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Reading, Writing, and Raisinettes[1]: Are School Finances Contributing to Children's Obesity?

Patricia M. Anderson

Department of Economics
Dartmouth College
Hanover, NH 03755-3514
And
National Bureau of Economic Research
patty.anderson@dartmouth.edu

Kristin F. Butcher

Federal Reserve Bank of Chicago
Research Department
230 S. LaSalle Street
Chicago, IL 60604
kbutcher@frbchi.org

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[1] This is in no way meant to impugn Raisinettes, the Nestle company or any of its other products.

Abstract

We use a two sample procedure to examine whether school food policies affect adolescent obesity, which has increased sharply over the past two decades. We use data from the School Health Policies and Programs Study to get information on school food policies – availability of "junk food", school has an exclusive ("pouring rights") contract with a soda company, and whether food and beverage companies are allowed to advertise through the school. We then estimate the fraction of schools in a county with these types of school food policies based on the fraction of district revenue that comes from the state, whether state law has imposed a property tax revenue limit on school districts, and whether the state has a school accountability law in place. We use the results of this regression to predict the fraction of schools with specific food policies in counties in the Youth Risk Behavior Survey (YRBS). Our second stage examines the relationship between obesity as measured in the YRBS and the predicted fraction of schools in the county with specific food policies, controlling for personal and county-level characteristics. We find that there is a positive and significant effect of predicted food policies on the probability that adolescents are obese. However, this relationship becomes insignificant when county-level education controls are included in the regression. We do the same exercise with the Behavioral Risk Factors Surveillance Survey (BRFSS) in order to see if school food policies have the same relationship with adult (aged 30-60) obesity – adults, presumably, cannot be directly affected by current school food policies. We find very similar results for adults and adolescents. This suggests that either, adults who are obese are less likely to object to school food policies that give adolescents access to snack foods and sodas, or that there is some other factor (correlated with the instruments and school food policies) that is driving both adult and adolescent obesity. More research is needed to differentiate between these two possibilities.

I. Introduction

Over the past three decades, weight problems among children have grown dramatically. After holding fairly steady at around 5% during the 1970s the percent of 12 to 19 year-olds that were obese doubled by the early nineties and was over 15% by 2000 (Ogden, et al., 2002). At some basic physiological level, the cause of this increase in overweight status among children is clear: weight gain is attributable to taking in more energy than one expends. What is unclear is what has upset this balance between energy intake and expenditure.

Observers have begun to question the role played by our schools, pointing in particular to declines in physical education and increases in the availability of soft drinks and snack foods. New accountability measures, which typically require that students achieve a certain minimum level on standardized tests or the school suffers consequences, may give schools an added incentive to invest resources in core academic curricula. Schools may need to raise new money in to order to achieve this goal while maintaining other programs. The tax reform movement during the 1970s and 1980s may have limited schools' ability to raise money. One way schools can get extra money to maintain optional programs or strengthen core academics is through soft drink and vending contracts, or through other snack food sales. The media is rife with examples of schools cutting deals with soda and snack vending companies. For example, one high school in Beltsville, MD made $72,438.53 in the 1999-2000 school year through a contract with a soft drink company and another $26,227.49 through a contract with a snack vending company. The almost $100,000 obtained was used for a variety of activities, including instructional uses such as computers and wiring, as well as extracurricular uses such as the yearbook, clubs and field trips (Nakamura, 2001). District level contracts can be even more lucrative – one Colorado Springs

district, for example, negotiated a 10-year beverage contract for $11.1 million dollars (DD Marketing, 2003).

The purpose of our study is two-fold. First, we want to examine whether there is a relationship between school financing, property tax revenue limits, and accountability measures and schools' food policies regarding snack foods and drinks. Second, we want to examine whether the availability of high-calorie snacks and drinks in schools can be linked to adolescent obesity. As school districts nationwide debate the benefits and costs of entering into contracts with soda companies or banning the sales of snacks and sodas on campus it is important to have solid information on which to base these decisions. For example, high-calorie snack foods and beverages may be so ubiquitous that adolescents will consume them whether or not they are available through the school. If that is the case, policy-makers might prefer schools to sell the foods students crave. In that way, at least, students are not leaving school to get that food (with all the attendant dangers that may entail) and schools can use the extra funds to students' advantage.

We use a two sample procedure to examine whether school food policies affect adolescent obesity. We use data from the School Health Policies and Programs Study to get information on school food policies – availability of "junk food", school has an exclusive ("pouring rights") contract with a soda company, and whether food and beverage companies are allowed to advertise through the school. We then merge on information on school district finances from the National Center for Education Statistics. We aggregate these data to the county level. We use these data to estimate the fraction of schools in a county with these types of school food policies based on the fraction of district revenue that comes from the state, whether state law has imposed a property tax revenue limit on school districts, and whether the state has a

school accountability law in place. We are then able to use the results of this regression to predict the fraction of schools with specific food policies in counties in the Youth Risk Behavior Survey (YRBS). Our second stage examines the relationship between obesity as measured in the YRBS and the predicted fraction of schools in the county with specific food policies, controlling for personal and county-level characteristics.

We find that there is a positive and significant effect of predicted food policies on the probability that adolescents are obese. However, this relationship becomes insignificant when county-level education controls are included in the regression. We do the same exercise with the Behavioral Risk Factors Surveillance Survey (BRFSS) in order to see if school food policies have the same relationship with adult (aged 30-60) obesity – adults, presumably, cannot be directly affected by current school food policies. We find very similar results for adults and adolescents. This suggests that either, adults who are obese are less likely to object to school food policies that give adolescents access to snack foods and sodas, or that there is some other factor (correlated with the instruments and school food policies) that is driving both adult and adolescent obesity. More research is needed to differentiate between these two possibilities.

The paper is organized as follows. In section II, we document the increase in obesity in the United States using the National Health and Nutrition Examination Survey, the Youth Risk Behavior Survey, and the Behavioral Risk Factor Surveillance System. In Section III, we use the School Health Policies and Programs Study to document the availability of snack foods and soft drinks in schools. Further, we show how district and county characteristics vary by school food policies. In Section IV we present the two sample estimation results. Section V concludes.

II. Obesity in the United States

Public health officials are alarmed at the increase in obesity in the United States. A recent surgeon general's report details the deleterious health effects of excess weight.[2] For example, individuals with a BMI above 30 have a 50 to 100 percent increased risk of premature death from all causes compared to individuals with BMI in the "healthy range" from 20 to 25. By some estimates, 300,000 deaths a year may be attributable to obesity, making it the second leading cause of "preventable" deaths after smoking (which accounts for 400,000 deaths). The increase in childhood obesity is particularly worrisome as obesity in childhood has both immediate and long-term health risks, including Type 2 diabetes, hypertension and cardiovascular disease (Ebbeling et. al. 2002). In addition, a recent Journal of the American Medical Association article reports that obese children have dismally low quality of life scores (Schwimmer et al. 2003).

Figures 1a and 1b show the changes in body-mass-index (BMI) over the last 30 years.[3] BMI is the measure typically used to categorize people into "healthy," "overweight," or "obese," categories. Adults are considered underweight if their BMI is less than 18.5, overweight if their BMI is 25 or more, and obese if their BMI is 30 or more. Children's BMI is categorized according to sex-specific height and weight charts for their age (see appendix for more details). Figures 1a and 1b use the National Health and Nutrition Examination Survey for information on height and weight used in calculating BMIs. The data are weighted to be nationally representative. The data on height and weight come from direct measurement, not self-reports.

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[2] The Surgeon General's Call to Action To Prevent Overweight and Obesity, U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General, Rockville MD, 2001. See pages 8-10 for health risks and economic consequences of excess weight.

[3] Body-mass-index is weight in kilograms divided by height in meters squared. It is the measure typically used to categorize weight. Children and adults have different BMI cutoffs used to categorize them into "healthy" and "unhealthy" weights. See data appendix for more details.

Figures 1a and 1b show the density function for BMI for adults (20-70) and children (2-19), respectively. In each figure, the vertical line represents the 95th percentile of the BMI distribution in the earliest period (1971-1974). Notice that for both children and adults, the BMI distributions for 1971-1974 and 1976-1980 are very similar, particularly in the right tail of the distribution. However, beginning in 1988-1994, the right tail gets thicker. This continues in the 1999-2000 period.

These figures demonstrate that the obesity "epidemic" does not appear to be a matter of a shift to the right of the entire distribution of BMI. Between the first and the latest NHANES, the median BMI for adults went from 24.6 to 26.8. However, BMI at the 95th percentile increased from 33.9 to 39.6. For children, the median increased from 17.7 to 18.5, while BMI at the 95th percentile increased from 26.1 to 30.2. This suggests that whatever changes have taken place to upset the balance between energy in-take and energy expenditure has not affected everyone in the same way. There appears to be some fraction of the population that is particularly susceptible to obesity, and the conditions are now right for their disease to flourish.

