PREVENTING CHILDHOOD OBESITY: HOW EFFECTIVE ARE SCHOOL HEALTH PROGRAMS?

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ABSTRACT

This study evaluated the effectiveness of the Coordinated School Health Program model in reducing childhood obesity rates using state-level data collected by the Centers for Disease Control and Prevention (CDC) for the years 1994, 2000, and 2006. I measured the effectiveness of school health policies including routine BMI screening, joint activities between health education and food service staff, staff training on nutrition, staff training on exercise, certifying health educators, prohibiting sale of junk food, limiting access to vending machines, whether schools teach about nutrition in class, and whether schools teach about exercise in class.

The only significant variables are **BMI Screen** and **Staff Nutrition Training**. **BMI Screen** is positively associated with the childhood obesity rate, suggesting that states may only include BMI screening as part of routine check-up after obesity rates have reached a critical stage, not as a preventative measure. Providing training in nutrition for school staff is the only policy that is by itself effective in reducing the state childhood obesity rate.

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INTRODUCTION

The pace at which the obesity epidemic is threatening the world's children and adolescents has raised immediate public health concern. Since the early 1970s, obesity has sharply and constantly increased among children from all socioeconomic levels, racial and ethnic groups, and regions of the United States (Cawley, 2006). According to the Obesity Action Coalition, obesity affects over 30% of American children and is the most common chronic disease of childhood. Healthy People 2010, a national initiative aimed at health promotion and disease prevention, identified overweight and obesity as 1 of 10 leading health indicators reflecting major health concerns in the United States (About Healthy People, 2010).

The Coordinated School Health Program (CSHP) model brings together 8 interactive components through school mechanism including Health Education, Physical Education, Health Services, Nutrition Services, Counseling Psychological & Social Services, Healthy School Environment, Health Promotion for Staff, and Family/Community Involvement. Different localities implement different elements of the model. In my thesis, I test the hypothesis that the program model is effective in reducing childhood obesity rates through use of multivariate regression on School Health Policies and Programs Studies (SHPPS) state-level data collected in the years 1994, 2000, and 2006 and obtained through the Centers for Disease Control and Prevention. No one party can be expected to effectively address this issue alone, but through active collaboration of the parties involved, it is possible to have significant effects on childhood obesity. I examine the effectiveness of school health programs in reducing childhood obesity.

The gravity of long-term implications of health risks caused by childhood obesity has gradually become evident. Some have even claimed that if no progress is made on the

prevention of this epidemic, it may reverse the course of steady increase in life expectancy (Daniels, 2006). The number of overweight children has more than doubled for those aged two to five, almost quadrupled for children aged six to eleven, and more than doubled among adolescents aged twelve to nineteen (Cawley, 2006). According to the 2007-2008 National Health and Nutrition Examination Survey (NHANES), approximately 17 percent of children and adolescents ages 2-19 years are obese and they will most likely become obese adults. One study revealed that an estimated 80 percent of overweight children aged 10-15 years were obese adults when they were 25 (Whitaker, et al., 1997). Further, a different study indicated that one in four of obese adults were overweight as children (Freedman, et al., 2001).

Obesity affects all population groups albeit in disproportionate ways. For example, the prevalence escalated more than twice as fast among minorities as compared to caucasians although psychosocial effects such as low self-esteem are more severe in white children. Those live in poverty are also more vulnerable due to the consumption of energy dense foods that are low in nutritional values and limited opportunity for exercise. Nonetheless, in developing countries where people are experiencing increasing Western influence in their lifestyle, childhood obesity is an emerging public health concern among those in the upper socioeconomic strata (Ebbeling, et al., 2002).

Childhood obesity epidemic is clearly a problem that demands immediate attention. Although genetic factors play a role in determining the development of the condition, poor nutrition and inadequate physical activities have been primary contributors to the sharp rise in childhood obesity in the United States in recent decades. Effective public policy is necessary to address this issue. The CSHP model engages various sectors of the society and is a promising

effort to promote the well being of our nation's future. The data analyses I will perform in this thesis will study the effectiveness of the CSH programs' components and of school authorities in reducing childhood obesity, and their shortcomings. The results will help guide school health policies and practices regarding interventions in this area.

The structure of this paper proceeds as follows: Section 2 provides background on childhood obesity and associated health risks, Section 3 reviews the literature of the epidemic prevention efforts and past studies, Section 4 gives a conceptual framework and a theoretical model of the research, Section 5 explains the data sources and variables, Section 6 provides an empirical model of the multivariate regression, and Section 7 shows the results of the regression on each variable. Finally, Section 8 provides policy implications and conclusions.

Background: Defining Childhood Obesity and Identifying Associated Health Risks

The World Health Organization (WHO) uses Body Mass Index (BMI), a common measure for weight status, to define obesity. BMI is a score calculated using the individual's body weight (in kilograms) divided by the square of his or her height (in meters) $BMI = \frac{weight(kg)}{height(m)^2}$. Although BMI provides the most useful and convenient population-level measure of weight status, because it does not measure body fat directly, it can only be used as a preliminary screening tool for weight-related health risks (WHO, 2006). Further assessments such as skinfold thickness measurements and family history are necessary for diagnosis.

In adults, obesity is defined as those with BMI score greater than 30. The measure is universal for both men and women across ages. For children, because they are still growing, however, it is much more difficult to determine the cutoff. There is therefore no global standard for determining childhood obesity.[1] Nonetheless, it is commonly accepted to use age and sex specific BMI, or BMI-for-age, as guide. In children and adolescents, BMI must be age and sex specific because for these populations, the amount of body fat changes with age and is different in boys and girls (CDC BMI for Children and Teens, 2009). The weight status categories for children and adolescents are determined as follows.

[1] WHO is currently developing an international growth reference for children older than five and adolescents.

Weight Status	Percentile Range
Underweight	Less than the 5th percentile
Healthy weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	Equal to or greater than the 95th percentile

Source: CDC BMI for Children and Teen, 2009

Childhood obesity has both long lasting medical and psychosocial effects, putting a heavy toll on the nation's health care spending. The annual pediatric obesity-related hospital costs are estimated to be $127 million (Ebbeling, et al., 2002). Various adverse health outcomes previously thought of as those that only occur in adults can now be found in children such as type 2 diabetes. Even if a condition does not become apparent until adulthood, obesity in childhood accelerates the onset of a condition in a person's lifetime. A cohort study in Britain over 57 years showed that childhood obesity doubled the risk of death from ischaemic heart disease in adulthood. In addition, obese children often have low self-esteem leading to depression, which may affect their academic performance and social interactions. Children with a negative self-image and low self-esteem often feel sad, lonely, nervous, and are more likely to engage in high-risk behaviors (Ebbeling, et al., 2002). One major risk factor of cardiovascular disease, the world's leading cause of death, is hypertension or high blood pressure. Obesity has been proven to increase the odds of developing the condition not only in adults but also in children (Daniels, 2006). For example, B. Rosner et al.'s study in 2000 showed that the likelihood of children developing hypertension is significantly higher for those whose body mass

index (BMI) is at 90th percentile or above than those whose BMI ranks at 10th percentile or below (Rosner, et al., 2000). Furthermore, childhood obesity has also been linked to such conditions as atherosclerosis (hardening of the arteries), dyslipidemia (abnormal changes in cholesterol and triglycerides in the blood), asthma, and obstructive sleep apnea (interruptions of breathing during sleep). See Appendix A for a list of childhood obesity-related disorders.

