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An Exploration of Adolescent Obesity Determinants

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An Exploration of Adolescent Obesity Determinants

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
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Dedication

To Warren for his constant support, enduring love and baking chocolate chip cookies just when I needed them.

I would not have gotten through this doctorate if it wasn't for him.

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Table of Contents

List of Tables

List of Figures

Abstract

In 2010, approximately two-thirds of adults and one-fifth of the adolescent population in the United States were considered either overweight or obese, resulting in the United States having the highest per capita obesity rate among all OECD countries. A considerable body of literature regarding health behavior, health outcomes, and public policy exists on what the Centers for Disease Control and Prevention considers an obesity epidemic. In response to the growing problem of childhood obesity, the Child Nutrition and WIC Reauthorization Act of 2004 (CNRA), which required that schools participating in the National School Lunch Program and/or School Breakfast Program have wellness policies on file, was passed.

The purpose of this research is to provide additional insight into the origin of the geographic variation in adolescent obesity rates between the U.S. states. Previous research has looked at differences in built environments, maternal employment, food prices, agriculture policies, and technology factors in an effort to explain the variation in adolescent obesity prevalence. This dissertation contributes to the literature by examining the hypothesis that state-level school wellness policies also played a role in determining the rates of childhood obesity. Using School Health Policies and Practices Study (SHPPS) surveys from 2000 – 2012, I derived a state-level school wellness policy measure. This, together with Youth Risk Behavior Surveillance survey data on adolescent BMI was used to measure the effect of the wellness policy mandate on adolescent obesity prevalence. Several models were applied to first demonstrate that the state of residence for an adolescent is indeed related to BMI trends and then

to investigate various determinants of adolescent obesity including the primary variable of interest, state school wellness policies.

The results of this research provide evidence of a statistically significant, although very small positive effect of school wellness policies on adolescent BMI that is contrary to my hypothesis. Dominance analysis showed that of the four wellness policy factors considered in the principal component composition of the wellness policy measure, policy components that met state requirements rather than those meeting health screen criteria, state recommendations, and national standards were most important in explaining the overall variance of the regression model. Interestingly, the public school attendance rate itself was also associated with a substantial decrease in adolescent BMI.

Understanding the determinants of adolescent obesity and how to effect change in the rising trend is a national concern. Obese adolescents are at significant risk of becoming obese adults and previous research has already shown the high economic costs associated with adult obesity and its comorbidities. Policies implemented in school, where adolescents consume a considerable portion of their daily calories and participate in physical activity, can help to build healthy habits that have the potential to lower the probability of an adolescent becoming an obese adult. Over time, a healthier adult population may result in lower economic costs associated with medical care and lost productivity.

Chapter 1: Introduction

In 2010, the United States had the highest per capita obesity rate among all OECD countries (OECD, 2011) indicating obesity a serious national health concern. In particular, decreasing the prevalence of childhood obesity has been one of the leading health concerns in the United States for several decades. Figure 1.1 shows that the percentage of overweight and obese youth, ages 6 through 19 nearly tripled between 1980 and 2010, growing from approximately 6% to 17% in only three decades (Ogden et al., 2010).

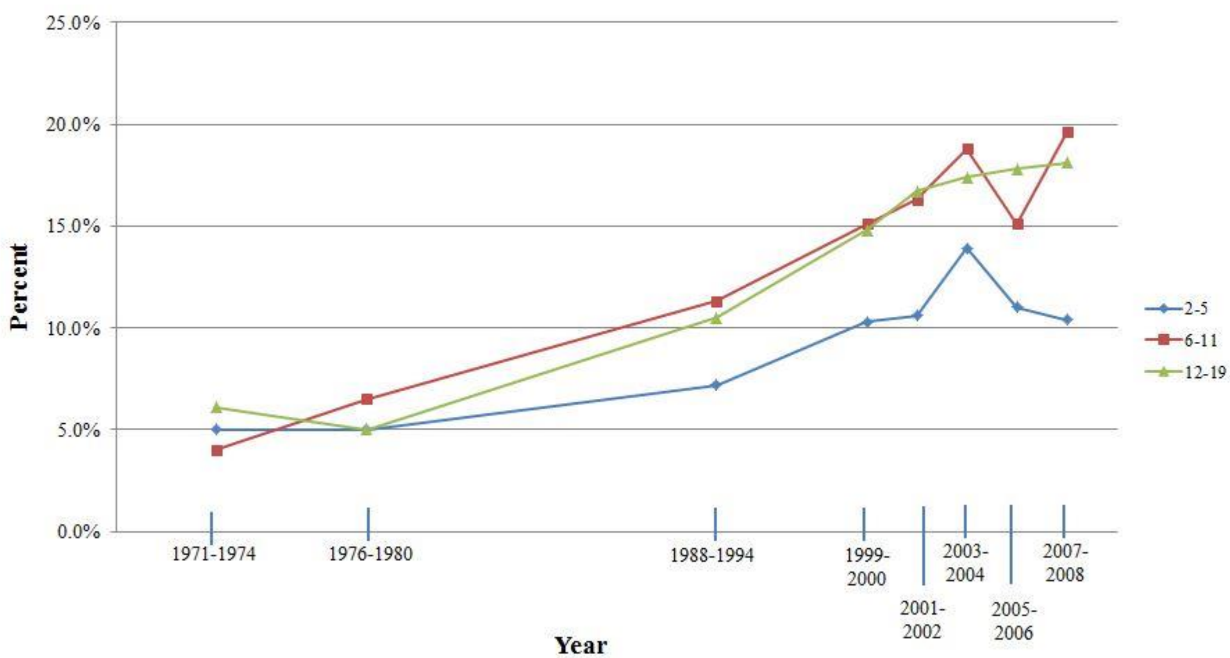

Figure 1.1 Prevalence trends of overweight and obese youth, ages 6-19 for years 1980-2010
CDC/NCHS, National Health Examination Surveys II (ages 6-11), III (ages 12-17), and National Health and Nutrition Examination Surveys (NHANES) 1999-2000, 2003-2004, 2005-2006, and 2007-2008

To illustrate the magnitude of the problem among adolescents aged 12-19 specifically, Figure 1.2 illustrates the prevalence of obesity rising from 11.3% to 19.3% for females and from 9.7% to 16.8% for males between 1988 and 2008. These representative obesity statistics are indicative of an alarming trend among United States' youth.

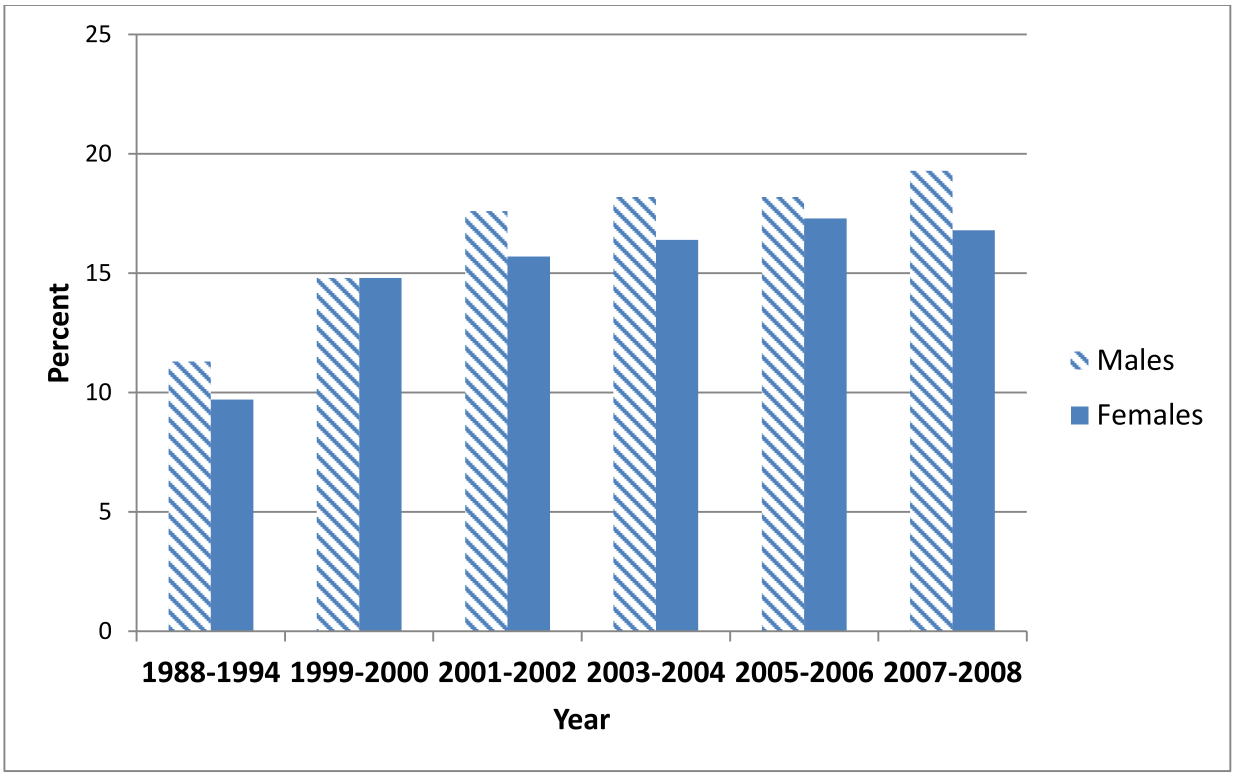

Figure 1.2 Prevalence of obesity by gender for adolescents ages 12-19, years 1988-2008
CDC/NCHS, National Health Examination Survey III, and National Health and Nutrition Examination Surveys (NHANES) 1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008

The growth in childhood obesity prevalence has been so rapid that the Centers for Disease Control and Prevention (CDC) now consider this to be an obesity epidemic (Centers for Disease Control and Prevention, 2011). In order to draw greater public awareness to the problem, the United States Department of Health and Human Services published the *Healthy People 2010* health promotion and disease prevention agenda in November 2000, in which one of the country's health goals was to achieve a 54% reduction in the obesity rate (from 11% to 5% prevalence rate) in children and adolescents ages 6 – 19 years.

The final review of this goal showed that not only was it not met, but there was actually a 63.6% increase in the obesity rate among this age group (Hines et al., 2011). During the transition to the next release, *Healthy People 2020*, in December, 2010, the revised agenda included lowering the childhood obesity prevalence rate of 16.1% to 14.5%, a more modest 10% reduction goal (US Department of Health and Human Services, 2012). The following research analyzes adolescent obesity trends over time. Additionally, this paper investigates the effect of an unfunded federal mandate requiring that U.S. public schools have a written wellness policy plan in place prior to the start of the 2006 – 2007 school year on the prevalence of adolescent obesity.

Chapter 2: Background of Adolescent Obesity

Many researchers have examined the various causes of the obesity epidemic. Obesity, particularly in children, is a health problem which is speculated to be related to individual characteristics that are genetic, learned and environmental (Anderson and Butcher, 2006). However, genetic changes cannot fully explain the significant increase in childhood obesity prevalence that has occurred in the relatively short time period since 1980, a time period when the rates were fairly stable. Moreover, genetic variations typically do not cause rapid change in the population health, but rather take affect slowly over time (Hill and Trowbridge, 1998). Additionally, children's eating patterns, caloric intake, and caloric expenditure are not only influenced, but also often controlled by individuals in both their home and school environments.

To begin to address the adolescent obesity problem, let us consider how eating preferences are formed in early stages of life. First, children's eating behaviors are learned primarily by consuming the foods made accessible to them by adults. In addition, children's eating habits are formed in their social environments through observing and learning the behaviors of adults around them (Birch and Fisher, 1998). We can also assume that children are not born with preferences for the energy dense (high-caloric, low-nutritive value) types of foods that are associated with the rising prevalence of obesity; they learn by associative conditioning through consuming what is repeatedly made available to them and the positive feelings of satiety they feel afterward (Birch and Deysher, 1985). In addition to the social environment of their family and peers, children's preferences for energy dense foods may be also influenced by media advertising. For instance, in a study of first-grade children, Goldberg (1978) found that those children exposed to commercials featuring high-sugar foods, were more likely to choose snacks that were also highly sugared, while the group exposed to media featuring healthy options, such as fruits and vegetables, were more likely to choose more of those types of foods. Similarly, Harris, et al. (2009), in a study of elementary school children, found that children consumed 45% more snack foods when they were shown television programming that contained any food advertising.

Physical inactivity may also be an important factor contributing to the childhood obesity epidemic. Kohl and Hobbs (1998) examined the interaction of a child's developmental, environmental, and sociodemographic factors that determine the level of physical activity among children and suggest that, since developmental factors are difficult to modify due to biological and/or physiological limitations, interventions that effect changes in children's built[1] and sociodemographic environments are best suited to promote greater physical activity. To that end, availability and access to safe community spaces where a child can play/exercise, as well as adequate physical education and activity time in school are vital to promoting healthy physical activity behaviors among the nation's youth.

Moreover, poverty rates have also been shown to play a role in obesity trends. As Figure 1.3 illustrates, Ogden, et al. (2010), using NHANES 2005-2008, found that although prevalence of obesity among the nation's youth decreases as household income increases, the effect of higher income is heterogeneous across different ethnic groups and genders. As income decreased, obesity rates exhibited a clear upward trend among white non-Hispanic boys and

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[1] According to the CDC, "the built environment includes all of the physical parts of where we live and work (e.g., homes, buildings, streets, open spaces, and infrastructure)." http://www.cdc.gov/nceh/publications/factsheets/impactofthebuiltenvironmentonhealth.pdf

girls, with obesity rates nearly doubling at the lowest end of the poverty-income ratio range. On the other hand, the data did not show a clear trend among the black non-Hispanic or Mexican American children's groups; obesity rates *decreased* among black non-Hispanic boys, and Mexican American boys and girls at the bottom of the poverty-income ratio range while obesity rates for black non-Hispanic girls increased. Such findings demonstrate that higher income does not necessarily translate to lower obesity rates any more or less than lower income correlates to higher obesity rates.

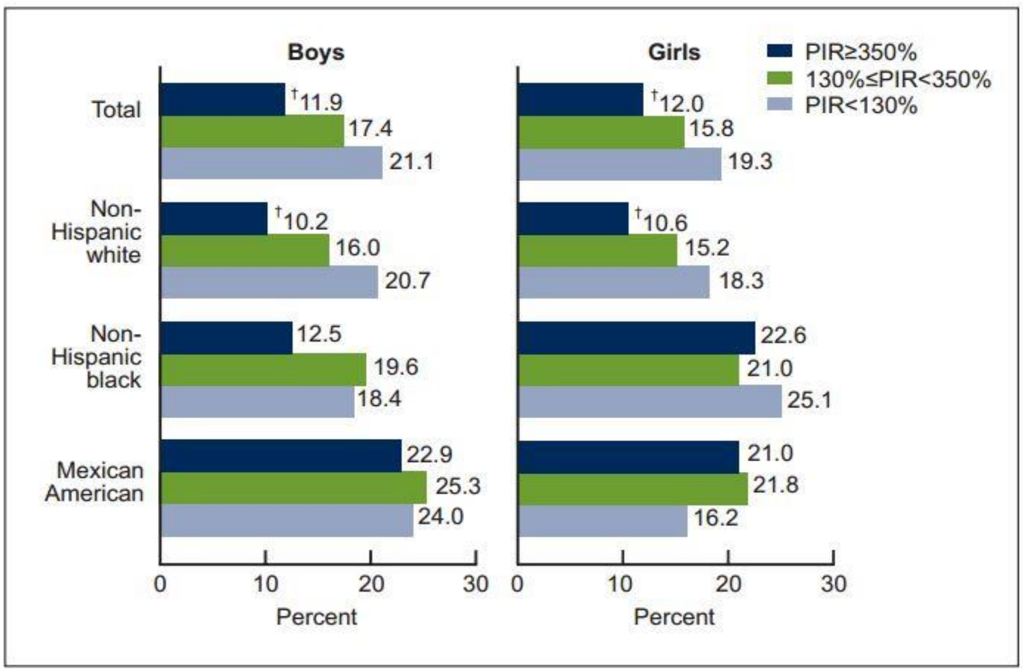

Figure 1.3 Prevalence of obesity among U.S. children and adolescents aged 2 – 19 years, by poverty income ratio, gender, and ethnicity, years 2005 – 2008. http://www.cdc.gov/nchs/data/databriefs/db51.pdf

Additionally, income inequality has steadily increased in the United States over the past several decades, with the Gini coefficient ranging from a low 0.397 in 1967 to a high 0.480 in 2014 (Figure 1.4). Within this same time period (1980 - 2010), the percentage of overweight and obese youth in the U.S., ages 6 through 19 nearly tripled, growing from approximately 6% to

17% (Ogden et al., 2010). These statistics are indicative of an alarming trend among United States' youth.

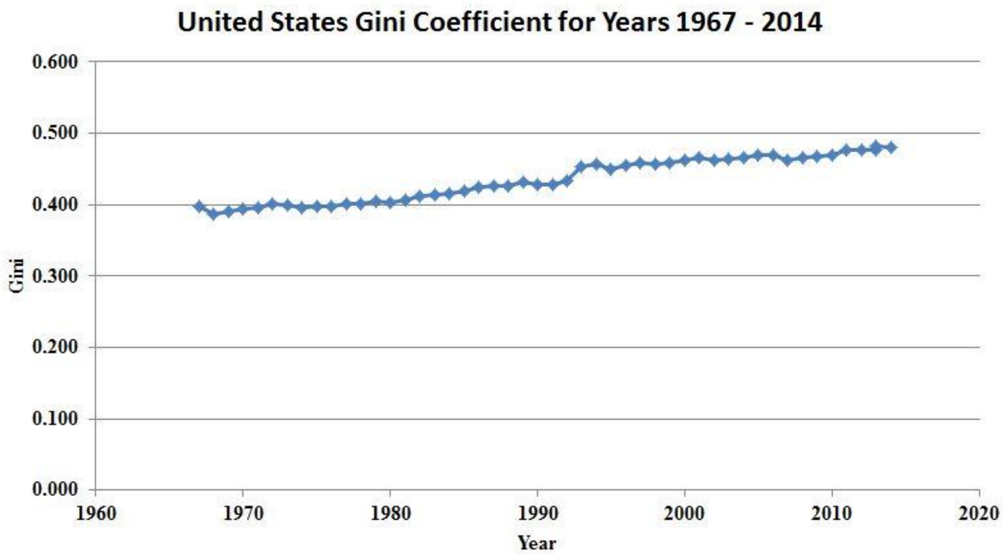

Figure 1.4 Gini Ratios for Households,1968-2013 U.S. Census Bureau, Historical Income Tables: Income Inequality, https://www.census.gov/hhes/www/income/data/historical/inequality/.

Income inequality may lead to poor physical and mental health because it creates "status anxiety." Since income inequality establishes a hierarchy among people, it increases status competition and causes stress, which in turn leads to negative consequences for one's health and longevity (Rowlingson, 2011; R. G. Wilkinson and Pickett, 2009). Among adolescents in particular, high levels of stress, more commonly found in lower socioeconomic groups, was shown to be associated with increased odds of developing obesity (Anderson, et. al., 2006; Goodman and Whitaker, 2002). In addition, the levels of adult and childhood obesity are higher in countries where income differences are greater (Offer et al., 2012; R. Wilkinson and Pickett, 2009). Finally, the low socioeconomic status of an individual's parents may negatively affect health due to stress in the womb and early life (Ravelli et al., 2007; R. Wilkinson and Pickett, 2009).

There is some disagreement among researchers regarding the magnitude and direction of the effect of income equality on adolescent BMI. In the United States, there is evidence (Akee et al., 2013; Egger et al., 2012; Lee et al., 2014; Shih et al., 2013) that individuals who live near the bottom of the income distribution, quite often use their limited resources to purchase low-cost, high-calorie/low-nutrient foods, resulting in a caloric imbalance where intake exceeds output, thus raising BMI over time. Conversely, Wang and Zhang (2006) find a diminishing correlation between socio-economic status and adolescent obesity using NHANES data from 1971 to 2002. My examination of the relationship between income inequality and adolescent obesity will use three different measures of income equality: the state Gini Coefficient, top 10% income share by state and top1% income share by state. To the best of my knowledge, this relationship has not been explored using YRBSS data on adolescent obesity.