Figures 2 and 3 show how the relationship between BMI, obesity, and age has changed over time. Figure 2 graphs the relationship between BMI and age, using a quartic in age to predict BMI in each NHANES sample. Figure 3 graphs the relationship between obesity and age, again using a quartic in age to predict obesity. In these two figures we again see that the data from 1971-1974 and the 1976-1980 data are virtually right on top of each other. However, in 1988-1994, the relationship between BMI and age, and obesity and age, shifts upward. This is disturbing as it suggests that weight gain may not level off at a particular age as one might have expected looking at a given cross-section of data. Put another way, we should expect that when

10 year olds today become 20 year olds in a decade, they will be even more likely to be obese than today's 20 year olds.

These figures demonstrate three important points. First, obesity is increasing and weight gain does not appear to be leveling off with age in the way it had in earlier cohorts. Second, as mentioned above, the current obesity epidemic is not caused by everyone increasing his or her weight by 10 percent, shifting some fraction of people above the obesity cutoff. Instead, it seems to be the case that people at the upper tail of the BMI distribution are gaining weight more rapidly than the rest of the population. Finally, these data imply that the epidemic began after 1980. Thus, as researchers search for explanations of the epidemic, we may want to particularly explore things that have changed since that time.

Before examining changes in school policies that may have affected children's weight, we first compare measures of BMI and obesity in the Youth Risk Behavior Survey (YRBS) and the Behavioral Risk Factor Surveillance System (BRFSS) to those in the NHANES. We use the YRBS and BRFSS in the analysis of the effects of school policies on children's obesity. These data contain self-reported measures of height and weight, so it is worth comparing them to official, directly-measured BMI statistics in the NHANES. Table 1 shows the comparisons. In this paper, we focus on adolescent obesity, so we show mean and median BMI, and BMI at the 95th percentile for 14 to 18 year olds in the NHANES (1999-2000) and the YRBS (where we have combined the 1999 and 2001 data). Later in the paper we check our results for adolescents using data for adults (aged 30-60) from the BRFSS, so we also show a comparison for BMI between these data and 30-60 year olds in the NHANES.

Columns 1 and 2 in Table 1 show measures of BMI for adolescents. Mean and median BMI are both slightly higher in the NHANES, where height and weight are measured by an

examiner, than in the YRBS, where height and weight are self-reported. However, BMI at the 95th percentile is close to 35 in the NHANES and only 32 in the YRBS. This translates into a about 4 percent more adolescents in the NHANES than in the YRBS categorized as obese. The data for adults shows a similar pattern. The mean and median BMIs are quite similar in both the NHANES and the BRFSS. However, the BMI at the 95th percentile and the fraction obese are dramatically higher in the NHANES. Both comparisons suggest that very heavy people are under-reporting their weight in the self-reported data. This suggests the self-reported data are prone to measurement error.[4]

III. School Food Policies

School food policies are currently being hotly debated. Policymakers are acting on the intuitive notion that having snacks and sodas readily accessible in schools contributes to children's obesity. For example, last year the Oakland school district banned junk food sales in schools, and the Los Angeles school district is banning the sale of soft drinks during school hours, beginning in 2004 (Fried et al., 2002). In response to a study showing high levels of obesity in New York City publics schools, the education department just banned candy, soda and other sugary snacks from school vending machines (Perez-Pena, 2003). Additionally several state legislatures have begun debating statewide bans on soft drinks and/or snack foods in schools (e.g. Hellmich, 2003). Child advocates point to the confusing message children receive when they are told to eat certain foods while studying nutrition in class, but quite another type of food is readily available at school. In fact, trial lawyers have pointed to the current state of school food policy as being ripe for legal action on behalf of obese children (Buckley, 2003).

[4] In the next revision we will incorporate the correction to self-reported height and weight developed in Cawley (1999).

Despite these movements on the legal and policy fronts, there are very few studies that address whether there is a direct relationship between school food policies and obesity. Among the existing studies on the basic topic, one related to ours is Ludwig, et al. (2001), who find that among a group of Massachusetts middle school children, those who were observed to consume more sugar-sweetened drinks were found to be more likely to be overweight. That study, though, has no information on where the children were consuming the sugary drinks. Another related study is the finding by Cullen et al. (2000) that fifth grade students in one Texas school district who had access to a school snack bar ate significantly fewer fruits and vegetables than did the fourth graders in the same district who did not have this access. This study, while implying that snack foods in schools will substitute for healthier foods offered as part of the National School Lunch Program, has no information on whether these lunch substitutions result in different overall probabilities of being overweight. Finally, in a recent study Kubik et al. (2003) find that students with more access to junk food in school eat less healthful foods outside of school as well.

There is also a series of papers that document the prevalence of high calorie, low nutritional quality snack foods in schools, using some of the same data we use. Pateman, et al. (1995), for example, use the 1994 SHPPS to report that about 17% of middle/junior and senior high schools have contracts with fast food restaurants. Using the 2000 SHPPS, Weschler et al. note that about 20% of schools offer brand name fast foods. In addition, they find that about half of districts have an exclusive contract, and about 72% of senior high schools have such a contract. Additionally, they report that 26%, 62% and 95% of elementary, middle/junior and senior high schools respectively allow student access to vending machines. In most of these schools, the vending machines are stocked with high fat or high sugar snacks and drinks.

Finally there are several recent articles addressing the growing concern that school policies may be contributing to the childhood obesity epidemic. Carter (2002) discusses not only the prevalence of vending machines, but also points out that in 2001 only half of high school students participated in PE classes, with less than one third doing so daily. Fried and Nestle (2002) discuss the fact that soft drink contracts are present in more than 240 school districts. They also note that these "pouring rights" contracts typically give the companies not only the right to sell sodas, but also to advertise on school grounds. Additionally, many include incentive clauses with financial rewards to the schools for selling more sodas to the students.

Table 2 presents information from the School Health Policies and Programs Study from 1994 and 2000.[5] These data form a nationally representative sample of schools, and include both public and private schools. The survey changed substantially between its first and second incarnations, and it is not possible to construct all of the same measures in both years. In addition, the 1994 survey only covered middle schools and high schools, whereas the 2000 survey also covered elementary schools.

The first two rows have information that was available in both years. They show the fraction of schools where students have access to a vending machine, and the fraction of schools with a contract with a brand name fast food restaurant.[6] For middle schools, access to vending machines did not change very much from 1994 to 2000. In both years, about 61-62 percent of schools gave students access to vending machines. However, for high schools the percentage of schools that gave students access to vending machines jumped from 88 percent to 95 percent. The fraction of schools that had a contract with a brand name fast food restaurant increased for both middle and high schools. For middle schools the percent increased from 13 percent to 25

[5] More details on these data are available in the Data Appendix.
[6] Note that students may still have access to hamburgers and french fries even if the school does not have a contract

percent, more than doubling. For high schools, the percentage increased from 19 percent to 27 percent over the 6-year period. Thus, at least based on these two measures, it seems as though there was a substantial increase in the fraction of schools that gave students access to various types of junk food. This change is important because in the last section we saw that childhood obesity rates continued to increase between 1994 and 2000.

The other six rows in the table give information on other food policies. Row three presents a measure of overall junk food availability. This is an indicator variable equal to one if students can buy chocolate, candy, cakes, ice cream, or salty snacks that are not fat free from a vending machine or school store. Row four has information on the fraction of schools where students can buy soft drinks from vending machines or a school store. Information on whether soda or snack food advertisements are allowed through the school, for example on a school bus, at a school sporting event, on school grounds, or on school textbooks, is presented in row five. "Pouring rights" is a term used for a contract where a venue agrees to sell only one brand of beverages. The fraction of schools with a pouring rights contract is in row six. These contracts may not just pay a flat fee for exclusive rights. For example, schools may get a percentage of the sales, or schools may even receive financial incentives to reach a certain level of sales. The fraction of schools with the former type of contract is in row seven, and with the latter is in row eight.

Looking down these various types of food policies, it is clear that it is more likely a school has the policy the older the students who attend the school. Thus, 29 percent of elementary schools give students access to junk food, but fully 85 percent of high schools do. Ninety-two percent of high schools allow students to buy soft drinks on campus. Only 19 percent of elementary schools allow advertisements to their students, but this figure increases to

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with a brand name fast food restaurant.

close to 30 percent for middle schools and 50 percent for high schools. Pouring rights contracts, and contracts that give schools incentives to increase sales are also quite common. Fifty percent of middle schools have a pouring rights contract, and 72 percent of high schools do. Fully 62 percent of high schools get a percentage of the sales, and 40 percent have incentives to hit particular target sales levels.

Table 2 makes it clear why child health advocates who think children's access to junk food and soft drinks are at the root of the childhood obesity epidemic are concerned about school policies. Most schools appear to give children, particularly adolescents, ready access to poor nutritional quality foods. Importantly, this access seems to have increased during a period when childhood obesity is on the rise.