The health threats and their associated costs that childhood obesity is posing on society have led a multitude of researchers to look for the root causes of and the most cost-effective methods of combating the epidemic. In the following section, I review the literature on school-based childhood obesity prevention programs.

Literature Review

Because overweight children are more likely to become overweight adult with associated health risks, a large amount of research has been done on the topic of childhood/pediatric obesity. Various scholars have studied the changes in food intake and physical activity patterns that, in addition to heritability, explain the increase in incidence of obesity in recent decades. Attempts have been made to curb childhood obesity rates through prevention programs implemented at local and district levels primarily through family-based and school-based interventions. For the purposes of this study, I focus on those initiatives that took place in school setting.

Most researchers argue that environmental factors in early life can determine the risk of later obesity. Very young children appear to have the innate ability to balance their caloric intake with the physical outflow. In other words, their intake is based on their energy needs. As they grow older, however, they seem to lose this ability and instead respond to external cues, such as the amount of food available (Anderson, et al., 2006). A cohort study of 8,234 children reveals factors that are statistically significantly associated with childhood obesity including sedentary behavior and dietary patterns among others. The odds ratio of developing obesity has a positive linear correlation with the number of hours of television viewing (Reilly, et al., 2005). Children who spend more time watching television are less likely to participate in physical activity (Lindsay, et al., 2006). In addition, junk food consumption pattern at age 3 was significantly associated with obesity at age 7. Television viewing may also induce poor eating habits by exposing children to commercials for non-nutritious foods that greatly influence their preferences for foods. In 1985, Dietz and Gortmaker found that an additional hour of television

viewing is associated with 2 percent of increase in the prevalence of obesity. Built environment such as proximity to school, recreational activities, green space, and the safety of neighborhood have also been identified as factors influencing the development of childhood obesity (Reilly, et al., 2005).

Despite evidence that reveals the trends in changes in environmental factors, O'Rahilly and Farooqi (2006) argue that causative mutation in human genes and the highly heritable nature of obesity is the true cause of the rise in the prevalence of childhood obesity. Their research finds the mutation to disrupt the function of hypothalamic integrative centers that leads to increased food intake. The study finds the estimated heritability of BMI to range between 64 and 84 percent. Various studies on the genetics of childhood obesity also concluded that approximately 25 to 40 percent of BMI is heritable (Anderson, et al., 2006). Even if mutations in our genes have made us more susceptible to obesity, the pace at which obesity has been increasing the past decades is far greater than genes can evolve.

Regardless of the true causes responsible for the increased prevalence, obesity has been a growing public health concern and there have been prevention and intervention efforts in school from various parties at the local and state levels. Many initiatives have proven successful in reducing children's caloric intake and increasing their physical activity but have had little effect on obesity rates. In Texas, the CATCH (Coordinated Approach to Child Health) Kids Club Program aimed to increase moderate to vigorous physical activity (MVPA). Children who participated in the afterschool program showed significantly increased levels of MVPA during the 6-month study period compared to the control group. The FitKid project in Georgia offered third graders a healthy snack in accordance with the USDA guidelines. The program also

included 40 minutes of continuous MVPA. After 8 months, those who participated showed a relative decrease in percentage of body fat compared to the control group (Wethington, 2009).

In Australia, Jo Salmon, et al., conducted a randomized controlled trial 'Switch Play' on 10 year-old children in 2002 with follow-up data collection at 6 and 12 months after completion. The objective was to prevent unhealthy weight gain by replacing television viewing time with more physical activities. Children participated in 19 sessions that encouraged them to reduce their screen time and instead engage in physical activities. Evaluation results indicate that 34 percent of parents whose children were in the program reported that their child now watches less television, and 16 percent of parents thought that their children were now more active. Most children enjoyed alternative physical activities. Only 7 to 17 percent found it difficult to turn off their favorite show. More than half of the children reported reducing their television viewing time, though fewer than half reported increasing their physical exercise. The response rate for this study was less than 50 percent and the effects on obesity rates were not measured (Salmon, et al., 2005).

Conducted over three years, the Pathways Program for American-Indian children was a large-scale randomized, controlled trial with 1,704 children in 3rd to 5th grades. The program was implemented in 41 schools in Arizona, New Mexico, and South Dakota, and consisted of 4 components: 1) change in dietary intake, 2) increase in physical activity, 3) a classroom curriculum focused on healthy eating and lifestyle, and 4) a family-involvement program. Report indicated that although the intervention resulted in significant decrease in fat intake and increase in health-related knowledge and behaviors, it did not lead to significant reduction in

neither percentage body fat (adiposity) nor in BMI. Similar physical activity levels were also observed in control and treatment groups (Caballero, et al., 2003).

In the United Kingdom, the Active Programme Promoting Lifestyle Education in Schools (APPLES) was implemented in 10 primary schools on children ages 8 to 10 over one academic year. Five schools were the treatment group and the other five served as the control group. The program involved participation from health professionals including a dietician, a community pediatrician, an obesity physician, a health promotion specialist, a psychologist, and a nutritional epidemiologist. Interventions included teacher training, nutrition education, provision of healthy school lunches, increased physical activity, improved playground facility and extracurricular activities. The program was assessed through BMI calculation, dietary information, level of physical activity, and psychological measures. The outcomes revealed an increase in vegetable consumption, but did not change other targeted behaviors or BMI (Sahota, et al., 2001).

The Christchurch Obesity Prevention Project in Schools (CHOPPS) was an 8-month program aimed to prevent excessive weight gain through reduction of soda consumption. The program was based in six junior schools in southwest England with 644 participants, ages 7 to 11 years old. The researchers used a clustered, randomized controlled trial as a method. Children had one hour each class each term to learn, through a variety of activities, about balanced healthy diet and which discouraged from "fizzy" drinks, diet or otherwise. The results show moderate positive changes, with a decrease of 0.6 glasses (average glass size 250 ml) of soda consumption over 3 days in the treatment group and an increase of 0.2 glasses in the control group. At 12 months as compared to baseline, obesity rates decreased 0.2 percent in the treatment group and increased 7.5 percent in the control group (James, et al., 2004).