Geographic location is another factor that has influenced childhood obesity in the U.S. Figures 1.5 and 1.6 illustrate findings by Bethell, et al. (2010), who used data from the National Survey of Children's Health for 2003 and 2007, and showed that after controlling for a child's socioeconomic status, a child's state of residence had a significant, independent effect on obesity status. According to their study, between 2003 and 2007, some states experienced increases in childhood obesity prevalence while others saw the trend decrease. States that had a rise in the obesity trend included a modest 0.3% in Louisiana to a substantial 13.4% in Mississippi. Conversely, the variation of childhood obesity prevalence decline among states ranged from 0.2% in Texas to 6.9% in South Dakota (*National Survey of Children's Health*, n.d.).

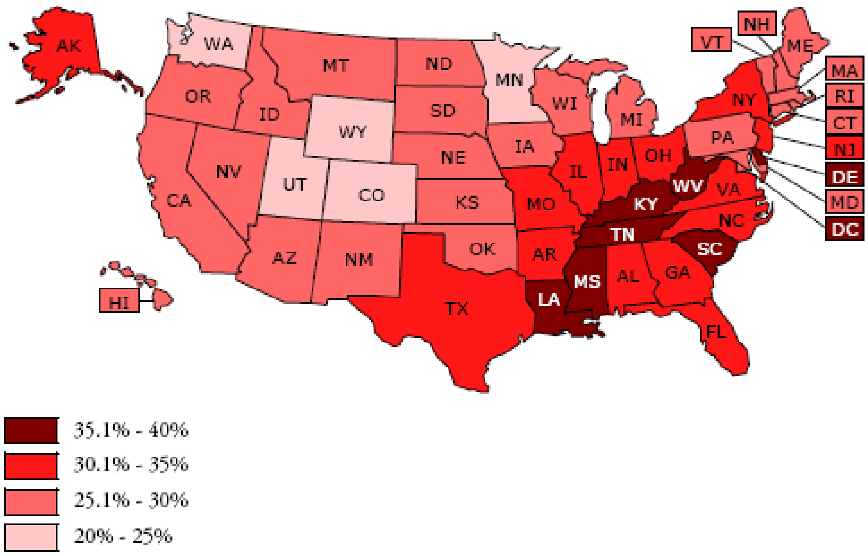

Figure 1.5: 2005 Rates of Overweight and Obese Children; http://childhealthdata.org/browse/rankings

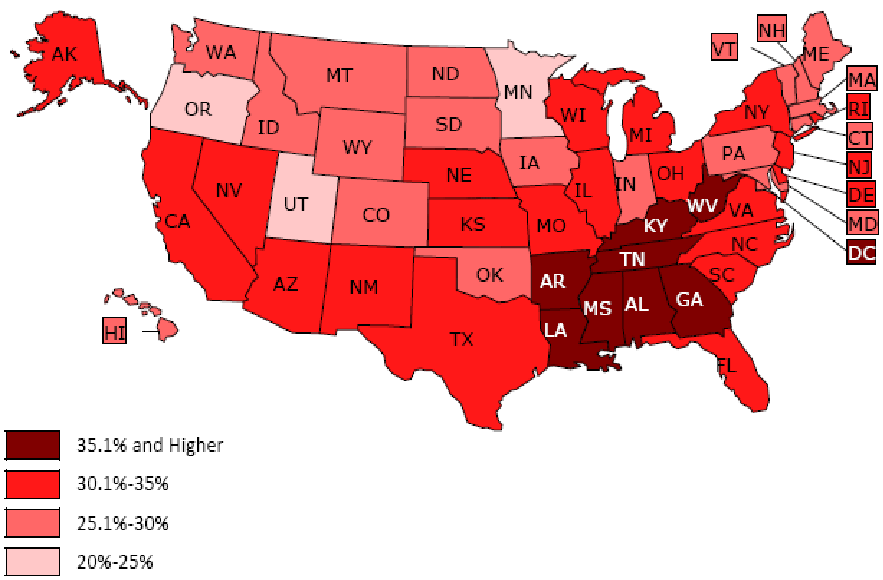

Figure 1.6: 2007 Rates of Overweight and Obese Children; http://childhealthdata.org/browse/rankings

This research provides additional insight into the origin of the geographic variation in obesity rates between the U.S. states. Previous research has looked at a myriad of factors in an effort to explain the variation in childhood obesity prevalence, including the differences in built environments, maternal employment, food prices, agriculture policies, and technology. This dissertation contributes to the literature by examining the hypothesis that state-level school wellness policies also played a role in determining the rates of childhood obesity.

Such a hypothesis is plausible due to a number of reasons: first, schools have the potential to play a unique role in shaping a student's diet and exercise related attitudes and behaviors. On average, K-12 students spend 6.6 hours per day and 180 days per year in school (Snyder and Dillow, 2012). Additionally, national data show that foods eaten at school contain 19% to 50% of students' total daily energy intake (Gleason and Suitor, 2001). Since adolescents spend such a significant portion of their waking hours and consume a considerable portion of their daily calories in school, it follows that intervention in school environments may be an effective policy tool in reducing the prevalence of adolescent obesity. By helping adolescents make healthy food choices and be more physically active, the excess caloric imbalance, which over time leads to obesity, may be reduced. Moreover, given that obese adolescents are at increased risk of becoming obese adults, it is essential that prevention strategies be implemented at a younger age in order to reduce the overall prevalence of obesity and its associated costs to society (Biro and Wien, 2010; Serdula et al., 1993; Whitaker et al., 1997).

In order to address the adolescent obesity epidemic, researchers should look to their learned behaviors and living environments as they are related to nutrition and physical activity in order to determine the contributing factors and potential solutions to the epidemic. Policies directing the development and implementation of interventions that affect adolescent nutrition and physical activity environments can have a significant impact on the prevalence of adolescent obesity. Given that youth spend a majority of their waking hours in school, policies directed at their nutrition and physical activity environments while on the school campus can have a considerable impact on the adolescent obesity epidemic (Snyder and Dillow, 2012).

2.1 Physical and Social Impact of Adolescent Obesity

There are numerous studies that illustrate the negative effect of obesity on an adolescent's health and well-being. For example, obese adolescents experience chronic physical health conditions, such as Type 2 diabetes, sleep apnea, fatty liver disease, and cardiovascular disease due to high blood pressure and high cholesterol (Dietz, 1998). The alarming fact is that historically, the above mentioned diseases had previously only been associated with adults (Katz, 2009; Reilly and Kelly, 2011). Adolescents are also subject to the social stigma of obesity, which oftentimes leads to exclusion amongst their peers, depression, and low self-esteem (Schwartz and Puhl, 2003; Strauss and Pollack, 2003). Moreover, overweight and obese adolescents often experience lower academic performance resulting in lower human capital attainment in adulthood (Ding et al., 2009; Sabia, 2007).

2.2 Economic Costs of Adolescent Obesity

There are also significant economic costs and externalities associated with the treatment of adolescent obesity-related disease. Obesity and its associated comorbidities raise medical expenditures and put stress on the health care system (Trasande and Chatterjee, 2009). Medical costs of obesity account for approximately 10% of total medical expenditure (Finkelstein et al., 2009). Furthermore, increased adolescent obesity was found to be correlated with both increased health care utilization and an increase in medical cost (Trasande and Chatterjee, 2009). Specifically, as shown in Trasande and Chatterjee (2009), elevated BMI (above the 84^{th} percentile) in 6 - 19 year olds is associated with an increased use of prescription drugs, emergency room visits, and outpatient visits totaling $14.1 billion in additional medical expenditure. These are not however, the only costs associated with obesity. In adults, obesity contributes to poor health which in turn, has been shown to lead to increased disability payments and decreases in work output due to both absenteeism (missed work days) and presenteeism (lower productivity while on the job). Burkhauser and Cawley (2004) found the relative risk of receiving disability income support due to obesity was 5.64 and 6.92 percentage points higher for women and men, respectively, compared to non-obese individuals. Finkelstein et al. (2005), reported that indirect costs associated with obesity-attributable absenteeism in the United States ranged from $77 to $1,033 per obese individual per year, depending on gender and obesity category.

In terms of lost productivity per obese person, Frezza et al. (2006) found that in New Mexico alone, the cost of obesity was estimated to be $1.5 billion in lost output (including lost jobs and lost tax revenue), or approximately $3,995 per obese person. Ricci and Chee (2005) estimated the total value of lost productive time (LPT) at work to be $11.7 billion per year among obese workers; approximately $7.8 billion of which is directly related to presenteeism. The productivity losses and indirect costs of absenteeism, disability, and presenteeism associated with obesity add to the overall costs borne by individuals and society as a whole. Projected indirect costs of adolescent obesity associated with lost productivity, disability leave, and premature mortality, from 2020 to 2050 based on assumptions about current productivity growth and obesity trends, were estimated to be approximately $208 billion (Lightwood et al., 2009).

Due to the increased current medical costs and future trend of even higher expenditures resulting from adolescent obesity and its comorbidities, there is an urgent need for the development of effective obesity prevention strategies. Since overweight and obese adolescents are at increased risk of adult obesity, prevention is crucial in order to reduce the magnitude of indirect costs associated with decreased worker productivity in the future.

Chapter 3: Background of the Child Nutrition and WIC Reauthorization Act of 2004

The Child Nutrition and WIC[2] Reauthorization Act of 2004 (CNRA) federal mandate required all public K-12 schools that received funding for federally reimbursable meal programs to directly address the school factors listed in Table 1.1 in their school wellness policies prior to the start of the 2006-2007 school year. The penalty for school districts that failed to comply with this mandate was the potential loss of their federal funding.

In a review of school policies to promote healthy eating and physical activity in schools, Story et al.(2009) discuss the CNRA. They find that although the policy directive was a step in the right direction towards the prevention of childhood obesity, there was a large amount of variation in schools' wording of the policies due to the weakness of the mandate in not setting minimum national standards for the policy components. Most of the current school wellness policy research reports data regarding compliance with the mandate and strength of the policies (Longley and Sneed, 2009; Moag-Stahlberg et al., 2008). Metos and Nanney (2007) found that approximately 78% of state school districts complied with the mandated written policy. However, the power of the language contained within the policies varied significantly. Similarly, a report published by *Bridging the Gap*, a Robert Wood Johnson Foundation program, found that three years following the mandate enactment, the percentage of students attending school in a

[2] According to the USDA, "the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides Federal grants to states for supplemental foods, health care referrals, and nutrition education for low-income pregnant, breastfeeding, and non-breastfeeding postpartum women, and to infants and children up to age five who are found to be at nutritional risk." http://www.fns.usda.gov/wic/women-infants-and-children-wic

district compliant in wellness policy rose from 81% to 99% (Chriqui et al., 2010). Although compliance was high, the average strength of the wording (rated as strong, weak, or nonexistent) among school districts in 47 states was a mere 33 out of 100 points.

Other studies have focused on implementation of the policy and whether or not there was a change in student's behavior. Lambert et al. (2010) found among elementary teachers representing 30 schools in Mississippi, that although 85.5% supported the wellness policy concept, only 59.7% thought that the policies had a positive influence on student health. One of the key factors to successful implementation of the CNRA was the assignment of a dedicated wellness coordinator. In a study of school districts in Pennsylvania, Probart et al. (2010) found that 92% of school districts had complied with the requirement of identifying an individual who had ultimate responsibility for policy implementation. However, only 28% had a dedicated wellness coordinator, perhaps implying that wellness policy responsibilities had been given to school staff and faculty in addition to their other job duties.

Less research has been done that evaluates the effect of the CNRA on the prevalence of adolescent obesity. Coffield et al. (2011) used self-reported weight and height data taken from adolescent driver license data in Utah in order to construct their dependent BMI variable. The analysis of each of their three models showed stronger policies containing more wellness policy components were correlated with significantly decreased odds of obesity. Conversely, utilizing data from the 2007 National Survey of Children's Health, Riis et al. (2012) found that stricter state school nutrition and physical activity policies were associated with greater odds of obesity, suggesting that states with high obesity prevalence responded to their health crises with increased policy implementation efforts.

While adolescent obesity is the result of many factors, very little research focuses on evaluating multidimensional prevention strategies. Although the literature appears to support a positive effect of the school environment and wellness policies on the prevalence of adolescent obesity, most studies address only one aspect of policy, such as nutrition, or physical activity. Thus, there is a significant gap in our knowledge of the impact of these prevention strategies. I explore the effects of CNRA on adolescent obesity rates. I investigate whether some U.S. states' policies were more effective in slowing, or reversing, the prevalence of adolescent obesity as a result of the CNRA. I examine the effect of the different components of the CNRA on adolescent's obesity rates and I evaluate each component's contribution to reduction in the obesity rates. Although the CNRA required a written policy to be in place, the mandate did not specifically address how policies were to be implemented nor evaluated. Consequently, it facilitated a high level of compliance with the written wellness policies, while setting no standards regarding measurement of their effectiveness. The estimation model that follows will explore the direction and magnitude of the effect of these state school wellness policies on adolescent BMI.

Table 1.1: Overview of the Child Nutrition and WIC Reauthorization Act of 2004

Health education	Goals for nutrition and health education
Physical education and activity	Goals for physical education and activity
Nutrition services	Guidelines for federal reimbursable meals meeting established U.S. Department of Agriculture (USDA) regulations and for all foods available on school campuses during the day
Faculty and staff health promotion	Designation of one or more individuals responsible for measuring the implementation of the wellness policy; involvement of school food authorities and school administrators in developing wellness policies
Family and community involvement	Involvement of parents, and the public in developing wellness policies

http://www.yaleruddcenter.org; CDC - NPAO - Local School Wellness Policy - Adolescent and School Health, 2013

Chapter 4: Literature Review

4.1 Obesity and Rational Choice Theory

Cutler et al. (2003) demonstrate that, according to basic economic theory, people make choices that give them greater utility (make them happier) therefore, if they choose to eat more and exercise less, and in the absence of negative externalities, there is no reason to intervene with policy to reduce obesity. We model the decision making behavior of adults as rational; adults are viewed as making informed decisions, subject to their time and budget constraints, while maximizing their utility, or sense of well-being. Within this framework, adult obesity can be modeled as a rational choice that an individual makes, having weighed the benefits (of current consumption of calories) against the costs (of current and discounted future health consequences) of their actions. There is however, according to Cawley (2010), "an abundance of precedents for treating children differently than adults on the basis of their inability to make responsible decisions: cigarette and alcohol sales to minors are banned; those under age 16 may not drive; and those under 18 may not vote." Children and adolescents are not seen as rational individuals due to their inability to weigh the future costs of their actions; it is this failure of the rationality assumption that justifies the case for interventions designed to reduce adolescent obesity. Moreover, in the case of adolescent obesity, adolescents seldom purchase their own food or decide what their daily meals will consist of either at home or at school (Anderson et al., 2003). Quite often, an adolescent's diet and time allocated to physical activity is dictated by the choices their parents make for them. Using micro-level data from the 1984-1999 Behavioral Risk Factor Surveillance System, Chou et al. (2004) find evidence of the association of change in dietary behaviors in the United States with the proliferation of fast food restaurants. Further research by Anderson et al. (2003) shows that over the past thirty years, the increase in maternal labor force participation, explains 12% to 35% of the increasing childhood obesity trend among families of high socio-economic status. As a result of the scarcity and increased value of their time, incentives exist for families to turn to the relatively lower cost convenience of fast foods. The higher energy (calorie) content and lower nutritional value of these foods is related to the growing adolescent obesity trend in the United States.

Additionally, current economic research suggests there are negative financial externalities associated with obesity. Individuals participating in a health insurance pool with other members who are obese suffer higher premiums than they would otherwise as the increased costs associated with treatment of obesity's comorbidities are spread out over the entire group (Bhattacharya and Sood, 2007). In a New England Journal of Medicine study, researchers found that the probability of a young child growing up to become an obese adult was approximately 24% if neither parent was obese, but rose to 62% if even one parent was obese (Whitaker et al., 1997). Evidence of such an inherent problem provides economic rationale for preventing obesity from the youngest age possible in order to minimize the potential negative externality costs.

Other contributing factors discussed in the literature include: genetic variations (e.g. race/ethnicity, gender, age), maternal behavior during a child's formative years, family food environment, family socioeconomic status, technology, and the physical environment (e.g. access to recreational facilities). The origin of obesity however, is primarily due to an energy imbalance where calorie consumption exceeds calorie expenditure. The growing consumption of high calorie, low nutrient, inexpensive processed foods along with a sedentary lifestyle combine to result in the growing obesity trend in the United States. An excess consumption of calories on a daily basis will result in weight gains which, if left unchecked, over time will lead to an increased probability of obesity. Recent economic research, focused on identifying the potential determinants of this imbalance, offers useful insights into changes that have taken place in our environment that may have given individuals incentive to consume more calories, expend fewer calories, or some combination of the two, thus contributing to the rise in obesity in general (Chou et al., 2004; Cutler et al., 2003; Lakdawalla and Philipson, 2002; Philipson and Posner, 1999).

Cutler et al. (2003) find that technology advances in the past three decades such as: vacuum packing, preserving, deep freezing, and microwaving have enabled the consumption of high calorie, low nutritive value, mass produced foods at a lower cost to consumers relative to foods prepared at home. Harris et al. (2007), using nationally representative data from the ACNielsen Homescan panel, confirm the increased use of convenience foods in U.S. homes today. They found a positive and significant relationship between households with children and additional spending on convenience foods thus asserting the earlier conclusion by Cutler et al. (2003); a considerable amount of food preparation has shifted from in-home to food manufacturers.

Cawley (2010) summarizes the aforementioned determinants by stating that, “it is not practical or desirable to lower childhood obesity by turning back the clock or reversing these trends.” Asking society to stop developing and using food technology, causing food prices to rise in the hopes that the effect will lead to decreased calorie consumption is folly.

The same is true of women in the labor force; the notion that today's society would even consider a decrease within a workforce comprised of more than 45% females is imprudent. Similar logic can be applied to the multiple contributory factors of adolescent obesity. Rather than looking to the past, policymakers' time would be better spent focusing on obesity prevention strategies that address the negative repercussions of the gains that society has made to date.

4.2 Obesity and Behavioral Economics

Behavioral economics literature argues that obesity is not a rational choice (Chou et al., 2004; Council on Communications and Media, 2011; Zimmerman, 2011). Zimmerman (2011) suggests that it is not the result of individual utility maximization given fixed preferences, but rather the outside influence of food producers who alter their products in such a way as to sway individual tastes towards unhealthy, high-calorie, low-nutrient foods. Moreover, a 2012 report published by the Institute of Medicine (IOM) concluded that in order to have a positive effect on the systemic, complex obesity problem, a significant societal change must take place. They advocate a paternalistic approach of government interventions that might "nudge" individuals towards better choices that would be more in the best interests for their health (Institute of Medicine (U.S.) and Glickman, 2012).

4.2.1 The Case for Paternalism

There are two main categories of systematic bias in individual behavior: cognitive bias and persistent self-control problems. Cognitive bias occurs when individuals prefer to follow the status-quo rather than search for alternatives that may improve their well-being.

Hendrickse et al. (2015), found support for this bias in a study of how food images triggered study individual's appetites, which in turn led to food cravings and eventual overeating. Persistent self-control problems in obese individuals are displayed in their regular inconsistency in discounting the future poor health trade-offs between their present and future selves.

Some school interventions that have shown potential in addressing both forms of bias in students who purchase their meals in school cafeterias are: placing fruit rather than high-calorie, high-fat snacks in more accessible areas, placing salad bar stations in a more central location than other food stations, and requiring that candy and soda be paid for in cash rather than with lunch card credits (Just et al., 2007).

Given that traditional economic theories do not do a very good job of explaining individual behavior, behavioral economics and a more paternalistic approach offers considerable prospects for researching the obesity issue from a different perspective. By assuming that individuals are not making choices in their own best interest, there are a considerable number of potential policy interventions other than, for example, influencing prices through the use of "sin taxes" designed to steer individuals away from goods that are considered harmful to them or increasing the amount of information available, such as showing calorie counts on menus.

4.3 Adolescent Obesity and Public Policy Intervention

While there is widespread agreement that obesity is a priority health concern in the United States, there is considerable disagreement as to whether and to what extent government should intervene with policies that are designed to affect the poor health choices made by overweight and obese consumers. Adolescent obesity can, however, benefit from the guiding principles of economics that support interventions in the case of such market failures, such as irrational behavior, externalities, and lack of information. Cawley (2010) suggests that the objective of obesity prevention policy should not be to set subjective goals, such as a particular level of obesity in society. Interventions should be established so that they correct market failures, thus allowing the "right" level of obesity to be reached in the most cost-effective manner possible.