Although at first glance Table 2 makes a compelling case for changes in the school environment regarding foods having an effect on children's weight, it does not show causality. It is possible, for example, that schools are simply responding to their students' demands for the types of foods they get at home and other places outside of schools. Schools where students are already overweight, because of the foods they consume at home or in their leisure pursuits, may be the schools that are particularly likely to adopt policies giving their students access to such foods. Put another way, this is precisely analogous to other debates about school quality. Is it that a particular school policy, be it access to junk food or class size, really has an impact on the outcome of interest, BMI or test scores? Or is it simply that parents who care more about their children's weight do not send their children to schools that are overflowing with junk foods, in the same way that parents who care more about their children's test scores do not send their children to schools with overcrowded classes?

Table 3 takes a first look at how school food policies vary with county and school district characteristics, and region of the country. Here, we have a sample of schools from the 2000 SHPPS and we have merged on to it school finance information from the National Center for Education Statistics (NCES) and demographic information at the county level from the 2000 Census. This table only includes data on public schools since we do not have access to school finance information for private schools. Here we focus on middle and senior high schools only since we will examine obesity outcomes for 14 to 18 year olds.

What we would like to know is whether schools that are in financial difficulty are more likely to enter into contracts with snack food and beverage companies, and in turn, whether these contracts have deleterious consequences for children's health. However, things are complicated by the fact that obesity varies by income, race, and ethnicity.[7] Although obesity has increased for all socioeconomic groups in the United States, obesity levels are higher for African Americans and Hispanics, higher for lower income individuals, and lower for better-educated individuals. Thus, we want to make sure that it is not simply that under-funded schools are more likely to enter into these types of contracts, and therefore poor children, who are more likely to be overweight in any case, happen to go to these under-funded schools.

Table 3 focuses on three types of school policies that we think capture the range of information available to us. We focus on junk food availability, whether the school has a pouring rights contract, and whether the school allows companies to advertise to its students. The first column of any pair gives the characteristics of the district or county for schools that allow the policy, and the second column pertains to those that do not allow the policy. Stars

[7] See http://www.cdc.gov/nccdphp/dnpa/obesity/trend/index.htm for several CDC reports on the correlates of obesity in the United States.

indicate whether the characteristics are significantly different between the columns; more stars mean a higher level of significance.

Looking down the rows, it is clear that these policies do not vary with the racial and ethnic make-up of the county. There is some evidence that counties where more of the population has less than a high school degree are more likely to have schools that allow these policies. Per capita income and percent of the county in poverty do not vary with whether schools make junk food available to students or with whether schools have a pouring rights contract. However, schools that allow advertisements to their children are more likely to be in counties with lower per capita income and where a higher percentage of the population is in poverty. Interestingly, counties that had more rapid population increases are more likely to give access to junk food and more likely to allow advertisements. Perhaps this indicates that these are counties where schools had an unexpectedly large student body, making them more in need of extra funding.

Thus, there is some evidence that schools that allow some of these potentially harmful food policies are in counties where people are less educated and poorer. This will make it important to control for these characteristics when we turn to explaining individual obesity, in order to make sure we are not merely picking up the fact that low income individuals happen to be overweight and they happen to attend schools that allow advertisements, for example.

Turning to the school district information, schools with lower total revenue per pupil are more likely to have pouring rights contracts and more likely to allow advertisements to students. The pupil teacher ratio is higher for schools that have pouring rights contracts, but does not differ by the other two policies.

Interestingly, school districts that receive a higher fraction of their revenue from the state are more likely to have each of these policies. State financing rules typically figure the revenue per pupil necessary to achieve an adequate level of education. They then estimate how much of that figure a district can raise locally, typically through property taxes. The state portion of the formula then brings the school district up to the target level. Thus, districts with higher fraction of their funding from the state are those that are assumed to be less able to raise funds locally.[8] The schools in districts that with less local fiscal capacity, then, are those that are more likely to make junk food available to kids, have pouring rights contracts, and allow advertisement to children – all things that are likely to increase the school's budget.

Finally, note that there are geographic differences in obesity, with the South and Midwest being heavier than the East and West.[9] Here we see that schools in the South are more likely to allow all three of these policies. Thus one may be concerned that casual observations of more obese children in schools with more exposure to potentially unhealthy policies may be due to a shared third factor that varies regionally.

IV. Effect of School Food Policies on Adolescent Obesity

A. Methodology

Much of our approach is dictated by the realities of the data at our disposal. In particular, there are no available data sets that include both school policies regarding junk food, school finances and individual heights, weights and demographics. Thus, we adopt a two-sample approach (Angrist and Krueger, 1992, 1995). If we had such data available, we could directly investigate the relationship between these policies and student obesity. However, even in this

[8] See, for example, the summary discussion of *Public School Finance Programs in the United States and Canada* by Sielke and Holmes at http://www.ed.sc.edu/aefa/reports/ch1.pdf.

case one would be concerned about bias due to endogeneity of the key policy variable. Thus, an instrumental variables approach would still be appropriate. While data limitations restrict our ability to estimate the simple OLS relationship between obesity and school food policies, our two-sample methodology is essentially an IV estimator and should also address the endogeneity issue.

Our first stage is estimated using county-level data. These data are based on school food policies from the SHPPS, and on district financing measures from the NCES, both aggregated to the county level. State indicators for the presence of property tax revenue limitation and school accountability measures are also merged on to these county data. Specifically, we estimate the following:

(1) $policy_c = \alpha + \beta_1 fraction\ of\ revenues\ from\ state_c + \beta_2 tax\ limitation_s + \beta_3 accountability_s + \varepsilon_c$

Where the c subscript represents county and the s subscript represents state.

The policy measure is either junk food availability, pouring rights or soda and snack food ads as described above. The fraction of revenues from the state is meant to capture local fiscal capacity. As noted above, even state funding formulas that are not explicitly equalization schemes, such as the very common foundation grant formula, result in there being a negative correlation between local fiscal capacity and the state share of funding. Tax limitation is an indicator variable for the state having passed a law applying to school districts limiting the growth of property tax revenues. Thus, this variable also reflects local fiscal capacity. Finally, accountability is an indicator variable for the state having a school accountability law.[10] Typically, such laws require schools to reach a certain level of achievement - often defined based on standardized tests - or face sanctions. In some instances, there are rewards for exceeding the

[9] See http://www.cdc.gov/nccdphp/dnpa/obesity/trend/index.htm for CDC reports on regional trends in obesity.
[10] See Appendix Table 1 for which states have these two laws, and the dates of implementation.

goals which have been set. Since accountability places strict requirements on schools, this variable reflects additional pressures on school budgets. Therefore, our maintained assumption for this first stage is that these variables are correlated with school food policies through school budgetary pressures, but that they are not directly related to children's obesity.

Having obtained estimates of α, β_1, β_2 and β_3 using the SHPSS/NCES county-level data, we then use these estimates to predict food policies in individual-level data from the YRBS. Because the independent variables in the first stage vary only at the county and state level, and since we know the county of residence for the YRBS, we can append the appropriate fiscal and legal variables to the individual data and create predicted food policies based on the first stage estimates. We can then estimate the effect of predicted food policy on the probability that an individual is obese, controlling for additional covariates.

We use a linear probability model of the following form:

$$(2) \quad obese_i = \alpha + \beta_1 \, predicted\ policy_c + \beta_2 X_i + \beta_3 Y99_i + \beta_4 G_i + \beta_5 C_c + \varepsilon_i$$

Where *obese* is an indicator variable equal to 1 if the individual's BMI is above a prescribed cutoff for his/her age and sex; X is a set of individual-level covariates including age and daily hours of television viewing and dummies for sex, race, and daily smoking; *Y99* is a dummy for being from the 1999 YRBS panel; G is a set of region dummies; and C is a set of county-level demographics from the 2000 Census including percent high school graduates, percent college graduates, per capita income and percent in poverty. Ideally, we would like to be able to control for the individual's socioeconomic status, but no information about the youths' parents is available in the YRBS. Thus, the county demographics are meant to proxy for likely family background characteristics. All of the data used in both stages are described in more detail in the Data Appendix.

B. The Relationship between School Food Policies and Finances

The results from estimating the first stages described by equation (1) above are shown in Table 4. The first column gives the means of the independent variables while the first row gives the means for the dependent variables across the 180 counties in the SHPPS. First, note that all of the estimated effects are of the predicted sign. Since higher values for each independent variable represents a higher level of local budgetary pressure, our hypothesis predicts a positive coefficient. For each policy, the fraction of total revenues that come from the state is significantly positive. At least one of the other two variables is also significant in each case. For junk food availability, it is the accountability rule that has a large positive impact, while for pouring rights and soda or snack food ads it is the property tax limitation law that is significant. Overall, junk food has the largest overall F-statistic, while for soda or snack food ads the p-value for the overall F-test is just significant at the 5 percent level. Note that our standard errors are corrected for arbitrary forms of heteroskedasticity and within state correlation.