Another intervention program, Planet Health, was conducted in Boston, Massachusetts, Metropolitan area on 1,295 children in grades 6 and 7. The trial was a randomized controlled field with 5 treatment schools and 5 control schools. Children in the treatment group received 32 sessions that focused on decreasing television viewing, decreasing consumption of high-fat foods, increasing fruit and vegetable intake, and increasing moderate and vigorous physical activity. The study was conducted over 2 years (1995-1997) and evaluated using before and after the program tests. The results show a statistically significant decrease in obesity among girls but no difference among boys. Both boys and girls reported reduced number of hours spent viewing television. Among girls, a one hour decrease in screen time was associated with a 0.85% decrease in obesity rates (Gortmaker et al., 1999).

Recently there has been increasing interest in childhood obesity intervention programs that include the participation of both parents and the community at large. The Get Fit with the Grizzlies program was initiated by the Memphis Grizzlies, the National Basketball Association franchise for the city, in 2006. Physical Education teachers delivered a 6-week curricular addition focusing on nutrition and physical activity to 1,519 fourth and fifth graders. Grizzlies' players, their mascot, and their dancers visited the schools to raise awareness and to create enthusiasm. Parents were engaged through homework and nutrition and physical activity log keeping. The researchers utilized the before and after the program test method for evaluation. Analyses show that there was a significant gain in health knowledge and health behavior. A six-week timeframe, however, is too limited to indicate long-term behavioral change and the study is not representative of the children populations since it took place in one large urban school district (Irwin, et al., 2010).

This thesis contributes to the literature in two important ways. First, it evaluates the effectiveness of a program model, not at an individual but at the state level for every state nationwide. Associations between children's dietary habits, physical activity level, and childhood obesity have been studied through various intervention programs. Some show statistically significant results but the applicability is limited because the subjects often lack diversity and are non-representative of American children as a whole. The success of these previous efforts that focus on modifying individuals' behavior through lower calorie intake or greater physical activity alone is also limited by the lack of changes in the potentially obesogenic environments. The Coordinated School Health Program model is not specifically for obesity prevention and not targeting any particular groups of children. This allows for a nationally representative sample and more realistic approach to obesity prevention than intensive programs that target behavior modifications, which often result in either reduction in caloric intake or increased physical activity or both but do not significantly alter obesity rates. The model also enforces the participation of parties that together form influential environmental factors in children's lives. Parents, teachers, healthcare professionals, as well as policy makers are engaged through this initiative in an effort to reduce and prevent the incidence of childhood obesity.

Second, the thesis looks at how laws and legal authorities affect obesity. The CDC's Public Health Law Program has identified law-based efforts as essential tools in combating obesity. Much has been discussed but the argument lacks quantitative supporting evidence. I intend to analyze how state laws and recommendations governing school policies influence children's weight status. By mechanism of multivariate regression, I plan to identify statistically

significant relationships between different components of the program model. The results will also determine the role of state laws with regard to childhood obesity. Policy makers can focus on the most effective determinants when designing childhood obesity prevention programs.

Conceptual Framework and Theoretical Model

Although a known cause of childhood obesity is heredity, the gene pool cannot evolve rapidly enough to be held accountable for the recent increase in childhood overweight and obesity (Anderson et al., 2006). The primary focus of the research today is on environmental and behavioral factors such as dietary patterns and physical activity that affect the energy balance. With proper diets and adequate exercise, childhood obesity is a preventable condition. Interventions at an early age are therefore necessary.

School can play a critical role in addressing childhood obesity both for students and parents. Despite recommendations by the American Academy of Pediatrics (AAP), the majority of healthcare professionals do not routinely use BMI to track children's growth and screen for potential weight-related problems. Parents are also unaware of the severe health risks associated with childhood obesity (Barlow, et al., 1998). Interventions often occur at the treatment stage after the child has been diagnosed of obesity in the form of dietary and exercise counseling to prevent the development of chronic diseases. Children spend a significant amount of time in school and have their social circle there. Policies to maintain children's healthy weight status, therefore, can be effectively implemented in a school setting. Previous research also pointed out the success of school-based intervention programs (Lindsay, et al., 2006).

CSHP provides a model consisting of 8 components that encourage the community participation and are my main factors of interest. For the purposes of this study, explanations for each component are limited to what is related to the prevention of childhood obesity.

1. Health Education – addresses the physical, mental, emotional and social aspects of health. Aimed to raise awareness among students regarding health-related risk behaviors

and disease prevention, the curriculum includes a variety of topics, among them, nutrition and diet, and physical fitness.

2. Physical Education – addresses physical activities in school. It is intended to promote optimum physical, mental, emotional, and social development through a variety of activities such as games, and rhythm and dance.
3. Health Services – ensures access and/or referral to appropriate primary health care services. Schools are encouraged to keep track of students' BMI and notify parents or guardians in the event that the student's BMI score indicates potential health risks.
4. Nutrition Services – ensures access to nutritious and healthy meals per U.S. Dietary Guidelines for American and limits the availability of junk food, vending machines, and unhealthy snacks.
5. Counseling and Psychological Services - individual and group assessments, interventions, and referrals to protect students' mental, emotional, and social wellbeing.
6. Healthy School Environment – attempts to improve the prospects for safe and clean physical surroundings as well as psychosocial climate including prohibition of bullying and sexual harassment.
7. Health Promotion for Staff – health promotion and counseling activities such as weight management for faculty and staff to improve their morale and personal commitment to the CSHP model.
8. Family/community involvement – encourages parental involvement and community resources and services to support the school health program. This component is not explicitly measured but is implied in questionnaires for the other 7 components.

I base this thesis on the following theoretical model:

Childhood Obesity = f(policy, teachers, parents, health professionals, habits, demographic, e)

where

Policy represents state policies governing health practices in school

Teachers represents teacher's involvement in the obesity prevention effort

Parents represents parents' involvement

Health professionals represents health professionals' involvement

Habits represents an individual's dietary and exercise habits

Demographic represents any demographic factors that may influence a person's weight status such as family history and race

e measures error

The data from the SHPPS were collected at state level, not the individual level. They cover state populations at large and thus are applicable to all children.

Data

This research utilizes panel data using program variables for reference years 1994, 2000, and 2006. The main data set was matched with control variables, which were obtained through various sources as close to the aforementioned years as possible.