In order to target the "right" level of adolescent obesity in this manner, interventions designed to address adolescent's lack of "rationality" through modifying their eating and physical activity behaviors while in school, can play a key role in reversing the upward trend. In school, administrators and teachers acting *in loco parentis* can help to instill healthy behaviors in their students by educating them and regulating their school environment. If school staff and faculty are provided with resources that allow the design and application of policies that outline specific, measureable goals and implementation procedures for student wellness, it is possible that the high tide of childhood obesity prevalence can be turned. Economic research on the prevalence of adolescent obesity discusses not only school wellness policies in general, but also the effect of individual policy components such as federally funded school meal programs and availability of competitive foods on school campuses.

Results pertaining to the correlation of participation in federally funded free and reduced-price school lunches and childhood weight gain are mixed in the economic literature. Schanzenbach (2009), utilizing a regression discontinuity design in order to study children at either side of the income eligibility cutoff for school lunch subsidies, found a significant positive correlation with increased obesity rates. Using panel data from the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) that followed approximately 15,000 students from 1,000 different schools from kindergarten through eighth grade, Schanzenbach (2009) found the increased calories consumed by students eligible for the free and reduced price lunch programs could lead to a two percentage point increase in obesity rates. Millimet et al. (2010) extend this research in order to control for the effects of selection into and participation in either the School Breakfast Program (SBP) and/or the National School Lunch Program (NSLP) on child obesity. The results of conditioning on SBP participation *and* allowing for positive selection into the SBP showed that the increase in child obesity rates was primarily the result of the NSLP, thus confirming Schanzenbach's earlier findings and also providing valuable information regarding the benefits of the SBP as well as a clear need to investigate the detrimental effects of the NSLP.

While school officials endeavor to provide nutritious meal choices in main dining areas, they also face the reality of annual budget gaps. In order to supplement their funding, many schools turn to offering "competitive foods" (foods and beverages sold outside of Federal meal programs, regardless of nutritional value). Kubik et al. (2005), in a cross-section study of middle school students in Minneapolis, Minnesota, found that school food practices that allowed access to competitive foods throughout the school day was associated with increased BMI rates. Although schools in the United States receive an estimated $750 million a year from companies that sell snacks and beverages (Egan, 2002), it is essential that they consider the nutritive value of the foods being offered. Already, many schools have taken it upon themselves to improve their competitive food offerings with little loss of revenue (Wharton et al., 2008).

Chapter 5: Conceptual Framework

Utilizing rational choice theory, this research will empirically test the relationship between state school wellness policies and adolescent obesity. According to rational choice theory, an individual's behavior is the result of that individual choosing the behavior that best maximizes their satisfaction, given that they are well informed of all alternatives and potential consequences of their actions (Simon, 1955). In economics, we assume that these individuals are rational in that they are able to weigh the discounted value of any future consequences against the benefits of their present choices (Becker and Murphy, 1988). The choices that these rational individuals make are subject to time and money constraints and they are assumed to allocate these resources in such a way that their utility, or satisfaction, is maximized.

A practical application of rational choice theory is Grossman's (1972) demand for good health in which individuals begin their lives with a certain health stock which depreciates over time until death occurs. Over the course of their lifetime, individuals can choose to consume goods and services that produce "health," subject to their time and budget constraints, in order to invest in their health stock, so that depreciation is slowed and their length of life extended. Since I am exploring adolescent obesity, and many of the decisions that affect an adolescent's health and body weight are made by parents as well as individuals acting *in loco parentis*, this research will employ a slightly modified version of an extended Grossman model, introduced by Lena Jacobson, that looks at the family as producers of health rather than the individual (Jacobson, 2000).

The extended Grossman model begins with a family utility function

$$U = U(H_m, H_f, H_a, Z)$$

where the family's utility is a function of the mother's and father's health, H_m, H_f, respectively, the adolescent's health, H_a, and consumption of other goods, *Z*.

The adolescent's health depreciates over time according to

$$\partial H_a / \partial t = I_a - \delta_a \mathrm{H}_a$$

where I_a are investments in the adolescent's health and δ_a is the depreciation of the adolescent's initial health stock, H_a.

According to Jacobson, the adolescent's health investments, I_a, are produced by the parent's use of their own time with the child and choice of market goods for the child. The investment in a child's health is thus produced according to the production function

$$I_a = I_a(M_a, h_{H_a,m}, h_{H_a,f}; E_{H,m}, E_{H,f})$$

where $h_{H_a,m}$ and $h_{H_a,f}$ represent the time spent in producing adolescent health by mother and father, respectively; $E_{H,m}$and $E_{H,f}$ are efficiency parameters (i.e. parent level of education) that may affect production of health; and finally, M_a , where

$$M_a = M_a^{public} + M_a^{private}$$

which represents the adolescent's consumption of goods M_a^{public} (school) and $M_a^{private}$ (all other goods). In this research, an adolescent's production of health, I_a, is based not only on parental choices of their consumption and time allocation, but also through school officials acting *in loco parentis* for adolescents who attend public schools. Thus, the final model is

$$I_a = I_a(M_a^{public} + M_a^{private}, h_{H_a,m}, h_{H_a,f}; E_{H,m}, E_{H,f}).$$

The relationship between all inputs in the production of a child's weight is illustrated in Figure 1.7, where both parents and school play a role in determining a child's nutrition, physical activity, nutrition education, and physical education, and both parents and school will have an impact on caloric consumption and expenditure.

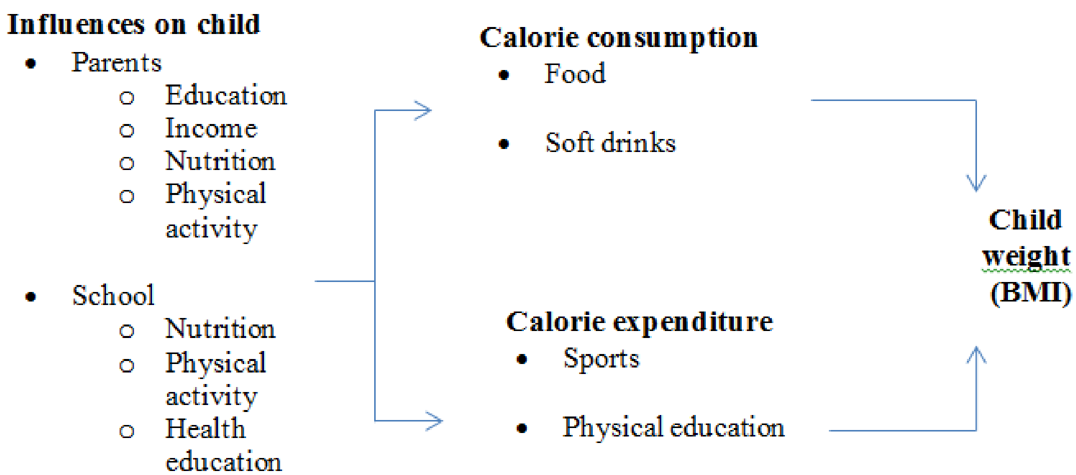

Figure 1.7: Child caloric consumption/expenditure influences

Chapter 6: Research Methodology

6.1 Model Specification

The model I estimate takes on the following form:

$$BMI_{ist} = \beta_0 + \beta_1 X_{ist} + \beta_2 Z_{ist} + \beta_3 C_{ist} + \beta_4 WellPolicy_{ist} + \beta_5 S + \mu_{ist}$$

where BMI_{ist} represents the body mass index measure for adolescent *i* in state *s* at time *t*; X_{ist} is a vector of child characteristics; Z_{ist} is a vector of state-level adult characteristics; C_{ist} is a vector of state-level contextual characteristics; *WellPolicy* is a measure of the state wellness policy; *S* represents state dummies; and finally, μ_{ist} represents unobservable factors that are uncorrelated with the rest of the independent variables.

6.2 Dependent Variable

As the output for an adolescent's health production function that contributes to overall family utility, I use Body Mass Index (BMI), a measure of obesity. BMI is the generally accepted measure used to describe weight status (underweight, healthy, overweight, and obese) for adults[3] however, due to the different growth rates between children and adolescents of

[3] According to the CDC, BMI is calculated by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703. http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#Interpreted

different age and gender, the BMI calculation is compared to the CDC's gender-specific BMI-for-age growth charts (Figures 1.8 and 1.9) to determine weight status.

Table 1.2 shows the range of weight status categories for an adolescent who is below the 5^{th} percentile on the CDC BMI-for-age growth chart (underweight) to above the 95^{th} percentile (obese). For example, a 15 year old girl with a calculated BMI of 27 would fall between the 90 and 95^{th} percentile on the CDC BMI-for-age growth chart for girls, thus placing her in the overweight category.

Table 1.2: CDC BMI-for-age weight status categories and corresponding percentiles

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

http://m.cdc.gov/en/HealthSafetyTopics/HealthyLiving/HealthyWeight/AssessingYourWeight/BodyMassIndex/BMIChildrenTeens

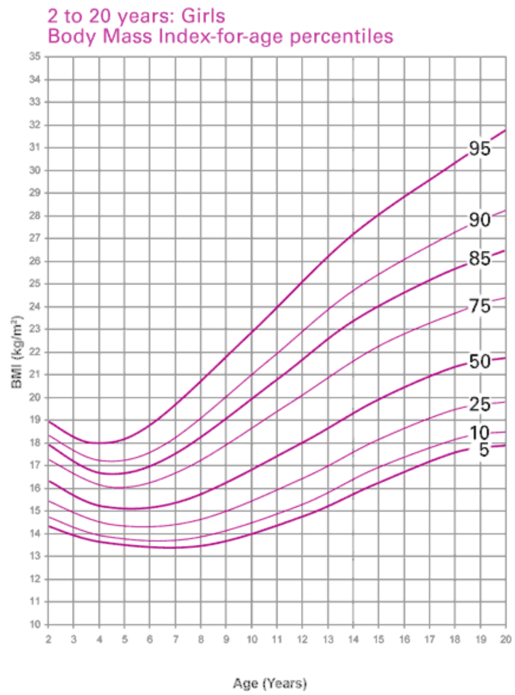

Figure 1.8: CDC BMI-for-age growth chart for girls
http://www.cdc.gov/growthcharts/data/set1clinical/cj41c024.pdf

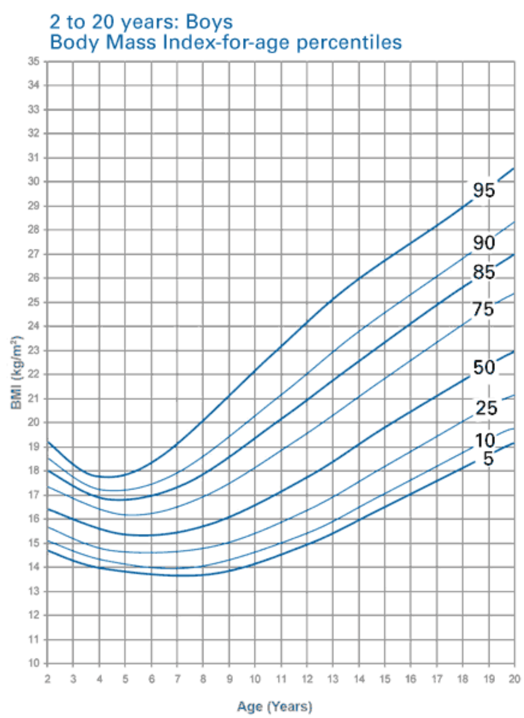

Figure 1.9: CDC BMI-for-age growth chart for boys
http://www.cdc.gov/growthcharts/data/set1clinical/cj41c024.pdf

6.3 The Primary Explanatory Variable

The primary explanatory variable of interest are the state school wellness policies that direct school officials' behavior as it relates to actions that may have an effect on adolescent health.

According to the OECD, composite indicators are seen as beneficial tools in providing a point of reference for country performance post-policy implementation as well as analyzing and formulating public policy performance across countries. They are useful for simplifying often complex, multi-dimensional policies and to help understand trends in both individual indicators and across countries and/or regions (Joint Research Centre-European Commission and others, 2008). Following the methodology outlined in the OECD's *Handbook on Constructing Composite Indicators,* I constructed an index that was used to: (1) develop a composite indicator based on elements of state school wellness policies that may impact adolescent obesity, (2) establish a benchmark measure of each state's performance in complying with the goals of the CNRA, (3) apply the indicator in order to describe the differences in adolescent BMI over time and across states, and (4) to determine the importance of the individual components of the index.

6.4 Other Explanatory Variables

Other individual-level explanatory variables included age, gender, race, and how many days per week the student participated in PE class. To control for state-level contextual effects, I included the state adult obesity rate, percent of the state population with a bachelor's degree, the state poverty rate, the state violent crime rate, and a measure of income inequality.

Income inequality was measured in one of three ways: 1) state-level Gini coefficient, 2) the concentration of income in a state's top 10 percent of income earners, and 3) the concentration of income in a state's top 1 percent of income earners. The Gini coefficient is the most commonly used measure of income inequality; it measures the extent to which income distribution among individuals deviates from a perfectly equal distribution with 0 representing perfect equality and 1 representing perfect inequality. A positive a positive sign on the regression coefficient of the Gini variable would indicate that income inequality leads to an increase in the BMI measure. The last two measures are income shares of the top 1 and top 10 percent of earners as a percentage of national income. A positive association between these variables and the BMI measure would imply that income inequality increases adolescent BMI.

To control for the fact that I am unable to observe whether an individual attends public or private school, I included the percent of the state's high school student population attending either public or private school. State dummy variables were added to control for unobserved state specific factors affecting individual student BMI (availability of outdoor park spaces for physical activity, number of grocery stores with fresh produce available, and number of fast food restaurants). Finally, I used year dummy variables to account for time-specific unobserved determinants of BMI. Table 1.3 summarizes all explanatory variables used in this research. Correlations for individual-level and state-level explanatory variables are shown in appendix tables A.1 and A.2, respectively.

Table 1.3: Explanatory Variables Used in Regression Analysis

Variable	Description
Age	Discrete, age in years
Female	Dummy variable =1 if female, =0 otherwise
Black	Dummy variable =1 if Black, = 0 otherwise
Asian	Dummy variable =1 if Asian, =0 otherwise
Hispanic	Dummy variable =1 if Hispanic, = 0 otherwise
Other	Dummy variable =1 if American Indian/Alaskan native, Hawaiian / Pacific Islander, Multiple-Hispanic, or Multiple – Non-Hispanic, =0 otherwise
Days in PE	Discrete, how many days in a week the individual participates in school PE class
Wellness Policy Index	Continuous, index value of the state from which the individual observation comes
Adult Obesity Rate	Continuous, adult obesity rate of the state from which the individual observation comes
College Education	Continuous, college education attainment of the state from which the individual observation comes
Poverty Rate	Continuous, poverty rate of the state from which the individual observation comes
Violent Crime Rate	Continuous, violent crime rate of the state from which the individual observation comes
Gini coefficient	Continuous, Gini coefficient of the state from which the individual observation comes
Top 10%	Continuous, income share of top 10 % income earners of the state from which the individual observation comes
Top 1%	Continuous, income share of top 1 % income earners of the state from which the individual observation comes
Public School Rate	Continuous, public school attendance rate of the state from which the individual observation comes
Private School Rate	Continuous, private school attendance rate of the state from which the individual observation comes
Year	Dummies indicating the year individual is observed
State	Dummies controlling for the state from which the individual observation comes

Chapter 7: Data Sources

The data for this research come from the following sources: (1) the Youth Risk Behavior Surveillance System (YRBSS); (2) the School Health Policies and Practices Study (SHPPS); (3) U.S. Census Bureau; (4) National Center for Chronic Disease Control and Prevention (CDC); and (5) the U.S. State-Level Income Inequality Data Series published and maintained by Mark W. Frank.

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7.1 Youth Risk Behavior Surveillance Survey

The Youth Risk Behavior Surveillance System (YRBSS), conducted biennially since 1991, is a nationally representative survey of high school students (grades 9–12) that was established by the CDC to monitor the prevalence of risky youth behaviors, including those relating to physical activity and obesity. The level of identification is both at the state and district level. However, the district level data collection was only funded for 22 large urban areas.

Variables used from the YRBSS included: age, gender, ethnicity, weight, height and the average number of days per week a student participated in physical education (PE) classes at school. Weight and height are self-reported in the YRBSS and are therefore likely reported with error. The nature of this reporting error in the YRBSS is unknown, because the true height and weight of YRBSS respondents is not observed. In order to determine the magnitude of reporting error in weight among high school students, researchers at the CDC surveyed high school students and collected data on both self-reported and measured weight and height.

They found that self-reported values of height, weight, and BMI were highly correlated with their measured values. The correlation coefficients for self-reported and measured weight and height were 0.93 and 0.90, respectively. For BMI constructed using self-reports and measurements, the correlation coefficient was found to be 0.89. The average student over reported height by 2.7 inches and underreported weight by 3.5 pounds, resulting in an underreported BMI of 2.6 units. Brener et al. (2003) conclude that self-reported height and weight by high school students are valid representations of measured values, and that the use of self-reported height and weight leads to, if anything, *understated* prevalence of obesity.

One of the drawbacks in using the YRBSS is that the CDC does not release school-level identifiers so I am unable to distinguish private from public school students. Since public schools are legally bound to comply with federal mandates whereas private schools are not, results obtained may be biased. Although the state requirements for public schools may set a standard that is adopted by private schools, the impact of state regulations is likely to be less for private school students than public school students. Since the models were estimated with a pooled sample of public and private school students, the estimates will likely underestimate the impact of state regulations on public school students. To help control for this bias, I have included the percentage of high school students in each state who attend either public or private school.

7.2 The School Health Policies and Practices Study

I obtained my wellness policy index data from the SHPPS. Data at the state level for years 2000, 2006, and 2012, from the Health Education, Physical Education and Activity, Health Services, Nutrition Services, and Family & Community Involvement questionnaires were used to construct the wellness policy indices for each state.

The SHPPS is the largest, most comprehensive examination of school health policies in the United States (Kann et al., 2007). Since 1994, the study has been completed every six years in collaboration with the Division of Adolescent and School Health (DASH), and the CDC. According to a Division of Adolescent and School Health article (2011), the purpose of SHPPS is to "assess school health policies and practices at the state, district, school, and classroom levels." School sampling was intended to recruit a nationally representative sample based on urban city, SES[4], school level (e.g, elementary, middle, and high), and enrollment size. The final sample included a total of 1,103 schools from across the United States and reflected a 78% response rate.

As shown in Table 1.4, a principal component analysis approach was used to group responses to survey questions into their respective domain of interest that correlated with the wellness policy mandate criteria. Principal component analysis is a statistical method used for data reduction purposes by analyzing the relationships among large numbers of variables in order to group them in terms of their common underlying dimensions or components. This approach was used to create a composite index that contained variables measuring similar concepts. Since the variable of interest in this research was the school wellness policy, in order to give a meaningful interpretation of its estimated coefficient, a single index variable was preferred to multiple discrete categories.

[4] According to the American Psychological Association, "socioeconomic status (SES) is often measured as a combination of education, income and occupation. It is commonly conceptualized as the social standing or class of an individual or group." http://www.apa.org/pi/ses/resources/publications/factsheet-education.aspx

Table 1.4: School Health Policies and Practice Study Domains

Domain	Description
Health Education	Indicates whether states adopted policy stating that schools follow national health education standards or guidelines
Physical Education & Activity	Indicates whether states adopted policy stating that schools follow national physical education and activity standards or guidelines
Nutrition Services	Indicates adherence to USDA nutrition standards
Health Services	Characteristics of state-level school health activities (e.g. health council to guide development and implementation of school wellness policy)
Family & Community Involvement	Describes types of health education offered to families and level of community involvement in developing school wellness strategy

http://www.cdc.gov/healthyyouth/shpps/brief.htm

7.2.1 Principal Component Analysis

Principal component analysis (PCA) is a multivariate statistical technique that is used to reduce the size of a dataset that consists of a large number of correlated variables while retaining as much of the variation as possible from the original dataset (Jolliffe, 2002). PCA, as introduced by Pearson in 1901 and later developed by Hotelling (1933), was not widely used until computer use allowed for computation of the matrix algebra involving more than four variables to be more tractable. The full potential of PCA has more recently been realized in a variety of empirical applications in both the physical and social sciences. However, it did not gain popularity as a means of deriving weights necessary in constructing a linear composite index until Filmer and Pritchett's (2001) paper in which they utilize PCA to formulate a linear index proxy for household wealth from asset ownership indicators. This research employs the PCA technique in order to exploit the variation and to reduce any redundancy that may exist within the SHPPS data.