C. The Effect of Predicted School Policies on Obesity

The results from estimating equation (2) described above are reported in Table 5. In this and the following two tables, the standard errors are adjusted for arbitrary forms of heteroskedasticity and within county correlation, but are not yet adjusted for the fact that the policies are predicted. Columns (1) – (3) use junk food availability as the predicted policy, columns (4) – (6) use pouring rights, and columns (7) – (9) use soda or snack food ads. For each set of three models, the first includes only individual characteristics and the year dummy, the second adds regional dummies and the third adds county demographics. In each of the columns we control for individual characteristics that the literature has suggested may be important determinants of obesity. For example, African Americans and Hispanics have a higher incidence

of obesity in national data, making controlling for race and ethnicity important. As mentioned above, the YRBS has limited socioeconomic information. We use a combination of controls for other types of behavior that may be correlated with such information or that other studies have pointed to as important determinants of obesity. For example, several studies (e.g. Dietz and Gortmaker, 1985) have pointed to television viewing as an important determinant of obesity in young people. Similarly, daily cigarette smoking is likely to be correlated with socioeconomic status or more generally one's concern for their health. Additionally some researchers have pointed to the role of smoking in weight control (e.g. Cawley, Markowitz, Taurus, 2003; Chou, Grossman, Saffer, 2002). Finally, as indicated earlier, we must use county demographics to proxy for parental demographics. In particular, the percent in the county who are high school or college graduates are indicators of likely parental education, while county per capita income and percent in poverty are indicators of likely parental income.

Turning first to junk food, the first column implies that a 10 percentage point increase in the probability that a school has junk food available would result in almost a one percentage point increase in the probability that an individual is obese. Controlling for region, as seen in column (2) does not change this implication by much. The point estimate is still significant, although slightly smaller. The impact of a 10 percentage point change is now just under 1 percentage point, at 0.7. Including region also has very little effect on the other covariates. In both cases females are less likely to be obese, while blacks and Hispanics are more likely.[11] Additionally, each additional hour of television viewing increases the probability of being obese by almost 2 percentage points, while being a daily smoker has a negative, but insignificant effect.

[11] Note that in the NHANES females are not less likely to be obese, so our finding may be a reflection of sex-specific errors in the YRBS self-reported height and weight

While region has little effect, including county demographics has a large impact on the estimated effect of the policy variable. As seen in column (3), the point estimate is now much smaller, implying that a 10 percentage point increase in the probability of junk food availability would increase the probability of obesity by just 0.1 percentage point. More importantly, the effect is no longer significant. Looking across columns (4) – (6) and (7) – (9), one sees the same basic pattern in which including region has a very small dampening effect of the policy coefficient and including the county demographics results in a very small and insignificant estimated impact.

Looking at the estimated effects of county characteristics may give us some insight into their role. While each covariate is negative in all three models, only the percent in county who are high school graduates is significant. One interpretation of columns (3), (6) and (9) is that the fraction in the county with low education is proxying for the home environment and that less educated parents are less concerned about their children's nutrition. A second interpretation is that for adolescents, living in a county with a poorly educated adult population actually makes them more likely to be obese. In this interpretation, the mechanism by which living around poorly educated adults affects adolescent obesity could, in fact, be through school health policies. Note also that given our two-sample method, the implication is actually that these low education counties are more likely to have constrained school budgets (i.e. a higher fraction of revenue from the state, a property tax revenue limit law and a school accountability law).

If the county demographics are in fact overcontrolling, as the second interpretation might imply, then we would want to focus on columns (2), (5) and (8) as the better estimate of the effect of school food policies. However, we know that these specifications have a large number of omitted variables. Thus, we estimate equation (2) on adults aged 30 to 60 from the BRFSS as

a control group. If the true effect was solely through school policies, there should be no estimated effect on adults. Additionally, the BRFSS contains individual-level information on education and income. If the first interpretation above is correct and if such information were available for the adolescents' parents, it would obviate the need for the county-level proxies. First, Table 6 replicates the same specifications from Table 5. Second, Table 7 shows the effect of including the individual-level controls versus using the county-level demographics.

Turning to Table 6, once we include region dummies the results look amazingly similar to those from Table 5. In particular, there is a significant positive effect of the school policies that becomes insignificant upon inclusion of county demographics. While the point estimates in columns (2), (5) and (8) are much higher than those from Table 5, because of the much higher incidence of obesity among adults, the elasticities are not as much higher, and occasionally are lower. The fact that these results are so similar to the adolescents suggests that something besides school food policy is driving the obesity outcomes. While columns (3), (6) and (9) are also similar, this could simply be due to the fact that there is no effect of school policy, and in Table 5 the county demographics successfully control for parental socioeconomic status, which is the real key to obesity. Similarly, then, in Table 6 the county demographics are just proxying for the adults' true socioeconomic status.

Turning to Table 7, we can examine whether the county demographics are simply successfully proxying for individual socioeconomic status or add additional information important for explaining obesity. In columns (1), (3) and (5), in addition to the individual variables in Table 6, we include dummy variables for whether the individual is a high school graduate or college graduate, as well as a set of dummies for income category.[12] We also include dummy variables for whether the individual is married and for currently working. With these

additional individual socioeconomic controls, the effect of school policy remains positive and significant. Again when we add county demographic controls (in addition to the actual individual demographics) the effect of the school policy becomes insignificant.

Taken together, these results suggest that it is not purely school food policies that increase adolescent obesity. However, the fact that the county-level controls are so important for both adolescents and adults (even in the presence of individual income and education controls) suggests that some locally-determined policy may play a role in obesity for citizens of all ages.

V. Summary and Avenues for Future Research

It is clear that childhood obesity and its attendant complications are on the rise. Less clear are the causes, and hence the appropriate policy responses. Some have turned their attention to the school environment in attempts to address this epidemic of childhood obesity. In particular, they point to: the availability of junk food through vending machines and school stores; contracts with soft drink companies; and advertisements for sodas and snack foods, and claim that these comprise a particularly harmful school environment. Thus, policymakers in many areas are acting on the intuitively appealing notion that the school environment is affecting children's health and imposing bans on selling sodas and snack foods during school hours.

Despite the tidal wave of policymaking aimed at changing the school environment to better promote children's health, there is little research examining whether there is a direct link between school food and children's weight problems, although there does seem to be a good prima facie case to be made that if schools are one of the places children spend the bulk of their time, the school environment may be a contributor to the obesity problem. Alternatively, it may be the case that even without the availability of snack foods in schools, students would load up

[12] The income data was collected in these categories.

on sugary drinks and snacks at a nearby convenience store or at other times outside of school. If so, new school policies might only harm school finances, with no positive effect on children's health. Additionally, if more students leave campus during the school day to obtain the junk food and soft drinks that they crave, they may even be placed at additional risk from, for example, traffic accidents.

Our preliminary results are more consistent with the latter interpretation than the former. We find that predicted school food policies (junk food availability, pouring rights contracts, soda and snack food advertising) are positively and significantly correlated with adolescent obesity, but that the relationship is similar for adult obesity, suggesting that the mechanism is not actually the school food policies. One implication of our findings is that simply removing soda and junk foods from schools may not reduce adolescent obesity. Furthermore, predicted school food policies are not significantly related to either adolescent or adult obesity when county-level education is held constant. Interestingly, county-level education matters for adult obesity, even when controlling for individual education level. These results suggest that community characteristics, not simply individual characteristics, are important determinants of obesity for both adolescents and adults.

The first stage of our analysis does show, however, that schools under budgetary pressure are the ones most likely to turn to these types of food policies. Presumably, then, these food policies contribute positively to school finances. New laws banning such fund raising techniques may thus have adverse consequences for students if schools rely on these funds for important programs.

Clearly, these results are just a first step in analyzing the relationship between school food policies and adolescent obesity. In the near future we plan to use the National Longitudinal

Survey of Youth, 1997 panel which will allow us to include much more detailed individual and family background controls in the obesity regressions. It will be interesting to see whether community-level characteristics continue to predict obesity in this framework.

More broadly it is clear that more work needs to be done in this area to fully understand the role of the school environment in adolescent obesity. For example, we did not investigate the role of physical education and sports programs that may be cut in the face of budget problems. This other side of the energy balance equation may also be important. Additionally, there are many localities that have recently passed junk food and/or soda bans in schools. A full evaluation of the effect of these policy changes would add much to our understanding of the effect of school food policies on adolescent obesity.

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DATA APPENDIX

Because no one data set contains all of the variables necessary for our analysis, we must build up our data from several different sources. These include the School Health Policies and Programs Study (SHPPS), the Common Core of Data for school districts from the National Center for Education Statistics (NCES), county summary data from the 2000 Census, and individual-level data on high school students from the Youth Risk Behavioral Survey (YRBS) and on adults from the Behavioral Risk Factor Surveillance System (BRFFS). We describe our use of each of these in turn.