Program Variables (Variables of Interest) **BMI Screen, Joint Health and Food Activities, Staff Fitness Training, Staff Nutrition Training, Teach Fitness, Teach Nutrition, Certified Health Educator, No Junk Meal, Limited Vending Machine**

Data Source: I use the School Health Policies and Practices Study (SHPPS) conducted by the Centers for Disease Control and Prevention. The study is the largest and most comprehensive assessment of school health policies and practices in the United States. It was conducted in 1994, 2000, and 2006 at state, district, school, and classroom levels nationwide. The data used in this analysis are state-level data due to the fact that the CDC will not disclose identities of locations at the county level or below and the completeness of demographic data used to isolate the effects of interested variables. Data were collected by computer-assisted telephone interviews or self-administered mail questionnaires. Respondents were state education agencies' employees who had primary responsibility for or were the most knowledgeable about policies being examined. Questions were designed to focus on the state policy side of the model. Most variables are binary in nature. The same variables are named differently for each survey year and not all variables have counterparts for all the years. Data were manipulated accordingly to enable statistical analysis. For example, the variable **No Junk Meal** represents whether the state requires or recommends that schools be prohibited from offering junk food for breakfast or

lunch. While the questionnaires for years 2000 and 2006 contain this exact variable, the 1994 questionnaire does not. Therefore, I selected the closest question, which asks whether the state permits fast food restaurants to offer food as part of school breakfast or lunch. See Appendix B for a complete list of modified variables.

Dependent Variable: Child Obese

Data Source: Data Resource Center for Child and Adolescent Health provides the data sets through the National Survey of Children's Health conducted in years 2003 and 2007 on children ages 10 to 17. Randomly selected telephone numbers were called to identify households with children for interviews. Approximately 2,000 interviews were conducted per state. Although the years of the survey do not match up exactly with the years of SHPPS, these are the best available data. Further, because data on childhood obesity are not available for the year 1994, adult obesity rates for the same year will be utilized as a proxy since they have a strong positive correlation. The adult obesity rates have been obtained through the CDC's Behavioral Risk Factor Surveillance System.

Control Variables (Demographic, Household, and Behavioral) Smoke Everyday, No Health Coverage, HH Income, Blow Poverty Level, HS Grad, Black, White

Data Source: Demographic and household data were collected from the Census Bureau to control for differences in geographic demography. The best available data for year 1994 were from year 1990 decennial census. For years 2000 and 2006, data were obtained from the American Community Survey, which started in year 2000 and has been conducted annually.

Behavioral Variables were collected from CDC's Behavioral Risk Factor Surveillance, the world's largest telephone health survey system with more than 350,000 adults interviewed each

year. The survey tracks health conditions and risk behaviors in the United States at the state level annually since 1984. Currently, data are collected in all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam.

Descriptive statistics

Variable	N	Min	Max	Mean	Standard dev.
ChildObese	148	8.5	22.8	15.064	3.057
BMIScrn**	147	0	1	59	0.492
Smoke Everyday	151	7.1	26.8	17.58	3.457
No Health Coverage	151	5.7	25.2	13.503	4.037
HH Income	153	20136	65144	39464.83	10173.31
Below Poverty Level	153	6.4	25.2	12.766	3.567
HS Grad	153	64.3	90.7	81.256	5.958
Black	153	0.3	65.8	10.952	11.727
White	153	24.3	98.6	79.795	14.286
Joint Health Food Acitivities**	151	0	1	99	N/A
Staff Fitness Training**	150	0	1	90	N/A
Staff Nutrition Training**	151	0	1	94	N/A
Certified Health Educator**	152	0	1	N/A	N/A
Teach Fit**	147	0	1	113	N/A
Teach Diet**	146	0	1	114	N/A
No Junk Meal**	151	0	1	61	N/A
Limited Vending Machine**	150	0	1	74	N/A
Oral Screen*,**	148	0	1	55	N/A

Notes: *OralScrn is used as an instrument for BMIScrn to address the potential endogeneity problem. ** For indicator variables, mean is the number of Observations equal to one.

Empirical Model

The panel data have both advantage and a problem. While I can use the repeated observations for each state to track changes over the years and get better parameter estimates, these observations are not independent of each other. Because the observations are not independent, it is not appropriate to run a cross sectional analysis in most cases due to the potential for biased estimates. Instead, random effect and fixed effect models are the preferred approaches. The random effect model treats individual effects of each state as random while the fixed effect assumes there is no variation within states over the years and treat the effects on the dependent variable as fixed. The Hausman specification test helps determine the appropriate model.

I propose the following underlying equation:

$$\textit{Child Obese} = \beta_0 + \beta_1 \textit{Smoke Everyday} + \beta_2 \textit{No Health Coverage} + \beta_3 \textit{HH Income} + \beta_4 \textit{Below Poverty Level} + \beta_5 \textit{HS Grad} + \beta_6 \textit{Black} + \beta_7 \textit{White} + \beta_8 \textit{BMI Screen} + \beta_9 \textit{Joint Health Food Activities} + \beta_{10} \textit{Staff Fitness Training} + \beta_{11} \textit{Staff Nutrition Training} + \beta_{12} \textit{Certified Health Educator} + \beta_{13} \textit{Teach Diet} + \beta_{14} \textit{Teach Fitness} + \beta_{15} \textit{No Junk Meal} + \beta_{16} \textit{Limited Vending Machine} + e$$

where

Child Obese measures childhood obesity rates at the state level. Obesity is defined as children whose (BMI) ranks at the 95th percentile or above. Due to the lack of availability of childhood obesity rates for year 1994, I substitute for the missing values using adult obesity rates for the corresponding states;

Smoke Everyday measures the percentage of population (adults) who smoke every day;

No Health Coverage measures the percentage of the population (adults) who do not have any kind of health coverage;

HH Income represents median household income;

Below Poverty Level measures the percentage of the population whose income is below poverty level;

HS Grad measures the percentage of the population who completed high school or equivalent;

Black measures the percentage of the population who consider themselves black;

White measures the percentage of the population who consider themselves white;

BMI Screen is whether the state has policy to screen students for height and weight or body mass problems;

Joint Health Food Activities is whether state-level child nutrition or food service staff work on school food service or nutrition activities with state-level school health education staff;

Staff Fitness Training is whether the state provides funding for or offers staff development on physical activity and fitness;

Staff Nutrition Training is whether the state provides funding for or offers staff development on nutrition and dietary behavior;

Certified Health Educator is whether the state offers teacher certification or endorsement in health education;

Teach Diet represents whether the state requires inclusion of nutrition and dietary behavior in schools' health education curriculum;

Teach Fit represents whether the state requires inclusion of fitness and classroom physical education in schools' health education curriculum;

No Junk Meal represents whether the state prohibits schools from offering junk food during breakfast or lunch;

Limited Vending Machine represents whether state has a policy for schools to limit student access to vending machines at least part of the day; and

e measures random error.

For the proposed equation, I expect the coefficients to have signs as follows. The coefficient for **Smoke Everyday** should be positive, indicating association between smoking adults and higher childhood obesity rate. The expected positive sign is based on the hypothesis that adults to smoke every day are not good role models for healthy living for children and children are more likely to live an unhealthy lifestyle, which leads to higher childhood obesity rate.

The coefficients for **No Health Coverage** and **Below Poverty** Level should be positive because without health insurance coverage, people are much less likely to receive regular screenings and care. They also tend to be in the lower income bracket, and less informed about healthy living and the health risks of being overweight and obese.