Formally, PCA takes a set of *k* correlated variables $X = \{X_1, X_2, \dots X_k\}$ (such as state school health policy variables) and transforms them into a new set of uncorrelated variables $Z = \{Z_1, Z_2, \dots, Z_k\}$ called principal components, each of which is an independent, linear weighted combination of the initial variables as follows:

$$Z_1 = a_{11}X_1 + a_{12}X_2 + \cdots + a_{1j}X_j$$
$$\vdots$$
$$Z_k = a_{k1}X_1 + a_{k2}X_2 + \cdots + a_{jk}X_j$$

where a_{jk} is the weight for the kth principal component and the jth variable. The weights (a_{jk}) for each principal component are derived from the eigenvectors of the correlation matrix and the variance by the eigenvalue of the corresponding eigenvector. Finally, principal components ($Z_1, Z_2, \dots, Z_k$) are arranged so that the first component (Z_1) accounts for the greatest amount of variation in the original data. The second component (Z_2), uncorrelated with the first component, explains the maximum remaining variance, which is less than the first. All successive components are uncorrelated with the preceding components and explain less and less of the variation in the original data.

The assumptions of PCA include: (1) sufficient number of observations, (2) no bias in selecting individual indicators, (3) strong correlations in the data and (4) multivariate normality.

When determining the minimum acceptable sample size in PCA, there are two classes of recommendations found in the literature; the first states that it is the number of cases (observations) that is important and the second suggests that it is instead the observation to variable ratio that is most important. There is little agreement in the literature as to which rule is best to follow however, in a study by MacCallum et al. (1999), a Monte Carlo experiment showed excellent results with a sample size of 60 and 20 variables or a 3:1 ratio of observations to variables. Similarly, the final sample of this paper's study included 153 observations and 56 variables or a 2.7 to 1 ratio.

Further, as the variables for this study were not selected ad hoc from various different sources, but instead taken from a specifically constructed survey, there should be little to no bias among the individual indicators as well as strong correlations within the data. Finally, given that standard PCA assumes multivariate normality, thus working best with continuous data, this research follows a technique developed by Kolenikov and Angeles (2009) that utilized polychoric correlations in the PCA analysis in order to accommodate the discrete nature of the SHPPS data.

7.2.2 Polychoric Principle Component Analysis Implementation

Prior to implementing the regression analysis, I performed principal component analysis (PCA) and calculated the wellness policy measures. Jolliffe (2002) suggests using Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) procedures prior to performing principal component analysis to determine if PCA is an appropriate method for analyzing the data.

The null hypothesis of the Bartlett test is that the observed correlation matrix is significantly different from the identity matrix. In determining the general relationship between variables, the determinant of the correlation matrix |R| is calculated; under the null hypothesis, |R| is equal to one whereas if the variables are highly correlated |R| will be closer to zero. The Bartlett's test statistic is calculated according to

$$\chi^2 = -\left(n - 1 - \frac{2p + 5}{6}\right) \times \ln|R|$$

where n is the number of observations, p is the number of variables and R is the correlation matrix, determines to what extent the data deviate from |R| = 1.

The KMO is a measure used to determine if the sample size is adequate for principal component analysis. It tests the ratio of partial correlations relative to original correlations in the sample. If the variables share common factors, the partial correlations should be small and KMO will be close to 1. The KMO test statistic is calculated according to

$$KMO = \left(\sum\sum r_{ij}^2\right) / \left(\sum\sum r_{ij}^2 + \left(\sum\sum a_{ij}^2\right)\right)$$

where a_{ij} are the partial correlations.

Analysis was performed in STATA (version 12) using the *"polychoric"* and *"polychoricpca"* commands to estimate the polychoric correlations among pairwise variables and perform the principal component analysis, respectively. Both the result of the KMO and Bartlett's test of sphericty, summarized in Table 1.5 below, indicate that principal component analysis is an appropriate method for analyzing this data.

Table 1.5: Summary of KMO and Bartlett's Test of Sphericity

KMO	Chi-Square	Bartlett's Test Degrees of freedom	Sig (p)
.8166	250.991	66	.000

Next, polychoric principal component analysis was applied to the variables in each of the five dimensions of the SHPPS data. Based on a review of the resulting initial solution, a decision was then made regarding how many principal components should be retained. Following Kaiser's generally accepted standard of eigenvalues greater than or equal to 1 (Kaiser, 1960), four principal components, shown in Table 1.6, which incorporated the original variables of the SHPPS were retained. These components, reflective of the KMO score of .8166, explain approximately 82% of the total variance.

Table 1.6: Eigenvalues of SHPPS

k	Eigenvalues	Proportion Explained	Proportion Cumulative
1	2.977	0.365	0.365
2	1.404	0.172	0.537
3	1.312	0.161	0.697
4	0.993	0.122	0.819

The principal component analysis factor extraction also produces factor loadings and uniqueness measures for each variable contained within the retained factors as shown in Table 1.7. Factor loadings describe the correlation between each variable and the principal component factors that have been extracted from the data. To illustrate, the *NatlHlthEdStd* variable, based on the SHPPS Health Education Questionnaire survey response to whether or not the state requires schools to follow a nationally recognized health education curriculum, is highly correlated with Factor 1, but insignificantly correlated with the other three factors. Similarly, the *OnsiteFastFood* variable, based on the SHPPS Health Education Questionnaire survey response to whether or not states allow brand name fast food service on site, is highly correlated with Factor 4, but insignificantly correlated with the other three factors.

The uniqueness measure is the part of the variance of the components within each factor that is “unique” and not shared with other variables. For example, 15.18% of the variance in the *NatlHlthEdStd* variables is not shared with other variables in the model. Conversely, the *SchoolCoord* variable, based on the SHPPS Health Education Questionnaire survey response to whether or not states require schools to have a committee, task force, etc. in charge of coordinating community and family involvement in school health programs, has a higher uniqueness value where 93.55% of its variance is not shared with other variables in the model.

Since we want the representative variables within each factor to be correlated with one another, the higher the value of the uniqueness measure, the less relevance it has in the overall factor model. Variables that loaded the highest on each respective factor are assigned to that factor (highlighted values in Table 1.7) for constructing the overall wellness policy index measure for each state.

Table 1.7: SHPPS PCA Factor Extraction Results

Survey	Variable	National Standards (Factor 1)	State Requirement (Factor 2)	Screening (Factor 3)	State Recommended (Factor 4)	Uniqueness
Health Education	*NatlHlthEdStd*	0.7572	0.1034	-0.5102	-0.0615	0.1518
Health Education	*HlthEdrequired*	0.0916	0.6333	-0.4941	0.2485	0.2848
Health Services	*StudentHlthHist*	0.1413	0.0457	0.5241	-0.2726	0.4399
Health Services	*HlthScreening*	0.1516	0.2422	0.3859	-0.3953	0.6804
Nutrition Services	*FoodSvcEduc*	0.0284	0.3172	0.1012	0.2108	0.8038
Nutrition Services	*USDAstdrds*	0.7086	-0.0617	0.3449	0.1379	0.3561
Nutrition Services	*OnsiteFastFood*	0.5642	0.0937	0.0857	0.6981	0.1783
Physical Education	*PEexempt*	0.2977	-0.5467	0.6274	-0.2994	0.1293
Physical Education	*PEactivity*	0.7734	-0.4226	0.3990	0.0059	0.064
Physical Education	*PErequired*	-0.0031	0.7259	-0.0106	0.0982	0.4633
Family/Community Involvement	*FamCommreq*	-0.0670	0.3239	0.0972	0.0474	0.8264
Family/Community Involvement	*SchoolCoord*	0.1988	0.1051	0.1169	0.4988	0.9355

7.2.3 Constructing the Wellness Policy Indices

Following the principal component estimation and assignment of variables to their respective factors based on the factor loadings, two wellness policy indices (WPIE and WPIWT) for each of the three SHPPS policy years (2000, 2006, and 2012) were calculated.

The first index (*WPIE)* was derived beginning with computation of factor scores (*f*) according to

$$f_{st} = \sum_{i=1}^{12} X_{ist}$$

where f_{st}represents the factor score for state *s* in year *t* and X_{ist} denotes a binary value for state *s* in year *t*, equal to one if the state had a requirement in place for wellness policy variable *i*, and zero otherwise.

Next, the equal weight (*b*) to be applied to each factor score was calculated according to

$$b = \frac{\sum_{k=1}^{4} G_k}{4}$$

where *k* identifies each retained component factor and *G* represents the associated eigenvalue obtained from the principal component extraction. Finally, *WPIE* was calculated according to

$$WPIE_{st} = b \sum_{k=1}^{4} f_{st}$$

where $WPIE_{st}$ represents the equal weighted wellness policy index calculation for state *s* in year *t*; *b* the equal weight measure; and, *f* the factor score for state *s* in year *t*. Results for the equal weighted index calculation are given in Table 1.9.

The second index (*WPIWT)* was derived as a weighted average (*bwt*) of the four principal components that accounted for the proportion of variance explained by each individual component according to

$$bwt_k = \frac{G_k}{\sum_{k=1}^{4} G_k}$$

where *k* identifies each retained component factor and *G* represents the eigenvalue obtained from the principal component extraction. Next, factor scores (*fwt*) were calculated for each of the four retained components according to

$$fwt_{kst} = \sum X_{kst}$$

where fwt_{kst} represents the factor score for principal component *k* for state *s* in year *t*; X_{ist} denotes a binary value for wellness policy variable *i* that comprises factor component *k* for state *s* in year *t* and is equal to one if the state had a requirement in place for wellness policy variable or zero otherwise.

Finally, *WPIWT* was calculated according to

$$WPIWT_{st} = \sum_{k=1}^{4} fwt_{kst} bwt_k$$

where $WPIWT_{st}$ represents the weighted average wellness policy index calculation for state *s* in year *t*; fwt_{kst} the factor score for component *k* for state *s* in year *t*; and bwt_k the weighted average measure for each component *k*. Results for the weighted average index calculation can be found in Table 1.8.

As shown in Table 1.9, when comparing the outcomes between the methods of wellness policy calculations, the state rankings were essentially the same (shaded states remained in the same quintile). Irrespective of the chosen technique, weighting methods are basically based on value judgments (Joint Research Centre-European Commission and others, 2008). For this reason, and rather than assume that each component of the index is equally significant in the final index construction, regression analysis utilized results of the weighted average index.

7.3 Other Data

In addition to the YRBSS and SHPPS surveys, I used U.S. Census Bureau data from both the American Community Survey (ACS) and the Current Population Survey (CPS) to obtain the percentage of the state population with a bachelor’s degree or higher, the state-level percentage of high school students attending either public or private school, and the state-level poverty and violent crimes rates. I also used data from the CDC to obtain adult obesity rates by state. The state-level Gini coefficient and proportion of top 1 and top 10 income earners for years 1999-2013 came from U.S. State-Level Income Inequality Data Series published and maintained by Mark W. Frank (Frank, 2013). These indices were constructed from individual tax filing data from the Internal Revenue Service.

Table 1.8: State wellness policy index results by year and method

State	2000		2006		2012	
	Equal weight	Weighted Average	Equal weight	Weighted Average	Equal weight	Weighted Average
Alabama	9.574	1.882	12.259	2.249	13.930	2.708
Alaska	10.866	2.224	5.154	0.951	16.716	3.436
Arizona	4.253	0.787	9.654	1.946	12.663	2.809
Arkansas	11.423	2.075	7.082	0.947	11.793	2.182
California	11.024	2.034	9.804	1.976	11.281	2.138
Colorado	7.894	1.446	12.621	2.394	8.785	1.930
Connecticut	13.039	2.742	14.209	3.128	16.523	3.538
Delaware	7.522	1.409	10.030	1.890	15.880	3.510
Florida	11.633	2.107	6.687	1.111	9.313	1.761
Georgia	5.015	0.851	9.863	1.436	10.239	1.726
Hawaii	11.701	2.336	15.045	2.991	13.373	2.767
Idaho	7.940	1.147	11.701	1.851	12.203	2.505
Illinois	9.415	1.353	11.202	2.096	12.609	2.507
Indiana	12.917	2.727	11.648	2.176	12.020	1.972
Iowa	8.231	1.198	11.657	2.377	12.073	2.275
Kansas	10.977	2.267	16.034	3.373	11.929	2.215
Kentucky	14.437	2.920	15.045	2.891	8.358	1.495
Louisiana	6.018	0.908	11.701	2.349	6.687	1.000
Maine	9.528	1.881	12.259	2.650	16.716	3.719
Maryland	18.597	3.688	13.373	2.842	13.373	2.297
Massachusetts	13.223	2.298	13.484	2.443	12.181	2.024
Michigan	10.120	1.699	11.175	1.821	13.626	2.894
Minnesota	13.057	2.522	11.984	2.482	15.335	3.165
Mississippi	4.829	1.065	15.602	3.505	17.106	3.316
Missouri	11.433	2.337	16.671	3.250	11.864	1.928
Montana	12.259	2.401	13.791	2.595	10.866	1.771
Nebraska	2.511	0.259	16.772	3.479	16.286	3.407
Nevada	10.030	1.877	15.045	2.977	8.358	1.756
New Hampshire	5.015	1.336	8.637	1.879	6.129	1.087
New Jersey	6.446	1.572	13.102	2.854	11.490	2.420
New Mexico	8.836	1.088	19.224	3.979	13.373	2.546
New York	13.557	2.597	12.366	2.600	5.230	0.626
North Carolina	15.045	2.977	17.242	3.398	16.716	3.270
North Dakota	11.075	2.044	14.933	3.127	15.300	3.095
Ohio	9.901	1.923	8.497	1.293	10.203	1.747
Oklahoma	7.237	1.315	12.442	2.715	11.312	2.146
Oregon	6.501	0.964	10.438	2.049	16.124	3.142
Pennsylvania	8.358	0.992	16.689	3.253	12.216	2.530
Rhode Island	8.358	1.445	11.701	2.397	6.687	1.359
South Carolina	17.831	3.567	14.209	3.004	17.831	3.484
South Dakota	10.698	2.218	15.713	3.404	5.006	0.669
Tennessee	11.144	2.035	9.473	1.341	16.972	3.310
Texas	9.722	1.618	6.371	0.795	15.071	3.302
Utah	12.816	2.528	13.373	2.795	10.030	2.375
Vermont	12.537	2.448	10.030	1.904	15.045	3.143
Virginia	11.351	2.380	15.602	3.416	15.184	3.097
Washington	2.507	0.247	16.270	3.234	11.325	2.446
West Virginia	17.552	3.645	13.373	2.546	15.776	3.452
Wisconsin	12.537	2.199	16.298	3.498	14.971	3.278
Wyoming	9.194	1.792	8.358	1.210	1.672	0.149

Table 1.9: Ranking of states by year and index calculation method

2000		2006		2012	
Equal Weight	Weighted Avg	Equal Weight	Weighted Avg	Equal Weight	Weighted Avg
Maryland	Maryland	New Mexico	New Mexico	South Carolina	Maine
South Carolina	West Virginia	North Carolina	Mississippi	Mississippi	Connecticut
West Virginia	South Carolina	Nebraska	Wisconsin	Tennessee	Delaware
North Carolina	North Carolina	Pennsylvania	Nebraska	North Carolina	South Carolina
Kentucky	Kentucky	Missouri	Virginia	Alaska	West Virginia
New York	Connecticut	Wisconsin	South Dakota	Maine	Alaska
Massachusetts	Indiana	Washington	North Carolina	Connecticut	Nebraska
Minnesota	New York	Kansas	Kansas	Nebraska	Mississippi
Connecticut	Utah	South Dakota	Pennsylvania	Oregon	Tennessee
Indiana	Minnesota	Mississippi	Missouri	Delaware	Texas
Utah	Vermont	Virginia	Washington	West Virginia	Wisconsin
Vermont	Montana	Hawaii	Connecticut	Minnesota	North Carolina
Wisconsin	Virginia	Kentucky	North Dakota	North Dakota	Minnesota
Montana	Missouri	Nevada	South Carolina	Virginia	Vermont
Hawaii	Hawaii	North Dakota	Hawaii	Texas	Oregon
Florida	Massachusetts	Connecticut	Nevada	Vermont	Virginia
Missouri	Kansas	South Carolina	Kentucky	Wisconsin	North Dakota
Arkansas	Alaska	Montana	New Jersey	Alabama	Michigan
Virginia	South Dakota	Massachusetts	Maryland	Michigan	Arizona
Tennessee	Wisconsin	Maryland	Utah	Hawaii	Hawaii
North Dakota	Florida	Utah	Oklahoma	Maryland	Alabama
California	Arkansas	West Virginia	Maine	New Mexico	New Mexico
Kansas	North Dakota	New Jersey	New York	Arizona	Pennsylvania
Alaska	Tennessee	Colorado	Montana	Illinois	Illinois
South Dakota	California	Oklahoma	West Virginia	Pennsylvania	Idaho
Michigan	Ohio	New York	Minnesota	Idaho	Washington
Nevada	Alabama	Alabama	Massachusetts	Massachusetts	New Jersey
Ohio	Maine	Maine	Rhode Island	Iowa	Utah
Texas	Nevada	Minnesota	Colorado	Indiana	District of Columbia
Alabama	Wyoming	Louisiana	Iowa	Kansas	Maryland
Maine	District of Columbia	Idaho	Louisiana	Missouri	Iowa
Illinois	Michigan	Rhode Island	Alabama	Arkansas	Kansas
Wyoming	Texas	Iowa	Indiana	District of Columbia	Arkansas
New Mexico	New Jersey	Indiana	Illinois	New Jersey	Oklahoma
Pennsylvania	Colorado	Illinois	Oregon	Washington	California
Rhode Island	Rhode Island	Michigan	California	Oklahoma	Massachusetts
Iowa	Delaware	Oregon	Arizona	California	Indiana
Idaho	Illinois	Delaware	Vermont	Montana	Colorado
Colorado	New Hampshire	Vermont	Delaware	Georgia	Missouri
Delaware	Oklahoma	Georgia	New Hampshire	Ohio	Montana
Oklahoma	Iowa	California	Idaho	Utah	Florida
District of Columbia	Idaho	Arizona	Michigan	Florida	Nevada
Oregon	New Mexico	Tennessee	District of Columbia	Colorado	Ohio
New Jersey	Mississippi	New Hampshire	Georgia	Kentucky	Georgia
Louisiana	Pennsylvania	Ohio	Tennessee	Nevada	Kentucky
Georgia	Oregon	Wyoming	Ohio	Louisiana	Rhode Island
New Hampshire	Louisiana	Arkansas	Wyoming	Rhode Island	New Hampshire
Mississippi	Georgia	District of Columbia	Florida	New Hampshire	Louisiana
Arizona	Arizona	Florida	Alaska	New York	South Dakota
Nebraska	Nebraska	Texas	Arkansas	South Dakota	New York
Washington	Washington	Alaska	Texas	Wyoming	Wyoming

Chapter 8: Descriptive Statistics

8.1 Adolescent BMI

The reported mean height and weight, 1.70 meters and 66.11 kilograms, respectively, resulted in a mean BMI of 22.82 with a standard deviation of 4.25 for the entire sample of high school students (Table 1.10). Mean BMI by gender and observation year is reported in Table 1.11. BMI by subgroup is reported in Table 1.12. Results demonstrate that males (23.20) tend to have higher BMI than females (22.46). BMI also increases with age from 21.94 at age 14 to 23.74 at age 18. Black (23.64), Hispanic (23.54), and the Other (22.72) categories all had higher BMI measures than both Asian (21.64) and White (22.67). These findings are consistent with the literature (Freedman, et al 2006, Albrecht & Gordon-Larsen, 2013).

The BMI measures for the sample as a whole correlate with the 75th percentile of the CDC growth charts, which is below both the representative overweight (85th percentile) and obese (95th percentile). This suggests that on average, 14-18 year old students in the United States are within a healthy weight range for their age, height and weight. However, as shown in Table 1.13, when examined by age and gender this is not the case. For example, a 17 year old female with a BMI of 22.85 would be at the 83rd percentile which is borderline overweight (85th percentile). When examined by age and gender, BMI for all subgroups were borderline overweight at approximately the 80th percentile on the CDC growth charts.