The SHPPS is a national study conducted in 1994 and 2000 for the Center for Disease Controls (CDC).[13] While the study covers a broad range of school health policies and procedures at the state, district, school and classroom level, we focus on the 2000 school environment survey. This questionnaire asks about the school's policies regarding such things as the availability of snack foods through vending machines, school stores and snack bars; the details of an exclusive contract with a soft drink manufacturer (if any); and the types of advertising for sodas and snack foods allowed. The food services questionnaire is also consulted, as it contains information on the sale of brand name fast foods in the school. Unfortunately, the majority of these questions were not asked in 1994. However, the food services policy questionnaire in that year covers a few similar areas – in particular there is information on student access to vending machines and brand name fast foods. While unlike the 1994 study, the 2000 study also includes elementary schools, we do not include them in our main analysis, since we will be focusing on youths age 14 to 18.

[13] For more information on SHPPS, see http://www.cdc.gov/nccdphp/dash/shpps/.

We choose three food policies from the SHPPS for the bulk of our analysis. First is an indicator of student access to junk foods, defined as the availability through vending machines or school stores of chocolate candy; other candy; cookies, crackers, cakes, pastries or other baked goods that are not low in fat; or salty snacks that are not low in fat. Second is an indicator for having an exclusive "pouring rights" contract with a soft drink manufacturer. Third is an indicator that advertisements promoting student consumption of candy, meals from fast food restaurants or soft drinks are permitted in any number of ways, such as in the school building, on textbook covers or food service menus, on buses, or at athletic fields.

Since we are focusing on public school financing issues, we limit ourselves to the public schools in the SHPPS. For these schools we can identify their school district and merge on district-level information about school finances from the NCES Common Core of Data.[14] While detailed financial data is available, we want a simple summary measure of local fiscal capacity. Thus, we choose to use the fraction of total district revenues that come from the state, since even state funding formulas that are not explicitly equalization schemes, such as the most common foundation grant formula, result in there being a negative correlation between local fiscal capacity and the state share of funding.[15]

The lowest geographic level of detail available in our individual-level data sets is the county. We therefore aggregate the SHPPS and NCES data up to the county level. Using the school weights in the SHPPS, then, we calculate the probability that a school in the county has each of these policies. The NCES fiscal data is averaged across all districts in the county using district enrollment levels as weights. Finally, we merge on two state-level indicators. The first

[14] More information about the NCES Common Core of Data can be found at http://nces.ed.gov/ccd/. The latest fiscal data available at the time the project began was for the 1998-1999 school year. Thus, the fiscal data lags the policy data by one year.

[15] See, for example, the summary discussion of *Public School Finance Programs in the United States and Canada*

is a dummy for whether the state has a law applying to school districts which limits property tax revenues.[16] These types of local government tax and expenditure limits were commonly passed beginning in the late 1970s and into the 1980s. The second indicator is a dummy for whether a state has passed a school accountability measure. These types of laws are mainly of a much more recent vintage, with many not implemented until the mid-1990s. Appendix Table 1 provides a complete list of states with each of these types of laws and the dates they were implemented, while Table 4 presents the means of the variables used in the analysis.

The second major component of the project uses individual level data on adolescents that includes height and weight. The YRBS is a biennial survey sponsored by the CDC that focuses mainly on youth health and safety behaviors, such as drug use, sexual activity and risky driving.[17] In order to encompass 2000 – the year of the school policy data, we pool the 1999 and 2001 YRBS surveys. It is beginning in 1999 that participants are asked to self report their height and weight. We use these measures to calculate the individual's body mass index (BMI). BMI is defined as weight in kilograms divided by height in meters squared (kg/m^2) and is a commonly used measure to define obesity and overweight in adults. According to guidelines in National Institutes of Health (1998), adults are considered underweight if their BMI is less than 18.5, overweight if their BMI is 25 or more, and obese if their BMI is 30 or more. Use of the BMI to assess children and adolescents has been slightly more controversial, although its use is fairly widespread.[18] The Centers for Disease Control (CDC) has recently endorsed the use of BMI to

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by Sielke and Holmes at http://www.ed.sc.edu/aefa/reports/ch1.pdf.

[16] These laws are from ACIR (1995) and thus reflect the legal environment as of 1995.

[17] See http://www.cdc/gov/yrbss for more about this survey.

[18] Ideally, one would prefer to measure overweight using a measure that reflects adiposity. Since it is impractical to do so in large scale surveys, researchers have employed the BMI, which only requires the measurement of height and weight. It is somewhat controversial when used to assess overweight among children because children experience growth spurts at individual-dependent ages and this can weaken the relationship between height and weight-based measures to adiposity. See Freeman, et al. (1995) and Whitaker, et al. (1997) for a discussion of the use of BMI in children. Recently, Dietz and Bellizzi (1999) reporting on a conference convened by the International

assess overweight status in children and adolescents, and has produced sex-specific BMI distributions for children aged 2 to 20 for just this purpose. These distributions are constructed mainly using the early years of NHANES data in order to provide a fixed standard against which to assess BMI.[19] Children above the 95th percentile of this (sex-age specific) BMI distribution are termed "overweight." Those above the 85th percentile of this BMI distribution are termed "at-risk of overweight." Because "overweight" is defined by comparing BMI to this fixed distribution, the percent of the population that is termed overweight and at-risk of overweight can (and does) exceed 5 percent and 15 percent, respectively. We use these CDC age and sex specific charts to define overweight cutoffs for children in our sample. To avoid confusing terminology, and since this BMI-determined "overweight" measure is similar to the adult obesity measure, we refer to adolescents above this cutoff as obese.

The YRBS data were collected using primary sampling units (PSUs) that were larger counties or groups of smaller, adjacent counties. Since the PSU identifiers for the larger counties are, in fact, the state-county FIPS code, we are able to merge county-level school financing information in the same manner as was done with the SHPPS data. Similarly, the state laws on school district property tax limitations and school accountability are merged on. Thus, the individual-level YRBS data contain not only adolescent height and weight, but also the predictors of school food policy and can be used for the second stage of two-sample instrumental variables. The main drawback to the YRBS data is the dearth of personal and family background

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Obesity Task Force, noted that the BMI "offered a reasonable measure with which to assess fatness in children and adolescents." Additionally, they conclude that a BMI above the 85th percentile for a child's age and sex group is likely to accord with the adult definition of overweight, and above the 95th percentile with the adult definition of obese.

[19] See http://www.cdc.gov/growthcharts/ for general information, and see http://www.cdc.gov/nchs/data/nhanes/growthcharts/bmiage.txt for specific BMI percentiles. The new CDC growth charts covering a large number of developmental markers are based on data from 1963-1994. However, the 1988-1994 data from NHANES III is generally excluded from the BMI charts. Prior to the release of these charts, percentiles based entirely on NHANES I from 1971-1974 had been available for older children. The newly released

characteristics. The only available demographics are age, race and sex, which we include in our model. As additional covariates, we use the survey responses to a question about whether the student is a daily smoker and about how many hours of television are watched on a typical weekday. Previous research has indicated that these behaviors are predictive of whether an individual is likely to be obese or not. While all of the YRBS interviewees are in high school, a few are just 12 or 13. We limit the analysis sample to only those between the ages of 14 and 18.

Since we cannot control for family background measures such as parental income and education, we use county-level demographics as proxies. Based on the 2000 Census, the on-line State and County Fact Finder can be used to obtain information about each of the counties in the YRBS.[20] We pull four key demographic variables – percent of adults in the county who are high school graduates, percent of adults in the county who are college graduates, percent of people in the county living in poverty, and per capita income in the county. Each of these is merged to the YRBS using the county FIPS code. Finally, based on the state identifier we create region dummies.[21]

The final data set we use, the BRFSS, is fairly analogous to the YRBS, but surveys adults. Also, this survey is undertaken annually. Thus, we use the 1999, 2000 and 2001 panels to encompass 2000 while still having a sample size and time-span similar to the YRBS. Again we use the state county FIPS code to merge the school food policy predictors and county demographics on to the individual-level data. Since the purpose of using the BRFSS data is to provide a control group for the high school students in the YRBS, we limit the sample to those between the ages of 30 and 60. In this way, younger adults that may have been exposed to

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cutoffs are similar.

[20] See http://www.census.gov for the Fact Finder.

[21] A categorical variable for region exists, which appears to be miscoded for 4 states in the 2001 survey. Thus, for consistency we simply code region dummies based directly on state.

similar policies are not included in the control group. The BRFSS data generally has a wider set of background characteristics, but does not include the television viewing variable. We are able to include a control for daily smoking as in the YRBS. For the adults, though, there are also variables on education level – we make a dummy variable for being a high school grad and for being a college grad. Income is collected in eight ranges, and we make separate dummy variables for each category. Finally, we also include a dummy variable for whether the individual is married and one for if currently working. Means for all of the variables used in the YRBS and BRFSS analysis are presented in Appendix Table 2.