I expect **HH Inccome** and **HS Grad** to have negative coefficients since higher income allows for more healthy meals and higher rates of high school graduation mean more people are likely to be aware of health risks and consequences of childhood obesity and would seek prevention rather than treatment.

Black should have a positive coefficient while White has a negative one. It has been well document in many studies on childhood obesity that African Americans have higher rates of obesity (Wang and Beydoun, 2007). States with higher percentage of white population, and

lower percentage of black population, are therefore expected to have lower childhood obesity rates.

The coefficient for **Joint Health Food Activities, Staff Fitness Training,** and **Staff Nutrition Training** could be either positive or not significant. While collaboration between food service and health education staff should result in better nutrition for students in schools, collaboration at the state level is far removed enough from the school level that the implementation of the collaborated efforts may not reach the school level. As for **Staff Fitness Training** and **Staff Nutrition Training**, if school personnel receive training in fitness and nutrition, they could act as role models for students in school and cause a meaningful negative association with **Child Obese**. On the other hand, the intervention does not affect students directly. The quality of the training on fitness and nutrition is not controlled for and the variables do not imply any follow up activities on how the knowledge is used. Thus, the variables could have no effect on childhood obesity rate.

Certified Health Educator should have a negative sign since states offering certification to health educators suggest structured guidelines and high standards for school health education. Certifying health educators ensures their knowledgeability and their ability to communicate it to students. This can be translated to healthier lifestyle for students and lower childhood obesity rate.

No Junk Meal and **Limited Vending Machine** should have negative coefficients. The interventions affect students directly, limiting their access to unhealthful foods. Because students spend much of their time in school, not having access to junk food at school could automatically shape a habit of not eating junk food when not in school as well. Nonetheless, if

limiting student access to junk food is not accompanied by nutrition education, it could make junk food more attractive and would lead students to choose junk food over healthful food whenever possible.

Results

The estimated equation measures the effects that demographic, behavioral, and policy factors have on childhood obesity rates at the state level. I performed the Hausman test to determine the appropriate model, and it indicated that the fixed effect model is the more appropriate approach. When test regressions were run, however, the results show coefficients signs on control variables that go against what many well-documented studies suggest. This inaccuracy may arise from the drop in degrees of freedom required for the fixed effects model that leads to lower model significance, widened confidence intervals, and biased estimates. Additionally, the Hausman test, while powerful, has well-noted flaws. In order for the test to be reliable, the fixed effect regression must be consistent and efficient. This is a demanding assumption that even when satisfied could still be hampered by the "small sample" problem. Because program data are only available at the state level (50 states and District of Columbia) and for 3 years, the maximum number of observations I can have were 153 (51x3). The actual number of observations in the final regression was 133 due to some missing values in the dataset, which is low. When this is the case, the Hausman test is undefined and potentially unreliable.

For the random effect model to be efficient, there must be intrastate variation between 1994 and 2006. There are enough reasons to believe that such variation exists. Since 2004, many states have toughened their legislations regarding nutrition. Twenty-seven states have crafted competitive food (foods and beverages available in schools but not eligible for reimbursement under the National School Lunch Program) policies that are more restrictive than the USDA guidelines. Eleven states have initiated legislation for the provision of school meals with higher nutritional standards than the USDA minimum requirements. Sixteen states now

require foods sold outside the school meal programs to have nutritional standards. Finally, in twenty-five states, student access to non-school foods is limited during school hours (Story, et al., 2009). Therefore, I chose to run regressions using the random effect model despite the Hausman test result.

One remaining concern with estimating this equation is the potential endogeneity problem with the **BMI Screen** variable, that **BMI Screen** may be partially influenced by **Child Obese**. Obviously, school officials may institute a program to screen BMI if obesity rates are rising. To address this concern, I used **Oral Screen**, state policy for schools to perform oral health screening on students, as an instrument. The variable showed high correlation of 0.58 with **BMI Screen** and a low correlation of 0.21 with **Child Obese**, making it a good instrument. The first-stage regression of the two-stage least-squares method (2SLS) where **BMI Screen** is regressed on all exogenous variables including **Oral Screen**, the instrument, also showed high statistic significance (P=0.000) for **Oral Screen**. The result demonstrated that **Oral Screen** is a good predictor of **BMI Screen** and ensured its success in predicting the ultimate outcome when used to replace **BMI Screen** in the second-stage regression.

Table 1: Model Summary	
R- Squared	
Within	0.2215
Between	0.7560
Overall	0.5901
Wald chi2	136.17
Number of Observations	128
Number of Groups	51

In the model, the coefficients for the variables were as follows:

Table 2: Model Coefficients				
Variable	**Coefficient**	**Standard Error of Coefficient**	**Z**	**Significance**
(Constant)	-5.036	8.176	-0.62	0.538
Smoke Everyday* **	0.402	0.104	3.86	0.000
No Health Coverage* **	0.205	0.074	2.78	0.005
HH Income **	0.000	0.000	2.02	0.043
Below Poverty Level* **	0.273	0.114	2.40	0.016
HS Grad	-0.211	0.079	-0.27	0.788
Black* **	0.108	0.031	3.50	0.000
White	0.016	0.025	0.67	0.502
BMI Screen **	2.320	1.044	2.22	0.026
Joint Health Food Activities	0.796	0.578	1.38	0.168
Certified Health Educator	0.553	0.742	0.74	0.456
Staff Fitness Training	0.689	0.641	1.07	0.282
Staff Nutrition Training **	-1.493	0.641	-2.33	0.020
Teach Fitness	0.914	0.775	1.18	0.238
Teach Diet	-0.489	0.808	-0.61	0.545
No Junk Meal	0.482	0.477	1.01	0.312
Limited Vending Machine	0.365	0.436	0.84	0.403

Notes: ** indicates significance at the 95 percent level
*** indicates significance at the 99 percent level

The behavioral variable, **Smoke Everyday**, is highly significant and positive. This indicates that states with higher proportion of adults who reported that they smoke every day are more likely to have higher childhood obesity rates. This confirms the results of a study published by the American Heart Association in 2005 that tobacco smoke exposure in teens increases the risk of developing metabolic syndrome, a disorder associated with excess belly fat

(Weitzman, et al., 2005). Although there is no study that directly links smoking with obesity, a study published in the American Journal of Preventive Medicine in 2006 reported that 20 percent of obese adults in the United States smoke (Freedman, et al., 2006).

No Health Coverage indicates that childhood obesity rates are higher where more people live without health coverage. People without health coverage are much less likely to get regular health screenings and preventative procedures than people with health insurance. This may mean that people who receive regular health checkups are made aware of their health risks and seek treatment before they become obese.

Demographic variable, **Black**, has high statistical significance, which suggest strong associations with childhood obesity rates. The positive coefficient indicates that states with higher proportion of black population are more likely to have higher childhood obesity rate. The result confirms the finding of previous studies that conclude that the black population is more susceptible to obesity.