Table 1.10: Individual Level Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum
Individual-Level Variables:				
BMI	22.82	4.25	10.11	39.99
log BMI	3.11	0.17	2.31	3.69
Age	15.92	1.19	14	18
Height (m)	1.70	0.10	1.04	2.41
Weight (kg)	66.11	15.36	29.48	180.99
Days in PE	1.85	2.15	0	5
	Percentage			
Categorical Variables				
Gender				
Male	48.86	(reference)		
Female	51.14			
Ethnicity				
White	50.31	(reference)		
Black	16.80			
Hispanic	11.80			
Asian	5.89			
Other	15.20			

Table 1.11: Mean Adolescent BMI by Gender and YRBSS Survey Year

Male			**Female**		
Year	Mean BMI	Standard Deviation	Year	Mean BMI	Standard Deviation
2001	23.21	4.22	2001	22.16	3.85
2007	23.42	4.42	2007	22.67	4.09
2013	23.09	4.45	2013	22.45	4.12

Table 1.12: Adolescent BMI by subgroups for years 2001, 2007, and 2013

	Mean	Standard Error	95% Confidence Interval
Gender			
Female	22.46	0.0109	22.44 – 22.48
Male	23.20	0.0120	23.18 – 23.23
Age			
14 years	21.94	0.0222	21.90 - 21.98
15 years	22.41	0.0151	22.38 - 22.44
16 years	22.88	0.0157	22.85 - 22.91
17 years	23.30	0.0170	23.26 - 23.33
18 years	23.74	0.0254	23.69 - 23.79
Ethnicity			
White	22.67	0.0137	22.64 – 22.70
Black	23.64	0.0241	23.59 – 23.68
Hispanic	23.54	0.0420	23.46 – 23.63
Asian	21.64	0.0411	21.56 – 21.72
Other	22.72	0.0120	22.70 – 22.74

Table 1.13: Adolescent BMI by Age and Gender for years 2001, 2007, and 2013

	Female		**Male**	
	Mean	Standard Deviation	Mean	Standard Deviation
14	21.79	3.92	22.11	4.30
15	22.17	3.98	22.67	4.31
16	22.50	4.01	23.29	4.39
17	22.85	4.13	23.75	4.36
18	23.17	4.31	24.22	4.41

Trends in BMI over time for each state, mean adolescent BMI by year for the entire sample, and mean adolescent BMI by region are reported in appendix tables A.3 – A.5, respectively.

8.2 Explanatory variables

Table 1.10 reports individual-level summary statistics. The average student in the sample was approximately 16 years old. Approximately 50.3% of the students reported being White, 16.8% Black, 11.8% Hispanic, 5.9% Asian, and 15.2% Other. The gender of the sample was split fairly evenly with 48.1% reporting being male and 51.9% female. On average, the students reported participating in PE class approximately 2 days per week.

Table 1.14 reports state-level summary statistics. On average, the Wellness Policy Index increased from 11.68 in year 2000 to 12.19 in year 2012. There was significant variation across time and between states in the Wellness Policy Index (see appendix table A.6). For example, in Florida, the index varied from 11.63 in Year 2000 to 6.69 in Year 2006 and finally to 9.31 in Year 2012. While, in other states, like Alabama, Arizona, and Mississippi, the index steadily increased over the same years.

Although schools were not mandated to have a policy in place prior to 2006, some states were already reacting to the upward trend in BMI among their under-18 populations. As anticipated, the mean Wellness Policy Index increased to 12.21 in year 2006, the year that all schools were required to have a policy in place and maintained at this level through year 2012. Although the overall mean of the Wellness Policy Index does not appear to have changed very much in the years since the mandate, a closer look at the trends both between states and within states over time, shown by the Year by Year Trend column in appendix table A.6, illustrates the variation in the implementation of wellness policies.

Since there were neither guidelines nor standards regarding implementation and measurement of the wellness policies, it is these differences and their correlation to the adolescent BMI trend that is relevant to this research.

The percentage of adult obesity (see appendix table A.7) ranged from a low mean of 34.6% in Utah to a high mean of 37.6% in North Dakota and an overall sample mean of 36.1%. The college education rate (see appendix table A.8) ranged from a low mean of 14.1% in Arkansas to a high mean of 32.1% in Maryland and an overall sample mean of 24.1% . Appendix table A.9 reports state poverty rates that ranged from a low mean 7.0% in New Hampshire of to a high mean of 19.6% in New Mexico and an overall sample mean of 12.8%. The prevalence of violent crime (see appendix table A.10) ranged from a low mean of 1.2% in Maine and Vermont to a high mean of 7.3% in South Carolina and an overall sample mean of 3.8%.

Income inequality was measured in three different ways: the state Gini coefficient with an overall mean of 0.61, the top 10% income share with an overall mean of 43.7%, and the top 1% income share with an overall mean of 18.2% (Table 1.14). The mean state Gini coefficient (see appendix table A.11) ranged from a low mean in Maine of 0.57 to a high mean in Florida of 0.67. Appendix table A.12 reports top 10% income shares that ranged from a low mean in West Virginia of 37.8% to a high mean in New York of 52.9%. The top 1% income shares (see appendix table A.13) ranged from a low mean of 13.9% in Maine to a high mean of 28.6% in Wyoming.

The percent of students who attended public school (see appendix table A.14) ranged from a low mean of 84.7% in Maryland to a high mean of 95.4% in Utah and an overall sample mean of 89.7% (Table 1.14). The percent of students who attended private school (see appendix table A.15) ranged from a low mean of 4.6% in Utah to a high mean of 15.3% in Maryland and an overall sample mean of 10.3% (Table 1.14).

Table 1.14: State Level Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum
Wellness Policy Index Year 2000	11.68	3.44	4.25	18.60
Wellness Policy Index Year 2006	12.21	3.03	6.37	19.22
Wellness Policy Index Year 2012	12.19	3.91	1.67	17.83
Adult Obesity Rate	25.91	3.42	16.80	35.40
College Education Rate	24.08	7.42	11.95	38.50
Poverty Rate	12.79	3.27	5.60	23.10
Violent Crime Rate	377.96	173.68	66.90	847.20
State Unemployment Rate	6.09	2.03	2.60	13.80
Gini Coefficient	0.61	0.04	0.53	0.76
Top 10%	0.44	0.05	0.36	0.65
Top 1%	0.18	0.05	0.11	0.50
Public High School Attendance Rate	89.71	0.03	81.90	97.70
Private High School Attendance Rate	10.29	0.03	2.30	18.10

Note: Violent Crime Rate is per 100,000 population.

Chapter 9: Empirical Implementation

9.1 OLS Estimation

I used basic OLS estimation in order to explore the effect of state wellness policies that are based on a calculated index score (see section 7.2.3). All regressions were run first with BMI and then *log* BMI as then outcome variable.

9.1.1 Determinants of Individual Adolescent BMI Regression

The first model specifications (Models 1-4) were used to analyze determinants of adolescent BMI exclusive of the state wellness policy measure in order to investigate determinants of adolescent BMI. The basic model specification was:

$$BMI_{ist} = \beta_0 + \beta_1 X_{ist} + \beta_2 Z_{ist} + \beta_3 C_{ist} + \mu_{ist}$$

where BMI_{ist} represents the body mass index measure for adolescent i in state *s* at time *t*; X_{ist} is a vector of child characteristics; Z_{ist} is a vector of state-level characteristics; C_{ist} is a vector of state-level contextual characteristics (Models 2, 3, and 4 included a measure of income inequality; state Gini coefficient, top 10% and top 1% income shares by state, respectively); and μ_{ist} represents unobservable factors that are uncorrelated with the rest of the independent variables. Models 5-8 replicated these regressions with *log* BMI as the outcome variable.

The first extension of the basic model (Model 9) excluded contextual effects and included state and time fixed effects as follows:

$$BMI_{ist} = \beta_0 + \beta_1 X_{ist} + \beta_2 Z_{ist} + \beta_3 S + \beta_4 T + \mu_{ist}$$

where *S* and *T* represent state and year fixed effects, respectively. Model 14 replicated this regression with *log* BMI as the outcome variable.

The second extension of the basic model (Models 10-13) incorporated contextual effects. Models 11, 12, and 13 included a measure of income inequality (state Gini coefficient, top 10% and top 1% income shares by state, respectively) in addition to state and time fixed effects as follows:

$$BMI_{ist} = \beta_0 + \beta_1 X_{ist} + \beta_2 Z_{ist} + \beta_3 C_{ist} + \beta_4 S + \beta_5 T + \mu_{ist}$$

Models 15-18 replicated these regressions with *log* BMI as the outcome variable.

9.1.2 Regression Post Wellness Policy Implementation Year

The next specification (Model 19) also used ordinary least squares analysis. The explanatory variable of interest, the wellness policy index, was included to test the effect of state wellness policy implementation on adolescent BMI with state dummy variables to control for state fixed effects. However, since we can only observe the policies that were implemented by each state in 2000, 2006 and 2012, each individual's BMI in year *t=2001, 2007, and 2012,* in state *s* was evaluated under the nearest previous wellness policy. I estimate the following equation:

$$BMI_{ist} = \beta_0 + \beta_1 X_{ist} + \beta_2 Z_{ist} + \beta_3 C_{ist} + \beta_4 S + \beta_5 WellPolIndex_{t-1} + \mu_{ist}$$

where *t* represents each of the YRBSS years 2001, 2007, and 2012; and $WellPolIndex_{t-1}$ represents the state wellness policy measure in the previous year. Models 20, 21, and 22 included a measure of income inequality; state Gini coefficient, top 10% and top 1% income shares by state, respectively. Model 23-26 replicated these regressions with *log* BMI as the outcome variable.

Chapter 10: Results

10.1 OLS Results

10.1.1 Determinants of Individual Adolescent BMI Regression

The outcome variable was either BMI or log BMI. Table 1.15 reports the regression results of the first four model specifications that were used to analyze determinants of adolescent BMI exclusive of the state wellness policy measure. Table 1.16 reports regression results with *log* BMI as the outcome variable.

Regression outcomes for individual and state-level coefficients were consistent across all model specifications. In Model 1, results that were highly significant and positively associated with adolescent BMI included: age (0.4325), black (0.9343), Hispanic (0.8788), other ethnicity (0.1039), adult obesity rate (0.0435), and state poverty rate (0.230). The age coefficient was not surprising; as students age, they also grow in height and weight, resulting in an increased BMI measure over time. The coefficient on adult obesity was also the expected sign. A considerable body of literature (Birch and Deysher, 1985; Coneus and Spiess, 2012; Svensson et al., 2011) has previously shown the significant positive correlation between parent and child BMI. A child whose parent is overweight or obese is much more likely to be overweight or obese themselves compared to those who grow up with normal weight parents.

Furthermore, reported ethnicity results are also consistent with the literature (Albrecht and Gordon-Larsen, 2013; Caprio et al., 2008; Freedman et al., 2006; Ogden et al., 2010).

Results that were highly significant and negatively associated with adolescent BMI included: female (-0.7248), Asian (-0.9896), adult college education rate (-1.7910) and public school attendance rate (-3.3952). The coefficient on female was as expected since females are on average both shorter in stature and lighter in weight compared to males, thus resulting in a lower BMI measure. Ethnicity results are also consistent with previously mentioned literature. As expected, an increase in the adult college education rate is shown to have a negative effect on adolescent BMI. Higher levels of education are associated with increased economic status and parents who influence their children with healthier behaviors such as less fast food consumption and higher levels of physical activity (Haines et al., 2008; Parikka et al., 2015). Interestingly, an increased rate of attendance in public schools is correlated with a decrease in adolescent BMI. This may be due to the fact that public schools are subject to both state and national standards related to physical education, physical activity and nutrition.

Model 5 (Table 1.16), using the same regressors as Model 1, reports results on *log* BMI allowing interpretation of coefficients as percentage changes. Highly significant results included college education rate and public school attendance rate. A one unit increase in the college education rate is associated with a 7.8% decrease in adolescent BMI and a one unit increase in the public school attendance rate is associated with a 14.6% decrease. Although the state poverty rate was also highly statistically significant, a one unit increase was only associated with a 0.08% increase in adolescent BMI. This finding is consistent with Ogden, et al. (2010) findings that higher income does not necessarily translate to lower obesity rates any more or less than lower income correlates to higher obesity rates.

Models 2-4 (Table 1.16) each control for a measure of income inequality; Model 2 includes the state Gini coefficient, Model 3 the income share held by the top 10% in each state, and Model 4 the income share held by the top 1% in each state. Each of the three inequality measure results was highly statistically significant and the expected positive sign. These results support findings that individuals who live near the bottom of the income distribution, quite often use their limited resources to purchase low-cost, high-calorie/low-nutrient foods, resulting in a caloric imbalance where intake exceeds output, thus raising BMI over time (Akee et al., 2013; Egger et al., 2012; Lee et al., 2014; Shih et al., 2013).

Models 6-8 (Table 1.16), using the same regressors as Models 2-4, report results on *log* BMI. A one unit increase in the state Gini coefficient, top 10% income share, and top 1% income share was associated with a 5.4%, 4.9%, and 4.2% increase, respectively in adolescent BMI. All other individual- and state-level results were consistent with the results from Model 5.

Models 9-13 (Table 1.17) include state and year fixed effects. Regression outcomes for individual-level coefficients were consistent across all model specifications and were also consistent with those reported in Models 1-4. Models 14-18 (Table 1.18), using the same regressors as Models 9-13, report results on *log* BMI. Across models 16-18 which included state-level contextual effects, a one unit increase in the college education rate was associated with a percentage decrease in adolescent BMI that ranged from 7.7 to 9.1 percent. A one unit increase in the state Gini coefficient, top 10% income share, and top 1% income share was associated with a 6.8%, 12.2%, and 6.1% increase, respectively in adolescent BMI.

Finally, reported state coefficients for Models 14-18 demonstrate that where a student lives matters geographically (Tables A.16 and A.17). As reported in Table A.3, the states with the highest mean adolescent BMI were Texas in year 2001, Mississippi in year 2007, and

Tennessee in year 2013 while Utah reported the lowest mean BMI in all years. Relative to Alabama, both Texas and Mississippi experienced a decrease in mean adolescent BMI while Tennessee reported a slight increase. Utah maintained a lower mean adolescent BMI relative to Alabama across all years. Most of the coefficients were significant and there was considerable variation in sign and magnitude. This supports the further investigation of state wellness policy implementation that follows.

10.1.2 Regression Post Wellness Policy Implementation

Tables 1.19 and 1.20 present results from Models that now include the state wellness policy indices as an explanatory variable. Although statistically significant, a one unit increase in the wellness policy index is associated with a negligible change in adolescent BMI ranging from 0.03 to 0.06 percent. Surprisingly, the public school attendance rate was highly statistically significant and negatively associated with adolescent BMI for all models. A one unit increase in the public school attendance rate was associated with a 38.1% (Model 23) decrease in adolescent BMI when income inequality was not controlled for and ranged from a 16.6 to 19.4% (Models 24-26) decrease when one of the three inequality measures was included in the regression. Exclusion of the public school explanatory variable from the regression analysis had no significant effect on the results (see appendix Table A.18). It may be the case that states experiencing higher adolescent BMI prevalence were already responding to the problem prior to the CRNA mandate and had begun implementing wellness policies in an effort to combat adolescent obesity. A one unit increase in the state Gini coefficient, top 10% income share, and top 1% income share was associated with a 14%, 21.4%, and 11% increase, respectively in adolescent BMI.

Table 1.15: OLS Regression Results: Determinants of Individual Adolescent BMI Without State and Year Fixed Effects

	Model 1	Model 2	Model 3	Model 4
Age	0.4325***	0.4311***	0.4308***	0.4310***
	(0.0073)	(0.0073)	(0.0073)	(0.0073)
Female	-0.7248***	-0.7263***	-0.7266***	-0.7264***
	(0.0171)	(0.0171)	(0.0171)	(0.0171)
Days in PE	0.0032	0.0015	0.0008	0.0012
	(0.0040)	(0.0040)	(0.0041)	(0.0040)
Black	0.9343***	0.9309***	0.9263***	0.9353***
	(0.0331)	(0.0331)	(0.0331)	(0.0331)
Hispanic	0.8788***	0.8728***	0.8573***	0.8782***
	(0.0466)	(0.0467)	(0.0468)	(0.0466)
Asian	-0.9896***	-0.9970***	-1.0045***	-0.9943***
	(0.0473)	(0.0473)	(0.0474)	(0.0473)
Other	0.1039***	0.1046***	0.1009***	0.1096***
	(0.0282)	(0.0282)	(0.0282)	(0.0282)
Adult Obesity Rate	0.0435***	0.0483***	0.0493***	0.0467***
	(0.0037)	(0.0038)	(0.0038)	(0.0037)
College Education Rate	-1.7910***	-2.0444***	-2.0228***	-1.8977***
	(0.2017)	(0.2074)	(0.2054)	(0.2025)
State Violent Crime Rate	-0.0006***	-0.0006***	-0.0006***	-0.0006***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Public School Attendance Rate	-3.3952***	-3.6864***	-3.6385***	-3.5939***
	(0.3497)	(0.3542)	(0.3518)	(0.3511)
State Poverty Rate	0.0230***	0.0150***	0.0160***	0.0196***
	(0.0035)	(0.0038)	(0.0037)	(0.0035)
State Gini Coefficient		1.2723***		
		(0.2342)		
State Top 10% Income Share			1.1242***	
			(0.1976)	
State Top 1% Income Share				1.0011***
				(0.1655)
Constant	17.6147***	17.1774***	17.3803***	17.6267***
	(0.3742)	(0.3819)	(0.3768)	(0.3742)
State FE	No	No	No	No
Year FE	No	No	No	No
Observations	243,392	243,392	243,392	243,392
R-squared	0.0338	0.0339	0.0339	0.0339

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dummy variables controlling for gender, with male being the omitted category and ethnicity, with white being the omitted category were included for all specifications.

Table 1.16: OLS Regression Results: Determinants of Individual Adolescent *log* BMI Without State and Year Fixed Effects

	Model 5	Model 6	Model 7	Model 8
Age	0.0191***	0.0191***	0.0190***	0.0191***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Female	-0.0299***	-0.0300***	-0.0300***	-0.0300***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Days in PE	0.0004**	0.0003*	0.0003	0.0003*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Black	0.0390***	0.0389***	0.0387***	0.0390***
	(0.0013)	(0.0013)	(0.0013)	(0.0013)
Hispanic	0.0367***	0.0365***	0.0358***	0.0367***
	(0.0019)	(0.0019)	(0.0019)	(0.0019)
Asian	-0.0436***	-0.0439***	-0.0442***	-0.0438***
	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Other	0.0038***	0.0038***	0.0036***	0.0040***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Adult Obesity Rate	0.0017***	0.0019***	0.0020***	0.0019***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
College Education Rate	-0.0779***	-0.0886***	-0.0880***	-0.0824***
	(0.0082)	(0.0084)	(0.0084)	(0.0082)
State Violent Crime Rate	-0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Public School Attendance Rate	-0.1466***	-0.1588***	-0.1571***	-0.1549***
	(0.0143)	(0.0145)	(0.0144)	(0.0144)
State Poverty Rate	0.0008***	0.0004***	0.0005***	0.0006***
	(0.0001)	(0.0002)	(0.0002)	(0.0001)
State Gini Coefficient		0.0536***		
		(0.0096)		
State Top 10% Income Share			0.0487***	
			(0.0082)	
State Top 1% Income Share				0.0421***
				(0.0068)
Constant	2.8877***	2.8692***	2.8775***	2.8882***
	(0.0153)	(0.0156)	(0.0154)	(0.0153)
State FE	No	No	No	No
Year FE	No	No	No	No
Observations	243,392	243,392	243,392	243,392
R-squared	0.0364	0.0366	0.0366	0.0366

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dummy variables controlling for gender, with male being the omitted category and ethnicity, with white being the omitted category were included for all specifications.