Appendix Table 1: Property Tax Revenue Limit and School Accountability By State

State	Property Tax Revenue Limit	Original Year of Enactment	School Accountability	Year System Implemented
Alabama	No		Yes	1997
Alaska	No		No	
Arizona	No		Yes	2000
Arkansas	Yes	1981	Yes	1999
California	No		Yes	1999
Colorado	Yes	1992	Yes	1999
Connecticut	No		Yes	1984
Delaware	No		Yes	1998
District of Columbia	No		Yes	1997
Florida	No		Yes	1999
Georgia	No		Yes	2000
Hawaii	No		No	
Idaho	No		No	
Illinois	Yes	1991	No	
Indiana	Yes	1973	Yes	1995
Iowa	No		No	
Kansas	No		Yes	1995
Kentucky	Yes	1979	Yes	1995
Louisiana	Yes	1978	Yes	1999
Maine	No		Yes	1999
Maryland	No		Yes	1999
Massachusetts	No		Yes	1998
Michigan	Yes	1978	Yes	1998
Minnesota	No		Yes	1996
Mississippi	Yes	1983	Yes	1994
Missouri	Yes	1980	Yes	1997
Montana	No		Yes	1998
Nebraska	No		No	
Nevada	No		Yes	1996
New Hampshire	No		Yes	1993
Hew Jersey	No		Yes	1995
New Mexico	Yes	1979	No	
New York	No		Yes	1998
North Carolina	No		Yes	1993
North Dakota	No		No	
Ohio	Yes	1976	Yes	1998
Oklahoma	No		Yes	1996
Oregon	Yes	1916	Yes	2000
Pennsylvania	No		Yes	1997
Rhode Island	No		Yes	1997
South Carolina	No		Yes	1999
South Dakota	No		No	
Tennessee	No		Yes	1996
Texas	Yes	1982	Yes	1994
Utah	No		No	
Vermont	No		Yes	1999
Virginia	No		Yes	1998
Washington	Yes	1979	Yes	1998
West Virginia	Yes	1990	Yes	1997
Wisconsin	No		Yes	1993
Wyoming	No		Yes	1999

Source: Property Tax Revenue Limit information is for 1995, from **Tax and Expenditure Limits on Local Governments** (ACIR, 1995)**.** School Accountability Information is from Mackie Raymond for 2000, from data used in "Improving Educational Quality: How Best to Evaluate Our Schools" (Hanushek and Raymond, 2002)**.**

Appendix Table 2: Sample Means

	Youth Data (YRBS)		Adult Data (BRFSS)
Obese (BMI in 95th percentile)	0.106	Obese (BMI >30)	0.229
	(0.307)		(0.420)
Predicted junk food availability	0.770	Predicted junk food availability	0.752
	(0.072)		(0.096)
Predicted pouring rights contract	0.676	Predicted pouring rights contract	0.664
	(0.096)		(0.073)
Predicted soda and snack food ads	0.440	Predicted soda and snack food ads	0.432
	(0.096)		(0.069)
Female	0.505	Male	0.509
	(0.500)		(0.500)
Age	16.070	Age	43.249
	(1.215)		(8.485)
Individual is Black	0.125	Individual is Black	0.131
	(0.331)		(0.338)
Individual is Hispanic	0.082	Individual is Hispanic	0.242
	(0.275)		(0.429)
Daily Smoker	0.118	Daily smoker	0.161
	(0.323)		
Hours of TV watched (per weekday)	2.227		
	(1.537)		
Northeast Region	0.102	Northeast Region	0.091
	(0.303)		(0.288)
Midwest Region	0.205	Midwest Region	0.177
	(0.403)		(0.382)
South Region	0.482	South Region	0.245
	(0.500)		(0.430)
West Region	0.211	West Region	0.487
	(0.408)		(0.500)
Dummy Variable for 1999	0.520	Dummy Variable for 1999	0.328
	(0.500)		(0.470)
		Dummy Variable for 2001	0.341
			(0.474)
		Individual is High School Graduate	0.630
			(0.483)
		Individual is College Graduate	0.369
			(0.483)
		Individual's Annual Income	53675.540
		(based on midpoint of brackets)	(32397.730)
		Individual is Married	0.636
			(0.481)
		Individual is Working	0.800
			(0.400)
Pct in county college grad	0.222	Pct in county college grad	0.271
	(0.120)		(.063)
Pct in county HS grad	0.790	Pct in county HS grad	0.775
	(0.076)		(.063)
Per capita county inc (in $1000's)	20.945	Per capita county inc (in $1000's)	22.704
	(5.157)		(3.924)
Pct in county in poverty	0.122	Pct in county in poverty	0.137
	(0.0621)		(.044)
Number of Observations	22963	Number of Observations	23406

Notes: Youth data is for high school students age 14-18 in the Youth Risk Behavioral Survey (YRBS) 1999 and 2001 panels. Adult data is for those age 30-60 in the Behavioral Risk Factor Surveillance System (BRFSS) 1999, 2000 and 2001 panels. County demographics are from the 2000 Census.

Figure 1a: Density Function for BMI for Adults Age 20-70
(95th Percentile in 1971-1974 Marked by Vertical Line)

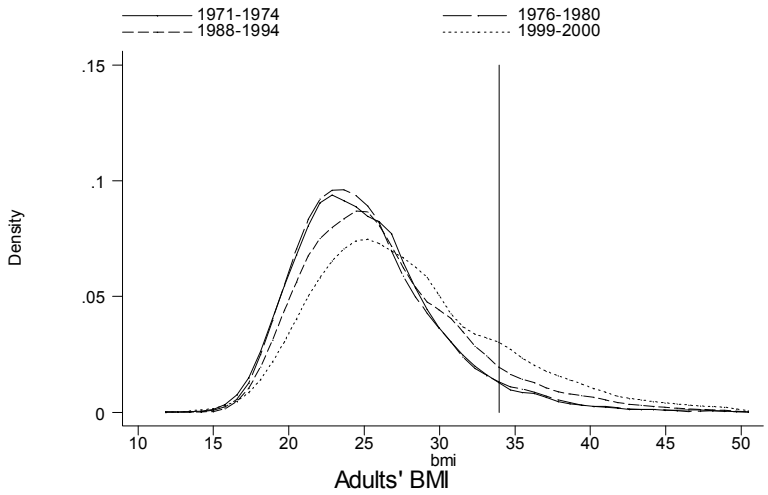

Figure 1b: Density Function for BMI for Children Age 2-19
(95th Percentile in 1971-1974 Marked by Vertical Line)

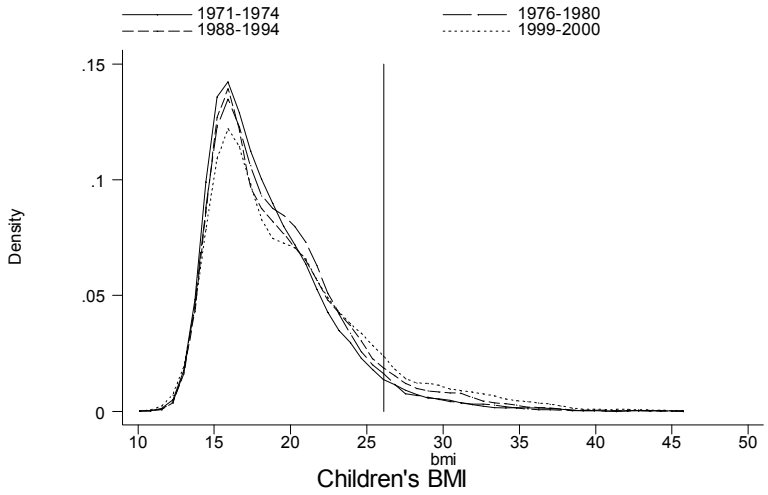

Figure 2: Relationship between BMI and Age over Time

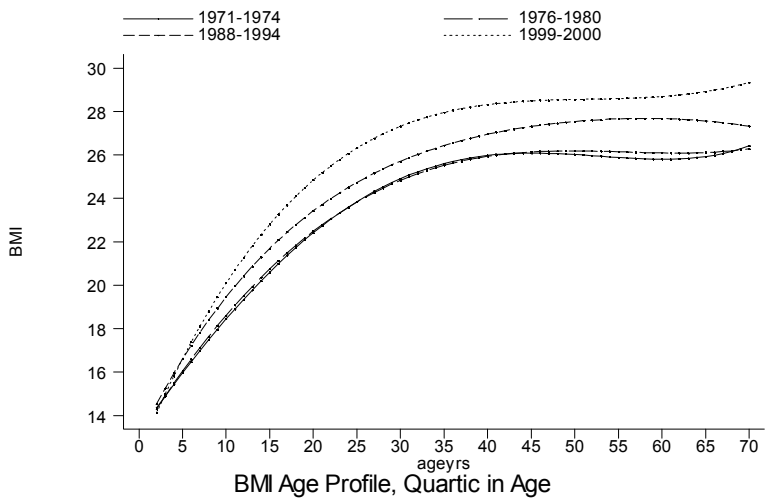

Figure 3: Relationship between Obesity and Age over Time

Table 1: Comparison of BMI and Obesity Across Data Sets
(Standard Deviations)