White and **HS Grad** are not statistically significant. Being white does not make someone more or less likely to develop obesity. The health risk for a white person depends on his/her genetic factors, dietary behavior, and level of physical activity. Having graduated from high school does not seem to reduce a person's risk of becoming obese either. The variable **HS Grad**, however, does not properly represent the participant pool in the **Child Obese** variable because it is comprised mainly of people who graduated from high school prior to the start of Coordinated School Health Program in 1994. The variable might develop statistical significance down the road when participants who make up this pool have gone through the program.

Both **HH Income** and **Below Poverty Level** are statistically significant at the 95% level and both show positive coefficients. Because these two variables essentially measures levels of income in opposite directions with **Below Poverty Level** having the cut-off at poverty line, the fact that both variables have positive coefficients may mean that at very low levels of income, children eat more fast foods and foods that are high in calories but low in nutrition, which tend to be less expensive than healthful foods. On the other hand, as household income increases, people have more disposable income to spend on food and may eat out more. Because restaurant meals tend to be more fattening than home-cooked meals, frequent eat-out experiences can lead to higher childhood obesity rates. Despite high statistical significance, however, the coefficient of **HH Income** has such extremely small magnitude that the effect on childhood obesity is negligible.

Joint Health Food Activities and **Certified Health Educator** are not statistically significant and are not appropriate to interpret. This suggests that collaboration at the state level between food service and health education staff does not have a meaningful effect on childhood obesity. It is unclear from the data available what kind of joint activities they have and what kind of changes that translate into for children in school. It is possible that they come together at conferences and discuss issues but the results do not get communicated to school staff and do not affect school operations in any significant manner. **Certified Health Educator** does not appear to meaningfully affect childhood obesity rate neither. Certifying health educators does not ensure they will teach about nutrition and fitness in school, or it is likely that there would be a lagged effect even if they effectively teach on the topics of nutrition and fitness. It takes a long time to build healthy habits in children that would last into their adulthood.

BMI Screen, instrumented by **Oral Screen**, shows a positive and statistically significant coefficient, indicating, *ceteris paribus,* that states with a policy to perform BMI screening in schools have 2.32 percent higher childhood obesity rates. Because this shows association and not direction, it is possible that higher childhood obesity rates induce states to implement such a policy in hopes of curbing the escalating rates.

Staff Nutrition Training is the only program variable, besides **BMI Screen**, that is statistically significant at all conventional levels. It also has the most powerful coefficient indicating that, *ceteris paribus,* states with a policy to fund or offer in-service training on nutrition and dietary behavior to school staff have 1.50 percent lower childhood obesity rates. Interestingly, **Staff Fitness Training**, the physical fitness counterpart of **Staff Nutrition Training**, is not significant. The two variables are highly correlated. Most states that offer funding or in-service training on nutrition and dietary behavior also offer the same thing for physical fitness but only the training in nutrition seem to have an effect on reducing childhood obesity. This may be because children take their teachers and school staff as their role models and it is easier to pass on knowledge on nutrition and healthy eating than to encourage children to do physical activities if the children lack personal motivation. Also, collinearity between these variables may be limiting the identification of both variables.

Teach Diet, Teach Fit, No Junk Meal and **Limited Vending Machine** are all not significant at the conventional levels and are not appropriate to interpret. Removing junk food and vending machines from school settings does not seem to affect childhood obesity. It is possible that children still have regular access to junk food outside of school or that how much children eat is more important than what they eat. Requiring schools to include the topics of

nutrition and physical education in their health education curriculum does not seem to affect childhood obesity either. This could be because insufficient amount of time is spent on the topics, the teaching is ineffective, or there are simply too many students in a classroom to permit participation and checking of understanding.

Policy Implications and Conclusions

This study evaluated the effectiveness of the Coordinated School Health Program model in reducing childhood obesity rates using state level data collected by the Centers for Disease Control and Prevention (CDC) through the School Health Policies and Programs Study (SHPPS) for the years 1994, 2000, and 2006. Though the surveys were also conducted at the district level, the identities of the districts were undisclosed due to confidentiality agreements. I measured the effectiveness of school health policies including routine BMI screening, joint activities between health education and food service staff, staff training on nutrition, staff training on exercise, certifying health educators, prohibiting sale of junk food, limiting access to vending machines, whether schools teach about nutrition in class, and whether schools teach about exercise in class. I consider these variables my "program variables." I controlled for demographic differences including race, education, income, health coverage, and adults' smoking habits. I consider these variables my "control variables." Results on control variables are consistent with previously existing findings. States with a high percentage of black population, of those living in poverty, and of those without health coverage are significantly more likely to have high childhood obesity rates. The results also confirmed a recent finding linking second-hand smoking to metabolic syndrome. States with higher percentages of adults who smoke every day have significantly higher childhood obesity rates.

The regression results did not yield as many statistically significant program variables as I had hoped and I suspect that this is because of the poor data quality. The only significant program variables are **BMI Screen** and **Staff Nutrition Training**. **BMI Screen** is positively associated with the childhood obesity rate, suggesting that states may only include BMI

screening as part of routine check-up after obesity rate has reached a critical stage, not as a preventative measure. Providing training in nutrition for school staff is the only policy that is by itself effective in reducing the state childhood obesity rate. Despite the less than perfect data, however, the findings in this study, significant or otherwise, have great implications for childhood obesity prevention programs.

To improve the effectiveness of childhood obesity prevention programs, I recommend the following:

1. Improve the quality and availability of data for accurate evaluations
2. Form meaningful partnerships that include policy makers, clinical experts, schools, and parents;
3. Focus not only on individual behavior modification but also on providing environments that promote healthy living;
4. Identify and develop leaders who can raise awareness of childhood obesity and mobilize personnel to focus on evaluating and improving prevention efforts;
5. Push both public and private health plans to cover treatment of childhood obesity;
6. Require BMI screening as part of routine check-ups and notify parents when there are potential health risks; and
7. Continually evaluate the effectiveness of programs and showcase successful prevention programs.

Improve the quality and availability of data for accurate evaluations

For researchers and analysts to be able to produce the most reliable results, good data must be available. Data are probably the single most important factor that allows for accurate evaluation of a program. Through the process of gathering and cleaning up data, it was evident that agencies that collect data for analysis need to be more cautious and pay more attention when creating survey questions and when coding survey answers. SHPPS data significantly differ from year to year in terms of content, the wording of questions, and the coding of answers, making it difficult to match them in a panel in order to run regressions. In addition, I was only able to work with state-level data because the identities for county-level data were undisclosed and therefore could not be matched with control variables. Because there are only 50 states (and the District of Columbia), this makes for large units of analysis and a low number of observations. The same regression run on county-level data would yield a much clearer picture and would be likely to yield more statistically-significant variables.

Form meaningful partnerships that include policy makers, clinical experts, schools, parents, and nonprofit organizations.