Table 1.17: OLS Regression Results: Determinants of Individual Adolescent BMI With State and Year Fixed Effects

	Model 9	Model 10	Model 11	Model 12	Model 13
Age	0.4278***	0.4282***	0.4283***	0.4283***	0.4284***
	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0073)
Female	-0.7256***	-0.7254***	-0.7257***	-0.7258***	-0.7256***
	(0.0171)	(0.0171)	(0.0171)	(0.0171)	(0.0171)
Days in PE	0.0032	0.0030	0.0029	0.0030	0.0029
	(0.0042)	(0.0042)	(0.0042)	(0.0042)	(0.0042)
Black	1.0005***	1.0133***	1.0158***	1.0119***	1.0193***
	(0.0337)	(0.0339)	(0.0339)	(0.0339)	(0.0339)
Hispanic	0.8451***	0.8656***	0.8696***	0.8646***	0.8782***
	(0.0480)	(0.0483)	(0.0484)	(0.0483)	(0.0484)
Asian	-0.9365***	-0.9219***	-0.9189***	-0.9227***	-0.9153***
	(0.0477)	(0.0478)	(0.0478)	(0.0478)	(0.0478)
Other	0.1845***	0.2017***	0.2071***	0.2008***	0.2116***
	(0.0298)	(0.0302)	(0.0303)	(0.0302)	(0.0303)
Adult Obesity Rate		-0.0112	-0.0128	-0.0269**	-0.0127
		(0.0118)	(0.0118)	(0.0123)	(0.0118)
College Education Rate		-1.1352	-2.2428**	-1.9111**	-2.1859**
		(0.8803)	(0.9377)	(0.8944)	(0.9101)
State Violent Crime Rate		-0.0003	-0.0000	0.0001	-0.0000
		(0.0002)	(0.0003)	(0.0003)	(0.0003)
Public School Attendance Rate		-1.6950	-0.9258	-0.6682	-0.5064
		(1.1709)	(1.1959)	(1.1991)	(1.2054)
State Poverty Rate		0.0251***	0.0266***	0.0219**	0.0266***
		(0.0094)	(0.0094)	(0.0094)	(0.0094)
Year 2001	-0.3754***	-0.3596***	-0.3011***	-0.2710***	-0.3008***
	(0.0276)	(0.0410)	(0.0446)	(0.0454)	(0.0430)
Year 2013	-0.1849***	-0.0949	0.0160	0.0083	0.0260
	(0.0304)	(0.1086)	(0.1130)	(0.1107)	(0.1118)
State Gini Coefficient			1.6503***		
			(0.5182)		
State Top 10% Income Share				2.9239***	
				(0.6537)	
State Top 1% Income Share					1.4803***
					(0.3434)
Constant	16.0441***	17.7749***	16.1548***	16.1105***	16.5071***
	(0.1485)	(1.1905)	(1.2944)	(1.2540)	(1.2269)
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	243,392	243,392	243,392	243,392	243,392
R-squared	0.0369	0.0370	0.0370	0.0371	0.0371

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dummy variables controlling for gender, with male being the omitted category and ethnicity, with white being the omitted category were included for all specifications. In Models 2 and 3, dummy variables controlling for state and years 2001, 2007, and 2013 were also included. Omitted state Alabama, omitted year 2007. State results are reported in Appendix A.16.

Table 1.18: OLS Regression Results: Determinants of Individual Adolescent *log* BMI With State and Year Fixed Effects

	Model 14	Model 15	Model 16	Model 17	Model 18
Age	0.0189***	0.0189***	0.0189***	0.0189***	0.0189***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Female	-0.0300***	-0.0300***	-0.0300***	-0.0300***	-0.0300***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Days in PE	0.0004**	0.0003**	0.0003**	0.0004**	0.0003**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Black	0.0419***	0.0424***	0.0425***	0.0424***	0.0427***
	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Hispanic	0.0354***	0.0363***	0.0364***	0.0362***	0.0368***
	(0.0019)	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Asian	-0.0413***	-0.0407***	-0.0406***	-0.0407***	-0.0404***
	(0.0020)	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Other	0.0073***	0.0080***	0.0082***	0.0080***	0.0084***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Adult Obesity Rate		-0.0004	-0.0004	-0.0010**	-0.0004
		(0.0005)	(0.0005)	(0.0005)	(0.0005)
College Education Rate		-0.0447	-0.0905**	-0.0771**	-0.0878**
		(0.0361)	(0.0385)	(0.0367)	(0.0373)
State Violent Crime Rate		-0.0000	-0.0000	0.0000	-0.0000
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
Public School Attendance Rate		-0.0735	-0.0417	-0.0307	-0.0247
		(0.0482)	(0.0492)	(0.0493)	(0.0496)
State Poverty Rate		0.0011***	0.0011***	0.0009**	0.0011***
		(0.0004)	(0.0004)	(0.0004)	(0.0004)
Year 2001	-0.0154***	-0.0146***	-0.0122***	-0.0109***	-0.0122***
	(0.0011)	(0.0017)	(0.0018)	(0.0019)	(0.0018)
Year 2013	-0.0086***	-0.0055	-0.0009	-0.0012	-0.0005
	(0.0012)	(0.0045)	(0.0046)	(0.0045)	(0.0046)
State Gini Coefficient			0.0682***		
			(0.0212)		
State Top 10% Income Share				0.1218***	
				(0.0270)	
State Top 1% Income Share					0.0607***
					(0.0142)
Constant	2.8118***	2.8841***	2.8172***	2.8148***	2.8321***
	(0.0061)	(0.0489)	(0.0531)	(0.0515)	(0.0504)
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	243,392	243,392	243,392	243,392	243,392
R-squared	0.0396	0.0397	0.0398	0.0398	0.0398

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dummy variables controlling for gender, with male being the omitted category and ethnicity, with white being the omitted category were included for all specifications. In Models 2 and 3, dummy variables controlling for state and years 2001, 2007, and 2013 were also included. Omitted state Alabama, omitted year 2007. State results are reported in Appendix A.7.

Table 1.19: Regression Results on Adolescent BMI Post Wellness Policy Implementation

	Model 19	Model 20	Model 21	Model 22
Wellness Policy Index	0.0105**	0.0065*	0.0103**	0.0129***
	(0.0041)	(0.0042)	(0.0041)	(0.0042)
Age	0.4287***	0.4283***	0.4282***	0.4283***
	(0.0073)	(0.0073)	(0.0073)	(0.0073)
Female	-0.7260***	-0.7264***	-0.7264***	-0.7262***
	(0.0171)	(0.0171)	(0.0171)	(0.0171)
Days in PE	0.0027	0.0028	0.0030	0.0028
	(0.0042)	(0.0042)	(0.0042)	(0.0042)
Black	1.0066***	1.0192***	1.0101***	1.0234***
	(0.0337)	(0.0338)	(0.0337)	(0.0338)
Hispanic	0.8584***	0.8702***	0.8583***	0.8810***
	(0.0484)	(0.0484)	(0.0484)	(0.0485)
Asian	-0.9257***	-0.9130***	-0.9220***	-0.9083***
	(0.0477)	(0.0477)	(0.0477)	(0.0477)
Other	0.1939***	0.2161***	0.2009***	0.2210***
	(0.0297)	(0.0299)	(0.0297)	(0.0299)
Adult Obesity Rate	0.0246**	0.0140	0.0427***	0.0183*
	(0.0111)	(0.0112)	(0.0113)	(0.0111)
College Education Rate	0.0937	-1.3039***	-0.7976**	-0.8018**
	(0.3456)	(0.3897)	(0.3587)	(0.3605)
State Violent Crime Rate	-0.0002	0.0002	0.0003	0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Public School Attendance Rate	-9.0988***	-4.4972***	-3.9469***	-4.5994***
	(1.0044)	(1.1541)	(1.1496)	(1.1256)
State Poverty Rate	0.0267***	0.0342***	0.0241***	0.0338***
	(0.0089)	(0.0090)	(0.0089)	(0.0089)
State Gini Coefficient		3.3484***		
		(0.4269)		
State Top 10% Income Share			5.1322***	
			(0.5424)	
State Top 1% Income Share				2.6393***
				(0.3022)
Constant	24.9357***	18.5475***	18.8056***	20.2043***
	(1.0636)	(1.3256)	(1.2490)	(1.1868)
Observations	243,392	243,392	243,392	243,392
R-squared	0.0366	0.0369	0.0369	0.0369

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1; Additional controls include: state dummy variables (coefficients not reported)

Table 1.20: Regression Results on Adolescent *log* BMI Post Wellness Policy Implementation

	Model 23	Model 24	Model 25	Model 26
Wellness Policy Index	0.0005***	0.0003*	0.0005***	0.0006***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Age	0.0189***	0.0189***	0.0189***	0.0189***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Female	-0.0300***	-0.0300***	-0.0300***	-0.0300***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Days in PE	0.0003**	0.0003**	0.0004**	0.0003**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Black	0.0421***	0.0426***	0.0423***	0.0428***
	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Hispanic	0.0359***	0.0364***	0.0359***	0.0369***
	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Asian	-0.0409***	-0.0404***	-0.0408***	-0.0402***
	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Other	0.0076***	0.0085***	0.0079***	0.0087***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Adult Obesity Rate	0.0010**	0.0006	0.0018***	0.0008*
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
College Education Rate	-0.0048	-0.0631***	-0.0420***	-0.0421***
	(0.0142)	(0.0159)	(0.0147)	(0.0148)
State Violent Crime Rate	-0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Public School Attendance Rate	-0.3813***	-0.1892***	-0.1660***	-0.1937***
	(0.0414)	(0.0476)	(0.0473)	(0.0465)
State Poverty Rate	0.0011***	0.0014***	0.0010***	0.0014***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
State Gini Coefficient		0.1397***		
		(0.0174)		
State Top 10% Income Share			0.2144***	
			(0.0223)	
State Top 1% Income Share				0.1100***
				(0.0124)
Constant	3.1857***	2.9191***	2.9296***	2.9885***
	(0.0437)	(0.0544)	(0.0513)	(0.0489)
Observations	243,392	243,392	243,392	243,392
R-squared	0.0393	0.0396	0.0397	0.0396

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1; Additional controls include: state dummy variables (coefficients not reported)

Chapter 11: Dominance Analysis

Dominance analysis is a statistical technique used to determine the relative importance of an individual variable based on the contribution of all pairs of explanatory variables to the overall variance of regression models containing all possible subsets of explanatory variables (Azen and Budescu, 2003). It allows each variable to be ranked from most important to least important according to how much of the additional overall explained variance of the model is explained by the variable (Grömping, 2007; Luchman, 2015). Azen and Budescu (2013) define three levels of dominance: complete, conditional, and general. Complete dominance exists when an explanatory variable has a greater contribution to the explained variance of the model than the dominated variable in all possible subset regressions. Conditional dominance exists when the average additional contribution to the explained variance of the model is greater for one explanatory variable compared to the dominated variable across all possible subset regressions. Finally, general dominance exists when the average additional contribution to the explained variance of the model is greater for one explanatory variable compared to the dominated variable across subset regressions of the same size.

Principal component analysis resulted in four factors that were used to generate the wellness policy index score for each state in the SHPPS survey years 2000, 2006, and 2012 (see Table 1.7). These four factors were: 1) policy that met national standards, 2) policy that met a state requirement, 3) policy that met health screening criteria, and 4) policy that met state recommendations. Of particular interest in this research is the relative importance of each of these factors in the regression analysis of the wellness policy effect on adolescent BMI trends. Dominance analysis was performed in STATA (version 12) using the *"domin"* command. Results of the dominance analysis are reported in Table 1.21.

Table 1.21: Dominance Analysis Results

Factor 2	completely dominates	Factor 1
Factor 3	completely dominates	Factor 1
Factor 2	conditionally dominates	Factor 4
Factor 4	generally dominates	Factor 1
Factor 2	generally dominates	Factor 3
Factor 3	generally dominates	Factor 4

The dominance analysis ranking of the factors and their associated SHPPS survey variables are given in Table 1.22. 1) policy that met state requirements, 2) policy that met health screening criteria, 3) policy that met state recommendations, and 4) policy that met national standards.

Interestingly, the factor ranked as most important contained survey items related to state wellness policy components required by the 2004 CRNA federal mandate (see Table 1.1) while the least impactful factor was related to policies that met national standards. Furthermore, health screening also appears to be an important component of the wellness policy implementation. Perhaps identifying students who are at risk of being overweight or obese through routine school health screenings and following through with family involvement by reporting the screening information, school health officials and staff might help slow the current obesity trend among adolescents.

Table 1.22: Dominance Analysis Factor Ranking

#1: Policy that met state requirements
Health education required
Food service education required
Physical education required
Family/Community involvement required
#2: Policy that met health screening criteria
Student health history
General health screening
PE exempt screening
#3: Policy that met state recommendations
Onsite fast food restrictions
School wellness policy coordinator
#4 Policy that met national standards
National health education standards
USDA nutrition standards
Physical education activity required

Chapter 12: Discussion

12.1 Conclusions

The prevalence of adolescent BMI is currently above the current health policy goal of 14.5% set forth in *Healthy People 2020*. In this research, I examined whether varying degrees of state wellness policy execution, as required by the Child Nutrition and WIC Reauthorization Act of 2004 explained the variation in the prevalence of adolescent obesity as measured by BMI. The results showed that prior to the federal policy being passed in 2006, states were already reacting to the obesity crisis and beginning to formulate their own wellness policy strategies.

Regression results indicated that there was little effect on the increasing BMI trends. This result is not surprising; weight loss and its associated lower BMI measure, happens over time as diet and physical activity changes occur. The fuller effects of each state's health education, nutrition, and physical activity wellness policy components would be expected to be seen in subsequent years following implementation. Even so, the disparity in effectiveness of the wellness policy implementation among states was evident. This is a direct reflection of the ambiguity of the policy mandate itself; states were tasked with having a written policy in place that would address health education, physical activity and education, nutrition, family and community involvement, and faculty/staff health promotion however, there were no stated standards or accountability mechanisms given in the mandate.

States had broad latitude in their interpretation and thus the level of implementation of the wellness policies; it is not unexpected that some states experienced better adolescent BMI outcomes than others as a result of these inconsistencies.

Understanding the determinants of adolescent obesity and how to effect change in the rising trend is a national concern. Obese adolescents are at significant risk of becoming obese adults and previous research has already shown the high economic costs associated with adult obesity and its comorbidities. Of great concern is that obese children and adolescents are now also being diagnosed with obesity-related diseases such as type-2 diabetes, high blood pressure, and cardiovascular disease that were previously diagnosed in adults. Policies implemented in school, where adolescents consume a considerable portion of their daily calories and participate in physical activity, can help to build healthy habits that have the potential to lower the probability of an adolescent becoming an obese adult. Over time, a healthier adult population may result in lower economic costs associated with medical care and lost productivity.

12.2 Study Limitations

One of the disadvantages in using the YRBSS is that the CDC does not release school-level identifiers so I am unable to distinguish private from public school students. Since public schools are legally bound to comply with federal mandates whereas private schools are not, results obtained may be biased. Although the state requirements for public schools may set a standard that is adopted by private schools, the impact of state regulations is likely to be less for private school students than public school students.

Since the models were estimated with a pooled sample of public and private school students, the estimates will likely underestimate the impact of state regulations on public school students.

An additional limitation of this data is that weight and height are self-reported in the YRBSS and are therefore likely reported with error. Although other studies have shown that high school students tend to report height and weight that understates the prevalence of obesity, future research should include observed height and weight data in order to corroborate the results of this study.

Finally, a drawback of this research is that I only observe the state of residence for each student. Therefore, I was only able to use state-level variables in the analysis. Future research should observations at an individual level that can be matched with corresponding county or school data.

12.3 Future Research

Future research in adolescent obesity should include investigation of peer effects. These studies could examine how and to what extent weight status of younger students is affected by their older peers. Similar analysis of same grade peers should also be performed. An understanding of the existence of such peer effects would allow emphasis to be placed on the interventions most likely to affect obesity trends.

Continued research in adolescent obesity should include analysis of specific interventions related to the five general components of the CRNA. Data at the individual student's school level will help to overcome the bias present in research that utilizes aggregate data. Given the appropriate level of data, this research could be extended to the individual student's county or school. The use of micro-level data would enhance the capability to study not only the effect of a school's wellness policy index overall on adolescent obesity trends, but would also allow for analysis of the interaction of the various policy components.

Finally, through use of a suitable instrument for the wellness policy index, potential bias that may exist due to schools, school districts, and state education agencies choosing to implement stricter wellness policies due to existing adolescent obesity trends can be addressed.

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Appendices

Appendix A: Additional Tables

Table A.1 Correlation Matrix of Individual-Level Demographic Explanatory Variables Used in Regression Analysis

	BMI	log BMI	Age	Female	Black	Hispanic	Asian	Other	daysPE
BMI	1								
log BMI	0.993 (0.000)	1							
Age	0.125 (0.000)	0.134 (0.000)	1						
Female	-0.0889 (0.000)	-0.0898 (0.000)	-0.0380 (0.000)	1					
Black	0.0728 (0.000)	0.0741 (0.000)	0.00218 (0.282)	0.00980 (0.000)	1				
Hispanic	0.0352 (0.000)	0.0363 (0.000)	0.0102 (0.000)	-0.000295 (0.884)	-0.0776 (0.000)	1			
Asian	-0.0508 (0.000)	-0.0536 (0.000)	-0.00257 (0.205)	-0.00546 (0.007)	-0.0681 (0.000)	-0.0373 (0.000)	1		
Other	-0.0224 (0.000)	-0.0252 (0.000)	-0.0311 (0.000)	-0.00428 (0.035)	-0.356 (0.000)	-0.195 (0.000)	-0.171 (0.000)	1	
daysPE	-0.0140 (0.000)	-0.0126 (0.000)	-0.189 (0.000)	-0.0968 (0.000)	0.00699 (0.001)	0.0225 (0.000)	0.00844 (0.000)	-0.0441 (0.000)	1

p-values in parentheses

Table A.2: Correlation Matrix of State-Level Explanatory Variables Used In Regression Analysis

	BMI	*log* BMI	Wellness Policy Index	State Adult Obesity Rate	State College Education Rate	State Poverty Rate	State Violent Crime Rate	State Gini Coefficient	State Top 10% Income Share	State Top 1% Income Share	State Public School Attendance Rate
BMI	1										
log BMI	0.9930 (0.000)	1									
Wellness Policy Index	0.0231 (0.019)	0.0161 (0.007)	1								
State Adult Obesity Rate	0.0417 (0.000)	0.0386 (0.000)	0.1590 (0.000)	1							
State College Education Rate	-0.0224 (0.000)	-0.0242 (0.000)	0.156 (0.000)	0.0522 (0.000)	1						
State Poverty Rate	0.0363 (0.000)	0.0333 (0.000)	-0.0205 (0.000)	0.4490 (0.000)	-0.3030 (0.000)	1					
State Violent Crime Rate	0.0175 (0.000)	0.0166 (0.000)	-0.0955 (0.000)	0.2800 (0.000)	-0.1780 (0.000)	0.2870 (0.000)	1				
State Gini Coefficient	0.0133 (0.000)	0.0124 (0.000)	-0.3260 (0.000)	-0.0150 (0.000)	0.0827 (0.000)	0.3380 (0.000)	0.1840 (0.000)	1			
State Top 10% Income Share	0.0138 (0.000)	0.0137 (0.000)	-0.3900 (0.000)	-0.0926 (0.000)	0.0922 (0.000)	0.2560 (0.000)	0.1680 (0.000)	0.8800 (0.000)	1		
State Top 1% Income Share	0.0123 (0.000)	0.0125 (0.000)	-0.4400 (0.000)	-0.0770 (0.000)	-0.0111 (0.000)	0.1460 (0.000)	0.1320 (0.000)	0.8850 (0.000)	0.8860 (0.000)	1	
State Public School Attendance Rate	-0.0026 (0.173)	-0.0025 (0.185)	-0.0747 (0.000)	-0.0862 (0.000)	-0.5400 (0.000)	0.2530 (0.000)	-0.2100 (0.000)	0.0631 (0.000)	0.0300 (0.000)	0.0621 (0.000)	1

p-values in parentheses

Table A.3: Mean BMI by State and YRBSS Survey Year

	Mean (all years)	2001	2007	2013
Alabama	23.24	22.94		23.66
Arizona	22.90		22.78	22.71
Arkansas	23.18	22.93	23.09	23.56
Connecticut	22.86		23.07	22.77
Delaware	23.12	22.75	23.20	23.30
Florida	22.73	22.66	22.81	22.77
Georgia	23.21		23.47	23.14
Idaho	22.51	22.11	22.76	22.65
Indiana	23.24		23.53	
Kansas	22.90		22.93	22.91
Kentucky	23.37		23.33	23.42
Maine	22.89	22.70	22.97	22.80
Maryland	22.64		23.12	22.59
Massachusetts	22.72	22.70	22.79	22.65
Michigan	22.85	22.64	23.17	22.85
Mississippi	23.43	23.29	23.96	22.91
Missouri	23.05	22.92	23.22	23.13
Montana	22.42	22.16	22.48	22.52
New Hampshire	22.94		23.05	22.89
New Jersey	22.71	22.59		22.56
New Mexico	22.53		22.48	22.60
New York	22.92		23.11	22.71
North Carolina	22.97	22.79	23.08	22.82
North Dakota	22.74	22.45	22.77	23.18
Ohio	23.05		23.12	23.15
Oklahoma	23.21		23.48	22.68
Rhode Island	22.87	22.50	22.96	22.86
South Carolina	23.04		23.30	23.06
South Dakota	22.67	22.46	22.74	22.82
Tennessee	23.54		23.80	23.76
Texas	23.45	23.38	23.54	23.51
Utah	21.85	21.67	22.04	21.80
Vermont	22.65	22.47	22.92	22.76
West Virginia	23.15		23.30	23.12
Wisconsin	22.86	22.84	23.02	22.91
Wyoming	22.34	21.99	22.40	22.59

Table A.4: Mean Adolescent BMI by Year

	Mean	Standard Deviation	Minimum	Maximum
2001	22.67	4.07	13.06	39.99
2007	23.04	4.27	13.02	39.99
2013	22.76	4.30	12.91	39.99

Table A.5: Mean Adolescent BMI by Region and YRBSS Survey Year

	Mean (all years)	2001	2007	2013
New England				
Mean	22.76	22.56	22.94	22.77
	(4.11)	(3.91)	(4.11)	(4.26)
East North Central				
Mean	22.94	22.72	23.20	22.92
	(4.20)	(4.02)	(4.25)	(4.30)
West North Central				
Mean	22.83	22.62	22.90	23.02
	(4.13)	(4.00)	(4.11)	(4.39)
South Atlantic				
Mean	22.86	22.72	23.13	22.68
	(4.28)	(4.13)	(4.34)	(4.24)
East South Central				
Mean	23.40	23.12	23.59	23.46
	(4.62)	(4.45)	(4.65)	(4.87)
West South Central				
Mean	23.34	23.29	23.42	23.33
	(4.52)	(4.48)	(4.56)	(4.63)
Mountain				
Mean	22.43	22.03	22.47	22.50
	(4.06)	(3.62)	(4.11)	(4.16)
Pacific				
Mean	22.89	22.59	23.11	22.69
	(4.22)	(3.98)	(4.20)	(4.29)

Standard deviations in parentheses.