	NHANES 1999-2000	YRBS 1999 and 2001	NHANES 1999-2000	BRFSS 1999-2001
Age	14-18	14-18	30-60	30-60
BMI Mean	23.48 (5.48)	22.91 (4.65)	28.39 (6.61)	26.99 (5.40)
BMI Median	22.07	21.79	27.07	26.00
BMI 95th Percentile	34.95	31.93	40.32	36.92
Fraction Obese	0.145 (0.352)	0.106 (0.307)	0.319 (0.466)	0.229 (0.420)
Number of Obs	1401	22963	2123	23406

Notes: Authors' calculations from the National Health and Nutrition Examination Survey (NHANES), the Youth Risk Behavior Survey (YRBS) and the Behavioral Risk Factor Surveillance System (BRFSS). The data are weighted.

Table 2: Food and Drink Access and Policies: Fraction of Schools
(standard deviations)
[number of observations]

	Elementary Schools		Middle Schools		High Schools	
	1994	2000	1994	2000	1994	2000
Vending Machines	NA	0.26 (0.441) [315]	0.61 (0.489) [311]	0.62 (0.486) [306]	0.88 (0.324) [291]	0.95 (0.220) [304]
Brand Name Fastfood	NA	0.16 (0.363) [277]	0.13 (0.337) [289]	0.25 (0.432) [271]	0.19 (0.391) [281]	0.27 (0.442) [274]
Junk Food Available	NA	0.29 (0.455) [316]	NA	0.55 (0.499) [307]	NA	0.85 (0.357) [304]
Students can buy Soft Drinks from Machine or School Store	NA	0.25 (0.433) [316]	NA	0.62 (0.487) [306]	NA	0.92 (0.274) [304]
Soda or Snack Food Advertisements	NA	0.19 (0.391) [316]	NA	0.29 (0.455) [307]	NA	0.49 (0.501) [304]
Exclusive Pouring Rights Contract	NA	0.38 (0.487) [314]	NA	0.50 (0.501) [300]	NA	0.72 (0.450) [298]
School Gets % of Soda Sales	NA	0.34 (0.474) [311]	NA	0.44 (0.497) [297]	NA	0.63 (0.482) [294]
School Receives Incentives from Soda Company	NA	0.09 (0.283) [308]	NA	0.19 (0.391) [280]	NA	0.39 (0.488) [279]

Source: Authors' calculations from the School Health Policies and Programs Study Data 1994 and 2000. The data include public schools and private schools. The means are weighted to be nationally representative. NA means that the data were not collected for that variable at that grade level or in that year. "Vending Machine" means the students have access to a vending machine. "Junk Food Available" means that the student can buy chocolate, candy, cakes, ice cream or salty snacks (that are not fat free) from a machine or school store. "Soda or Snack Food Advertisements" means that advertisements are allowed at least at one type of school related activity or in one or more places at the school - for example, on a school bus, at a school sporting event, on school grounds, or school textbooks etc. "Pouring Rights" contracts means the school has agreed to sell one brand of soft drinks. "School gets % of Sales" and "School Receives Incentives from Soda Company" refer to the types of compensation deals schools enter into with soft drink providers.

Table 3: School District and County Characteristics by School Food Policy
(Standard Deviations)

	Junk Food Available	No Junk Food Available	Pouring Rights Contracts	No Pouring Rights Contracts	Ads. Allowed	No Ads. Allowed
County Characteristics (2000 Census)						
County Population	543947	614218	530636	598196	380576*	682582
	(1312276)	(1268162)	(1262045)	(1214355)	(979592)	(1445326)
Population Change	12.49*	9.5	11.7	10.5	13.3*	10.3
(2000 - 1990)	(12.67)	(13.78)	(13.38)	(12.46)	(14.51)	(12.14)
Percent White	50.7	83.7	81.0	83.1	80.6	82.5
	(15.82)	(15.91)	(16.72)	(14.47)	(16.58)	(15.42)
Percent African-	10.0	8.7	10.4	8.07	10.5	8.9
American	(13.69)	(14.46)	(15.10)	(11.90)	(15.79)	(12.6)
Percent Hispanic	9.5	8.09	8.39	9.59	9.4	8.8
	(13.84)	(12.48)	(12.69)	(13.40)	(17.01)	(2.99)
Percent HS	79.4**	82.0	80.0	81.1	79.0**	81.2
Graduates	(8.06)	(6.44)	(7.51)	(7.47)	(8.34)	(6.97)
Percent College	20.5	22.0	20.2	22.3	19.9*	21.8
Graduates	(8.48)	(8.55)	(7.88)	(9.41)	(7.69)	(8.93)
Per Capita Income	19776	20175	19481	20602	18955**	20520
	(4789)	(5435)	(4217)	(6064)	(4202)	(5389)
Percent in Poverty	12.8	12.1	12.5	12.5	13.3**	12.0
	(5.92)	5.45)	(5.82)	(5.50)	(6.35)	(5.31)
School District Characteristics						
Total Revenue Per	7488	7620	7220**	8013	6884**	7932
Pupil	(2202)	(2143)	(1764)	(2654)	(1406)	(2458)
Percent of Revenue	6.9	6.3	6.8	6.5	7.3*	6.3
Federal Sources	(4.13)	(4.37)	(4.09)	(4.38)	(4.38)	(4.08)
Percent of Revenue	50.5*	45.4	50.6*	45.6	51.5**	47.0
State Sources	(16.88)	(17.65)	(15.83)	(18.81)	(14.63)	(18.58)
Student/Teacher	16.0	15.3	16.2**	15.1	16.2	15.5
Ratio	(3.03)	(3.33)	(2.79)	(3.64)	(2.70)	(3.39)
Region of the Country						
East	0.14	0.13	0.11	0.18	0.04**	0.20
	(0.351)	(0.338)	(0.209)	(0.386)	(0.204)	(0.399)
Midwest	0.23**	0.45	0.34	0.274	0.33	0.30
	(0.423)	(0.500)	(0.474)	(0.448)	(0.472)	(0.459)
South	0.39**	0.22	0.37**	0.25	0.44**	0.25
	(0.487)	(0.415)	(0.483)	(0.434)	(0.497)	(0.436)
West	0.24	0.20	0.19*	0.30	0.19	0.25
	(0.427)	(0.403)	(0.389)	(0.458)	(0.392)	(0.433)
Number of Schools	345	123	315	142	203	264

Source: Author's calculations using SHPPS data merged to NCES school district information and County information from the 2000 Census. * means the difference is significant at at least the 10% level. ** means the difference is significant at least at the 5% level.

Table 4: First Stage Predictions of Food Policies

	Mean of Independent Variable (Std Dev)	Junk Food Available in School	School has Pouring Rights Contract	Soda or Snack Food Ads in School
Mean of Dependent Variable		0.748	0.671	0.441
(Std Dev)		(0.352)	(0.405)	(0.406)
Share of Total Revenues	0.495	0.348	0.509	0.446
from State Sources	(0.142)	(0.167)	(0.215)	(0.222)
State Law Limits Property	0.372	0.025	0.129	0.149
Tax Revenues	(0.485)	(0.048)	(0.049)	(0.071)
State has Imposed School	0.856	0.245	0.066	0.010
Accountability Rules	(0.353)	(0.073)	(0.068)	(0.076)
Constant		0.357	0.315	0.156
		(0.098)	(0.111)	(0.123)
No. Observations	180	180	179	180
R-squared		0.09	0.06	0.06
Overall F(3,40)		7.02	5.10	2.88
Overall p-value		0.0007	0.0044	0.0478

Notes: Dependent variables come from public middle and high schools sampled in the School Health Policy and Programs Study (SHPPS). SHPPS school weights are used to aggregate the data to the county level. Revenues come from the NCES Common Core Data for each district. District enrollment is used to aggregate the data to the county level. "Junk Food Available" means that the student can buy chocolate, candy, cakes, ice cream or salty snacks (that are not fat free) from a machine or school store. "Pouring Rights" contracts means the school has agreed to sell one brand of soft drinks. "Soda or Snack Food Advertisements" means that advertisements are allowed at least at one type of school related activity or in one or more places at the school - for example, on a school bus, at a school sporting event, on school grounds, or school textbooks etc. Standard errors (in parentheses) are adjusted for arbitrary correlation within state.