Childhood obesity prevention programs cannot be successful without coordinated and concerted efforts among all stakeholders. Policy makers must sit down with clinical experts, education department, health department, and nonprofit leadership to raise the sense of urgency for the childhood obesity issue among citizens. Together, they can coordinate effective approaches that include stakeholders' participation and efficiently allocate resources. Grassroots nonprofits can reach out to people in the community or co-sponsor activities such as conferences

with the local health department to raise awareness of the issue. Clinical experts should offer training for healthcare providers in weight management and obesity prevention. These healthcare providers should then offer similar training to school staff at the local level. Schools should foster collaboration between parents and teachers, and between food services staff and health educators.

The Childhood Obesity Action Network (COAN) organized by the National Initiative for Children's Healthcare Quality (NICHQ) started a web-based national network of healthcare professionals nationwide with the aim of reducing childhood obesity rates in all 50 states by 2017. Since 2007, COAN's membership has grown to include over 3,000 healthcare professionals. COAN connects healthcare professionals with policy makers and researchers and supports them in becoming agents of change in their communities. COAN also provides distance learning tools and key strategies in combating childhood obesity (NICHQ, 2010). It is crucial to support such efforts in order to encourage continual interaction among stakeholders.

Focus not only on individual behavior modification but also on providing environments that promote healthy living.

My study has shown that merely requiring nutrition and physical education is not enough to reduce childhood obesity rates. States should consider putting time requirements on nutrition and physical education as they can easily be overlooked or given inadequate attention. Evaluation of students' knowledge of the topics should also be considered. Health education is not a "core" subject and subjects such as science and math usually take precedence when a school curriculum is crafted. The lack of significance on **No Junk Food** and **Limited Vending**

Machines also show that simply restricting student access to junk food and vending machines in schools is not an effective method. It is important to nurture healthy eating habits at home and outside the home as well as in school. In addition, laws should be implemented to limit pervasive environmental factors that promote junk food and discourage physical activity. Otherwise, personal motivation to achieve long-term weight control can easily be overwhelmed by an adverse environment especially in our culture where convenience is of high value. Novel technologies and services such as elevators, dishwashers, and drive-through windows are created each day to facilitate our daily activities, minimizing our energy expenditure in the process.

Indeed, this idea is not new. Many states have passed laws aimed at creating environments that promote healthy living such as snack taxes, menu labeling laws, and policies to improve streets and sidewalks. Thirty states currently have some form of snack taxes, although it is argued that the taxes disproportionately penalize the low-income population, as they tend to consume more snacks than their high income counterparts (Levi, et al., 2009). To eliminate this problem, the money generated from snack taxes should go to subsidize healthy food options and to fund educational campaigns on nutrition for the public, particularly for those with low incomes.

Menu labeling law is relatively new. Only four states presently require nutrition labeling at fast food and chain restaurants that show total calories, fat, saturated fat, trans fat, as well as sodium content on their menus. Restaurant associations wield tremendous political power, making this type of legislation difficult to pass. Supported by the Utah Restaurant Association, the state passed an anti-menu labeling law in March 2009 (Levi, et al., 2009).

Nine states have adopted policies to improve streets and sidewalks to promote physical activities especially among children who live within walking distance from their schools. Safety has been a major concern lowering the level of physical activity. A study in Australia revealed that people are 65 percent more likely to travel by foot in neighborhoods with sidewalks. The American Recovery and Reinvestment Act of 2009 appropriated $825 million to the Department of Transportation for Transportation Enhancements, which include pedestrian and bicycle infrastructure and safety programs (Levi, et al., 2009).

Identify and develop leaders who can raise awareness of childhood obesity and mobilize personnel to focus on evaluating and improving prevention efforts.

As with any issue, to implement policy solutions effectively, key leaders must be identified and potential leaders developed. Successful leaders know their community, are charismatic, have passion for health issues, are well connected, and are committed to eliminating childhood obesity. These leaders must exist at each level and for each type of stakeholder and come together to create coherent approaches to combat the epidemic.

These leaders must be able to identify where the most vulnerable groups are located in their community and develop policies that ensure their healthy lifestyles. Consistent with previous studies, I used a number of variables including **Below Poverty Level**, **Black**, and **Smoke Everyday**. It has been well-documented that the black population and those who live in poverty are more susceptible to childhood obesity. Based on this evidence, it is imperative that any health program aimed at reducing childhood obesity focus on these target populations who also tend to have no health coverage, another indicator for increased risk of childhood obesity.

Because the target populations are often minority groups, leaders should have cultural understanding so that they are able to identify themselves with the relevant populations. **Smoke Everyday** also supports a more recent finding that second-hand smoking increases the risk of developing obesity in children. Tobacco and obesity are two major causes of preventable deaths in the United States. The link between the two risk factors suggests that we cannot address one problem without addressing the other and that we may need a tighter control on tobacco use where children are present.

Require BMI screening as part of routine check-up and notify parents when there are potential health risks.

Currently, twenty states have legislation requiring BMI screening of children and adolescents (Levi et al., 2009). Evidence from my study, however, shows that BMI screening may only be implemented when state childhood obesity rates reache a critical stage. And even in states where BMI screenings are conducted, most schools are not required to take actions when the results reveal potential health risks. BMI screening is a simple procedure that should be routinely performed to capture the early signs of childhood obesity. Given the magnitude and intensity of the epidemic, we should utilize preventative measures and keep parents informed. Parents of at-risk children should be trained to monitor their children's caloric intake and physical activity level. Ideally, this would be done through counseling or training sessions, but can also be done through distribution of reading materials.

A debate over mandated BMI screening is ongoing. A review of the policy showed that children identified as overweight or obese may experience psychological problems as they feel

stigmatized by the label and may attempt to lose weight through unhealthy measures. The experience in the state of Arkansas, however, argues otherwise. In 2003, the Arkansas legislature passed a law requiring annual BMI screening in public schools because of the alarming pace at which the childhood obesity rate was rising. Evaluation over the first four years revealed that parents did not find the issue controversial. Parents were better able to identify accurately their child's weight status. In the fourth year, 81 percent of parents were aware of diabetes as a health risk for overweight children compared to 66 percent in the first year. Finally, the level of bullying in school and unhealthy dieting behavior did not increase over four years and remained comparable to other states (Levi, et al., 2009).

Continually evaluate the effectiveness of prevention programs and showcase successful initiatives.

Whether or not a program should be replicated somewhere else depends on its effectiveness. Evaluation studies should be conducted periodically to monitor the outcomes and impact of childhood obesity prevention programs in order to find the most effective approaches and to distribute funding. Obesity is an emerging and rapidly growing epidemic that is at least partially preventable and many stakeholders are willing to fund initiatives that are proven to alleviate the problem.