Table A.6: Mean Wellness Policy Index by State and SHPPS Survey Year

		SHPPS Survey Year			
	Mean (all years)	2000	2006	2012	Year by Year Trend
Alabama	8.97	9.57	12.26	13.93	
Arizona	7.99	4.25	9.65	12.66	
Arkansas	8.10	11.42	7.08	11.79	
Connecticut	14.48	13.04	14.21	16.52	
Delaware	8.55	7.52	10.03	15.88	
Florida	8.94	11.63	6.69	9.31	
Georgia	8.36	5.02	9.86	10.24	
Idaho	10.25	7.94	11.70	12.20	
Indiana	12.06	12.92	11.65	12.02	
Kansas	14.23	10.98	16.03	11.93	
Kentucky	14.02	14.44	15.05	8.36	
Maine	13.11	9.53	12.26	16.72	
Maryland	13.50	18.60	13.37	13.37	
Massachusetts	11.08	13.22	13.48	12.18	
Michigan	10.13	10.12	11.18	13.63	
Mississippi	10.58	4.83	15.60	17.11	
Missouri	11.32	11.43	16.67	11.86	
Montana	11.24	12.26	13.79	10.87	
New Hampshire	7.11	5.02	8.64	6.13	
New Jersey	10.12	6.45	13.10	11.49	
New Mexico	15.54	8.84	19.22	13.37	
New York	10.84	13.56	12.37	5.23	
North Carolina	16.31	15.05	17.24	16.72	
North Dakota	11.74	11.08	14.93	15.30	
Ohio	7.37	9.90	8.49	10.20	
Oklahoma	10.60	7.24	12.44	11.31	
Rhode Island	9.94	8.36	11.70	6.69	
South Carolina	9.44	17.83	14.21	17.83	
South Dakota	10.77	10.70	15.71	5.01	
Tennessee	11.14	11.14	9.47	16.97	
Texas	8.93	9.72	6.37	15.07	
Utah	11.02	12.82	13.37	10.03	
Vermont	11.65	12.54	10.03	15.05	
West Virginia	13.18	17.55	13.37	15.78	
Wisconsin	13.58	12.54	16.30	14.97	
Wyoming	6.87	9.19	8.36	1.67	

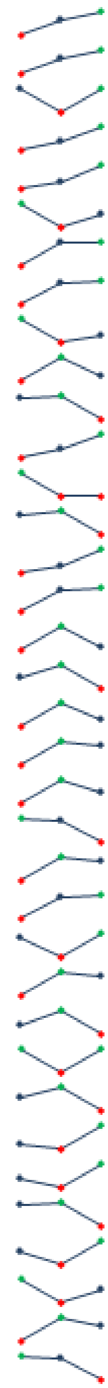


Table A.7: Mean Prevalence of Adult Obesity by State

	Mean	Standard Error	95% Confidence Interval
Alabama	35.48	0.0105	35.47-35.49
Arizona	36.75	0.0123	36.73-36.77
Arkansas	35.14	0.0095	35.12-35.16
Connecticut	37.31	0.0089	37.29-37.33
Delaware	36.04	0.0089	36.01-36.06
Florida	36.77	0.0044	36.75-36.79
Georgia	35.96	0.0077	35.94-35.98
Idaho	36.24	0.0205	36.22-36.25
Indiana	35.28	0.0045	35.27-35.29
Kansas	35.73	0.0006	35.72-35.75
Kentucky	36.99	0.0089	36.95-37.03
Maine	37.06	0.0069	37.05-37.07
Maryland	35.95	0.0118	35.95-35.95
Massachusetts	35.19	0.0116	35.17-35.21
Michigan	35.08	0.0083	35.07-35.10
Mississippi	35.13	0.0083	35.10-35.15
Missouri	35.09	0.0135	35.07-35.11
Montana	36.96	0.0073	36.95-36.98
New Hampshire	36.14	0.0040	36.13-36.13
New Jersey	36.77	0.0102	36.75-36.80
New Mexico	36.65	0.0089	36.63-36.66
New York	36.01	0.0126	36.00-36.02
North Carolina	35.65	0.0067	35.63-35.67
North Dakota	37.55	0.0086	37.53-37.57
Ohio	35.63	0.0051	35.60-35.65
Oklahoma	35.74	0.0056	35.73-35.76
Rhode Island	37.44	0.0094	37.42-37.46
South Carolina	35.19	0.0091	35.18-35.20
South Dakota	37.17	0.0055	37.16-37.18
Tennessee	35.98	0.0065	35.96-36.00
Texas	35.80	0.0129	35.78-35.81
Utah	34.58	0.0089	34.57-34.59
Vermont	35.50	0.0085	35.49-35.51
West Virginia	35.39	0.0105	35.36-35.41
Wisconsin	36.62	0.0123	36.60-36.63
Wyoming	36.50	0.0095	36.48-36.51

Table A.8: Mean College Education Rate by State

	Mean	Standard Error	95% Confidence Interval
Alabama	0.1621	0.0004	0.1613-0.1628
Arizona	0.1900	0.0003	0.1894-0.1906
Arkansas	0.1409	0.0004	0.1402-0.1416
Connecticut	0.2791	0.0005	0.2782-0.2800
Delaware	0.2050	0.0004	0.2042-0.2057
Florida	0.2007	0.0002	0.2003-0.2011
Georgia	0.1969	0.0004	0.1961-0.1976
Idaho	0.1752	0.0004	0.1744-0.1761
Indiana	0.1693	0.0004	0.1685-0.1701
Kansas	0.2336	0.0006	0.2325-0.2347
Kentucky	0.1500	0.0003	0.1494-0.1505
Maine	0.2326	0.0003	0.2321-0.2332
Maryland	0.3208	0.0001	0.3206-0.3210
Massachusetts	0.2672	0.0004	0.2665-0.2680
Michigan	0.1845	0.0003	0.1839-0.1850
Mississippi	0.1435	0.0003	0.1430-0.1441
Missouri	0.1795	0.0004	0.1787-0.1803
Montana	0.2028	0.0003	0.2022-0.2034
New Hampshire	0.2622	0.0006	0.2610-0.2635
New Jersey	0.2769	0.0007	0.2755-0.2783
New Mexico	0.1806	0.0001	0.1804-0.1808
New York	0.2510	0.0003	0.2505-0.2515
North Carolina	0.1844	0.0003	0.1838-0.1850
North Dakota	0.1982	0.0005	0.1972-0.1992
Ohio	0.1859	0.0004	0.1850-0.1867
Oklahoma	0.1729	0.0004	0.1721-0.1737
Rhode Island	0.2432	0.0005	0.2422-0.2441
South Carolina	0.1709	0.0004	0.1701-0.1717
South Dakota	0.1783	0.0004	0.1776-0.1790
Tennessee	0.1815	0.0004	0.1807-0.1823
Texas	0.1829	0.0003	0.1823-0.1835
Utah	0.1907	0.0005	0.1898-0.1916
Vermont	0.2678	0.0002	0.2674-0.2683
West Virginia	0.1423	0.0004	0.1415-0.1431
Wisconsin	0.1989	0.0004	0.1981-0.1997
Wyoming	0.1711	0.0004	0.1704-0.1718

Table A.9: Mean Prevalence of Poverty by State

	Mean	Standard Error	95% Confidence Interval
Alabama	15.89	0.0073	15.87-15.90
Arizona	16.78	0.0265	16.72-16.83
Arkansas	16.37	0.0216	16.32-16.41
Connecticut	9.62	0.0105	9.60-9.64
Delaware	10.16	0.0200	10.12-10.20
Florida	13.55	0.0083	13.53-13.56
Georgia	15.37	0.0238	15.33-15.42
Idaho	12.15	0.0191	12.11-12.19
Indiana	13.42	0.0249	13.37-13.47
Kansas	13.14	0.0098	13.12-13.16
Kentucky	16.01	0.0153	15.98-16.04
Maine	12.22	0.0054	12.21-12.23
Maryland	10.18	0.0014	10.18-10.19
Massachusetts	10.65	0.0063	10.64-10.67
Michigan	12.31	0.0129	12.29-12.34
Mississippi	19.61	0.0293	19.55-19.67
Missouri	12.22	0.0178	12.19-12.25
Montana	14.53	0.0078	14.51-14.54
New Hampshire	7.02	0.0148	6.99-7.04
New Jersey	9.37	0.0192	9.33-9.41
New Mexico	19.64	0.0175	19.67-19.67
New York	14.86	0.0031	14.85-14.87
North Carolina	15.36	0.0131	15.34-15.39
North Dakota	10.93	0.0133	10.91-10.96
Ohio	12.78	0.0128	12.75-12.80
Oklahoma	13.79	0.0105	13.77-13.81
Rhode Island	12.18	0.0121	12.16-12.21
South Carolina	14.11	0.0250	14.06-14.16
South Dakota	11.26	0.0224	11.21-11.30
Tennessee	15.84	0.0129	15.82-15.87
Texas	16.32	0.0065	16.31-16.34
Utah	9.08	0.0136	9.05-9.11
Vermont	9.27	0.0043	9.26-9.27
West Virginia	16.42	0.0103	16.40-16.44
Wisconsin	10.55	0.0115	10.53-10.58
Wyoming	10.38	0.0082	10.37-10.40

Table A.10: Mean Violent Crime Rate by State

	Mean	Standard Error	95% Confidence Interval
Alabama	445.4	0.2627	444.9-446.0
Arizona	466.4	0.4319	465.6-467.3
Arkansas	486.1	0.4110	485.3-486.9
Connecticut	282.3	0.1588	282.0-282.6
Delaware	632.4	0.5505	631.4-633.5
Florida	631.1	0.6960	629.7-632.4
Georgia	429.3	0.4430	428.4-430.1
Idaho	237.3	0.1784	236.9-237.6
Indiana	335.2	0.0918	335.1-335.4
Kansas	387.6	0.4509	386.7-388.5
Kentucky	259.0	0.2311	258.5-259.4
Maine	122.1	0.0346	122.1-122.2
Maryland	487.6	0.2011	487.2-488.0
Massachusetts	469.1	0.2689	468.5-469.6
Michigan	509.2	0.2905	508.6-509.8
Mississippi	306.1	0.3283	305.5-306.8
Missouri	506.5	0.3789	505.7-507.2
Montana	301.5	0.3328	300.9-302.2
New Hampshire	172.0	0.3815	171.2-172.7
New Jersey	331.3	0.4226	330.5-332.1
New Mexico	621.6	0.2209	621.1-622.0
New York	427.8	0.2146	427.4-428.3
North Carolina	429.9	0.3609	429.2-430.6
North Dakota	171.2	0.7410	169.8-172.7
Ohio	327.0	0.2627	326.5-327.5
Oklahoma	490.3	0.2846	489.7-490.8
Rhode Island	256.8	0.1697	256.5-257.2
South Carolina	731.2	1.2829	728.6-733.7
South Dakota	211.2	0.4504	210.3-212.1
Tennessee	671.3	0.6223	670.1-672.6
Texas	497.0	0.4302	496.1-497.8
Utah	231.6	0.2015	231.2-232.0
Vermont	124.5	0.0465	124.4-124.6
West Virginia	293.9	0.2743	293.4-294.5
Wisconsin	253.5	0.1650	253.2-253.8
Wyoming	232.9	0.1538	232.6-233.2

Note: Violent Crime Rate is per 100,000 population.

Table A.11: Mean Gini Coefficient by State and YRBSS Survey Year

	Mean (all years)	2001	2007	2013	Year by Year Trend
Alabama	0.60	0.56	0.65	0.59	
Arizona	0.59	0.56	0.60	0.62	
Arkansas	0.61	0.56	0.67	0.61	
Connecticut	0.66	0.65	0.63	0.70	
Delaware	0.59	0.55	0.56	0.66	
Florida	0.67	0.62	0.69	0.71	
Georgia	0.61	0.58	0.64	0.63	
Idaho	0.62	0.57	0.64	0.64	
Indiana	0.57	0.54	0.60	0.58	
Kansas	0.59	0.55	0.60	0.61	
Kentucky	0.59	0.54	0.63	0.58	
Maine	0.57	0.54	0.60	0.56	
Maryland	0.57	0.56	0.55	0.59	
Massachusetts	0.61	0.60	0.60	0.65	
Michigan	0.59	0.55	0.61	0.62	
Mississippi	0.62	0.55	0.71	0.60	
Missouri	0.60	0.56	0.62	0.61	
Montana	0.62	0.58	0.66	0.63	
New Hampshire	0.57	0.55	0.56	0.60	
New Jersey	0.61	0.60	0.59	0.65	
New Mexico	0.61	0.59	0.65	0.60	
New York	0.67	0.65	0.66	0.71	
North Carolina	0.59	0.55	0.62	0.60	
North Dakota	0.59	0.55	0.60	0.62	
Ohio	0.57	0.53	0.59	0.58	
Oklahoma	0.61	0.56	0.64	0.62	
Rhode Island	0.58	0.56	0.59	0.60	
South Carolina	0.59	0.55	0.64	0.60	
South Dakota	0.61	0.57	0.64	0.63	
Tennessee	0.61	0.56	0.65	0.61	
Texas	0.63	0.60	0.65	0.65	
Utah	0.59	0.55	0.59	0.62	
Vermont	0.58	0.55	0.61	0.59	
West Virginia	0.57	0.52	0.63	0.55	
Wisconsin	0.57	0.54	0.58	0.59	
Wyoming	0.67	0.62	0.64	0.76	

Table A.12: Mean Top 10% Income Share by State and YRBSS Survey Year

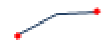
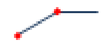
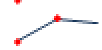
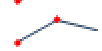
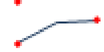
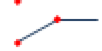
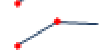
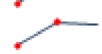
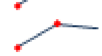
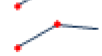
	Mean (all years)	2001	2007	2013	Year by Year Trend
Alabama	0.43	0.40	0.45	0.43	
Arizona	0.43	0.40	0.45	0.45	
Arkansas	0.43	0.40	0.43	0.46	
Connecticut	0.53	0.51	0.53	0.55	
Delaware	0.45	0.40	0.42	0.53	
Florida	0.51	0.47	0.53	0.54	
Georgia	0.45	0.42	0.46	0.46	
Idaho	0.43	0.39	0.45	0.44	
Indiana	0.40	0.37	0.41	0.42	
Kansas	0.43	0.38	0.44	0.45	
Kentucky	0.41	0.38	0.42	0.41	
Maine	0.40	0.38	0.41	0.40	
Maryland	0.41	0.40	0.42	0.42	
Massachusetts	0.48	0.46	0.48	0.49	
Michigan	0.42	0.38	0.42	0.45	
Mississippi	0.42	0.40	0.44	0.43	
Missouri	0.43	0.40	0.44	0.45	
Montana	0.43	0.40	0.43	0.45	
New Hampshire	0.42	0.40	0.43	0.42	
New Jersey	0.46	0.45	0.47	0.48	
New Mexico	0.43	0.42	0.43	0.43	
New York	0.54	0.51	0.55	0.55	
North Carolina	0.43	0.40	0.44	0.44	
North Dakota	0.42	0.37	0.41	0.47	
Ohio	0.41	0.38	0.41	0.42	
Oklahoma	0.44	0.40	0.46	0.47	
Rhode Island	0.42	0.40	0.43	0.43	
South Carolina	0.42	0.39	0.44	0.43	
South Dakota	0.43	0.40	0.44	0.47	
Tennessee	0.44	0.41	0.46	0.46	
Texas	0.48	0.45	0.50	0.50	
Utah	0.42	0.39	0.44	0.44	
Vermont	0.41	0.39	0.43	0.42	
West Virginia	0.38	0.36	0.39	0.38	
Wisconsin	0.40	0.37	0.42	0.42	
Wyoming	0.54	0.46	0.52	0.65	

Table A.13: Mean Top 1% Income Share by State and YRBSS Survey Year

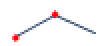
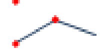
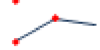
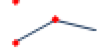
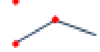
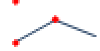
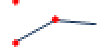
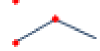
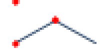
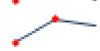
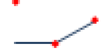
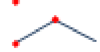
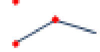
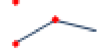
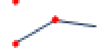
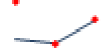
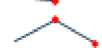
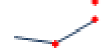
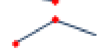
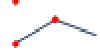
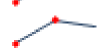
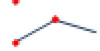
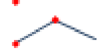
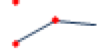
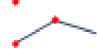
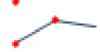
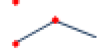
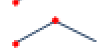
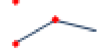
	Mean (all years)	2001	2007	2013	Year by Year Trend
Alabama	0.17	0.14	0.22	0.15	
Arizona	0.18	0.14	0.21	0.17	
Arkansas	0.18	0.14	0.22	0.19	
Connecticut	0.25	0.25	0.21	0.30	
Delaware	0.20	0.14	0.20	0.26	
Florida	0.24	0.20	0.25	0.28	
Georgia	0.18	0.15	0.21	0.18	
Idaho	0.18	0.13	0.23	0.17	
Indiana	0.16	0.13	0.20	0.15	
Kansas	0.17	0.13	0.21	0.19	
Kentucky	0.16	0.13	0.21	0.14	
Maine	0.15	0.13	0.20	0.13	
Maryland	0.16	0.14	0.18	0.17	
Massachusetts	0.21	0.20	0.20	0.24	
Michigan	0.17	0.12	0.20	0.18	
Mississippi	0.17	0.14	0.23	0.15	
Missouri	0.18	0.14	0.22	0.18	
Montana	0.18	0.13	0.22	0.18	
New Hampshire	0.17	0.14	0.19	0.18	
New Jersey	0.19	0.19	0.18	0.21	
New Mexico	0.17	0.15	0.21	0.15	
New York	0.27	0.26	0.24	0.31	
North Carolina	0.17	0.13	0.20	0.16	
North Dakota	0.18	0.11	0.21	0.22	
Ohio	0.16	0.13	0.21	0.16	
Oklahoma	0.20	0.14	0.24	0.21	
Rhode Island	0.17	0.15	0.20	0.17	
South Carolina	0.16	0.13	0.21	0.15	
South Dakota	0.20	0.14	0.23	0.21	
Tennessee	0.19	0.15	0.23	0.19	
Texas	0.21	0.17	0.23	0.24	
Utah	0.18	0.13	0.22	0.19	
Vermont	0.16	0.13	0.21	0.15	
West Virginia	0.14	0.11	0.20	0.12	
Wisconsin	0.17	0.13	0.21	0.17	
Wyoming	0.33	0.23	0.28	0.50	

