount of time spent watching television and videos, gender, and income were all shown to have some correlation with the obesity level of the children examined. Some of the results were consistent with literature while others provided another data point among conflicting studies. Overall, the model provides some support that children in low income or minority areas are less likely to eat healthy food and be obese. In addition, because so many children have no choice whether to participate in the school lunch program, this is all the more reason to make sure that the food is healthy. There is empirical evidence that childhood obesity is becoming a major problem in this country and it is imperative that schools play a role in the healthy development of children. Schoolchildren are a captive audience and good habits can be embedded early while they are attending classes. One of the best ways to present healthy food choices to kids is through school lunch, which will also give particular attention to low income children who are more likely to be participating in the program.
Compromise between legislators, parents, and school administration is probably the only realistic mode to make any significant impact on this national problem. As was previously recommended, schools need to implement programs educating children on healthy eating habits while they are in a place where they have easy access to the information. While in school, children are also at an age when they can develop these habits and are more likely to hold on to them for life. The regression results noted the influence of the amount of sedentary activities that children participate in as a key determinate of obesity. Schools need to increase the amount of physical activity that is mandatory in curriculum plans as well as provide information on physical fitness along with the nutritional information. All of these good habits need to be developed at home as well, but again, not every family might have to resources necessary to combat childhood obesity.

Given the magnitude of the National School Lunch Program, both politically and monetarily, and the implications for childhood obesity on our nation’s healthcare system, these plans should be put in place. Some of these children are unable to get the nutrition and exercise necessary in their homes and schools are the best place for them to learn the importance of health, nutrition, and physical fitness at an early age. The results of these programs and improved nutrition in school lunch programs will have pervasive positive effects on national healthcare costs, as well as business and political interests in the agriculture and food service industries. Our nation’s children deserve better lunches in schools and more hope for a healthy future.
Sources


APPENDIX ONE.

Variable Coding—NHANES

**BMXBMI**  
Body Mass Index

**DBD381**  
Times/wk student gets a school lunch,  
0= None, 7777= Refused, 9999= Don't know

**DBQ390**  
School lunch free, reduced, or full price  
1= Free, 2= Reduced price, 3= Full price, 7= Refused, 9= Don't know

**INDHHINC**  
Annual Household Income  
1= $0 to $24,999, 2= $25,000+

**PAD020**  
Walked or bicycled over past 30 days  
1= Yes, 2= No, 3= Unable to do activity, 7= Refused, 9= Don't know

**PAD200**  
Vigorous activity over past 30 days  
1= Yes, 2= No, 3= Unable to do activity, 7= Refused, 9= Don't know

**PAD320**  
Moderate activity over past 30 days  
1= Yes, 2= No, 3= Unable to do activity, 7= Refused, 9= Don't know

**PAD480**  
Daily hours of TV, video, or computer use  
0= Less than 1 hour, 1= 1 hour, 2= 2 hours, 3= 3 hours, 4= 4 hours, 5= 5 hours or more, or 6= None 77= Refused 99= Don't know

**PAD590**  
# of hours watch TV or videos past 30 days  
0= Less than 1 hour, 1= 1 hour, 2= 2 hours, 3= 3 hours, 4= 4 hours, 5= 5 hours or more, 6= None, 77= Refused, 99= Don't know

**PAD600**  
# of hours use computer past 30 days  
0= Less than 1 hour, 1= 1 hour, 2= 2 hours, 3= 3 hours, 4= 4 hours, 5= 5 hours, 6= None, 77= Refused, 99= Don't know

**PAQ100**  
Tasks around home/yard past 30 days  
1= Yes, 2= No, 3= Unable to do activity, 7= Refused, 9= Don't know

**PAQ180**  
Average level of physical activity each day
1= {you sit/he/she sits} during the day and {do/does} not walk, 2= {you stand or walk/he/she stands or walks} about a lot during the, 3= {you/he/she} lift(s) light load or {have/has} to climb stairs or, 4= {you/he/she} {do/does} heavy work or {carry/carries} heavy, 7= Refused, 9= Don't know

PAQ520  Compare activity w/others same age
1= more active, 2= less active, or 3= About the same, 7= Refused, 9= Don't Know

PAQ560  Times/wk you play or exercise hard,
77777= Refused, 99999= Don't know

RIAGENDR  Gender
1 = male, 2 = female

RIDAGEYR  Age

RIDRETH1  Race
1= Mexican American, 2= Other Hispanic, 3= Non-Hispanic White, 4= Non-Hispanic Black, 5= Other Race - Including Multi-Racial

WHD020  Self reported weight,
7777= Refused, 9999= Don't know

WHD050  Self reported weight one year ago,
7777= Refused, 9999= Don't know

WHQ060  Weight Change Intentional
1= Yes, 2= No, 7= Refused, 9= Don't know
APPENDIX TWO.

Diagnostic Tests on the Regression Models

A useful, quick predictor of the quality of the models is the R-squared value, often called the “coefficient of determination” along with its accompanying F-value. Regression one has an R-squared value of 0.2112 which means that 21.12% of the variation in obesity can be explained by the independent variables in this model. Regression two has the same R-squared value. The F value of regression one is 59.81 which is far above critical F-values at high significance levels, indicating that the null hypothesis that the coefficients are jointly equal to zero can be rejected. This result means that the variables in this model provide some explanatory value to obesity levels. The F value of regression two is 68.30 which is also far above critical F-values at high significance levels, indicating that the variables in this model also provide some explanatory value to obesity levels.

An additional diagnostic test for the validity of the regression models is the Durbin-Watson test, which tests for first order autocorrelation, but is increasingly used as a quick indicator of model specification. As a general rule of thumb, the Durbin Watson test statistic should be close to two. The Durbin-Watson statistics for both of the models in this study are 1.982, indicating that both models are probably properly specified but further tests must be run.

A correlation matrix was also constructed to determine if there was any correlation between the independent variables in the regressions. If there are high pair
wise correlations, this indicates multicollinearity in the model. There were no noticeable pair wise correlations indicating that multicollinearity was not likely a problem.

The results are in the following table:

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30
Scatter plot for Regression One (all children):

Plot of rbmxbmi*pbmxbmi. Legend: A = 1 obs, B = 2 obs, etc.
Scatter plot for Regression Two (all children eating school lunch):

Plot of rbmxbmi*pbmxbmi. Legend: A = 1 obs, B = 2 obs, etc.