Greater support and funding should be directed towards personnel development. **Staff Nutrition Training** stood out as the only statistically significant program variable. This clearly suggests that influencing adults to eat better has an effect that trickles down to children that can make a lasting impact. The next logical step would be to investigate in further detail how staff

development programs on nutrition are different than those that focus on fitness, since only the nutrition program is effective. States should require standards for program quality and follow-up activities.

Push both public and private health plans to cover treatment of childhood obesity.

Most health plans currently do not cover the treatment and counseling of childhood obesity, making it unaffordable and undesirable to at-risk populations. It is critical that clinical experts advocate for coverage of childhood obesity prevention and treatment. Supporting evidence could come from programs that are proven to be effective and show that this could save a tremendous amount of healthcare costs in the long run. Undeniably, policy makers are extremely important players in determining health plan coverage. Some states already have laws requiring private health plans to reimburse for obesity-related services. Medicare already recognize adult obesity as a disease, making it possible for beneficiaries to be reimbursed for such services as nutrition and exercise counseling (Simpson, et al., 2009). Adult obesity, however, is a preventable condition that is already present in many people when they become eligible for Medicare. Often, it is a result of lifelong habits of excess caloric intake and lack of exercise since childhood. Therefore, intervention to prevent adult obesity must occur before adulthood.

Conclusions

It is hoped that the results presented in this thesis will point policy makers in the right directions with regard to a first step toward developing a blueprint for an effective national childhood obesity prevention program. Because the Coordinated School Health Program model

merely provides the framework and is not a timed intervention, each state has have the flexibility to adapt and create the policies that work best with its population. The CDC also collects data every six years on school health policies, which makes it possible to measure the long-term impact of the policies on reducing childhood obesity. Going forward, it will be important to look at the effects of health policies at the local level, be it at the county or district level. As stakeholders become more aware of the graveness of the situation and more states adopt policies aimed at creating environments for healthy living too, researchers should look at how they can help school health policies. The magnitude of the burden that childhood obesity threatens to put on the nation calls for effective health policies that would halt or even reverse the rising trend of this epidemic.

Appendix A: Childhood Obesity-Related Disorders

System and disorder	Explanation	Estimated prevalence in pediatric populations
Cardiovascular		
Hypertension	High blood pressure	2-4%
Left ventricularhy pertrophy	Increased thickness of the heart's main pumping chamber	Unknown
Atherosclerosis	Hardening of the arteries	50% (fatty streaks) 8% (fibrous plaques) 4% (>40 in those with stenosis)
Metabolic		
Insulin Resistance	The process in which the action of insulin is retarded	Unknown
Dyslipidemia	Abnormal changes in cholesterol and triglycerides (fats) in the blood	5-10%
Metabolic Syndrome	Constellation of risk factors including increased waist circumference, elevated blood pressure, increased triglyceride and decreased HDL-cholesterol concentrations, and raised plasma glucose	4% overall 30% in obese
Type 2 diabetes	A condition in which the body either makes too little insulin or cannot properly use the insulin it makes, leading to elevated blood glucose	1-15 persons per 100,000 overall, almost all in obese
Pulmonary		
Asthma	A chronic inflammatory pulmonary disorder characterized by 7-9% reversible obstruction of the airway	7-9%
Obstructive sleep apnea	A breathing disorder characterized by interruptions of breathing during sleep	1-5% overall, approx. 25% in obese

System and disorder	Explanation	Estimated prevalence in pediatric populations
Gastrointestinal		
Nonalcoholic fatty liver disease	Fatty inflammation of the liver not caused by excessive alcohol use	3-8% overall,5 0%i n obese
Gastroesophageal reflux	Backward flow of stomach contents into the esophagus	2-20%
Skeletal		
Tibiavara (Blount disease)	Bowing of children's legs caused by a growth disturbance in the proximal tibial epiphysis	Uncommon
Slipped capital-femoral epiphysis	A disorder of the hip's growth plate	1-8 persons per 100,000
Psychosocial		
Depression	A mood disorder characterized by sadness and loss of interest in usually satisfying activities	1-2% in children 3-5% in adolescents
Other		
Polycystic ovary syndrome	A constellation of abnormalities including abnormal menses, clinical manifestations of such androgen excess as acne and excessive growth of hair, elevated levels of circulatory androgens, and polycystic ovaries on ultrasound evaluation	Unknown in adolescents, 5-10% in adult women
Pseudotumor cerebri	Raised intracranial pressure	Rare

***Source**: Daniels, Stephen R. "The Consequences of Childhood Overweight and Obesity." The Future of Children Childhood Obesity 16 (2006): 47-67. Princeton University. 10 Nov. 2010 http://www.jstor.org/stable/3556550*

Appendix B: Variable Modification

Certified Health Educator	
1994	At what levels does your state offer a combined teacher certification or endorsement in health education and physical education?
2000	Does your state offer certification, licensure, or endorsement to teach health education?
2006	Does your state offer certification, licensure, or endorsement to teach health education?
Joint Health Food Activities	
1994	During the past two years, with which programs in your state has the school food service program been involved in joint state-level activities or projects? b. Health education
2000	During the past 12 months, have state food service staff worked on school food service or nutrition activities with each of the following groups? a. State health education staff
2006	During the past 12 months, have state-level child nutrition or food service staff worked on school food service or nutrition activities with state-level school health education staff?
Limited Vending Machine	
1994	On which of these topics has your state established policies for districts or schools? a. School vending machines
2000	Does your state education agency require or recommend that schools be prohibited from offering these foods in the following settings? g. In vending machines
2006	Does your state require or recommend that schools prohibit student access to vending machines for at least part of the school day?

No Junk Meal	
1994	Does your state permit food service management companies or fast food restaurants to offer foods as part of school breakfast or lunch programs?
2000	Do policies adopted by your state allow schools to offer brand-name fast foods (e.g., Pizza Hut, Taco Bell, or Subway) as part of school meals or as a la carte items?
2006	Does your state require or recommend that schools be prohibited from offering junk foods a la carte during breakfast or lunch periods
Staff Nutrition Training	
1994	During the past two years, on which health education topics has your state offered (provided or made available) in-service training to health education teachers? i.Dietary behaviors and nutrition
2000	Has your state adopted a policy stating that districts or schools will provide any funding for or sponsor each of the following services or programs for school faculty and staff? c. Nutrition and dietary behavior counseling
2006	Has your state adopted a policy stating that districts or schools will provide funding for or offer activities for faculty and staff related to the following? a.Nutrition education

Staff Fitness Training	
1994	During the past two years, on which health education topics has your state offered (provided or made available) in-service training to health education teachers? s.Physical activity and fitness
2000	Has your state adopted a policy stating that districts or schools will provide any funding for or sponsor each of the following services or programs for school faculty and staff? e. Physical activity and fitness counseling
2006	Has your state adopted a policy stating that districts or schools will provide funding for or offer activities for faculty and staff related to the following? l. Physical activity and fitness counseling

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