Table A.14: Mean Public High School Attendance Rate by State

	Mean	Standard Error	95% Confidence Interval
Alabama	88.79	0.0001	88.78-88.80
Arizona	93.93	0.0000	93.92-93.94
Arkansas	92.53	0.0001	92.51-92.55
Connecticut	89.12	0.0001	89.11-89.14
Delaware	85.14	0.0001	85.11-85.17
Florida	89.56	0.0000	89.55-89.56
Georgia	90.58	0.0001	90.56-90.59
Idaho	93.63	0.0001	93.62-93.65
Indiana	90.76	0.0001	90.75-90.77
Kansas	90.84	0.0001	90.81-90.87
Kentucky	89.25	0.0001	89.24-89.26
Maine	88.62	0.0001	88.60-88.63
Maryland	84.65	0.0000	84.65-84.66
Massachusetts	87.25	0.0001	87.24-87.27
Michigan	91.59	0.0000	91.58-91.59
Mississippi	89.06	0.0001	89.05-89.07
Missouri	88.28	0.0001	88.27-88.29
Montana	92.95	0.0001	92.93-92.97
New Hampshire	88.78	0.0001	88.76-88.79
New Jersey	88.05	0.0001	88.03-88.06
New Mexico	91.65	0.0001	91.64-91.67
New York	86.73	0.0000	86.73-86.74
North Carolina	91.96	0.0000	91.95-91.97
North Dakota	93.37	0.0002	93.33-93.40
Ohio	88.31	0.0001	88.29-88.33
Oklahoma	92.29	0.0001	92.26-92.30
Rhode Island	86.32	0.0001	86.30-86.34
South Carolina	91.39	0.0001	91.36-91.42
South Dakota	93.24	0.0002	93.20-93.28
Tennessee	87.51	0.0001	87.50-87.53
Texas	93.83	0.0000	93.82-93.83
Utah	95.38	0.0001	95.37-95.39
Vermont	89.14	0.0000	89.13-89.15
West Virginia	93.16	0.0000	93.15-93.17
Wisconsin	91.05	0.0000	91.04-91.06
Wyoming	95.12	0.0001	95.10-95.15

Table A.15: Mean Private High School Attendance Rate by State

	Mean	Standard Error	95% Confidence Interval
Alabama	11.21	0.0001	11.20-11.23
Arizona	6.07	0.0000	6.07-6.08
Arkansas	7.47	0.0001	7.45-7.49
Connecticut	10.88	0.0001	10.86-10.89
Delaware	14.86	0.0001	14.83-14.89
Florida	10.44	0.0000	10.44-10.45
Georgia	9.42	0.0001	9.41-9.44
Idaho	6.37	0.0001	6.35-6.38
Indiana	9.24	0.0001	9.23-9.25
Kansas	9.16	0.0001	9.13-9.19
Kentucky	10.75	0.0001	10.74-10.76
Maine	11.38	0.0001	11.37-11.40
Maryland	15.35	0.0000	15.34-15.35
Massachusetts	12.75	0.0001	12.73-12.76
Michigan	8.41	0.0000	8.41-8.42
Mississippi	10.94	0.0001	10.93-10.95
Missouri	11.72	0.0001	11.71-11.74
Montana	7.05	0.0001	7.03-7.07
New Hampshire	11.22	0.0001	11.21-11.24
New Jersey	11.95	0.0001	11.94-11.97
New Mexico	8.35	0.0001	8.33-8.36
New York	13.27	0.0000	13.26-13.27
North Carolina	8.04	0.0000	8.03-8.05
North Dakota	6.63	0.0001	6.60-6.66
Ohio	11.69	0.0001	11.67-11.71
Oklahoma	7.72	0.0001	7.70-7.74
Rhode Island	13.68	0.0001	13.66-13.70
South Carolina	8.61	0.0001	8.58-8.64
South Dakota	6.76	0.0002	6.72-6.80
Tennessee	12.49	0.0001	12.47-12.50
Texas	6.17	0.0000	6.18-6.18
Utah	4.62	0.0001	4.61-4.63
Vermont	10.86	0.0000	10.85-10.87
West Virginia	6.84	0.0000	6.83-6.85
Wisconsin	8.95	0.0000	8.94-8.96
Wyoming	4.88	0.0001	4.85-4.91

Table A.16: OLS State Regression Results: Determinants of Individual Adolescent BMI With State and Year Fixed Effects

	Model 9	Model 10	Model 11	Model 12	Model 13
Arizona	-0.7633***	-0.7400***	-0.7994***	-0.9442***	-0.8280***
	(0.1197)	(0.1578)	(0.1592)	(0.1656)	(0.1595)
Arkansas	-0.0213	-0.0033	-0.1091	-0.1373	-0.1130
	(0.1135)	(0.1297)	(0.1341)	(0.1338)	(0.1324)
Delaware	-0.2047**	-0.0279	-0.0003	-0.1948	-0.0405
	(0.1026)	(0.1362)	(0.1364)	(0.1416)	(0.1363)
Florida	-0.6473***	-0.5703***	-0.7504***	-1.0341***	-0.7307***
	(0.0962)	(0.1481)	(0.1593)	(0.1829)	(0.1533)
Georgia	-0.2445**	-0.1813	-0.2175*	-0.3268**	-0.2031
	(0.1143)	(0.1252)	(0.1260)	(0.1301)	(0.1254)
Idaho	-0.6701***	-0.5873***	-0.6092***	-0.6819***	-0.6012***
	(0.1064)	(0.1441)	(0.1443)	(0.1461)	(0.1442)
Indiana	0.0632	0.1272	0.1580	0.1280	0.1050
	(0.1361)	(0.1546)	(0.1548)	(0.1546)	(0.1548)
Kansas	-0.3445***	-0.1946	-0.1514	-0.2687**	-0.1923
	(0.1149)	(0.1334)	(0.1338)	(0.1349)	(0.1334)
Kentucky	0.0823	-0.0094	-0.0061	0.0439	-0.0043
	(0.1137)	(0.1250)	(0.1250)	(0.1253)	(0.1250)
Maine	-0.3587***	-0.3556**	-0.1924	-0.2492*	-0.2169
	(0.0987)	(0.1490)	(0.1569)	(0.1506)	(0.1519)
Maryland	-0.6959***	-0.5409***	-0.4052**	-0.4997***	-0.4012**
	(0.0907)	(0.1581)	(0.1630)	(0.1583)	(0.1609)
Massachusetts	-0.4456***	-0.2998*	-0.2223	-0.5451***	-0.2525
	(0.0978)	(0.1762)	(0.1772)	(0.1859)	(0.1763)
Michigan	-0.3295***	-0.1657	-0.1862*	-0.2548**	-0.1956*
	(0.0973)	(0.1126)	(0.1128)	(0.1148)	(0.1129)
Mississippi	-0.1699	-0.3566***	-0.3974***	-0.3123**	-0.3647***
	(0.1157)	(0.1258)	(0.1265)	(0.1260)	(0.1258)
Missouri	-0.2558**	-0.1538	-0.1498	-0.2469*	-0.1566
	(0.1110)	(0.1291)	(0.1291)	(0.1311)	(0.1291)
Montana	-0.7931***	-0.7517***	-0.7958***	-0.9079***	-0.7813***
	(0.0957)	(0.1468)	(0.1477)	(0.1520)	(0.1471)
New Hampshire	-0.2680**	-0.0795	0.1398	-0.0276	0.0801
	(0.1188)	(0.1923)	(0.2031)	(0.1924)	(0.1951)
New Jersey	-0.5757***	-0.4193**	-0.3533**	-0.5796***	-0.3497**
	(0.1115)	(0.1713)	(0.1721)	(0.1756)	(0.1718)
New Mexico	-0.6376***	-0.7207***	-0.8585***	-0.9260***	-0.8197***
	(0.1035)	(0.1688)	(0.1747)	(0.1759)	(0.1706)
New York	-0.4932***	-0.4773***	-0.5000***	-0.8407***	-0.5031***
	(0.0956)	(0.1529)	(0.1533)	(0.1747)	(0.1531)
North Carolina	-0.2924***	-0.2114*	-0.2290*	-0.3273***	-0.2517**
	(0.1076)	(0.1234)	(0.1236)	(0.1269)	(0.1239)
North Dakota	-0.5756***	-0.6180***	-0.5237***	-0.5884***	-0.5381***
	(0.1322)	(0.1858)	(0.1876)	(0.1857)	(0.1863)
Ohio	-0.2743**	-0.2486*	-0.1742	-0.2159	-0.2322
	(0.1280)	(0.1428)	(0.1443)	(0.1429)	(0.1428)
Oklahoma	-0.1669	-0.0613	-0.1447	-0.2427*	-0.1775
	(0.1183)	(0.1299)	(0.1329)	(0.1369)	(0.1330)
Rhode Island	-0.3678***	-0.3634**	-0.2066	-0.3685**	-0.2231
	(0.1051)	(0.1812)	(0.1866)	(0.1812)	(0.1834)

South Carolina	-0.2538	-0.1052	-0.2576	-0.2937	-0.2355
	(0.1647)	(0.1899)	(0.1962)	(0.1952)	(0.1925)
South Dakota	-0.5712***	-0.4259***	-0.4134***	-0.5273***	-0.4444***
	(0.1082)	(0.1483)	(0.1483)	(0.1505)	(0.1484)
Tennessee	0.2438**	0.2830**	0.1880	0.1374	0.2030
	(0.1212)	(0.1390)	(0.1426)	(0.1432)	(0.1404)
Texas	-0.0458	0.0344	-0.0818	-0.2566*	-0.1009
	(0.0982)	(0.1211)	(0.1270)	(0.1393)	(0.1255)
Utah	-1.2977***	-1.1493***	-1.1161***	-1.3106***	-1.1792***
	(0.1044)	(0.1729)	(0.1730)	(0.1777)	(0.1732)
Vermont	-0.3906***	-0.2841	-0.0835	-0.2434	-0.0974
	(0.0913)	(0.1876)	(0.1964)	(0.1876)	(0.1915)
West Virginia	-0.0053	0.0050	-0.0051	0.1103	-0.0236
	(0.1276)	(0.1469)	(0.1469)	(0.1483)	(0.1471)
Wisconsin	-0.4254***	-0.3122**	-0.2098	-0.3080**	-0.2671*
	(0.1074)	(0.1393)	(0.1424)	(0.1393)	(0.1395)
Wyoming	-0.8308***	-0.7271***	-0.8618***	-1.2283***	-1.0137***
	(0.0996)	(0.1551)	(0.1609)	(0.1917)	(0.1688)

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dummy variables controlling for gender, with male being the omitted category and ethnicity, with white being the omitted category were included for all specifications. In Models 9-13, dummy variables controlling for state and years 2001, 2007, and 2013 were also included. Omitted state Alabama, omitted year 2007.

Table A.17: OLS State Regression Results: Determinants of Individual Adolescent *log* BMI With State and Year Fixed Effects

	Model 14	Model 15	Model 16	Model 17	Model 18
Arizona	-0.0320***	-0.0302***	-0.0326***	-0.0387***	-0.0338***
	(0.0049)	(0.0065)	(0.0065)	(0.0068)	(0.0065)
Arkansas	-0.0016	-0.0004	-0.0047	-0.0060	-0.0049
	(0.0046)	(0.0053)	(0.0054)	(0.0054)	(0.0054)
Delaware	-0.0070*	0.0010	0.0021	-0.0059	0.0005
	(0.0042)	(0.0055)	(0.0056)	(0.0058)	(0.0055)
Florida	-0.0263***	-0.0220***	-0.0294***	-0.0413***	-0.0286***
	(0.0039)	(0.0060)	(0.0065)	(0.0075)	(0.0063)
Georgia	-0.0092**	-0.0062	-0.0077	-0.0123**	-0.0071
	(0.0046)	(0.0051)	(0.0051)	(0.0053)	(0.0051)
Idaho	-0.0270***	-0.0233***	-0.0242***	-0.0273***	-0.0239***
	(0.0043)	(0.0059)	(0.0059)	(0.0060)	(0.0059)
Indiana	0.0030	0.0060	0.0072	0.0060	0.0050
	(0.0055)	(0.0063)	(0.0063)	(0.0063)	(0.0063)
Kansas	-0.0130***	-0.0064	-0.0046	-0.0095*	-0.0063
	(0.0047)	(0.0054)	(0.0055)	(0.0055)	(0.0054)
Kentucky	0.0026	-0.0013	-0.0011	0.0009	-0.0011
	(0.0046)	(0.0051)	(0.0051)	(0.0051)	(0.0051)
Maine	-0.0134***	-0.0134**	-0.0066	-0.0089	-0.0077
	(0.0040)	(0.0061)	(0.0064)	(0.0062)	(0.0062)
Maryland	-0.0277***	-0.0208***	-0.0151**	-0.0190***	-0.0150**
	(0.0037)	(0.0065)	(0.0067)	(0.0065)	(0.0066)
Massachusetts	-0.0167***	-0.0100	-0.0068	-0.0203***	-0.0081
	(0.0040)	(0.0072)	(0.0072)	(0.0076)	(0.0072)
Michigan	-0.0125***	-0.0051	-0.0060	-0.0088*	-0.0063
	(0.0040)	(0.0046)	(0.0046)	(0.0047)	(0.0046)
Mississippi	-0.0093**	-0.0174***	-0.0191***	-0.0156***	-0.0177***
	(0.0047)	(0.0051)	(0.0051)	(0.0051)	(0.0051)
Missouri	-0.0108**	-0.0060	-0.0059	-0.0099*	-0.0062
	(0.0045)	(0.0053)	(0.0053)	(0.0053)	(0.0053)
Montana	-0.0310***	-0.0287***	-0.0305***	-0.0352***	-0.0299***
	(0.0039)	(0.0060)	(0.0060)	(0.0062)	(0.0060)
New Hampshire	-0.0093*	-0.0015	0.0076	0.0007	0.0050
	(0.0048)	(0.0079)	(0.0083)	(0.0079)	(0.0080)
New Jersey	-0.0226***	-0.0159**	-0.0131*	-0.0225***	-0.0130*
	(0.0046)	(0.0070)	(0.0070)	(0.0072)	(0.0070)
New Mexico	-0.0273***	-0.0295***	-0.0352***	-0.0381***	-0.0336***
	(0.0042)	(0.0069)	(0.0071)	(0.0072)	(0.0070)
New York	-0.0198***	-0.0187***	-0.0197***	-0.0339***	-0.0198***
	(0.0039)	(0.0062)	(0.0062)	(0.0071)	(0.0062)
North Carolina	-0.0125***	-0.0087*	-0.0094*	-0.0135***	-0.0103**
	(0.0044)	(0.0050)	(0.0050)	(0.0052)	(0.0050)
North Dakota	-0.0228***	-0.0247***	-0.0208***	-0.0235***	-0.0214***
	(0.0054)	(0.0076)	(0.0077)	(0.0076)	(0.0076)
Ohio	-0.0105**	-0.0093	-0.0062	-0.0079	-0.0086
	(0.0052)	(0.0058)	(0.0058)	(0.0058)	(0.0058)
Oklahoma	-0.0076	-0.0027	-0.0062	-0.0103*	-0.0075
	(0.0048)	(0.0053)	(0.0054)	(0.0056)	(0.0054)
Rhode Island	-0.0134***	-0.0131*	-0.0066	-0.0133*	-0.0073
	(0.0043)	(0.0074)	(0.0076)	(0.0074)	(0.0075)

South Carolina	-0.0106	-0.0034	-0.0097	-0.0112	-0.0087
	(0.0067)	(0.0077)	(0.0080)	(0.0079)	(0.0078)
South Dakota	-0.0215***	-0.0153**	-0.0148**	-0.0196***	-0.0161***
	(0.0044)	(0.0061)	(0.0061)	(0.0062)	(0.0061)
Tennessee	0.0092*	0.0114**	0.0075	0.0053	0.0081
	(0.0049)	(0.0056)	(0.0058)	(0.0058)	(0.0057)
Texas	-0.0023	0.0016	-0.0032	-0.0105*	-0.0040
	(0.0040)	(0.0049)	(0.0052)	(0.0057)	(0.0051)
Utah	-0.0544***	-0.0476***	-0.0462***	-0.0543***	-0.0488***
	(0.0043)	(0.0071)	(0.0071)	(0.0073)	(0.0071)
Vermont	-0.0149***	-0.0104	-0.0021	-0.0087	-0.0027
	(0.0037)	(0.0077)	(0.0080)	(0.0077)	(0.0078)
West Virginia	-0.0011	-0.0007	-0.0011	0.0037	-0.0018
	(0.0052)	(0.0060)	(0.0060)	(0.0060)	(0.0060)
Wisconsin	-0.0156***	-0.0107*	-0.0065	-0.0105*	-0.0089
	(0.0044)	(0.0057)	(0.0058)	(0.0057)	(0.0057)
Wyoming	-0.0335***	-0.0287***	-0.0343***	-0.0496***	-0.0404***
	(0.0041)	(0.0064)	(0.0066)	(0.0079)	(0.0069)

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dummy variables controlling for gender, with male being the omitted category and ethnicity, with white being the omitted category were included for all specifications. In Models 2 and 3, dummy variables controlling for state and years 2001, 2007, and 2013 were also included. Omitted state Alabama, omitted year 2007.

Table A.18: OLS State Regression Results: Determinants of Individual Adolescent BMI With State and Year Fixed Effects Exclusive of Public School Attendance

	Model 1	Model 2	Model 3	Model 4
Wellness Policy Index	0.0023	0.0025	0.0075*	0.0100**
	(0.0040)	(0.0040)	(0.0040)	(0.0040)
Age	0.4286***	0.4282***	0.4281***	0.4282***
	(0.0073)	(0.0073)	(0.0073)	(0.0073)
Female	-0.7263***	-0.7266***	-0.7266***	-0.7264***
	(0.0171)	(0.0171)	(0.0171)	(0.0171)
Days in PE	0.0027	0.0028	0.0031	0.0028
	(0.0042)	(0.0042)	(0.0042)	(0.0042)
Black	0.9979***	1.0187***	1.0078***	1.0233***
	(0.0337)	(0.0338)	(0.0337)	(0.0338)
Hispanic	0.8540***	0.8711***	0.8567***	0.8837***
	(0.0484)	(0.0484)	(0.0484)	(0.0485)
Asian	-0.9361***	-0.9142***	-0.9249***	-0.9091***
	(0.0477)	(0.0477)	(0.0477)	(0.0477)
Other	0.1835***	0.2170***	0.1985***	0.2222***
	(0.0297)	(0.0299)	(0.0297)	(0.0299)
Adult Obesity Rate	-0.0004	-0.0024	-0.0374***	-0.0073
	(0.0108)	(0.0108)	(0.0112)	(0.0108)
College Education Rate	-0.8520**	-1.9746***	-1.2664***	-1.3654***
	(0.3316)	(0.3487)	(0.3334)	(0.3349)
State Violent Crime Rate	-0.0000	0.0003	0.0004*	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
State Poverty Rate	0.0406***	0.0412***	0.0284***	0.0408***
	(0.0088)	(0.0088)	(0.0088)	(0.0088)
State Gini Coefficient		4.0889***		
		(0.3718)		
State Top 10% Income Share			5.9758***	
			(0.4740)	
State Top 1% Income Share				3.1667***
				(0.2697)
Constant	15.9687***	13.7056***	14.7428***	15.6121***
	(0.3643)	(0.4137)	(0.3739)	(0.3644)
Observations	243,392	243,392	243,392	243,392
R-squared	0.0363	0.0368	0.0369	0.0368

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1; Additional controls include: state dummy variables (coefficients not reported)

About the Author

Anastasia King Smith graduated magna cum laude from St. Petersburg College in St. Petersburg, Florida with a B.A.S. in Information Technology Management in 2006. In 2010, she earned an M.A. in Business Economics from the University of South Florida. That same year, she was accepted into the USF College of Business Ph.D. program and was awarded a graduate fellowship for her first year of doctoral study. Her fields of study included health economics, public economics and public health.

As an undergraduate, Mrs. Smith was awarded a National Science Foundation Scholarship in Mathematics in recognition of academic achievement and as a graduate student she was employed by the Economics Department as a teaching assistant from period of 2010-2012. She has been employed with Pfeiffer University as an Assistant Professor of Economics since 2013.