Table 5: Effect of School Policies on the Probability of Being Obese
High School Students Age 14 - 18

	Junk Food Available (1)	Junk Food Available (2)	Junk Food Available (3)	Pouring Rights (4)	Pouring Rights (5)	Pouring Rights (6)	Soda or Snack Food Ads (7)	Soda or Snack Food Ads (8)	Soda or Snack Food Ads (9)
Predicted Policy	0.099	0.070	0.013	0.100	0.058	0.007	0.099	0.055	0.011
	(0.047)	(0.029)	(0.041)	(0.038)	(0.026)	(0.040)	(0.040)	(0.026)	(0.037)
Female	-0.070	-0.070	-0.070	-0.070	-0.070	-0.070	-0.070	-0.070	-0.070
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Individual is Black	0.020	0.019	0.019	0.021	0.019	0.019	0.021	0.019	0.019
	(0.014)	(0.012)	(0.012)	(0.014)	(0.012)	(0.012)	(0.014)	(0.012)	(0.012)
Individual is Hispanic	0.044	0.051	0.047	0.042	0.050	0.047	0.042	0.049	0.047
	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)
Daily smoker	-0.008	-0.012	-0.013	-0.008	-0.012	-0.013	-0.008	-0.012	-0.013
	(0.011)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
Daily hours of TV	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Pct in county college grad			-0.028			-0.029			-0.029
			(0.022)			(0.022)			(0.021)
Pct in county HS grad			-0.151			-0.153			-0.153
			(0.082)			(0.080)			(0.079)
Per capita county inc			-0.001			-0.001			-0.001
			(0.001)			(0.001)			(0.001)
Pct in county in poverty			-0.144			-0.149			-0.151
			(0.105)			(0.101)			(0.100)
Constant	0.072	0.079	0.284	0.080	0.092	0.292	0.104	0.107	0.293
	(0.081)	(0.075)	(0.149)	(0.081)	(0.077)	(0.149)	(0.077)	(0.074)	(0.139)
Region Dummies	NO	YES	YES	NO	YES	YES	NO	YES	YES
Observations	22963	22963	22963	22963	22963	22963	22963	22963	22963
R-squared	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Notes: Data is for high school students age 14 to 18 in the Youth Risk Behavioral Survey (YRBS) 1999 and 2001 panels. All models include a year dummy for 1999 and a control for student age. County demographic variables are based on the 2000 Census. Per capita county income is measured in $1000's. Standard errors (in parentheses) are corrected to allow for arbitrary correlation within county. "Junk Food Available" means that the student can buy chocolate, candy, cakes, ice cream or salty snacks (that are not fat free) from a machine or school store. "Pouring Rights" contracts means the school has agreed to sell one brand of soft drinks. "Soda or Snack Food Advertisements" means that advertisements are allowed at least at one type of school related activity or in one or more places at the school - for example, on a school bus, at a school sporting event, on school grounds, or school textbooks etc. See Table 4 for the prediction of these policy variables.

Table 6: Effect of School Policies on the Probability of Being Obese
Adults Age 30 - 60

	Junk Food Available (1)	Junk Food Available (2)	Junk Food Available (3)	Pouring Rights (4)	Pouring Rights (5)	Pouring Rights (6)	Soda or Snack Food Ads (7)	Soda or Snack Food Ads (8)	Soda or Snack Food Ads (9)
Predicted Policy	-0.007	0.125	0.035	0.175	0.189	0.098	0.237	0.218	0.134
	(0.049)	(0.031)	(0.036)	(0.063)	(0.053)	(0.084)	(0.054)	(0.072)	(0.124)
Male	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Individual is Black	0.150	0.140	0.135	0.146	0.137	0.135	0.144	0.138	0.135
	(0.010)	(0.011)	(0.012)	(0.010)	(0.011)	(0.012)	(0.011)	(0.011)	(0.012)
Individual is Hispanic	0.099	0.103	0.105	0.096	0.101	0.105	0.097	0.102	0.105
	(0.018)	(0.019)	(0.017)	(0.018)	(0.018)	(0.017)	(0.018)	(0.018)	(0.017)
Daily smoker	-0.041	-0.044	-0.046	-0.042	-0.044	-0.046	-0.043	-0.044	-0.046
	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.009)
Pct in county college grad			-0.205			-0.201			-0.222
			(0.137)			(0.129)			(0.131)
Pct in county HS grad			0.510			0.508			0.515
			(0.226)			(0.207)			(0.203)
Per capita county income			0.002			0.002			0.003
			(0.003)			(0.003)			(0.003)
Pct in county in poverty			0.771			0.758			0.768
			(0.380)			(0.345)			(0.336)
Constant	0.047	-0.068	-0.479	-0.073	-0.096	-0.533	-0.058	-0.061	-0.537
	(0.042)	(0.041)	(0.238)	(0.048)	(0.043)	(0.265)	(0.036)	(0.038)	(0.267)
Region Dummies	NO	YES	YES	NO	YES	YES	NO	YES	YES
Observations	23406	23406	23406	23406	23406	23406	23406	23406	23406
R-squared	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Notes: Data is for adults age 30 to 60 in the Behavioral Risk Factor Surveillance System (BRFSS) 1999, 2000 and 2001 panels. All models include age and year dummies. County demographic variables are based on the 2000 Census. Per capita county income is measured in $1000's. Standard errors (in parentheses) are corrected to allow for arbitrary correlation within county. "Junk Food Available" means that the student can buy chocolate, candy, cakes, ice cream or salty snacks (that are not fat free) from a machine or school store. "Pouring Rights" contracts means the school has agreed to sell one brand of soft drinks. "Soda or Snack Food Advertisements" means that advertisements are allowed at least at one type of school related activity or in one or more places at the school - for example, on a school bus, at a school sporting event, on school grounds, or school textbooks etc. See Table 4 for the prediction of the policy variables.

Table 7: Effect of School Policies on the Probability of Being Obese
Adults Age 30 – 60, including individual characteristics

	Junk Food Available (1)	Junk Food Available (2)	Pouring Rights (3)	Pouring Rights (4)	Soda or Snack Food Ads (5)	Soda or Snack Food Ads (6)
Predicted Policy	0.080	0.033	0.124	0.110	0.148	0.148
	(0.026)	(0.029)	(0.047)	(0.074)	(0.067)	(0.110)
Male	0.023	0.023	0.023	0.022	0.023	0.023
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Individual is Black	0.107	0.104	0.106	0.104	0.106	0.104
	(0.011)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)
Individual is Hispanic	0.049	0.051	0.048	0.051	0.048	0.052
	(0.016)	(0.014)	(0.016)	(0.014)	(0.015)	(0.014)
Daily smoker	-0.072	-0.072	-0.072	-0.072	-0.072	-0.072
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Individual is Married	0.003	0.004	0.003	0.004	0.003	0.004
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Individual is Working	-0.022	-0.022	-0.023	-0.023	-0.023	-0.023
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Individual is HS Grad	-0.035	-0.034	-0.034	-0.034	-0.034	-0.034
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Individual is College Grad	-0.060	-0.060	-0.060	-0.060	-0.060	-0.060
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Individual Inc is $10-$15k	0.042	0.042	0.042	0.042	0.042	0.042
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Individual Inc is $15-$20k	0.015	0.015	0.015	0.016	0.015	0.016
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Individual Inc is $20-$25k	-0.031	-0.032	-0.031	-0.031	-0.031	-0.031
	(0.025)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Individual Inc is $25-$35k	0.008	0.007	0.009	0.008	0.008	0.008
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Individual Inc is $35-$50k	0.010	0.009	0.010	0.010	0.010	0.010
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Individual Inc is $50-$75k	-0.012	-0.012	-0.012	-0.011	-0.012	-0.012
	(0.027)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Individual Inc is > $75k	-0.047	-0.045	-0.046	-0.045	-0.046	-0.045
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Pct in county college grad		-0.159		-0.148		-0.172
		(0.114)		(0.109)		(0.111)
Pct in county HS grad		0.420		0.414		0.422
		(0.206)		(0.188)		(0.183)
Per capita county income		0.004		0.004		0.005
		(0.002)		(0.002)		(0.003)
Pct in county in poverty		0.765		0.745		0.755
		(0.343)		(0.310)		(0.299)
Constant	0.066	-0.366	0.047	-0.429	0.067	-0.433
	(0.050)	(0.216)	(0.047)	(0.235)	(0.044)	(0.235)
Observations	23406	23406	23406	23406	23406	23406
R-squared	0.04	0.04	0.04	0.04	0.04	0.04

Notes: Data is for adults age 30 to 60 in the Behavioral Risk Factor Surveillance System (BRFSS) 1999, 2000 and 2001 panels. All models include age, region and year dummies. Standard errors (in parentheses) are corrected to allow for arbitrary correlation within county. For additional information on variables, see the notes to Table 6